

Article

Evaluating the Efficacy of Sustainability Initiatives in the Canadian Port Sector

Jennifer L. MacNeil *, Michelle Adams and Tony R. Walker 

School for Resource and Environmental Studies, Dalhousie University, Halifax, NS B3H 4R2, Canada; michelle.adams@dal.ca (M.A.); trwalker@dal.ca (T.R.W.)

* Correspondence: jenn.macneil@dal.ca

Abstract: Maritime ports are critical nodes in the Canadian resource-based economy that can have significant environmental impacts near coastal communities and marine ecosystems. To address these impacts, Canadian Port Authorities (CPAs) assess their environmental performance using the Green Marine Environmental Program (GMEP). Reliance on this program necessitates its evaluation as an effective initiative to address sustainability in its broader context. An analysis was performed to identify links between United Nations Sustainable Development Goals (UN SDG) targets relevant to the Canadian Port Sector and GMEP performance indicators. Results indicate that there are significant gaps in the GMEP, with only 14 of 36 relevant SDG targets directly linked to the program. Findings suggest either an expansion of the GMEP to incorporate these broader sustainability goals, or the development and inclusion of a new framework for CPAs to bridge gaps between the GMEP and SDG targets to improve sustainability in their maritime port operations.

Keywords: maritime ports; sustainability initiatives; port sustainability; environmental performance; Green Marine (GM); United Nations Sustainable Development Goals (UN SDGs)



Citation: MacNeil, J.L.; Adams, M.; Walker, T.R. Evaluating the Efficacy of Sustainability Initiatives in the Canadian Port Sector. *Sustainability* **2022**, *14*, 373. <https://doi.org/10.3390/su14010373>

Academic Editor: Antonio Comi

Received: 2 November 2021

Accepted: 27 December 2021

Published: 30 December 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Canadian maritime ports have a significant impact across all regions and industry sectors in the country, making ports an essential component of Canada's resource-based economy. The role of ports cannot be undervalued as they facilitate a growing economy, improve the logistics of bringing goods to market, and are critical components to competitive, safe, and environmentally sustainable marine corridors [1–4]. According to Transport Canada, in 2017, ports and marine shipping moved 19% (CAD 101 billion) of Canada's exports to global markets and 21% (CAD 116 billion) of Canada's total imports [2]. Canada Port Authorities (CPAs) also spur economic development by contributing approximately 213,000 direct and indirect jobs, accounting for over CAD 25 billion of Canada's Gross Domestic Product (GDP) [5].

The CPAs were created under the 1998 *Canada Marine Act* to transfer the cost of port operations from taxpayers to users [2]. Eighteen ports were designated as CPAs due to their local, regional, national, and international strategic importance [6]. The CPAs operate at arm's length from the federal government as "federally incorporated, autonomous, non-share corporations" [6]. Though they are financially self-sufficient, they are responsible for fulfilling public policy objectives and regulatory requirements, creating a balance between commercial autonomy and the accountability required for the use of public assets [6]. The Minister of Transport creates the Letters Patent, which outline how CPAs are governed, as well as their major activities and powers, and the lands and waters under their management [6]. The CPAs must follow regulations that prohibit activities that adversely impact the soil, water, or air; however, the CPAs are not encouraged to move beyond regulatory compliance and address sustainability in its broader context, which is problematic given the adverse impacts that ports can have at the local level [6].

Despite port cities having a unique and diverse culture, port development typically results in positive economic gains, negative environmental impacts, and both positive and negative social impacts [7,8]. Ports are complex systems whose existence, and continued expansion to accommodate economic growth, inevitably lead to environmental impacts such as habitat loss, wastewater, air emissions, dust generation, and the release of fine particulate matter in the air; light and noise pollution, sediment contamination, dredging, the accidental release of ballast water and fuel oil residues from ships; as well as marine debris from land-based activities [1,3,4,9–14]. Though job creation with increased port development is a positive social impact, there are many adverse social impacts associated with the daily operations and growth in the port area. Contaminants in the air cause respiratory health issues; noise pollution causes stress and sleep disturbances, and the movement of goods between the port and hinterland via truck and rail creates congestion which increases the risk of accidents [11,12]. Safety and security are also a concern for CPAs, with the major ports being vulnerable to the smuggling of counterfeit goods, contraband, and other hazardous materials that are difficult to inspect and seize due to the large volume of container traffic processed [15]. These issues often cause tension between the port and local communities, as safety and well-being are impacted by the negative externalities of port operations.

Knowing the potential environmental and social impacts to local communities, the CPAs must balance the port's role as a catalyst of economic growth with the increased negative environmental and social impacts at the local level. These externalities related to an evolving marine industry must be carefully managed and CPAs require sector-specific tools to improve their sustainability performance. As entities of the federal government, the CPAs should align this performance with the Government of Canada's goals and strategies for sustainability, specifically Canada's Federal Sustainable Development Strategy (FSDS).

1.1. Canada's Commitment to Sustainable Development

The FSDS 2019–2022 prioritizes the goals and targets of the United Nations Sustainable Development Goals (UN SDGs) within the Canadian landscape [16]. Central to Canada's commitment to implementing the UN SDGs, the government continues to develop policies and programs that will focus on reconciliation with Indigenous peoples, reducing poverty, strengthening the middle class, advancing gender equality, justice for all Canadians, and climate action through clean energy and oceans [16]. The FSDS encompasses 13 goals that will allow the government to support international agreements, informed and sustainable decision-making, strong environmental legislation, partnerships with Indigenous peoples, as well as maintaining engagement with Canadians and key stakeholders [16].

In addition to the FSDS, Transportation 2030, released in 2016, is a strategic plan to improve trade and economic growth, create a cleaner environment, and improve the well-being of the middle class [17]. The main components of the plan are to provide travelers with: ameliorated, low-cost modes of transportation; a safer, more secure transportation system; to reduce air pollution through green and innovative transportation; build competitive marine corridors that are environmentally sustainable; and to improve trade corridors to global markets [17]. An outcome of Transport 2030 was the Port Modernization Review conducted by Transport Canada to improve "sustainable and inclusive economic growth through effective governance and innovative operations" [2].

The Review has five key objectives:

1. Facilitating the movement of goods and people to keep Canada's economy competitive
2. Strengthen relationships with Indigenous and local communities
3. Improve environmentally sustainable infrastructure and operations
4. Enhance port security and safety
5. Optimize governance and accountability

Upon completing the review, Transport Canada identified key areas requiring additional research and analysis, including the role of CPAs in Canada's supply chains, innovation and best practices in port operations, competitiveness barriers and opportuni-

ties, as well as port governance, financing, and service delivery models [2]. The intent is to engage with key stakeholders to identify the changes required for the port system to meet the key objectives outlined in the review. Unfortunately, there is no significant evidence to suggest that Canada's port sector has prioritized "sustainable and inclusive economic growth" since the Review was first published in 2016 [2].

1.2. Overview of Sustainability in the Canadian Port Sector

Though they are federal entities, the CPAs do not meet the same governance reporting standards that are required in Canada's private sector, inconsistently reporting financial, social, and environmental performance [18]. Despite some CPAs meeting, and often exceeding, these reporting standards, this inconsistency in reporting across the sector suggests that there is significant room for improvement. This is an opportunity for the federal government, as well as the CPAs themselves, to implement mechanisms to ensure that sustainability performance is focused on continuous improvement, above and beyond regulatory compliance. Unfortunately, while CPAs are extensions of the federal government, they do not appear as partners in the FSDS goals (Table 1). This is troublesome as the CPAs could play a significant role in achieving these goals.

Table 1. Relevance of the Canadian Federal Sustainable Development Strategy (FSDS) goals to CPAs.

FSDS Goals	Are CPAs Explicitly Implicated?	Do CPAs Have a Role?
1. Effective action on climate change	No	Yes
2. Low-carbon government	No	Yes
3. Clean growth	No	No
4. Modern and resilient infrastructure	No	Yes
5. Clean energy	No	Yes
6. Healthy coasts and oceans	No	Yes
7. Pristine lakes and rivers	No	Yes
8. Sustainably managed lands and forests	No	No
9. Healthy wildlife population	No	Yes
10. Clean drinking water	No	No
11. Sustainable food	No	No
12. Connecting Canadians with nature	No	No
13. Safe and healthy communities	No	Yes

In a survey of Canadian and US ports, Ashrafi et al. found that only 29% of respondents disclosed their sustainability performance using a standalone sustainability report [19]. The survey also identified that 65% of respondent ports had adopted a sustainability initiative of some sort, with the Green Marine Environmental Program (GMEP) being the most common initiative [19]. A previous study by Hossain et al. also identified sustainability initiatives employed by the CPAs to improve sustainability performance; these included the GMEP, ISO 14001, and the Global Reporting Initiative (GRI), as well as initiatives by individual ports based on industry best practices [3].

While the GMEP has been widely accepted as the standard for environmental excellence in the North American maritime industry, there are no claims linked to the broader definitions of sustainability. Though port performance indicator programs have historically focused on environmental indicators, given that CPAs are embedded within local communities, it is also important to consider the social and economic externalities associated with their operations [20]. Each CPA has obtained certification through the GMEP to improve environmental performance; however, in most cases, it is the only initiative adopted by CPAs to address sustainability. More recently, the GMEP has begun to include

social metrics such as Community Relations in their program, with the intent to improve relationships with community stakeholders through open and transparent dialogue [21]. Members of the GMEP are pushing for a shift in performance metrics to evaluate sustainability holistically, using the social, economic, and environmental dimensions, and the program has begun using language focused on sustainability, rather than environmental performance, in their most recent publication [22–24]. Reliance on the program necessitates an evaluation to determine if the program adequately addresses goals identified by the UN SDGs and Canada’s FSDS. This study aimed to describe and evaluate the GMEP and identify performance gaps relative to the UN SDGs. This will provide CPAs, as well as the GMEP, with a baseline assessment of the program’s ability to address relevant SDG targets. Merits of the GMEP and areas for improvement are presented, based on elements identified throughout the port sustainability literature.

2. Materials and Methods

2.1. Identification of Relevant Sustainability Initiatives

Hossain et al. previously identified the sustainability initiatives employed by CPAs to improve sustainability performance, including the GMEP, ISO 14001, the GRI, and specific internal initiatives by individual CPAs (uncertified environmental-management systems) based on industry best practices [3]. Websites for those CPAs included in the 2019 study were reviewed to determine if new initiatives had been either adopted or discarded since that study was published. Table 2 identifies each CPA and the current initiatives they employ to provide a benchmark for further evaluation of the actual efficacy of the sustainability initiatives employed by CPAs in addressing both environmental and social pillars of sustainability.

Table 2. Sustainability Initiatives in Canada Port Authorities (adapted from Hossain et al. [3]).

Port Authority (PA)	Sustainability Initiatives			
	GMEP	EMS	ISO 14001	GRI
Belledune	X	X		
Halifax	X	X	X	
Hamilton-Oshawa	X			
Montreal	X	X	X	
Nanaimo	X			
Port Alberni	X			
Prince Rupert	X			
Quebec	X			
Saguenay	X	X		
Saint John	X			
Sept-Îles	X			
St. John’s	X			
Thunder Bay	X			
Toronto	X			
Trois-Rivieres	X	X		
Vancouver	X			X
Windsor	X			

The GMEP remained the only initiative adopted by all CPAs to improve environmental performance. Both the Port of Halifax and Port of Montreal obtained ISO 14001 certification, while the Port of Vancouver used the GRI Reporting Standards to create their

2020 sustainability report [25–27]. The initiatives undertaken in these ports have been excluded from the evaluation as they are considered not reflective of those that only follow the GMEP. The rationale for their exclusion is described below.

ISO 14001 is a set of process standards that allow organizations to identify the environmental aspects unique to the organization, guiding the implementation of an EMS [28]. Though a component of ISO 14001 is continuous improvement, the program does not identify what level of environmental performance must be achieved. Instead, it assumes that improved environmental management will lead to improved environmental performance [29–31]. Additionally, there is evidence to suggest that the adoption of ISO 14001 often has short-term effects on improved environmental performance instead of long-term improvement because organizations often implement the standard as a reactive response to external pressures instead of a proactive strategy to improve environmental performance [31]. ISO 14001 was excluded from this analysis because it cannot be compared between CPAs, as certification with this standard is based on the development of individual environmental policies and management plans [28]. Additionally, with only two CPAs having obtained certification, this certification standard is not reflective of all CPAs and was, therefore, excluded from this analysis.

The GRI Sustainability Reporting Standards have become the global standard for sustainability reporting. They are a “modular, interrelated structure, and represent the best practice for reporting on a range of economic, environmental and social impacts” [32]. The GRI requires organizations to report both their positive and negative economic, environmental, and social impacts, as well as how these impacts are managed [33]. Despite various programs focused on some elements of sustainability, the CPAs do not have an integrative initiative that incorporates the three dimensions of sustainability that is often seen in other industries [34]. Though the use of the GRI Standards do not ensure that a CPA will improve their sustainability performance, there is a growing body of literature to suggest that organizations who use the GRI Standards are more likely to report on UN SDG targets and seek external assurance, which improves the credibility and reliability of sustainability reporting [35–37]. With only one CPA using the GRI Standards, this initiative is not considered to be reflective of the majority and was, therefore, excluded from analysis; however, the GRI Standards could provide the basis for a robust sustainability framework that could (theoretically) be used to address gaps in the GMEP [24].

2.2. Sustainability Initiatives: Green Marine

The GMEP was established in 2007 to mitigate the potential environmental impacts caused by the North American maritime industry. The GMEP is a certification program that offers “a detailed framework for maritime companies to first establish and then reduce their environmental footprint” [21]. Members of the program are expected to strengthen their environmental performance through continuous improvements, create awareness of the marine industry’s activities and benefits, and build strong relationships with stakeholders [38]. The program is voluntary, with a transparent and rigorous certification process. Participants—ship owners, port authorities, seaway companies, terminal facilities, and shipyards—must benchmark their environmental performance using Green Marine’s Self-Evaluation Framework [39].

The Self-Evaluation Framework is used to evaluate each environmental performance indicator (PI) on a five-point scale, ranging from regulatory compliance to industry leadership [40]. As of 2020, the program uses 14 PIs that address important environmental issues related to air, land, and water, at both the regional and international level [21]. To ensure transparency, participants must submit results for third-party verification every two years, using accredited verifiers who conduct on-site visits to verify the documented proof and justification used in the Self-Evaluation Framework [41]. To remain certified, participants must show year-over-year improvement and agree to publish their self-evaluation results in Green Marine’s Annual Report [21]. The criteria under each performance indicator are reportedly revised yearly to ensure they are “in the spirit of continuous improvement” [41].

The PIs themselves are reportedly revised to broaden the scope of environmental issues identified by environmental, academic, and government experts, as well as input from Green Marine's key stakeholder groups [42]. At present, ports must document their performance in 7 of 14 PIs: community impacts, dry bulk handling and storage, environmental leadership, greenhouse gas emissions, prevention of spills and leakages, underwater noise, and waste management [43]. The objectives of each PI can be found in Table 3.

Table 3. GMEP PIs and their objectives for ports and seaways [43].

PI for Ports	Objective
Aquatic Invasive Species *	Reduce the risk of introducing and propagating aquatic invasive organisms and pathogens associated with ballast water discharges and biofouling
Greenhouse Gases and Air Pollutants	Reduce GHGs and air pollutant emissions
Spill Prevention	Minimize spills and leakages of pollutants into the environment (water, land)
Dry Bulk Handling and Storage	Reduce cargo losses and dust generated during handling, transportation, and storage of dry bulk
Community Impacts	Reduce the amount of noise, dust, odor, and light to which people residing close to port facilities are exposed
Environmental Leadership	Recognize the significant influence of port authorities and Seaway corporations as landowners and/or managers over the environmental practices of their tenants and/or users
Waste Management	Increase waste diversion and reduce at source the waste arising from administrative activities and site operations
Underwater Noise	Manage underwater noise sources during ongoing activities, development/construction, and/or port maintenance activities to reduce impacts to marine mammals

* Note: Ports are not yet required to document their performance for the (AIS) criteria that were introduced in 2020 but will be required to do so if it is developed into a complete PI in the future [43].

The GMEP provides several benefits to participants including the use of the certified logo, tools to strengthen environmental performance, knowledge sharing among the maritime community, involvement in program development, and gaining national and international recognition for sustainability efforts, as well as protecting the social license to operate [38]. The program has had continuous growth over the last 13 years, with membership increasing from 83 members in 2007 to 390 members in 2020 [42]. As reported by Walker, new participants enter at a lower certification level, which has had an impact on the overall program average [1]. Green Marine requires participants to achieve at least one Level 2 certification in a performance indicator in their first year of participation [42]. In 2020, 50% of participants had an average at or above Level 2; 22% at Level 3; 16% at Level 4; and 2% at Level 5 [42]. The overall program average has consistently remained 2.9 since 2018, with ports and terminals having the highest overall average (2.90) [42].

2.3. Identifying UN Sustainable Development Goals Relevant to Canadian Port Authorities

The UN SDGs provide a blueprint for improving sustainability by addressing current challenges pertaining to poverty, inequality, climate, environmental degradation, prosperity, peace, and justice [44]. The Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) developed an indicator framework that allows countries and other organizations to measure their sustainable development [45]. The goals were created to allow for flexibility, such that governments can set their own targets and incorporate them into national policies and strategies [46]. Ports in other jurisdictions have been focused on improving sustainability performance that meets the goals outlined in the UN SDGs rather than domestic government initiatives such as the Canadian FSDS [16,45]. The World Ports Sustainability Program (WPSP) was developed in 2017 by the International Association of Ports and Harbors (IAPH) to coordinate ports globally and ensure that their sustainability

management is following the targets outlined in the UN SDGs [47]. The WPSP is focused on five themes related to the SDGs: resilient infrastructure; climate and energy; community outreach and port-city dialogue; safety and security; and governance and ethics [48]. The program's mission is to encourage ports globally to "engage with business, governmental and societal stakeholders in creating sustainable added value for the local communities and wider regions in which their ports are embedded" [48].

The indicators developed by the UN are intended to be used as a baseline for sustainability measurement. In the Canadian context, not all SDGs are relevant to the port sector. For this research, the indicators for each SDG were reviewed; only those that were directly applicable to CPA governance and operations were selected. The CMA outlines the capacity and powers of the CPAs as "port activities related to shipping, navigation, transportation of passengers and goods, handling of goods and storage of goods" and other activities "necessary to support port operations" [49] (p. 4). The indicators for SDGs 1, 2, 4, 10, and 16 were eliminated from this study because addressing issues related to poverty, food security, literacy and education, inequality among countries, and issues related to the rule of law are not under the jurisdiction of CPAs [45]. The indicators for each of the remaining SDGs were systematically reviewed. Indicators were eliminated in an iterative process, first removing those that were related to sustainable development in jurisdictions outside of Canada (developing nations), then removing additional indicators when the CPA could not have a direct influence over the actions in that indicator. The relevant goals and targets are presented in Table 4.

Table 4. UN SDGs applicable to the Canadian Port Authorities [45].








UN Sustainable Development Goal	Targets and Indicators *
	<p>(3.6) Decrease the number of deaths and injuries from road traffic accidents</p> <p>(3.9) Reduce the number of deaths and illnesses from hazardous chemicals, as well as air, water, and soil pollution and contamination</p>
	<p>(5.5) Ensure women have equal opportunities for leadership at all levels of decision-making in the organization (i.e., the proportion of women in managerial positions at the CPA)</p>
	<p>(6.3) Improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally</p> <ul style="list-style-type: none"> • (6.3.1) Proportion of wastewater safely treated • (6.3.2) Proportion of bodies of water with good ambient water quality <p>(6.4) Substantially increase water usage efficiency and ensure sustainable withdrawals and supply of freshwater</p> <ul style="list-style-type: none"> • (6.4.1) Change in water-use efficiency over time • (6.4.2) Level of water stress: freshwater withdrawal as a proportion of available freshwater resources <p>(6.5.) By 2030, implement integrated water-resource management</p> <p>(6.6) Protect and restore water-related ecosystems including mountains, forests, wetlands, rivers, aquifers, and lakes</p>

Table 4. Cont.

UN Sustainable Development Goal	Targets and Indicators *
	<p>(7.2) Increase substantially the share of renewable energy in the global energy mix</p> <p>(7.3) Double the global rate of improvement in energy efficiency</p> <ul style="list-style-type: none"> (7.3.1) Energy intensity measured in terms of primary energy and GDP
	<p>(8.3) Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation, and encourage the formalization and growth of micro-, small-, and medium enterprises</p> <p>(8.5) Achieve full and productive employment and decent work for all, including equal pay for work of equal value</p> <p>(8.8) Protect labor rights and promote safe and secure working environments for all workers</p> <ul style="list-style-type: none"> (8.8.1) Decrease frequency of fatal and non-fatal occupational injuries
	<p>(9.1) Develop quality, reliable, sustainable, and resilient infrastructure, to support economic development and human well-being</p> <p>(9.4) Upgrade infrastructure and retrofits to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and processes</p> <ul style="list-style-type: none"> (9.4.1) CO₂ emission per unit of value added <p>(9.5) Enhance scientific research, upgrade technological capabilities, including encouraging innovation and increasing the number of research and development workers, and research and development spending</p>
	<p>(11.2) Provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety</p> <p>(11.5) Reduce the number of deaths and the number of people affected by direct economic losses caused by disasters, including water-related disasters that damage critical infrastructure and create service disruptions to basic services</p> <p>(11.6) Reduce the adverse per capita environmental impact of cities (special attention to air quality [annual mean levels of fine particulate matter reduced] and waste management)</p> <p>(11.a) Support positive economic, social, and environmental links between urban, peri-urban, and rural areas by strengthening development planning</p>
	<p>(12.2) Achieve the sustainable management and efficient use of natural resources</p> <ul style="list-style-type: none"> (12.2.1) Material footprint (12.2.2) Material consumption <p>(12.4) Achieve the environmentally sound management of chemicals and all wastes through their life cycle, and significantly reduce their release to air, water, and soil</p> <p>(12.5) Significantly reduce waste generation through prevention, reduction, recycling, and reuse</p> <p>(12.6) Adopt sustainable practices and integrate sustainability information in the reporting cycle</p> <ul style="list-style-type: none"> (12.6.1) Publishing sustainability reports <p>(12.7) Promote public procurement practices that are sustainable, in accordance with national policies and priorities</p>

Table 4. Cont.

UN Sustainable Development Goal	Targets and Indicators *
	<p>(13.1) Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters</p> <ul style="list-style-type: none"> (13.1.2) Adopt and implement disaster-risk-reduction strategies in line with the Sendai Framework for Disaster Risk Reduction <p>(13.2) Integrate climate change measures into policies, strategies, and planning</p> <ul style="list-style-type: none"> (13.2.1) Establish and operationalize integrated policies/strategies/plans that increase the ability of the port to adapt to the adverse impacts of climate change and foster climate resilience and low GHG emissions <p>(13.3) Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning within port operations</p> <ul style="list-style-type: none"> (13.3.2) Strengthening capacity-building to implement adaptation, mitigation and technology transfer, and development
	<p>(14.1) Prevent and significantly reduce marine pollution of all kinds, from land-based activities, including marine debris and nutrient pollution</p> <ul style="list-style-type: none"> (14.1.1) Index of coastal eutrophication and floating plastic debris density. <p>(14.2) Sustainably manage and protect marine and coastal ecosystems to avoid adverse impacts, including by strengthening their resilience and taking action for their restoration in order to achieve healthy and productive oceans</p> <p>(14.3) Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation</p>
	<p>(15.5) Act to reduce the degradation of natural habitats, halt the loss of biodiversity, and protect and prevent the extinction of threatened species</p> <p>(15.8) Introduce measures to prevent the introduction and the impact of invasive alien species on land and water ecosystems</p> <p>(15.9) Integrate ecosystem and biodiversity values into port planning and policies</p>
	<p>(17.6) Improve access to science, technology, and innovation and enhance knowledge sharing</p> <p>(17.17) Encourage and promote effective public, public–private, and civil society partnerships, building on the experience and resourcing strategies of partnerships</p>

* Note: Second column presents the specific targets and indicators relevant to CPAs, as not all are applicable. Indicators have been adapted to use language relevant to the port, where applicable [45].

2.4. Evaluation Criteria: Green Marine

All 17 CPAs have obtained GMEP certification, to varying degrees; however, the GMEP is often the only initiative adopted by CPAs to address sustainability (Table 2). The reliance on the GMEP necessitates an evaluation to determine if the program adequately addresses targets identified in the UN SDGs. This work focuses on assessing the GMEP within a Canadian context; however, in using the SDG Indicators, the intention is to ensure its application within jurisdictions outside of Canada.

The evaluation required the development of a matrix to demonstrate the links between the GMEP PIs and SDG indicators. The relevant SDG targets and indicators are outlined in Table 4 and are presented on the vertical axis of the matrix. The GMEP PIs are along the horizontal axis of the matrix. The primary objectives of each GMEP PI were previously identified in Table 3 and will not be repeated here. The matrix provides a visual representation of the gaps that exist in the GMEP when compared to the SDGs that can and should be addressed by the port sector if a more fulsome view of sustainability were applied. As there are multiple levels of certification for each indicator in the GMEP (one through five), it is assumed that a Level 5 certification has been obtained, to demonstrate the most rigorous standard that could be achieved from using the GMEP as a performance metric. The links

between GMEP PIs and the SDGs are classified as direct, indirect, or no link. Direct links are represented in green; indirect links in yellow; and no link in red.

A direct link is classified when the indicator in the GMEP directly contributed to achieving the SDG target for the specified goal. For example, the GMEP PI for Spill Prevention focuses on minimizing spills and leakages of pollutants—both on land and in water. The Spill Prevention PI includes collecting and treating “storm water via an appropriate storm water treatment device, process or procedure” (p. 6), as well as sampling and analyzing stormwater to ensure that the systems in place are operating properly [43]. This PI is directly linked to SDG 6, specifically target 6.3 which focuses on improving “water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater . . . ” [45]. As such, the link is denoted by a green box in the matrix.

An indirect link is classified when a GMEP PI can have an indirect impact on achieving a target outlined in the SDG indicators. To avoid ambiguous connections, the action of obtaining the specified GMEP indicator had to be one-step removed from the desired impact of the specified SDG indicator. The Greenhouse Gases and Air Pollutants PI for the GMEP has an objective of reducing GHG and air pollutant emissions [43]. The reduction in GHG and air pollutants has an indirect impact on SDG 3, specifically the indicator focused on reducing “the number of deaths and illnesses from hazardous chemicals, as well as air, water and soil pollution and contamination” [45]. The intent of the GMEP PI is simply to reduce emissions; however, this could have an indirect impact on reducing illnesses related to poor air quality, resulting from the release of air pollutants. For this reason, the link is denoted as an indirect link in yellow in the matrix.

There are two distinct instances where a GMEP PI was classified as having no link to the SDG indicators. The first is where the PI does not contribute in any obvious way to the SDG target for a specified goal. For example, the GMEP’s GHG and Air Pollutants PI cannot be linked in any obvious way to the SDG 5 target of achieving gender equality in the workplace. Additionally, the no link is also used when the GMEP PI and SDG indicator are several steps removed from each other, creating too many contingencies to guarantee that there could be an impact on the SDG indicator. For example, if a CPA lowers GHG emissions by reducing fossil fuel use, and increases their use of renewable energy, this could potentially impact SDG 7 by increasing the share of renewable energy in the global mix; however, there is no guarantee that the CPA would take this route to lower emissions. For this reason, it was classified as no link. Outcomes of this analysis are shown in Table 5, which provides a comprehensive overview of the lack of links between GMEP PIs and the UN SDGs relevant to CPAs.

Table 5. Links between GMEP PIs and the UN SDGs relevant to CPAs. Links are identified using color-coded cells: direct links = green; indirect = yellow; no link = red.

SDG	SDG Indicator	Green Marine Indicators							
		Aquatic Invasive Species	GHGs and Air Pollutants	Spill Prevention	Dry Bulk Handling and Storage	Community Impacts	Waste Management	Environmental Leadership	Underwater Noise
3	Decrease # of deaths/injuries from road traffic accidents								
	Reduce # of deaths/illnesses from air, water, and soil pollution/contamination								
5	Increase # of women in managerial positions								
6	Increase proportion of treated wastewater from operations								
	Test and improve ambient water quality in local freshwater and marine sources								
	Improve water-use efficiency over time								
	Protect/restore water-related ecosystems impacted by port activities								
7	Increase share of renewable energy in the global energy mix								
8	Improve energy efficiency								
	Policies that support productive activities, job creation, etc., in growth of SMEs								
	Productive employment for all, with equal pay for work of equal value								
	Decrease frequency of occupational injuries								
9	Sustainable and resilient infrastructure to support economic development								
	Upgrade infrastructure to increase resource efficiency and adopt clean tech								
	Enhance research, upgrade tech including increased spending on R&D								
11	Reduce losses related to natural disasters (damage to infrastructure and service disruptions)								
	Reduce adverse environmental impact of cities—increase waste diversion								
	Reduce adverse environmental impact of cities—decrease levels of fine particulate matter								
	Positive economic/social/environmental links between urban/peri-urban/rural areas								

Table 5. Cont.

SDG	SDG Indicator	Green Marine Indicators							
		Aquatic Invasive Species	GHGs and Air Pollutants	Spill Prevention	Dry Bulk Handling and Storage	Community Impacts	Waste Management	Environmental Leadership	Underwater Noise
12	Sustainable management of natural resources—reduce material footprint								
	Sustainable management of natural resources—reduce material consumption								
	Manage chemicals through their lifecycle and reduce release into water/air/soil								
	Reduce waste generation through prevention, reduction, recycling, and reuse								
	Adopt sustainable practices and integrate sustainability reporting in financial cycle								
	Promote sustainable public procurement practices								
13	Adopt and implement disaster risk reduction strategies in line with Sendai Framework								
	Integrate climate change measures into policies, strategies, and planning								
	Capacity-building for climate change mitigation, adaptation, impact reduction and early warning								
14	Prevent marine pollution from land-based activities (marine debris and nutrient pollution)								
	Sustainably manage and protect marine and coastal ecosystems to avoid adverse impacts								
	Minimize the impacts of ocean acidification								
15	Reduce degradation of natural habitats, halt loss of biodiversity, protect threatened species								
	Measures to prevent the introduction/impact of invasive alien species to land/water ecosystems								
	Integrate ecosystem and biodiversity values into port planning and policies								
17	Improve access to science, technology, and innovation, plus enhance knowledge sharing								
	Promote effective public, public-private, civil society partnerships								

3. Results

The GMEP is primarily focused on improving environmental performance in the maritime industry. The Green Marine 2020 Performance Indicators for Ports only address social dimensions of sustainability with its consideration of community impacts; however, the objective of the PI is to “reduce the amount of noise, dust, odour and light to which people residing close to port facilities are exposed” [43] (p. 9). At the time of this study, the GMEP did not address important social issues such as relationships with local communities, relationships, and partnerships with Indigenous Peoples, or workplace diversity and equity; however, the 2021 Program Summary included an optional Community Relations PI to “maintain or improve the quality of relations with various community stakeholders through open and transparent communications” [43,50]. Each section below provides examples of the way GMEP PIs address specific SDG.

3.1. Aquatic Invasive Species (AIS)

The GMEP PI guide for 2020 included AIS criteria for ports with the intent to develop a complete list of PIs for 2021 [43]. Since that time, the program has redirected the focus of the PI to shipowners, as the release of ballast water and process of biofouling are the most common methods of transmission of AIS [50]. With further development of this PI to include ports, a direct impact could be associated with target 15.8 which focuses on preventing the introduction of invasive species to land- and water-based ecosystems [45]. It could also be indirectly linked to SDG 17—a commitment to cooperation among industry, research, and government—because it encourages CPAs to work with the scientific community and government organizations [43].

3.2. Greenhouse Gases (GHGs) and Air Pollutants

The GMEP GHG and Air Pollutants PI can only be directly linked to SDG 11, specifically, the indicator for reducing annual mean levels of fine particulate matter to reduce the adverse environmental impacts of cities [45]. GMEP participants have the choice to transition to lower emission equipment that uses cleaner fuels and engine repowers [43]. As this is a choice and not a mandatory requirement to obtain Level 5 certification, the link with SDG 9 to adopt cleaner technology and retrofits to reduce CO₂ emissions can only be classified as indirect. The link to SDG 3 is also considered indirect because the intent of the PI is to reduce GHG emissions and air pollutants; a reduction in illness related to poor air quality could result but is not the intention of the PIs implementation [43].

3.3. Spill Prevention

The objective of the spill prevention indicator is to “reduce spills and leakages of pollutants into the environment” both water and land [43]. This objective can be directly linked to SDG 6 through the proportion of wastewater being treated, as the Spill Prevention PI requires that storm water be collected, treated, sampled, and analyzed before it can be released into the environment [43]. There are also direct links between SDG 12 through the reduction of chemical releases into water and soil; as well as SDG 14 through the prevention of marine pollution through land-based activities. The link to SDG 3 is indirect because the intent of the PI is to reduce spills into local environments, which could potentially result in a reduction in illness related to soil and water contamination.

3.4. Dry Bulk Handling and Storage

Dry bulk handling and storage can cause a significant amount of dust during its handling, transportation, and storage [43]. This indicator is only used for PAs who operate dry bulk terminals. The dust can have an adverse impact on individuals with respiratory issues living near or working in the port area [11,12]. The measures taken to reduce dust, therefore, contribute directly to SDG 11, by decreasing the levels of fine particulate matter that impact cities, as well as SDG 14 by preventing marine pollution caused by land-based activities. There is an indirect link to SDG 3 and 6 because the intent of the indicator is to

“reduce cargo losses and dust generated during the handling of dry bulk”, which again, can potentially reduce the illness related to increased fine particulate matter in the air (SDG 3), as well as improve water quality by reducing pollution [43].

3.5. Community Impacts

The indicator for community impacts focuses on reducing the noise, dust, odor, and light that impact communities living close to the port and its facilities [43]. Ports can be exempt from this indicator if they can prove that there are no local communities impacted by their operations [43]. The indicator touches briefly on the importance of community engagement and building positive relationships with local communities, though strategies such as having a complaint line are more reactive than proactive [43]. There is only a direct link between this PI and SDG 11 due to its primary focus is to reduce the impact of the port to the surrounding community. There is an overlap with the measures taken in the dry bulk handling storage indicator to reduce dust. Therefore, there are indirect links to SDG 3 and 6 for the same reasons mentioned above.

3.6. Environmental Leadership

The purpose of this indicator is to demonstrate how PAs can influence their tenants to improve their own environmental practices/performance [43]. No direct or indirect links were identified between this PI and the SDG targets. To obtain a Level 4 certification in this PI, ports must complete four of twelve listed criteria; completing two additional criteria will provide Level 5 certification [43]. The criteria differ significantly; there are easily attainable objectives that require few resources and others that require a proactive approach to environmental management with more significant time and cost commitments. For example, a port may choose to simply donate revenue to environmental or social projects to offset their footprint [43]; this contributes little to port sustainability. As there is no guarantee that a port will select the more challenging criteria to attain certification, the connections to the SDGs can only be evaluated using the six criteria with the least meaningful impacts, resulting in no clearly identified linkages.

3.7. Waste Management

This indicator’s purpose is to reduce waste in administrative and operational activities and encourage waste diversion [43]. This directly links to SDG 11 and 12; the port is reducing its environmental impact through waste reduction and diversion through recycling and reuse, thus decreasing the amount of urban solid waste collected by the city [45]. Diverting waste and performing waste audits could potentially allow ports to reduce their material footprint and improve resource efficiency, particularly if they focus on waste valorization, thus creating an indirect link to SDG 12. The PI also encourages practices such as the promotion of an environmental purchasing policy and sustainable purchasing practices, creating a second indirect link to SDG 12.

3.8. Underwater Noise

The underwater noise from construction/development and from ships entering and leaving the port can disrupt communication and migration of marine mammals [12,43]. The purpose of this indicator is to reduce the impact on these mammals; however, it also acknowledges that other species may be impacted by underwater noise and this will be a future area of study [43]. There are indirect links between this PI and SDGs 15 and 17. Monitoring and reducing underwater noise could potentially halt the loss of biodiversity and degradation to natural habitats, though this is not the intent. As the PI encourages collaboration between the port and scientific community, to build relationships and share knowledge, there is an indirect link to SDG 17 [43].

4. Discussion

The GMEP is touted as the premier environmental program in North America [1,3]. In many instances, the program is beneficial in its ability to facilitate improved environmental performance in the port sector; however, the program focuses primarily on pollution prevention and is limited in its capacity to address the UN SDGs relevant to the Canadian Port Sector. In Table 5, these 12 SDGs were identified, along with the 36 SDG targets that could be measured by the CPAs. Of these 36 SDG targets, only seven were directly linked to the PIs used by the GMEP. There were an additional eight targets with indirect links, suggesting that changes to objectives and criteria in the relevant GMEP PIs could lead to more direct links between the program and achievement of the SDG targets. Of note, 13 of the remaining SDG targets with no links to the GMEP PIs are environmental indicators that should be under the purview of an environmental program. The matrix provides a stark visual representation of the GMEP's efficacy in addressing the SDG targets relevant to the port sector. The following discussion highlights the areas of focus that could be used to improve the efficacy of the GMEP, strengthening or creating links between their PIs and the SDG targets.

The GHG and Air Pollutant PI encourages CPAs to reduce their emissions; however, its primary focus is to reduce source pollution. The GMEP does suggest the use of the Greenhouse Gas Protocol—an accounting and reporting standard that provides sector guidance, calculation tools, and training for both businesses and government [51]. It facilitates the accounting and reporting of the GHGs listed in the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) for both direct and indirect emissions [52]. As noted, the PI for GHG and Air Pollutants focuses primarily on Scope 1 emissions, those caused directly by the CPA. It does not account for indirect emissions, such as the purchase of electricity for their operations (Scope 2) or the indirect emissions related to the products used, waste disposal, and outsourced activities (Scope 3) [52]. If CPAs focused on indirect, as well as direct emissions, it could lead to proactive strategies to reduce emissions rather than reactionary strategies developed in response to regulatory and legislative pressure. To create direct links to the SDGs, the GMEP would have to move beyond GHG reporting to encouraging CPAs to adopt technology and practices that would continually reduce GHG emissions, whether that be through shifting to renewable energy, alternative fuels, retrofitting infrastructure, and implementing smart grids [4,53]. Additionally, with oceans absorbing 23% of annual anthropogenic CO₂ emissions from the atmosphere, the active reduction in GHG emissions by the CPAs can also ensure that ports are not a significant contributor to the decreasing pH levels that cause ocean acidification [54].

A review of literature reveals that port authorities (PAs), especially in Europe, have been focused on adopting green energy consumption [3,55]. Ports are often located in areas suitable for power generation from renewable sources, such as wind, wave, tidal, and geothermal energy, as well as having infrastructure that could be outfitted with solar panels [56]. PAs have also begun to invest in their electrical grids to create smart energy-management systems and offer onshore power (OPS) that allow vessels to be powered through on-grid electricity while docked at the port [53,56,57]. These measures help to reduce the combustion of fuels on ships and reduce emissions locally; however, there can be barriers to their installation (cost) and OPS may not always be a better alternative depending on how the port obtains their primary source of electricity [58–60]. Energy has continually been an environmental concern identified by EcoPorts, with ESPOs Annual Report for 2019 stating that half of the ports belonging to the EcoPorts program had developed on-shore power supplies for ships at port [61,62]. The GMEP could benefit from the development of an energy indicator, as this would address SDGs 7, 9, 11, and 12 more effectively.

Despite the focus on reduction in air emissions, there are no additional measures in the GMEP to prepare CPAs for climate change. The EcoPorts SDM asks ports to consider if there would be operational challenges that could be related to climate change and what steps the port has taken to strengthen resilience for their current infrastructure [61]. Becker et al. suggest that port infrastructure, operations, and supply chains will all become vulnerable to oceanic and atmospheric changes that will lead to more frequent and intense storms, as well as flooding related to sea-level rise [63]. Failing to prepare for the changes associated with climate change can result in significant economic costs. Providing indicators that ensure that ports are preparing for these changes would contribute to the capacity building required to meet targets in SDG 13.

Improving efficiencies in resource consumption is also an area that should be addressed by the GMEP. Presently, the program addresses SDG 6 and 12 by encouraging PAs to implement wastewater treatment, prevent the release of hazardous chemicals, as well as diverting waste [43]. The GMEP could expand their indicators to further address issues such as water use efficiency, providing waste disposal for ships entering port and other port users, as well as encouraging CPAs to focus on green procurement in their indicators. For example, though the reduction of particulate matter is important, the use of a fine-mist spray to limit cargo residues during the unloading and loading of dry bulk cargo leads to an increased consumption of freshwater resources [43]. In an effort to reduce marine pollution, the EU Directive on Port Reception Facilities requires that ships traveling between ports dispose of their waste at port reception facilities [64]. There could also be a more significant portion of the program that focuses on green procurement and investment—both of which are outlined in Canada's FSDS [16]. The GMEP requires CPAs to adopt an environmentally preferable purchasing policy in upper levels of certification; however, it specifies that this should be related to the purchase of products with less packaging or derived from recycled content [43]. Though this type of circular thinking is important, it should include all materials used for all port operations rather than just administrative operations.

As noted previously, the GMEP is an environmental program, which means there is little overlap between the program's PIs and the socially focused SDGs. The Canadian Port Modernization Review suggested that CPAs should build relationships with Indigenous peoples and local communities by developing partnerships, hosting open houses, starting good neighbor committees, and engaging with the public on social media [2]. There are measures in the GMEP to engage with the public, but it is primarily intended to manage complaints from the community. In the higher levels of certification, the GMEP requires CPAs to be involved in community organizations (not just paying dues), though this requirement appears to be more focused on public relations than efforts to build relationships with surrounding communities [43].

The Environmental Leadership PI is problematic because it offers CPAs a choice, with considerable disparity in the rigor of criteria used to attain Level 5 certification. For example, one option is to submit a sustainability report using recognized standards (GRI) and only one CPA publishes sustainability reports using the GRI Standards [3,27,43]. However, another option is to simply donate time and financial aid to green causes, which could be considered a superficial solution known as greenwashing. There is a heavy focus on CPAs ensuring that tenants and terminal operators within the port area become members of the GMEP, as well as communicating their own involvement with the program publicly. At its core, this is simply just advertisement and expansion for the program rather than a focus on improved performance. To be an environmental leader, an organization should be among the first adopters of industry best practices related to environmental performance, rather than selectively choosing from a list of criteria of varying impact, to demonstrate commitment to environmental performance.

5. Conclusions

Green Marine is effective in helping ports address specific environmental issues relevant to the port sector. Unfortunately, most CPAs rely exclusively on this program to improve sustainability performance, and the GMEP does not effectively address the bulk of SDGs relevant to the Canadian Port Sector. Despite offering several benefits to participants—the use of certified logo, involvement in program development, enhancing social license to operate—the GMEP is limited in its ability to affect meaningful change in the overall sustainability goals of CPAs [39]. This finding necessitates either an expansion of the GMEP to incorporate these broader sustainability goals, or the development and inclusion of an additional framework that can be used by CPAs to bridge gaps between the GMEP and the UN SDG targets applicable to their operations.

Despite being federal agencies, CPAs are absent from the FSDS, which could suggest that their goals are not currently aligned with those of the federal government. CPAs could be contributing to the FSDS goals of Clean Growth, Modern and Resilient Infrastructure, and Clean Energy, with the addition of new indicators and adjustments to current GMEP indicators. Through investments in clean energy, green infrastructure, clean power, and energy efficiency, CPAs could help Canada reach its commitments to the UN 2030 Agenda for Sustainable Development. Although the GMEP provides opportunities for CPAs to monitor and improve their environmental performance, further work is necessary to develop a framework that incorporates metrics from globally recognized sustainability standards to provide CPAs with the indicators needed to improve both environmental and social sustainability performance [24]. To conclude, the GRI Standards could be used in the development of a port-specific framework for CPAs to improve their sustainability performance.

Limitations and Future Studies

This research was presented through an evidentiary lens, with a critical descriptive assessment of the GMEP. This methodology was selected due to the scope and time constraints of the research. Future studies could engage with key stakeholders (CPAs, Green Marine, Transport Canada) through interviews and surveys to obtain bottom-up input on how sustainability can be operationalized into port performance. Future studies could also evaluate the GMEP at a larger scale (North America) or by comparing sustainability initiatives in other jurisdictions (EcoPorts). Such future research will benefit from stronger collaboration between environmental managers and decision makers at port authorities, academia, and relevant partners in all levels of government (municipal, provincial, and federal) as well as marine transportation and port industry partners.

Author Contributions: Conceptualization, J.L.M. and M.A.; methodology, J.L.M.; validation, J.L.M. and M.A.; investigation, J.L.M.; data curation, J.L.M.; writing—original draft preparation, J.L.M.; writing—review and editing, J.L.M., M.A. and T.R.W.; visualization, J.L.M. and M.A.; supervision, M.A. and T.R.W.; project administration, M.A. and T.R.W.; funding acquisition, M.A. and T.R.W. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Social Sciences and Humanities Research Council of Canada, Green Shipping Partnership Grant No. 895-2017-1003.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This study was supported by the Social Sciences and Humanities Research Council (SSHRC) of Canada funded project “Green Shipping: Governance and Innovation for a Sustainable Maritime Supply Chain” and the Nova Scotia Research and Innovation Graduate Scholarship (NSGS).

Conflicts of Interest: The authors declare no conflict of interest.

References

- Walker, T.R. Green Marine: An environmental program to establish sustainability in marine transportation. *Mar. Pollut. Bull.* **2016**, *105*, 199–207. [CrossRef]
- Transport Canada. Ports Modernization Review: Discussion Paper. Available online: <https://www.tc.gc.ca/eng/ports-modernization-review-discussion-paper.html> (accessed on 4 February 2021).
- Hossain, T.; Adams, M.; Walker, T.R. Sustainability initiatives in Canadian ports. *Mar. Policy* **2019**, *106*, 103519. [CrossRef]
- Hossain, T.; Adams, M.; Walker, T.R. Role of sustainability in global seaports. *Ocean Coast. Manag.* **2021**, *202*, 105435. [CrossRef]
- Association of Canadian Port Authorities. About ACPA—Organization. 2016. Available online: <http://www.acpa-ports.net/about/index.html> (accessed on 4 February 2021).
- Government of Canada. Backgrounder on Canada's Port System. 2019. Available online: <https://www.tc.gc.ca/eng/backgrounder-canada-port-system.html> (accessed on 4 February 2021).
- Schipper, C.A.; Vreugdenhil, H.; de Jong, M.P.C. A sustainability assessment of ports and port-city plans: Comparing ambitions with achievements. *Transp. Res. Part D* **2017**, *57*, 84–111. [CrossRef]
- Fenton, P. The role of port cities and transnational municipal networks in efforts to reduce greenhouse gas emissions on land and at sea from shipping—An assessment of the World Ports Climate Initiative. *Mar. Policy* **2017**, *75*, 271–277. [CrossRef]
- Darbra, R.M.; Ronza, A.; Casal, J.; Stojanovic, T.A.; Wooldridge, C. The self-diagnosis methods: A new methodology to assess environmental management in seaports. *Mar. Pollut. Bull.* **2004**, *48*, 420–428. [CrossRef] [PubMed]
- Darbra, R.M.; Pittam, N.; Royston, K.A.; Darbra, J.P.; Journee, H. Survey on environmental monitoring requirements of European ports. *J. Environ. Manag.* **2009**, *90*, 1396–1403. [CrossRef] [PubMed]
- Merk, O. *The Competitiveness of Global Port-Cities: Synthesis Report*; OECD Publishing: Paris, France, 2013.
- Council of Canadian Academies. *The Value of Commercial Marine Shipping to Canada*; The Expert Panel on the Social and Economic Value of Marine Shipping to Canada, Council of Canadian Academies: Ottawa, ON, Canada, 2017.
- Lam, J.S.L.; Notteboom, T. The greening of ports: A comparison of port management tools used by leading ports in Asia and Europe. *Transp. Rev.* **2014**, *34*, 169–189. [CrossRef]
- Walker, T.R.; Adebambo, O.; Feijoo, M.C.D.A.; Elhaimer, E.; Hossain, T.; Edwards, S.J.; Morrison, C.E.; Romo, J.; Sharma, N.; Taylor, N.; et al. Environmental effects of marine transportation. In *World Seas: An Environmental Evaluation*; Academic Press: Cambridge, MA, USA, 2019; pp. 505–530.
- Public Safety Canada. Marine Ports and Organized Crime. 2015. Available online: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/rgnzd-crm-brf-25/rgnzd-crm-brf-25-eng.pdf> (accessed on 6 February 2021).
- Environment and Climate Change Canada. Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada 2019–2022. 2020. Available online: https://www.fds-sfdd.ca/downloads/FSDS_2019-2022.pdf (accessed on 4 February 2021).
- Transport Canada. Transportation 2030: A Strategic Plan for the Future of Transportation in Canada. 2019. Available online: <https://tc.canada.ca/en/initiatives/transportation-2030-strategic-plan-future-transportation-canada> (accessed on 4 February 2021).
- Brooks, M.R. Canada's Ports Policy Needs to Move into the 21st Century. 2018. Available online: <https://theconversation.com/canadas-ports-policy-needs-to-move-into-the-21st-century-105534> (accessed on 25 January 2021).
- Ashrafi, M.; Acciaro, M.; Walker, T.R.; Magnan, G.M.; Adams, M. Corporate sustainability in Canadian and US maritime ports. *J. Clean. Prod.* **2019**, *220*, 386–397. [CrossRef]
- Alamouh, A.S.; Ballini, F.; Ölçer, A.I. Revisiting port sustainability as a foundation for the implementation of the United Nations Sustainable Development Goals (UN SDGs). *J. Shipp. Trade* **2021**, *6*, 19. [CrossRef]
- Green Marine Management Corporation. Scope and Criteria. 2021. Available online: <https://green-marine.org/certification/scope-and-criteria/> (accessed on 7 April 2021).
- Green Marine. Green Wave Magazine. June 2021. Available online: <https://green-marine.org/wp-content/uploads/2021/07/GreenMarineMagazineSummer-Ete2021.pdf> (accessed on 9 July 2021).
- Green Marine. Green Wave Magazine. October, 2021. Available online: https://us13.campaign-archive.com/?e=__test_email__&u=b1fd7846bab8358d191d23573&id=ac9a6fbd6b (accessed on 5 November 2021).
- MacNeil, J.L.; Adams, M.; Walker, T.R. Development of framework for improved sustainability in the Canadian Port Sector. *Sustainability* **2021**, *13*, 11980. [CrossRef]
- Port of Halifax. Environment. 2020. Available online: <https://www.portofhalifax.ca/policies-and-planning/environment/> (accessed on 12 October 2020).
- Port of Montreal. Environment: Stronger Together. 2020. Available online: <https://www.port-montreal.com/en/the-port-of-montreal/news/news/environnement-together> (accessed on 12 October 2020).
- Port of Vancouver. Sustainability Report 2020. 2021. Available online: https://portvancouver.metro.net/indicators/our_business (accessed on 15 October 2021).
- International Organization for Standardization. Introduction to ISO 14001:2015. 2015. Available online: <https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100371.pdf> (accessed on 6 February 2021).
- Johnstone, L. A systematic analysis of environmental management systems in SMEs: Possible research directions from a management accounting and control stance. *J. Clean. Prod.* **2020**, *244*, 118802. [CrossRef]
- Vastag, G. Revisiting ISO 14000 diffusion: A new “look” at the drivers of certification. *Prod. Oper. Manag.* **2009**, *13*, 260–267. [CrossRef]

31. Testa, F.; Rizzi, F.; Daddi, T.; Gusmerotti, N.M.; Frey, M.; Iraldo, F. EMAS and ISO 14001: The differences in effectively improving environmental performance. *J. Clean. Prod.* **2014**, *68*, 165–173. [CrossRef]
32. GRI. GRI Standards. 2020. Available online: <https://www.globalreporting.org/standards> (accessed on 6 February 2021).
33. GRI. GRI 101: Foundation. 2016. Available online: <https://www.globalreporting.org/standards/media/1036/gri-101-foundation-2016.pdf> (accessed on 6 February 2021).
34. Langenus, M.; Dooms, M. Creating an industry-level business model for sustainability: The case of the European ports industry. *J. Clean. Prod.* **2018**, *195*, 949–962. [CrossRef]
35. Curtó-Pagès, F.; Ortega-Rivera, E.; Castellón-Durán, M.; Jané-Llopis, E. Coming in from the cold: A longitudinal analysis of SDG reporting practices by Spanish listed companies since the approval of the 2030 Agenda. *Sustainability* **2021**, *13*, 1178. [CrossRef]
36. Koseoglu, M.A.; Uyar, A.; Kilic, M.; Kuzey, C.; Karaman, A.S. Exploring the connections among CSR performance, reporting, and external assurance: Evidence from the hospitality and tourism industry. *Int. J. Hosp. Manag.* **2021**, *94*, 102819. [CrossRef]
37. Karaman, A.S.; Orazalin, N.; Uyar, A.; Shahbaz, M. CSR achievement, reporting, and assurance in the energy sector: Does economic development matter? *Energy Policy* **2021**, *149*, 112007. [CrossRef]
38. Green Marine. About Us—Guiding Principles. 2021. Available online: <https://green-marine.org/about-us/> (accessed on 7 April 2021).
39. Green Marine. Become a Member. 2021. Available online: https://green-marine.org/members/become-a-member/?tab_id=participants (accessed on 7 April 2020).
40. Green Marine Management Corporation. Assessing the Performance. 2019. Available online: <https://green-marine.org/certification/self-evaluation-guides/> (accessed on 7 April 2020).
41. Green Marine. Green Marine Verifiers. 2021. Available online: <https://green-marine.org/certification/verifiers/> (accessed on 7 April 2021).
42. Green Marine. Green Marine Performance Report 2020. 2020. Available online: https://green-marine.org/wp-content/uploads/2021/06/GM_perfo_report2020_ENG.pdf (accessed on 7 April 2021).
43. Green Marine Management Corporation. Performance Indicators for Ports St. Lawrence Seaway Corporations. 2020. Available online: https://green-marine.org/wp-content/uploads/2020/03/2020_Summary_PortsSeaway.pdf (accessed on 22 July 2020).
44. United Nations. Sustainable Development Goals. 2019. Available online: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/> (accessed on 22 July 2020).
45. United Nations Statistics Division. SDG Indicators. 2020. Available online: https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202020%20review_Eng.pdf (accessed on 22 July 2020).
46. Cormier, R.; Elliott, M. SMART marine goals, targets and management—Is SDG 14 operational or aspirational, is ‘Life Below Water’ sinking or swimming? *Mar. Pollut. Bull.* **2017**, *123*, 28–33. [CrossRef]
47. World Ports Sustainability Program. About WPSP. 2019. Available online: <https://sustainableworldports.org/about/> (accessed on 24 July 2021).
48. World Ports Sustainability Program. World Ports Sustainability Report 2020. 2020. Available online: <https://sustainableworldports.org/wp-content/uploads/WORLD-PORTS-SUSTAINABILITY-REPORT-2020.pdf> (accessed on 25 July 2020).
49. Government of Canada. Canada Marine Act (S.C. 1998, c. 10). Justice Laws Website. 2020. Available online: <https://laws-lois.justice.gc.ca/eng/acts/C-6.7/page-4.html#docCont> (accessed on 7 April 2021).
50. Green Marine Management Corporation. Green Marine Environmental Program 2021 Performance Indicators for Ports & St. Lawrence Seaway Corporations. 2021. Available online: https://green-marine.org/wp-content/uploads/2021/08/2021_Summary_PortsSeaway.pdf (accessed on 14 April 2021).
51. World Resources Institute. Greenhouse Gas Protocol. 2020. Available online: <https://www.wri.org/our-work/project/greenhouse-gas-protocol> (accessed on 12 October 2020).
52. Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard. 2020. Available online: <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf> (accessed on 12 October 2020).
53. Iris, C.; Lam, J.S.L. A review of energy efficiency in ports: Operational strategies, technologies and energy management systems. *Renew. Sustain. Energy Rev.* **2019**, *112*, 170–182. [CrossRef]
54. United Nations Department of Economic and Social Affairs. Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development: Progress and Info. 2020. Available online: <https://sdgs.un.org/goals/goal14> (accessed on 25 October 2020).
55. Puig, M.; Raptis, S.; Wooldridge, C.; Darbra, R.M. Performance trends of environmental management in European ports. *Mar. Pollut. Bull.* **2021**, *160*, 111686. [CrossRef]
56. Acciaro, M.; Ghiara, H.; Cusano, M.I. Energy management in seaports: A new role for port authorities. *Energy Policy* **2014**, *71*, 4–12. [CrossRef]
57. Krämer, I.; Czermański, E. Onshore power one option to reduce air emissions in ports. *Sustain. Manag. Forum* **2020**, *28*, 13–20. [CrossRef]
58. Iris, C.; Lam, J.S.L. Optimal energy management and operations planning in seaports with smart grid while harnessing renewable energy under uncertainty. *Omega* **2021**, *103*, 102445. [CrossRef]
59. Coppola, T.; Fantauzzi, M.; Lauria, D.; Pisani, C.; Quaranta, F. A sustainable electrical interface to mitigate emissions due to power supply in ports. *Renew. Sustain. Energy Rev.* **2016**, *54*, 816–823. [CrossRef]

60. Gutierrez-Romero, J.E.; Esteve-Pérez, J.; Zamora, B. Implementing onshore power supply from renewable energy sources for requirements of ships at berth. *Appl. Energy* **2019**, *255*, 113883. [[CrossRef](#)]
61. European Sea Ports Organization. ESPO Environmental Report 2019: EcoPorts in Sights 2019. 2019. Available online: <https://www.espo.be/media/Environmental%20Report-2019%20FINAL.pdf> (accessed on 10 August 2020).
62. European Sea Ports Organization. Our Organization. 2020. Available online: <https://www.espo.be/organisation> (accessed on 10 August 2020).
63. Becker, A.; Ng, A.K.Y.; McEvoy, D.; Mullett, J. Implications of climate change for shipping: Ports and supply chains. *WIREs Clim. Chang.* **2018**, *9*, e508. [[CrossRef](#)]
64. European Commission. Final Adoption of New Rules to Collect and Recycle Waste from Ships. 2019. Available online: https://ec.europa.eu/transport/modes/maritime/news/2019-04-09-final-adoption-new-rules-collect-and-recycle-waste-ships_en (accessed on 30 September 2020).