



## Article

# Management of Waste Collection from Yachts and Tall Ships from the Perspective of Sustainable Water Tourism

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**Abstract:** This article deals with the issue of waste collection from yachts and tall ships that is important from the perspective of sustainable tourism. There are, of course, procedures that regulate the passing of waste by vessels, which also apply to tourist vessels. However, the authors made an attempt to analyze the process of waste collection carried out under non-standard conditions, i.e., during a mass event held at the port of the Tall Ships Races final, which took place in 2017 in Szczecin. Many yachts and tall ships participated in the event, and in addition, due to the multiplicity of attractions, the event area was very popular among tourists and visitors (over one and a half million people in three days). Due to the safety of the participants, and the need to maintain high aesthetic standards, the procedures for collecting waste from vessels had to be modified. In addition to the preparation of a flowchart on which the existing procedural modifications were presented, based on the source data received from the waste collection company, quantitative and structural analyses of the waste were carried out. The conducted research showed that the waste collection required the coordination of the activities of many entities. This article also draws attention to operational problems that occurred during waste collection from vessels during the Tall Ships Races final. Statistical analysis allowed for the determination of the days where the vessels disposed the most solid and liquid waste, and how the structure of the amount of collected waste was shaped. The Tall Ships Races is the most popular and the biggest event of this type in the world—gathering the largest number of tall ships. They are carried out annually, and their route leads through various ports; however, the regatta final is the culminating point that attracts the largest number of tourists. For this reason, many cities are trying to become its organizers. In 2018, the finals took place in the Dutch port of Harlingen, and in 2019, the Danish port of Aarhus will be responsible for its organization. Two years later, in 2021, the Tall Ships Races regatta final will be hosted by Szczecin again. The results of the research conducted in this article may be helpful for appropriate preparation by subsequent ports for waste collection, which may contribute to the safety of the participants taking part in the event.

**Keywords:** sustainable tourism; water tourism; waste management; The Tall Ship Races; statistical analysis

## 1. Introduction

A growing interest in various forms of water tourism has been observed in Europe for over 10 years. Initially, it mainly concerned the Mediterranean Sea coastal regions, where climate and

natural beauty have always been strong tourism attractions [1]. Currently, however, water tourism is also dynamically developing in regions where the climate is cooler, among others in the North and Baltic Sea [2]. One of the most popular forms of water tourism is sailing, which—cultivated in close contact with nature, on board vessels mainly propelled by sails—is often considered to be an example of environmentally friendly tourism. However, attention should be paid to the fact that a lot of waste is produced during frequent weeks of cruises. Ports must ensure that they are efficiently collected, so that the environment is not polluted, and that the comfort of sailing is not reduced. Waste management has been included in one of 20 key groups of sustainable development issues of tourism [3]. As part of the work of the United Nations Environment Program (UNEP), the Global Initiative on Marine Litter, in which 12 marine regions from different continents participated, formulated the basic areas in which problems are related to sea water pollution. These included, among others: Economic effects; and impacts on aesthetics and coastal tourism, human health, safety, and habitat destruction. It should be noted that some types of marine litter have a very slow rate of decomposition, leading to a gradual, but significant, level of accumulation in the coastal and marine environment [4]. Part of the sea pollution is generated by ships (including tourist ones, such as cruisers, yachts, and tall ships) and can be relatively easily eliminated only if the ports properly meet their obligation to collect waste. This is extremely important, because it can contribute to the reduction of illegal discharges of ship-generated waste and cargo residues to the sea [5].

According to the definition, sustainable tourism should meet the needs of present tourists and host regions, while protecting and enhancing opportunities for the future. It requires the management of all resources in such a way that economic, social, and aesthetic needs can be fulfilled, while maintaining cultural integrity, essential ecological processes, biological diversity, and life support systems [6].

This article analyzes the process of collecting waste from yachts and tall ships, using the example of the Tall Ship Races (TTSR) final. Wastes are defined as substances or objects that are disposed or to be disposed, or that are required to be disposed, in accordance with the provisions of national legislation. Ship waste is all waste, non-hazardous and hazardous, that has occurred during ship navigation, as well as the waste being transported by cargo vessels. In general, ship waste includes: Solid waste (solid municipal waste, and ship cargo residues) and liquid waste (waste oils and wastewaters) [7]. It should be noted that due to the fact that this article focuses on yachts and tall ships, which are passenger vessels, ship cargo residues did not occur among waste. Over 100 vessels participated in the event, including 70 participating in the race [8], which, due to the nature of the event, were mostly moored in the most prestigious part of the city—where there were a number of accompanying events, such as concerts and theatrical performances. Moreover, in these places, there are numerous additional attractions located, among others, an amusement park, and shopping and catering points.

The accumulation of attractions (many accompanying events, including concerts of shanty groups, outdoor review of marine films, sand sculptures, and concerts on the stage built at Wały Chrobrego) [8], resulted in the fact that during four days (August 5–8), an area of over 250,000 m<sup>2</sup> (the area including the main event on both sides of the Odra River and accompanying events in the immediate vicinity) [9] was visited by about 1.5 million people [8]. The estimates of the organizers and services show that in all events participated, a total of over 2 million residents and tourists were attendant. Such a number during all days, visited, among others, Wały Chrobrego, Łasztownia, boulevards, embankments, Grodzka Island, and all places of the accompanying events. It should be remembered that this year, the area of the event has grown significantly, going far beyond Wały Chrobrego [10]. More than 5600 police officers and over 600 officers from other services cared for order and security during the race [11]. The Szczecin final of the Tall Ships Races was the largest outdoor event in Poland in 2017 [8]. At that time, the incoming vessels had to dispose of waste, which was quite a challenge because of the crowds of visitors and mooring in a difficult-to-reach place for means of transport.

According to the knowledge of the authors, there is no study related to the provision of these services during the mass event. In this case, the point is to pay attention to the organizational aspects, which, on the one hand, ensure the proper protection of the environment, and, on the other hand,

ensure the undisturbed course of the event. It is also important that the analyzed event is related to water tourism. It should be noted that the subject matter, relating to waste collection from watercraft, is very rarely the subject of scientific study. Waste collection from tourist units, such as yachts and tall ships, is also rarely analyzed. In most cases, the analysis refers mainly to cruisers [12,13]. During the literature research, no scientific studies on the issue of tall ship waste discharge were found. In this context, it can be said that this article is a pioneer, and an original study that fills in the partially existing gap. It draws attention to very important and overlooked issues.

The remainder of this article is organized in the following order. In Section 2, an overview of the literature on the subject is presented, systematizing the key concepts for this article: A yacht and a tall ship, because there were no clear literature definitions in this respect. The legal acts regulating waste collection from vessels are also discussed. Section 3 presents the purpose of this article, puts forward hypotheses, describes the research material, and indicates the methods used. Section 4 presents basic information about the Tall Ships Races, and presents a case study regarding its finals, which took place in 2017 in Szczecin. This part focuses primarily on the aspects regarding the organization of waste collection from vessels taking part in the event. For a better illustration of the problem, a block diagram of the applicable procedure was developed. The diagram includes information on activities, the entities responsible for them, and the required documentation. In Section 5, based on source data received from the Espadon Sp. z o.o., analysis of the structure and the amount of waste disposed of by yachts and tall ships taking part in the described event was made. Lastly, Section 6 is devoted to the discussion of the results obtained and conclusions.

## 2. Theoretical Aspects of Waste Collection from Yachts and Tall Ships

The available literature addressing issues related to the waste collection from tourist vessels is usually concentrated on cruisers [12–16], which is obviously understandable, due to their size and the number of passengers that they take on board at one time. However, given the growing popularity of sailing, this topic is also important for yachts and tall ships. Meanwhile, as far as waste collection from these vessels is concerned, it is very rarely mentioned in the scientific literature. This may be due to the fact that the theoretical aspects of sailing are relatively rarely researched. Often, even clear definitions of basic concepts are lacking. This is the case with the terms, “yacht” and “tall ship”. Although, most likely, the majority of the Tall Ships Races participants could easily indicate which vessels are yachts, and which are tall ships, it is impossible to find such a distinction in the literature. J. Czajewski defines a tall ship as “a ship that is propelled by sails” [17]; the definition of a sailing yacht is very similar, according to which it is “a yacht whose main source of propulsion are sails” [18]. Following this line of reasoning, one should look for the difference in the terms, “yacht” and “tall ship”. However, a yacht is defined as “a sailing or mechanical propulsion vessel, intended, irrespective of size and structure, for non-commercial purposes: Sports, tourism, recreation, or representation” [17], while according to the Maritime Safety Act, a ship is “a vessel used in the marine environment [19]”. It follows that a sailing yacht and a tall ship, in accordance with the applicable definitions, would be identical concepts. For the purposes of this article, however, the authors propose to distinguish these concepts. The basic criteria for distinguishing them is the hull length and the number of masts. The following definition of a tall ship is proposed: A tall ship is a ship with a hull length of over 24 m, which is propelled by sails, and which has at least two masts. Some of the tall ships also have characteristic sails. Yachts mostly have triangular sails, while tall ships have a so-called gaff rig or a square rig. The assumed hull length of 24 m results from the fact that, according to the regulations applicable in most European countries, only yachts with hulls exceeding such a length require registration. Issues related to waste and sewage collection from yachts and tall ships in the existing literature are mainly discussed in the context of designing marinas, and the organization of services provided on their premises [20–23], and from the perspective of possible crisis situations that may occur in their area [24]. Some authors have discussed the issue of collecting waste from yachts, considering the impact of the operation of marinas on the environment [25–27], or in general—nautical

tourism [28,29]. Meanwhile, it is worth considering how waste collection affects the functioning of the city area in which the mass event is organized, especially when there is a large accumulation of vessels that are disposing of waste. Mass events require extraordinary measures to ensure the safety of participants [30,31], transport accessibility of the venue, and supplies [32]. However, issues related to reverse logistics are also equally important.

All ships, regardless of their type, are producers of many wastes. Pollution from ships that are discharged into the sea and port waters harms living organisms and water ecosystems by destroying their ecological and aesthetic values, and pose a threat to human health and life. In order to protect the marine environment, many international legal regulations were introduced to enable the use of all environmental goods while maintaining its protection and taking responsibility for violating its status [33]. The most important acts regulating the problem of waste management in the marine environment include:

- (1) The International Convention for the Prevention of Pollution from Ships—MARPOL 73/78 Convention—Provisions of the International Convention for the Prevention of Pollution from Ships, 1973, drawn up in London on 2 November 1973, as amended by the Complement Protocols drawn up in London on 17 February 1978 [34] and the Complement Protocols drawn up in London on 26 September 1997 [35];
- (2) The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter—the so-called London Convention (LC 1972), drawn up in Moscow, Washington, London and Mexico on 29 December 1972, in force since 30 August 1975 [36]; and
- (3) Convention on the Protection of the Marine Environment of the Baltic Sea Area—the so-called Helsinki Convention, drawn up in Helsinki on 9 April 1992, [37].

MARPOL 73/78 is the basic legal act that regulates issues that are related to the protection of the marine environment, which is why it will be discussed in the most detail. The regulations included in the convention refer to all types of vessels, and the states that are parties to the convention are obliged to implement the rules that are contained therein. The Convention consists of six annexes, each of which refers to a different source of marine pollution from ships: Oils, harmful liquid substances, harmful substances carried in the sea in packaging, sewage, garbage, and air pollutants.

The main issue addressed in the London Convention (LC 1972) is the effective prevention of pollution caused by the dumping of waste and other matter. The countries belonging to this Convention are obliged to apply all measures and techniques contributing to the reduction of the amount of waste dumped into the sea.

In the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area, the provisions included in the MARPOL 73/78 convention were taken into account and tightened. The parties to the Convention have committed to taking joint actions to protect the environment of the Baltic Sea. The latest version of the Helsinki Convention was adopted in 1992. It defines the maritime area covered by legal regulations, and presents the scope of liability for damage caused, and the rules for resolving disputes.

### 3. Materials and Methods

The main goal of this article was to analyze the process of organizing waste and sewage collection from yachts and tall ships, as well as the statistical analysis of the structure and the amount of waste at a mass event, such as the Tall Ships Races. This article also presents preliminary recommendations regarding the proper organization of waste collection, which is the result of analyzes and observations made during waste and sewage collection from yachts and tall ships.

The results of both analyses may contribute to the better preparation of waste management during subsequent events of that type, which will take place not only in Szczecin, which is the subject of the analysis presented, but also in other cities. Every year, another European city is the organizer of this

event, with a similar number of vessels taking part, which allows the assumption that the scale of the problem related to the waste collection will generally be similar.

The following research hypotheses were formulated for the purpose of the study:

**Hypothesis 1 (H1).** *Proper waste collection process requires the coordination of activities of many entities.*

**Hypothesis 2 (H2).** *Proper management of waste collection determines the undisturbed course of a mass event.*

**Hypothesis 3 (H3).** *Proper waste collection is one of the factors of sustainable tourism.*

In the study, one of the research methods was a case study. The organization of waste collection from yachts and tall ships participating in the 2017 Szczecin Tall Ships Races was analyzed. A detailed description of the event covered by the case study is described in Section 4. This article also used literature and documentation analysis. Source materials originating from an agency responsible for operating ships, the port of Szczecin-Świnoujście and the enterprises Espadon Sp. z o.o. (Szczecin Poland), in collecting waste during the mooring of sailing ships in the port of Szczecin were analyzed. The observation method was also used. One of the authors of this article, during the period of the described event, was working in the company, Espadon Sp. z o.o., which was responsible for waste collection from yachts and tall ships. His duties included co-participation in planning works that were aimed at providing the right number of transport means and developing routes. In addition, he was involved in the development of documentation regarding waste collection. He also accompanied the drivers of vehicles during their duties. All of this allowed him to get to know the discussed issues from the practical side, and to contribute to the collection of primary data used during the writing of this article. For the analysis of the structure of the volume of waste collected during the four days of the final, classical, position, and dispersion measures were used, and the distribution of the amount of waste collected using histograms and boxplot was graphically presented.

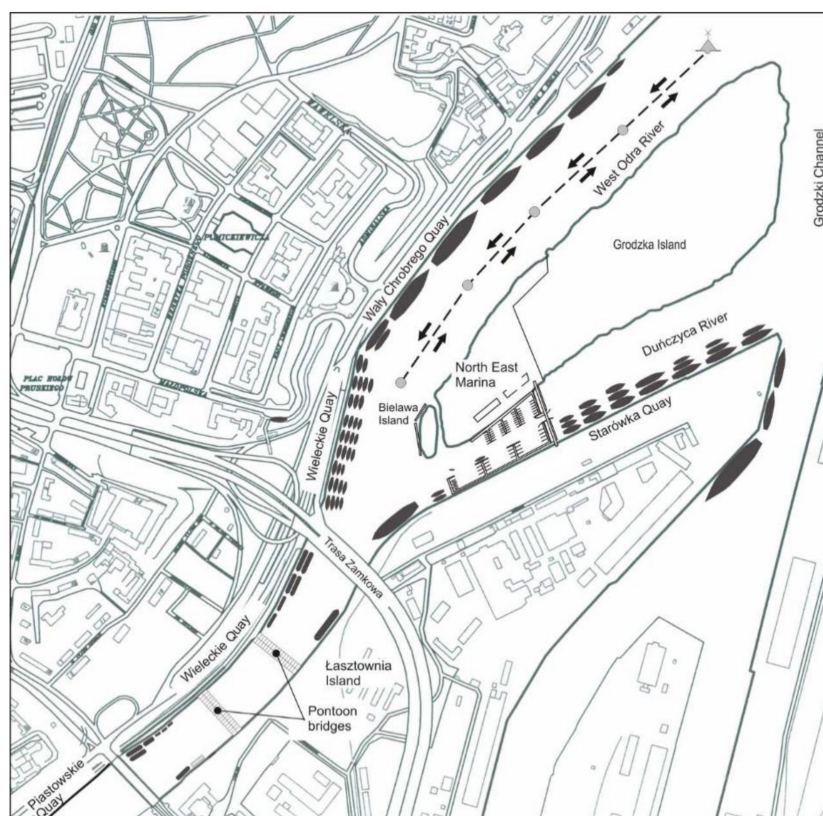
#### 4. Waste Collection from Yachts and Tall Ships during the Final of the Tall Ships Races in Szczecin

Typically, the Tall Ships Races series attracts 70–100 sail training vessels. The idea is to provide an opportunity for the young trainee crews to mix with their contemporaries from other nations, and to visit new communities. Races are held every summer in European waters, from the Baltic to the Mediterranean. The first one took place in July 1956 between Torbay in the UK and Lisbon in Portugal, and 20 vessels participated —divided into two classes, those over 100 tons and those under. That first race was planned to be a one-off, but it attracted such huge press coverage, particularly in the countries of the vessels taking part, that the Organizing Committee decided to repeat the event every second year. The body that is responsible for its organization is Sail Training International Race. The Races usually comprise four ports; each of them organizes a programme of social, sports, and cultural events and activities for the trainee crews. The final day in port includes a crew parade through the streets, and a prize-giving. The arrival of the ships, berthing, undocking, and other ships services, like waste collection, are all handled by each port's harbormaster [38]. The Tall Ships' Races final took place in Szczecin three times: In 2007, 2013, and in 2017. It is always a powerful mass event. It attracts not only the residents of a given city, but also a huge number of tourists. In 2007, about 2 million people participated in it, in 2013, 2.25 million, and about 2 million in 2017 [10,39]. It is worth noting that the number of inhabitants of this city is estimated to be around 380,000. At that time, over 70 tall ships and many yachts were moored in the city. Smaller yachts were moored at the North East yacht port, where all of the 74 parking spaces were used throughout the duration of the event, and some yachts were even "long side" moored, i.e., moored to the side of another yacht.

As far as tall ships are concerned, depending on the length of the vessels and their draft, they were assigned places at the quays: Pasażerski, Wały Chrobrego, Bułgarski, Starówka, and Wieleckie, and smaller yachts were moored in the Northeast marina (Figure 1). The quays of Wały Chrobrego, Pasażerski, Akademia Morska, and Wieleckie are located in the very center of the city, in the most

representative area, which is most visited by tourists. However, during the TTSR finals in 2017, when tall ships were open for sightseeing, with a concert stage, an amusement park, and numerous shopping and catering points set up on land, the tourist traffic was record-breaking. For reasons of safety, the area was closed to car traffic. Also, the remaining quays, usually rarely visited by tourists, were visited during the event.

Record pedestrian traffic, streets closed to traffic, and a large accumulation of tall ships, are factors that greatly hindered the handling of ships in the field of waste collection. Therefore, standard procedures were impossible to apply.



**Figure 1.** Location of yachts and tall ships during the final of the Tall Ships Races in Szczecin in 2017.  
Source: Own study based on [40].

The service of tall ships must be done in such a way as not to disturb the accompanying events, and not to negatively affect the image of the place, valid during the analyzed event. According to the schedule, the accompanying events began every day in the morning (9:00–10:00), and from 10:00, tall ships were made available for sightseeing [41]. For this reason, tourists visited the area in the morning and spent time there until late at night. It was necessary to organize waste collection from vessels in a way that would not disturb the aesthetic experience, which is one of the elements of sustainable tourism. In addition, the implementation of waste collection in a field so crowded could be impossible, or cause a serious threat to the health, and even the lives of the participants of the event. During the presence of tourists, only emergency vehicles could move around this area. The movement of other vehicles could result in serious accidents. Waste collection carried out in the presence of such crowds of tourists could lead to technical disturbances, such as damage to the hose used for liquid waste collection. As a result, it could lead to the dumping of waste, contamination of the area, and the exclusion of a large area from the event. This procedure is shown in Figure 2.

As can be seen in Figure 2, the four main stages can be distinguished in the current procedure:

Stage 1: Informing about the willingness to dispose of waste;

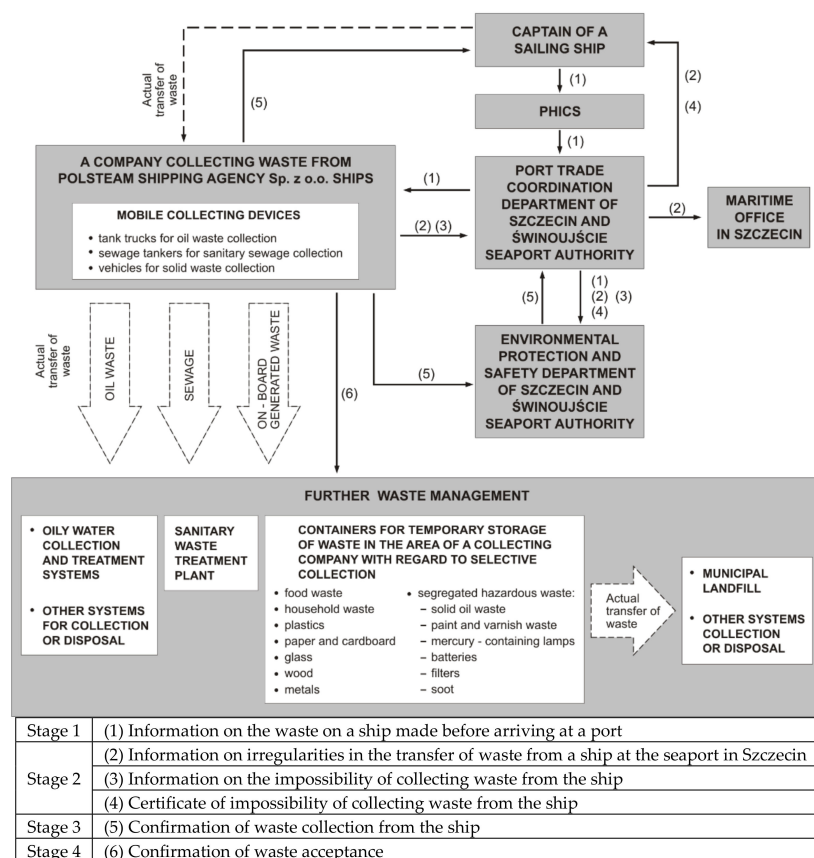
Stage 2: Waste collection;

Stage 3: Confirmation of collection; and

Stage 4: Confirmation of waste acceptance.

During stage 1, the vessel captain, prior to the planned arrival to the port in Szczecin, provides information about the waste that he wants to dispose of in the port, using the control and information system for Polish ports (Polish Harbours Information & Control System - PHICS). The manner of providing information, including the time of their submission, were specified in the regulation of the Minister of Maritime Economy and Inland Navigation of 4 November 2016 on the transfer of information on waste on board [42] (Official Journal of 2016, item 1851).

The second stage begins with the organization and implementation of the reported waste collection. The company collecting the waste sets the date of waste collection with the agent. In the case of the Tall Ships Races Final, a special procedure was in force, in which the days of potential collection, as well as the hours, were specified in detail. Due to the need to reconcile these activities with the ongoing event that attracted hundreds of thousands of participants, it was necessary to agree on the collection times with its organizers. Finally, it was agreed that segregated waste collection would be carried out in the morning between 5:00 a.m. and 6:00 a.m. on each day of the race, that is, from 4–8 August 2017. In the case of liquid oil waste and sewage, which are received using tankers and slurry tankers, the reception hours were set at 2:00 a.m.–7:30 a.m. (if the vessel officer reported the need for such a service by 12:00 on the previous day). The requirement dictated by the safety and the efficiency of collection was the use of the collecting company's pump.



**Figure 2.** The waste collection procedure during the final of the Tall Ships Races in Szczecin in 2017.

Source: Own study based on [43] (pp. 52–53).

After liquid waste oil and sewage collection, the representative of the company collecting the waste and the vessel officer confirmed its implementation on the appropriate form.

The daily schedule regarding solid waste collection was transferred to the Szczecin and Świnoujście Maritime Port Authority (ZMPŚiŚ), and the vessel received confirmation only in the event of a prior notification of such need.

If it would not be possible to collect the waste from the vessel while mooring in the port, or that it would be impossible to collect a particular type of waste, the company responsible for collecting the waste was obliged to notify the captain. In addition, he would receive a Certificate of Inability to Collect Waste, issued by the Port Turnover Coordination Department. The certificate indicated the nearest port or harbor that was ready to collect waste.

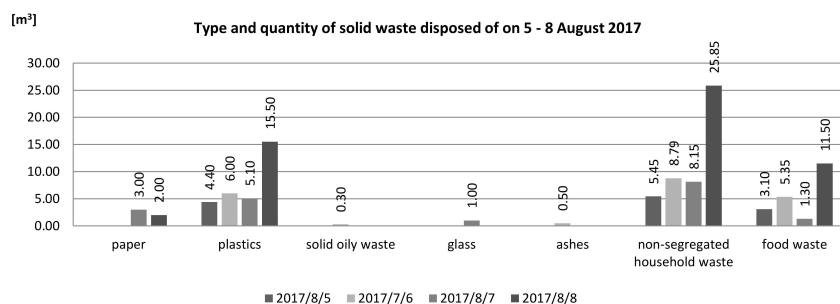
From the results of the analysis of the TTSR final, the procedures involved in the process of collecting waste from tall ships were attended by numerous entities. The initiator was the Captain, and the subsequent entities were the ZMPŚiŚ Port Coordination Department, Environmental Protection Department, and Health and Safety of ZMPŚiŚ, optionally (in case of difficulties) the Maritime Office in Szczecin, and the company responsible for physical waste collection, having signed a contract with the ZMPŚiŚ Board. In addition, the issues of the organization of the waste collection and, above all, the hours of service provision were agreed with the City Hall, i.e., the body that is responsible for organizing the event.

In the entire collection process, the further management of waste could not be omitted, which required further transport and the involvement of additional entities (appropriate for a given type of waste): Sewage treatment plants, landfills, etc.

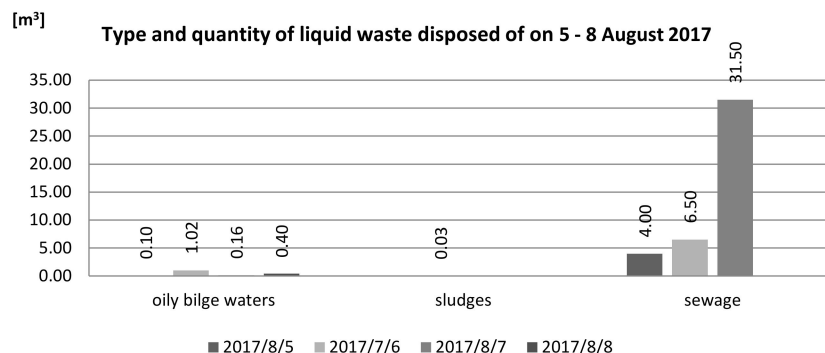
As for the smaller yachts moored in the North East Marina, there was no need to modify the existing procedure. Household wastes were thrown by the crew into appropriate containers located in the marina, sewage from portable toilets went to the sanitary installation, while sanitary sewage from solid reservoirs and bilge water was removed by the means of pumps that were available in the marina.

## 5. Analysis of the Structure of the Quantity of Waste Collection from Yachts and Tall Ships

This section analyzes the structure of the quantity of waste collected from yachts and tall ships during the Tall Ships Races final in Szczecin. Figure 3 shows the total amounts of solid waste collected over the four days. In total, 107.29 m<sup>3</sup> of solid waste and 43.71 m<sup>3</sup> of liquid waste was collected from all vessels. The largest amount of collected waste was non-segregated household waste—over 48 m<sup>3</sup> of this waste was collected in four days, which constituted 0.69 m<sup>3</sup> of this waste per vessel. The next waste was plastics, with an amount of 31 m<sup>3</sup>, and food waste (over 21 m<sup>3</sup>) during the four days of the race final. This means that the amount of this waste per vessel was 0.44 m<sup>3</sup> and 0.3 m<sup>3</sup>, respectively. The largest amount of liquid waste was collected in the form of sewage; it was a total of 42 m<sup>3</sup>, which accounted for 96% of all liquid waste within four days. An important fact is that the vessels disposed of the most sewage on the day before the final of the Tall Ships Races. This was up to 31.5 m<sup>3</sup>, which accounted for 72% of all liquid waste collected. The largest amount of solid waste was disposed on the last day of the event, which was 54.85 m<sup>3</sup> (51% of all solid waste). Figure 4 shows the distribution of total values of liquid waste delivered during the four days of the race final.

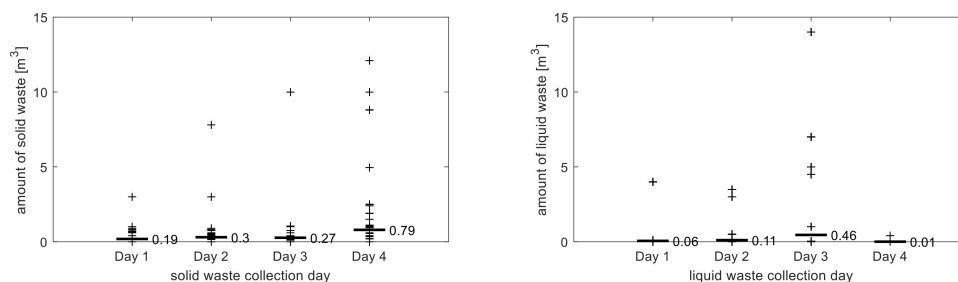


**Figure 3.** Total quantities of solid waste disposed of in the next days of the race finals in Szczecin by waste type. Source: Own study based on [44].

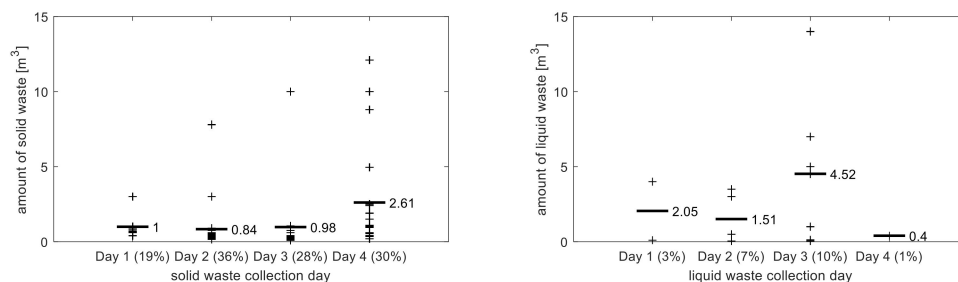


**Figure 4.** Total quantities of liquid waste disposed of in the next days of the race finals in Szczecin by waste type. Source: Own study based on [44].

Data on the average quantities of waste were analyzed in two options: All vessels, including those that did not dispose of waste, and only those that disposed of the waste. Figure 5 presents the distribution of the quantities and the average values of solid and liquid waste disposed of by vessels in the next four days of the final. In determining the average number of waste disposed of in the following days, all vessels reported to the organizers, including those that did not dispose of any waste, were included. Figure 6 shows the distribution of the amount of solid and liquid waste, as well as their average amounts in the next days of the race final, including only those vessels that disposed of waste. These distributions confirm that the largest amount of liquid waste was collected on the day before the last day of the final, and solid waste on the last day. On the last day of the race, each vessel disposed of, on average,  $0.79 \text{ m}^3$  of solid waste. Considering only those vessels that disposed of waste on this day (30% of all vessels), the average value of collected solid waste was  $2.61 \text{ m}^3$ . In the case of liquid waste, on the day before the last day of the final, the average value of the waste collected from all vessels was  $0.46 \text{ m}^3$ , while when analyzing only those vessels that actually disposed of waste on that day (10% of vessels), the average value was  $4.52 \text{ m}^3$  of liquid waste.

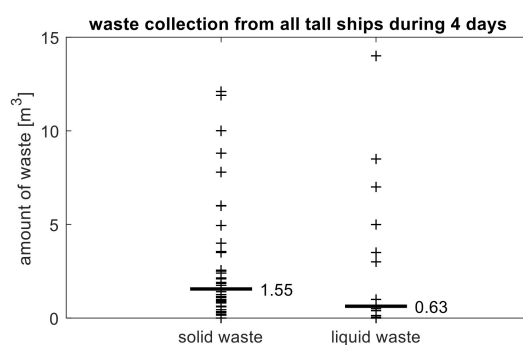


**Figure 5.** Distribution of the amount of solid and liquid wastes collected from ships per day, and the mean values of collected waste from ships (the bold lines). Source: Own study based on [44].

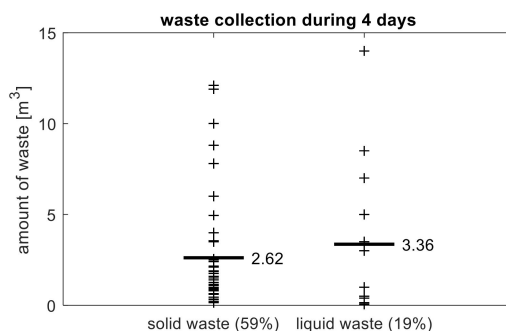


**Figure 6.** Distribution of the amount of solid and liquid wastes collected from ships per day, and the mean values, taking into account only those ships from which waste was picked up (the bold lines). Source: Own study based on [44].

During the four days of the Tall Ships Races in Szczecin, 59% of vessels disposed of solid waste, and 19% of vessels disposed of liquid waste. Distributions of the amount of waste collected from individual vessels, and the average values of waste collected, taking into account all registered vessels and only those that disposed of waste, are shown in Figures 7 and 8. Considering all of the vessels registered by the organizers, an average of  $1.55 \text{ m}^3$  of solid waste and  $0.63 \text{ m}^3$  of liquid waste were collected from each of the tall ships. The standard deviations were, respectively,  $2.74 \text{ m}^3$  and  $2.21 \text{ m}^3$ , and the coefficients of variation were, respectively, 179% and 354%. Such high values of the coefficient of variation, analyzing the four days of the race final, indicate that there was a large variation in the amount of solid waste collected. Considering the 59% of vessels from which solid waste was collected, the average value of waste per vessel was  $2.62 \text{ m}^3$ , the standard deviation was  $3.17 \text{ m}^3$ , and the variation coefficient was 121%. However, the average volume of liquid waste collected on the basis of the 19% of vessels that disposed of waste amounted to  $3.36 \text{ m}^3$ , the standard deviation was  $4.26 \text{ m}^3$ , and the coefficient of variation was 127%. As in the previous case, the coefficients of variation in the amount of solid and liquid waste collected were high (over 120%); therefore, the variation in the amount of waste collected from vessels was high.

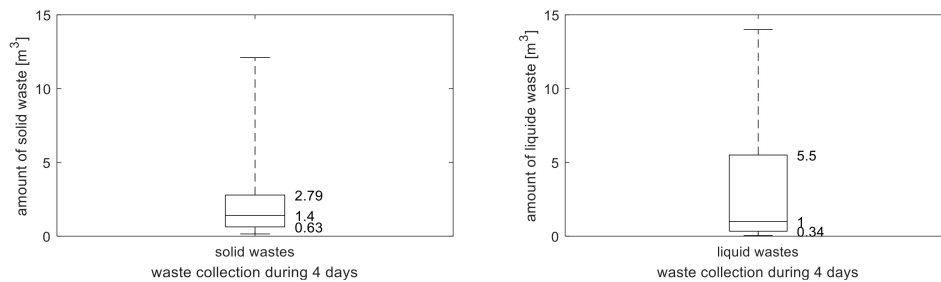


**Figure 7.** Distribution of the amount of solid and liquid wastes collected from ships over the four days, and the mean values of the collected waste from ships (the bold lines). Source: Own study based on [44].



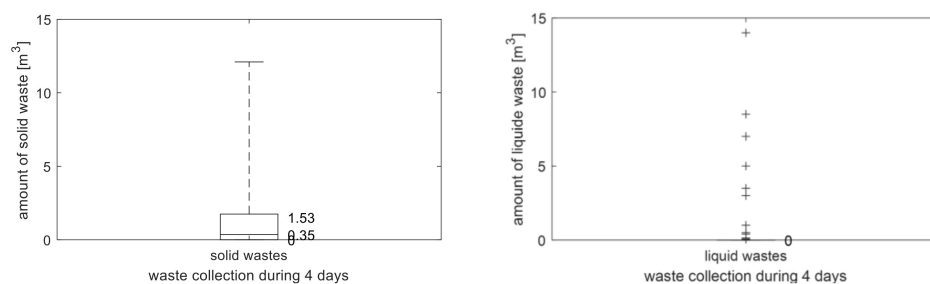
**Figure 8.** Distribution of the amount of solid and liquid wastes collected from ships over four days, and the mean values, taking into account only those ships from which waste was collected (the bold lines). Source: Own study based on [44].

Analyzing the boxplots (Figure 9), and taking into account the vessels that disposed of waste, it can be concluded that 50% of waste from 59% of vessels disposing solid waste ranged from  $0.63$  to  $2.79 \text{ m}^3$ , with a median of  $1.4 \text{ m}^3$  of solid waste. For liquid waste, considering 19% of the vessels that disposed of waste, 50% of the waste was in the range of  $0.34$  to  $5.5 \text{ m}^3$  of liquid waste, and the median was  $1 \text{ m}^3$ .



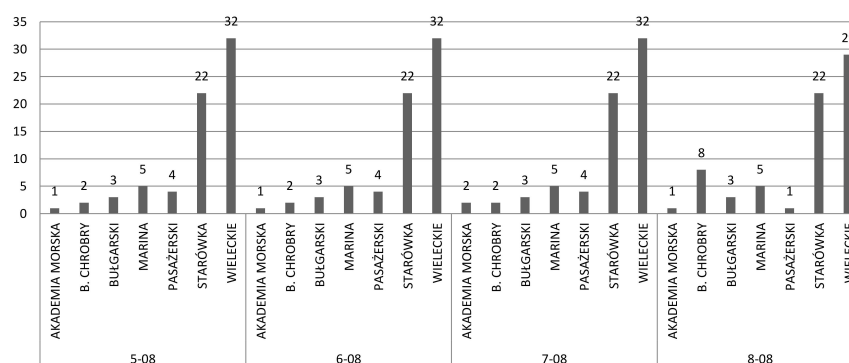
**Figure 9.** Boxplots showing the median, upper, and lower quartiles, and the maximum and minimum values for the amounts of solid and liquid waste collected during the four days, determined on the basis of 59% (solid waste) and 19% (liquid waste) of vessels that disposed of waste. Source: Own study based on [44].

Figure 10 presents boxplots generated on the basis of the value of solid and liquid waste disposed within four days by all vessels, with zero-values included. The median of the total solid waste amounted in this case to  $0.5 \text{ m}^3$ . Quarter values were 0 and  $1.53 \text{ m}^3$ , and so 75% of vessels disposed of up to  $1.53 \text{ m}^3$  of solid waste. The boxplot on the total volume of liquid waste indicates that the number of disposing vessels was small. Among all of the analyzed vessels (including zero values), they were considered irrelevant; therefore, in this case, the median and quartile values were 0.



**Figure 10.** Boxplots showing the median, upper, and lower quartiles, and maximum and minimum values for the amount of solid and liquid waste collected during the four days, determined on the basis of all vessels. Source: Own study based on [44].

Figure 11 shows the number of vessels that moored at a given quay. Every day, most vessels were at the Wieleckie quay, ranging from about 40% to 46% of all vessels, and also at the Starówka quay—about 30% of all vessels. On the last day of the Tall Ships Race final, the rotation of three vessels from the Wieleckie quay to B. Chrobry was visible. On the third day, there was an increase by one vessel at the Akademia Morska quay. Such small changes indicate that the vessels that arrived on the first day left only after the final of the race. This information is important, due to the amount of waste, and the organization of its collection.



**Figure 11.** Number of vessels at a given quay on the four analyzed days of the Tall Ships Races final. Source: Own study based on [44].

## 6. Discussion and Conclusions

The study carried out for the purposes of this article confirmed the adopted research hypotheses. Waste collection from mooring vessels at the place of a multi-day mass event is a big challenge. Incorrect organization may disrupt the course of the event, and this may cause a threat to its participants, or may lead to environmental contamination. Waste collection carried out at the wrong time could contribute to the appearance of unfavorable aesthetic impressions in tourists, and thus reduce their overall assessment of the event. Any irregularities could negatively affect attendance at similar events organized in the future, and spoil the image of the city built over the years. This could result in a decline in tourism revenues. Two million tourists taking part in the Tall Ships Races, lasting just four days, generates demand for many services and products, thus bringing economic benefits that cannot be unnoticed. Losing even a part of the participants could reduce the expected revenues of many business entities. It should not be forgotten that the area where the event takes place, apart from the tourist function, also has a residential function, and is a place where offices and teaching centers are located. The lack of an efficient waste collection system could therefore have a negative impact on the comfort of residents. Due to the fact that sustainable tourism requires “(...) proper management that meets economic, social and aesthetic needs (...)” [45] (p. 21), then proper waste collection is one of the factors of sustainable tourism, and this confirms the hypothesis, H3.

To avoid this situation, the cooperation of numerous entities is required. In the analyzed case, the captains of the vessels, Port Coordination Department of ZMPSiŚ S.A, Department of Environmental Protection and Occupational Health and Safety of ZMPSiŚ, Maritime Office in Szczecin, City Hall, and the company, Espadon Sp. z o.o., were involved in the waste collection; this confirms the hypothesis, H1. The mass event held at the mooring point of so many vessels required the use of a non-standard procedure. In the analyzed case, the changes were mainly related to the waste collection hours. In addition, it should be mentioned that the company collecting the waste had to make some modifications in its standard activities, because it was struggling with operational problems resulting from the need to adjust the area to the event, and the servicing of non-standard vessels. Such problems included, for example, the inability to reach the Wały Chrobrego coast. This forced the necessity for collecting liquid waste through a hose with a length of 100 m, which resulted in a long flow time, and was of considerable difficulty with such a large number of serviced vessels. Another problem was the occurrence of non-standard types of joints on some ships, which extended the assembly of waste collection devices, and required special supervision over the process of waste flow. The tall ships were often moored at the quays, which are not normally used to service such vessels. Their technical parameters made it impossible to collect waste with large vehicles. Therefore, the company had to provide smaller forms of transport, increasing their number. However, the introduction of the described changes allowed the avoidance of conflicts with other entities involved in the service of the event, as well as not having a negative impact on its course, which confirms the hypothesis, H2.

The analysis of the structure of the amount of waste collected showed that the most solid waste was disposed of on the last day, while the most liquid waste was collected on the day before the final day. Not all vessels disposed of waste. Solid waste was disposed of by 59% of tall ships, and liquid waste by 19%. The analysis of the structure of the amount of waste collected was carried out for two cases. In the first case, all of the vessels were included, including those with a zero value of the disposed waste. In the second case, only those tall ships that disposed of the waste were taken into account. The average values for the vessels of liquid and solid wastes collected in two indicated misses were obtained. The generated distributions and the designated statistical indicators show a large dispersion of the amount of waste disposed by tall ships. However, when analyzing the distribution of the number of vessels in individual quays for subsequent days, it can be concluded that none of the vessels left earlier. An exception was seen in one vessel, which arrived on the day before the final, and left the same day. On the other hand, changes in the placement of the moored vessels were short, and they occurred only on the last day of the final. It should be noted that this study of the amount, and the structure of waste collected during the Tall Ships Races finals in Szczecin is the

only such study that has been carried out. Guided by the results of the research conducted, we can propose recommendations regarding the proper organization of the waste collection. In the first place, a flexible waste collection procedure should be created, as well as an appropriate communication process between all entities involved in this process. In this respect, the flow of information at the operational level is also important, e.g., directly between the company that is collecting the waste, and the captain of the vessel. Earlier information about, for example, the parameters of the waste disposal facilities owned by the tall ships could shorten the time of waste collection and minimize the risk of complications. It is also necessary to monitor the entire process, and to collect and analyze data on the amount and type of waste collected, as this can form the basis for planning future activities.

The presented results will be used to analyze the collection of a possible amount of waste when organizing mass events that are similar in character to the Tall Ships Races.

Using the knowledge in this article, authorities can prepare waste collection in an appropriate way, and determine the scale of the amount of waste that is disposed by vessels that can be expected when organizing these types of mass events. Apart from practical implications, in a broader perspective, the research presented in this article may become an important contribution to the development of sustainable tourism. It draws attention to a very important issue that is related to waste collection from tourist vessels, which is usually overlooked in a scientific study. For this reason, the research presented in this article is unique in nature.

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## References

1. Luković, T. *Nautical Tourism*; CABI: Wallingford, UK, 2013; ISBN 178064244X.
2. Jennings, G. Water-based tourism, sport, leisure, and recreation experiences. In *Water-Based Tourism, Sport, Leisure, and Recreation Experiences*; Routledge: Abingdon-on-Thames, UK, 2007; pp. 19–38.
3. Tanguay, G.A.; Rajaonson, J.; Therrien, M.-C. *Sustainable Tourism Indicators: Selection Criteria for Policy Implementation and Scientific Recognition*; Centre Interuniversitaire de Recherche en Analyse des Organisations, CIRANO-Scientific Publication: Montréal, QC, Canada, 2011; pp. 5–60.
4. Jeftić, L.; Sheavly, S.; Adler, E. *Marine Litter: A GLOBAL Challenge*; United Nations Environment Programme (UNEP): Nairobi, Kenya, 2009; ISBN 978-92-807-3029-6.
5. Beza, P.E.; Kitsantas, T.D.; Mitselos, F.A. Ship Waste Management in the Port of Igoumenitsa. *J. Phys. Sci. Appl.* **2014**, *4*, 375–380.
6. Liu, Z. Sustainable tourism development: A critique. *J. Sustain. Tour.* **2003**, *11*, 459–475. [CrossRef]
7. Presburger-Ulniković, V.; Vukić, M.; Jančić-Heinemann, R.; Antonović, D. Ship waste quantities prediction model for the port of Belgrade. *Chem. Ind. Chem. Eng. Q./CICEQ* **2011**, *17*, 239–248. [CrossRef]
8. Prof. Zarzecki: Organizacja The Tall Ships Races w Szczecinie była Strzałem w Dziesiątkę. Available online: <http://www.gospodarkamorska.pl/Rybolowstwo/prof-zarzecki-organizacja-the-tall-ships-races-w-szczecinie-byla-strzałem-w-dziesiątkę.html> (accessed on 23 September 2018).
9. Wyniki i Interpretacja Badania Ankietowego—Załącznik nr 1 do raportu “Wpływ Finału Regat the Tall Ships Races 2017 na Gospodarkę Miasta Szczecin”. Available online: [http://bip.um.szczecin.pl/UMSzczecinFiles/file/TTSR\\_2017\\_20171129\\_-\\_Zalacznik\\_nr\\_1\\_.pdf](http://bip.um.szczecin.pl/UMSzczecinFiles/file/TTSR_2017_20171129_-_Zalacznik_nr_1_.pdf) (accessed on 18 September 2018).
10. Szczecin Stał na Wysokości Zadania! Available online: <http://tallships.szczecin.eu/pl/812-szczecin-stal-na-wysokosci-zadania> (accessed on 17 September 2018).
11. Klimczak, M. The Tall Ships Races 2017 Dużym Sukcesem Miasta. Available online: <https://gs24.pl/the-tall-ships-races-2017-duzym-sukcesem-miasta/ar/12448908> (accessed on 15 August 2018).

12. Slišković, M.; Ukić, H.; Božić, K. Assessment of Solid Waste from Cruise Ships in the Port of Split. *Trans. Marit. Sci.* **2016**, *5*, 155–160. [CrossRef]
13. Svaetichin, I.; Inkinen, T. Port waste management in the Baltic Sea area: A four port study on the legal requirements, processes and collaboration. *Sustainability* **2017**, *9*, 699. [CrossRef]
14. Carić, H. Cruising tourism environmental impacts: Case study of Dubrovnik, Croatia. In *MCRR3–2010 Conference Proceedings, Journal of Coastal Research, Special Issue, No. 61*; Micallef, A., Ed.; Grosseto: Tuscany, Italy, 2011; pp. 104–113. ISSN 0749–0208. Available online: <http://www.bioone.org/doi/abs/10.2112/SI61-001.2> (accessed on 15 August 2018).
15. Carić, H. Cruise tourism environmental risks. In *Cruise Tourism and Society*; Springer: Berlin, Germany, 2012; pp. 47–67.
16. Dowling, R.K. The cruising industry. In *Cruise Ship Tourism*; Dowling, R.K., Ed.; CABI: Wallingford, UK, 2006; pp. 3–17.
17. Czajewski, J. *Encyklopedia Żeglarska*; Polskie Wydawnictwo Naukowe (PWN): Warszawa, Poland, 1996.
18. Kolaszewski, A.; Świdwiński, P. *Żeglarz Jachtowy i Jachtowy Sternik Morski*; Oficyna Wydawnicza Alma-Press: Warszawa, Poland, 2017.
19. Ustawa z Dnia 18 Sierpnia 2011 r. o Bezpieczeństwie Morskim (Dz.U. 2011 nr 228 poz. 1368). Available online: <http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20112281368/T/D20111368L.pdf> (accessed on 15 August 2018).
20. Dolgen, D.; Alpaslan, M.N.; Serifoglu, A.G. Best waste management programs (BWMPs) for marinas: A case study. *J. Coast. Conserv.* **2003**, *9*, 57–63. [CrossRef]
21. Bilski, M. Selected human factors in marina design. *Procedia Manuf.* **2015**, *3*, 1646–1653. [CrossRef]
22. Čorić, D.; Padovan, A.V.; Čičovački, L. Prevention of pollution by yachts' sewage in the ports of nautical tourism—The legal framework. In *IMSC2017 Book of Proceedings*; Faculty of Maritime Studie: Split, Croatia, 2017; pp. 381–394.
23. Malinowska, M. Koncepcja zarządzania odpadami w nowoczesnej marinie. *Zesz. Nauk. Akad. Morskiej w Gdyni* **2012**, *76*, 45–53.
24. Kişi, H. Contingency planning in marina management. In *Proceedings of the First International Joint Symposium on Business Administration, Gokceada, Turkey, 1–3 June 2000*; Available online: <http://joanes.opf.slu.cz/vvr/akce/turecko/pdf/Kisi.pdf> (accessed on 12 August 2018).
25. Min Jet, L.O.O.; Demirel, M.C.; Anita, G.; Jayasinghe, R.P.P.K. *The Impact of Marinas on the Coastal Zone*; INUAF STUDIA-Instituto Universitário Dom Afonso III. Suplemento 16, Scientiae Rerum Diffusio: Loulé, Portugal, 2009; pp. 25–27. ISBN 978-989-8334-00-8.
26. Batyk, I.M. Potrzeba ochrony środowiska w województwie warmińsko-mazurskim związana z rozwojem działalności turystycznej. *Infrastruktura i Ekologia Terenów Wiejskich* **2013**, *1*, 7–16.
27. Pardali, A.; Sakellariadou, F. *Economic and Environmental Impacts from the Operation of Marinas: The Greek Case*; Marine Engineering and Ports II; WIT Press: Southampton, UK, 2000; pp. 219–229. ISSN 1732-5587.
28. Sevinç, F.; Güzel, T. Sustainable yacht tourism practices. *Manag. Mark. J.* **2017**, *15*, 61–76.
29. Borčić, L.; Slišković, M.; Mrčelić, G.J. Ecological aspects of nautical tourism. In *Proceedings of the 5th International Marine Science Conference, Faculty of Maritime Studies: Split, Croatia, 22–23 April 2013*; pp. 109–112.
30. Herdt, A.; Brown, R.; Scott-Fleming, I.; Cao, G.; MacDonald, M.; Henderson, D.; Vanos, J. Outdoor Thermal Comfort during Anomalous Heat at the 2015 Pan American Games in Toronto, Canada. *Atmosphere* **2018**, *9*, 321. [CrossRef]
31. Krul, J.; Sanou, B.; Swart, E.L.; Girbes, A.R.J. Medical care at mass gatherings: Emergency medical services at large-scale rave events. *Prehosp. Disaster Med.* **2012**, *27*, 71–74. [CrossRef] [PubMed]
32. Łapko, A. Urban tourism in Szczecin and its impact on the functioning of the urban transport system. *Procedia Soc. Behav. Sci.* **2014**, *151*, 207–214. [CrossRef]
33. Pérez, I.; González, M.M.; Jiménez, J.L. Size matters? Evaluating the drivers of waste from ships at ports in Europe. *Transp. Res. Part D Transp. Environ.* **2017**, *57*, 403–412. [CrossRef]
34. Międzynarodowa Konwencja o Zapobieganiu Zanieczyszczaniu Morza Przez Statki, 1973, Sporządzona w Londynie Dnia 2 Listopada 1973 r. Wraz z Załącznikami I, II, III, IV, i V, Oraz Protokół z 1978 r. Dotyczący tej Konwencji, wraz z Załącznikiem I, Sporządzony. Available online: <http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU19870170101/O/D19870101.pdf> (accessed on 15 August 2018).

35. Protokół z 1997 r. Uzupełniający Międzynarodową Konwencję o Zapobieganiu Zanieczyszczaniu Morza Przez Statki, 1973, Zmodyfikowaną Przynależnym do Niej Protokółem z 1978 r. (Dz.U. 2005 nr 202 poz. 1679). Available online: <http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20052021679/O/D20051679.pdf> (accessed on 15 August 2018).
36. Konwencja o Zapobieganiu Zanieczyszczaniu Mórz Przez Zatapianie Odpadów i Innych Substancji, Sporządzona w Moskwie, Waszyngtonie, Londynie i Meksyku dnia 29 grudnia 1972 r. (Dz.U. 1984 nr 11 poz. 46). Available online: <http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU19840110046/O/D19840046.pdf> (accessed on 15 August 2018).
37. Konwencja o Ochronie Środowiska Morskiego Obszaru Morza Bałtyckiego, Sporządzona w Helsinkach dnia 9 Kwietnia 1992 r. (Dz.U. 2000 nr 28 poz. 346). Available online: <http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20000280346/T/D20000346L.pdf> (accessed on 15 August 2018).
38. Sail Training International History. Available online: <https://sailtraininginternational.org/sailtraining/origins> (accessed on 7 July 2018).
39. Orfin, K. Creating the image of tourist destination on events example. Case study-The Tall Ships' Races 2007 and 2013 in Szczecin. *Zesz. Naukowe Uniw. Szczec. Ekonom. Probl. Tur.* **2014**, *2*, 233–246.
40. Polsteam Shipping Agency—internal company documents. Available online: [www.polsteamagency.pl](http://www.polsteamagency.pl) (accessed on 8 July 2018).
41. Wybierz Dzień. Available online: <http://tallships.szczecin.eu/pl/co-gdzie-kiedy/73-co-gdzie-kiedy/program-imprezy/niedziela-06-08-2017> (accessed on 8 December 2018).
42. Rozporządzenie Ministra Gospodarki Morskiej i Żeglugi Śródlądowej z dnia 4 Listopada 2016 r. w Sprawie Przekazywania Informacji o Odpadach Znajdujących się na Statku (Dz.U. 2016 poz. 1851). Available online: <http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20160001851> (accessed on 8 July 2018).
43. Plan Gospodarowania Odpadami Oraz Pozostałościami Ładunkowymi Ze Statków W Porcie Morskim w Szczecinie. Available online: [http://port.szczecin.pl/files/port/pdf/PGO\\_SZ.PDF](http://port.szczecin.pl/files/port/pdf/PGO_SZ.PDF) (accessed on 8 July 2018).
44. Espadon Sp. z o.o.—internal company documents. Available online: <http://www.espadon.net.pl/> (accessed on 8 July 2018).
45. World Tourism Organization (WTO). *Guide for Local Authorities on Developing Sustainable Tourism*; World Tourism Organization: Madrid, Spain, 1998.



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