



Towards cleaner shores: Assessing the Great Canadian Shoreline Cleanup's most recent data on volunteer engagement and litter removal along the coast of British Columbia, Canada



Cassandra Konecny^{a,b}, Vanessa Fladmark^{b,c,*}, Santiago De la Puente^b

^a Department of Zoology, The University of British Columbia, Vancouver, BC, Canada

^b Institute for the Ocean and Fisheries, The University of British Columbia, Vancouver, BC, Canada

^c Earth, Ocean and Atmospheric Sciences Department, The University of British Columbia, Vancouver, BC, Canada

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ABSTRACT

This paper analyzes voluntary cleanups organized by the Great Canadian Shoreline Cleanup (GCSC) along the coast of British Columbia (2013–2016). Cleanup performance indicators, litter composition and diversity were compared between years and across areas (i.e., North Coast of British Columbia, Inner Coast of Vancouver Island, West Coast of Vancouver Island, and Southern Strait of Georgia). Significant differences in parameters were found between areas but not across time. Spatial variation in trash composition and diversity was mostly related to source of litter. Trash yield per kilometre of shoreline was higher in isolated areas and in areas with exposed shorelines. The majority of recovered litter items were composed of plastic. Local actions, complementary to the GCSC, such as banning single-use, non-biodegradable takeout containers on beaches, implementing trash buy-back programs, and modifying waste management and recycling regulations, are proposed as mechanisms for strengthening the prevention and mitigation of coastal pollution in British Columbia.

1. Introduction

Humans directly modify the oceans through pollution, affecting marine ecosystems' composition, structure and function (Lehtonen et al., 2017; Worm et al., 2017). Marine debris has lethal consequences on marine biota through entanglement and ingestion, and sub-lethal effects from the bioaccumulation and biomagnification of chemical pollutants (Alava et al., 2017; Hasenbein et al., 2017; Worm et al., 2017). Additionally, debris can potentially travel across oceans transporting invasive species, impacting biodiversity by modifying local food-webs (Sigler, 2014).

Marine pollution concerns are growing as global litter production increases, and mismanaged garbage disposal facilities continue to exist (Tibbetts, 2015). The annual influx of ocean litter has increased from 6.4 million tonnes in 1975 (National Research Council, 1975) to 12.7 million tonnes of plastic alone in 2010 (Jambeck et al., 2015).

Efforts to mitigate and prevent further effects of marine pollution currently include removing marine debris, implementing effective trash

management and disposal strategies, and fostering changes in the production of items commonly recovered as debris (Sheavly and Register, 2007; Storrer and McGlashan, 2006). The success of initiatives is largely dependent on the level of citizen engagement, as informed populations more willingly take active roles in solving environmental problems and demanding accountability from local governments and multinational corporations (Gelcich et al., 2014; McKinley and Fletcher, 2012).

The Great Canadian Shoreline Cleanup (GCSC) is a conservation initiative of the Vancouver Aquarium (OceanWise) and WWF-Canada, aiming to promote understanding of shoreline litter by encouraging Canadians to rehabilitate shorelines through voluntary cleanups (GCSC, 2017). This paper provides a synthesis of the most recent spatial and temporal trends in cleanup effort, yield and litter profiles of coastal cleanups, orchestrated by the GCSC in the province of British Columbia (BC). The results provide useful information for stakeholder groups attempting to change littering behaviour of citizens through awareness campaigns and changes in policy.

* Corresponding author at: Earth, Ocean and Atmospheric Sciences Department, The University of British Columbia, 2207 Main Mall, Vancouver, BC V6T1Z4, Canada.

E-mail address: vfladmark@eoas.ubc.ca (V. Fladmark).

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2. Methods

2.1. Data collection

Cleanups organized by the GCSC are advertised by a variety of means including their website, public events and at the Vancouver Aquarium. The GCSC or volunteer cleanup leaders provide details of the cleanups and volunteers sign up using a virtual interface (GCSC, 2017). Volunteers track litter data during cleanups, providing tallies of individual litter items, number of volunteers, distance of shoreline cleaned, overall weight of trash collected, and any comments on unusual items and animal entanglement.

2.2. Study area

The GCSC considers any boundary where land meets water as a shoreline (rivers, streams, ocean, lakes, etc.). For this study, we analyzed coastal cleanups registered in BC between 2013 and 2016. Cleanups were considered ‘coastal’ if within 1 km of the ocean-land interface. The total area included in our analysis was approximately 35,000 km², with an unequal distribution of cleanups across this area. The BC coastline was separated into four regions based on similarities in physical oceanographic processes and anthropogenic influences. These were: (i) North Coast of BC (NCBC), with low population density; (ii) Inner Coast of Vancouver Island (ICVI), encompassing a sheltered coastal sea and a high density of aquaculture farms; (iii) West Coast of Vancouver Island (WCVI), with exposed shorelines and low population density; and (iv) Southern Strait of Georgia (SSOG), with low wave exposure and high population density cities including Metro Vancouver, Victoria and Nanaimo (Fig. 1). For more information on the distribution of human activities along the BC coastline review (Robb, 2014).

2.3. Cleanup performance indicators (CPIs)

Performance indicators were created based on information provided by the GCSC to compare cleanups spatially and temporally. These include cleanup effort (number of volunteers; and total distance swept), trash yield (weight of trash in kilograms), and trash yield per unit of effort (trash yield per volunteer and per kilometre of shoreline). These indicators did not follow a normal distribution, therefore statistical

Table 1
Classification of litter items according to their source and material.

| Source | Material | Litter items | | |
|------------|----------|--|--|--|
| Dumping | Glass | Glass pieces | | |
| | Metal | Appliances (refrigerators, washers, etc.) Batteries | | |
| | Plastic | Foam pieces Other plastic bottles (oil, bleach, etc.) Plastic pieces | | |
| Fishing | Rubber | Tires | | |
| | Other | Building materials | | |
| | Plastic | Buoys and floats | | |
| | | Fishing line Fishing lures & light sticks Fishing nets Strapping bands | | |
| Hygiene | Cloth | Tampons & tampon applicators | | |
| | Plastic | Diapers Syringes | | |
| | | Rubber | Condoms | |
| Recreation | Cloth | Clothing and shoes | | |
| | Glass | Beverage bottles | | |
| | Metal | Beverage cans Bottle caps | | |
| | | Paper | Cups & plates Fireworks Paper bags 6-pack holders Balloons | |
| | Plastic | Beverage bottles (2 L or less) Bottle caps Cups & plates Food wrappers & containers Forks, knives & spoons Lids Other packaging Plastic bags Straws & stirrers Takeout containers Toys | | |
| | | Smoking | Plastic | Cigarette lighters Cigarettes & cigarette filters Tobacco packaging wrappers |
| | | Other | Cigar tips | |

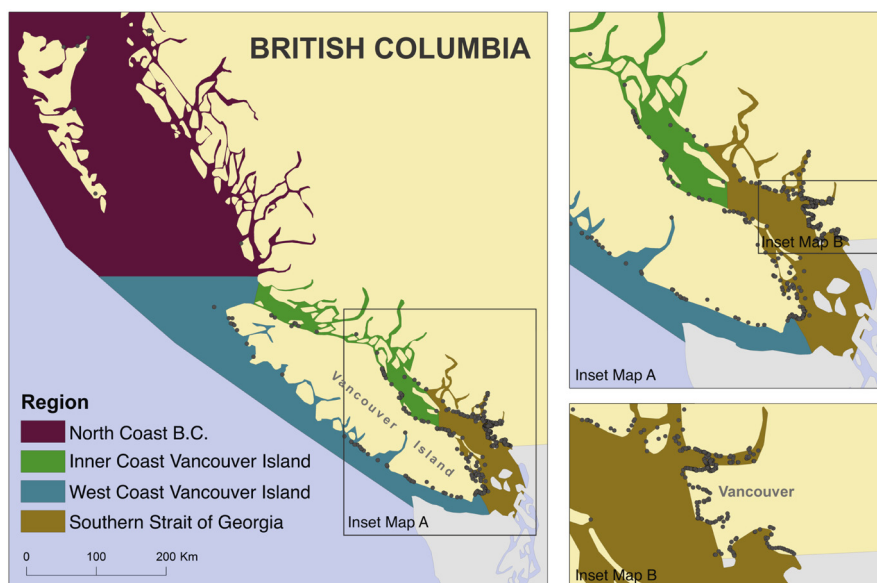


Fig. 1. Distribution of clean-ups (grey circles) registered along the coast of British Columbia between 2013 and 2016. Colours represent the regions compared in this study.

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