Journal of *Marine Science and Engineering*

MDPI

Article

A Methodological Proposal for the Management of Submerged Cultural Heritage: Study Cases from Cartagena de Indias, Colombia

Diana María Quintana-Saavedra [1,2,*], Rafael Ricardo Torres-Parra [3], Richard Guzmán-Martínez [1], Giorgio Anfuso [4,*], Juan Jose Muñoz-Pérez [4], Saul Vallejo [1] and Bismarck Jigena-Antelo [4]

[1] Underwater Cultural Heritage Group, Colombian National Maritime Directorate (DIMAR), Bogotá 111321, Colombia
[2] Facultad de Ciencias Naturales e Ingeniería, Universidad Jorge Tadeo Lozano, Bogotá 110311, Colombia
[3] Grupo de Investigación en Geociencias GEO4, Departamento de Física y Geociencias, Universidad del Norte, km 5 vía Puerto Colombia, Barranquilla 081007, Colombia
[4] Campus de Puerto Real, Universidad de Cádiz, CASEM, Puerto Real, 11510 Cádiz, Spain
* Correspondence: dianam.quintanas@utadeo.edu.co or diana.quintana@dimar.mil.co (D.M.Q.-S.); giorgio.anfuso@uca.es (G.A.)

Abstract: This paper proposes a comprehensive methodology for the management of submerged cultural heritage sites despite their worldwide location. The methodology is applied to four colonial shipwrecks located in Cartagena de Indias Bay (Colombia), two of them in the Inner Bay and two in the Bocachica sector. Five criteria are used and scored from 1 (indicating a low risk for the wreck) to 5 (high risk). The sum of the scores obtained at each criterion ranges from 5 to 25, and when the value obtained is higher than 15, management action is required. Five criteria were analyzed; (i) The historical criterion is based on the antiquity of the wreck. The ones investigated in this paper are associated with the Battle of Cartagena de Indias (A.D. 1741), having been submerged for ~280 years (all wrecks obtained a score of 3); (ii) The geographical criterion concerns the depth at which the wreck is located, which determines its accessibility. In Cartagena Bay, wrecks are situated at a water depth between 15.6 and 29.7 m (all wrecks were scored 4); (iii) The shipwreck condition criterion indicates the level of preservation, including organic and inorganic material, distinguishing among wooden hulls, ballast stones, and cannons. Obtained scores were 4 and 3 for the wrecks, respectively, located in the Inner Bay and in the Bocachica sector. (iv) The oceanographic criterion, linked to chemical and biological conditions of the water column, influences wreck conservation. All wrecks investigated scored 5. (v) The socioeconomic criterion indicates the multiple maritime and cultural activities presently taking place that might affect the wreck. In Cartagena Bay, all wrecks were scored 4. According to the total score obtained (20—Inner Bay and 19—Bocachica sector), guidelines for shipwreck conservation of cultural heritage in Cartagena Bay are proposed.

Keywords: shipwreck; conservation; marine spatial planning

Citation: Quintana-Saavedra, D.M.; Torres-Parra, R.R.; Guzmán-Martínez, R.; Anfuso, G.; Muñoz-Pérez, J.J.; Vallejo, S.; Jigena-Antelo, B. A Methodological Proposal for the Management of Submerged Cultural Heritage: Study Cases from Cartagena de Indias, Colombia. *J. Mar. Sci. Eng.* **2023**, *11*, 694. https://doi.org/10.3390/jmse11040694

Academic Editor: Rodger Tomlinson

Received: 1 March 2023
Revised: 19 March 2023
Accepted: 21 March 2023
Published: 24 March 2023

1. Introduction

The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines Underwater Cultural Heritage (UCH) as all traces of human existence (e.g., prehistoric structures, artefacts, shipwrecks and/or objects) of a cultural, historical, or archaeological nature that, for at least 100 years, have been partially or totally immersed, periodically or permanently, in oceans, lakes, and rivers [1]. At present, coastal countries seek to formulate management plans for their territories to conserve and/or protect their UCH sites, including shipwrecks that lie on the seabed. However, the management of each one of them becomes a challenge due to the complexity of the surrounding geographical environment [2,3], which makes each site unique [4].

The UCH is an invaluable source of knowledge for humanity as it allows data to be collected for the reconstruction of different kinds of historical maritime events [5,6]. To accurately understand a particular event related to a shipwreck, investigations in different fields need to be performed [7,8]. First, it is important to collect historical information related to the events that brought about the shipwreck formation. In the world, there are different repositories of historical information from the colonial era, such as the General Archive of the Indies in Seville and the History Museum in Madrid, both in Spain and, in Colombia, the Luis Ángel Arango Library and the General Archive of the Nation in Bogotá, among others. In addition, information from oral sources involving local communities is also important, as their knowledge might be useful for describing and reconstructing historical scenarios in a direct way [9].

Second, it is necessary to investigate the geographical context where the UCH rests. The shipwreck's location and depth, its distance from the coastline, and the possible influences on it of actual socioeconomic activities need to be characterised. To achieve such objectives, it is of paramount relevance to adequately define the platforms and equipment required to study the shipwreck site [10].

Third, once the geographic context has been characterized, it is necessary to identify the actual conditions of the wreck site within the seabed environment. This activity requires the use of non-intrusive techniques, which might include the use of geophysical sensors and diving inspections [11–13]. Understanding this context is essential to define preservation or conservation strategies [2,14].

Fourth, the aquatic environment influences the matter transformation process in different ways [5]. The main variables that affect objects in the seabed are seawater conditions, such as temperature, pH, level of nutrients, as well as sediment characteristics and dynamics [15,16]. Presently, there are different comprehensive networks to monitor aquatic conditions and their variability close to underwater assets of cultural interest [10]. They require interdisciplinary approaches to assess oceanic conditions and, in most cases, obtained results allow the formulation of specific management plans [17]. Unfortunately, the cost of a comprehensive and interdisciplinary monitoring program is often a limitation for the long-term sustainability of management plans [18].

Once all the above-mentioned information is available, it is possible to formulate a sound management model to preserve the elements that make up the UCH site. Such a model needs to balance the preservation of the shipwreck material [19], its physical and legal protection [20], and the accessibility of the society to the historical and cultural frame of the site, among other aspects. Further, a sound UCH management model needs to be harmonised with actual socioeconomic activities and land use plans [21]. Therefore, each UCH management plan is unique, based on the own particular conditions of each wreck and the national policies of the country in which is it located.

This article proposes a methodology based on the analysis and scoring of the five most relevant criteria for the characterization and management of UCH sites. It should be noted that the proposed methodology can be applied anywhere in the world where similar basic information is available. This paper applied it to four colonial shipwrecks located in the Bay of Cartagena de Indias, Colombia, to illustrate its relevance and easy applicability.

2. Study Area

Cartagena Bay (Colombia) is located in the northeast of South America, in the Caribbean Sea, between latitudes 10.26° N and 10.45° N and longitudes 75.5° W and 75.6° W (Figure 1). In 2019, Cartagena de Indias population showed more than one million inhabitants, and its bay is, at present, considered a strategic place for the economy of Colombia since it holds important ports, industry and truism activities. Tierra Bomba Island separates the Bay from the Caribbean Sea, forming a shallow basin of 84 km^2, with an average depth of 26 m. The access to the Bay takes place through the Bocagrande and Bocachica entrances. The former is located on the northern side of the bay, while the latter, which is deeper and allows the entry of larger ships since colonial times, is located on the southern side. The Bay presents

estuarine characteristics [22] because it is influenced by the Canal del Dique, an artificial arm of the Magdalena River.

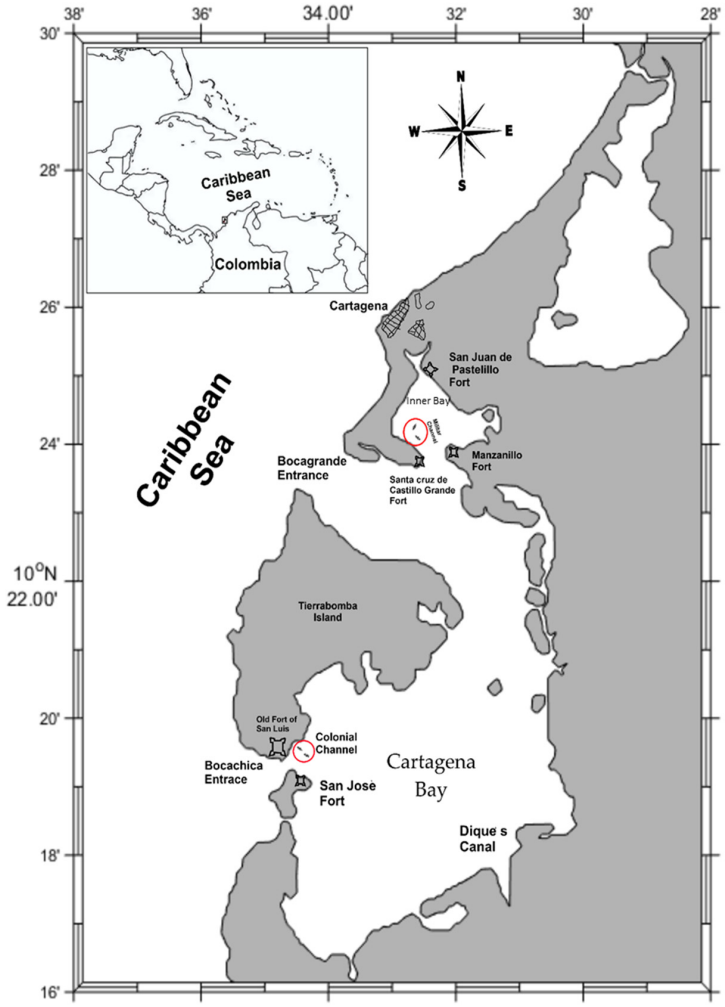

Figure 1. Location of the study area, Cartagena de Indias Bay, Colombia. The four shipwrecks are highlighted with two red circles and are located in the Inner Bay (*Conquistador* and *Dragón*) and in Bocachica (*África* and *San Carlos*).

The studied wrecks were Spanish ships sunk in the Battle of Cartagena de Indias in A.D. 1741 when the English army attacked the city. The wrecks are *San Carlos* and *África* ships, sunk at the Bocachica entrance and *Conquistador* and *Dragón* ships in the Inner Bay, in front of Manzanillo Fort (Figure 1).

During the Colonial period, Cartagena de Indias was one of the most important cities of the Spanish Empire in America. At present, the city is recognized by UNESCO as a world heritage site due to the historical importance of its port, forts, and other surviving remains of military constructions emplaced under Spanish domination, mostly in the 17th century. The historical importance of Cartagena is also related to several shipwrecks lying at the bottom of the Bay as evidence of different naval battles that took place during the above-mentioned century [23–25].

3. Methodology

This paper presents a new methodological proposal for the management of submerged cultural heritage sites based on the assessment of five criteria (Table 1) selected according to manuals and guidelines proposed by UNESCO [21,26]. A few existing methods used different criteria to assess the heritage evaluation and significance of historic shipwrecks [14,27].

Selected criteria in this paper fulfil the following relevant issues: (i) they accurately assess the conditions of a specific UCH site from different perspectives; (ii) they show solid technical bases to support an evaluation on a numerical scale objectively; (iii) they are easy to follow and apply; and (iv) they can be used in different locations and contexts. Therefore, the selected criteria and their numerical evaluation constitute a novelty and original proposal based on an extensive bibliographic review (summarized in Table 1). Despite the above, the methodology proposed still presents a low subjective component that is difficult to eliminate in such a typology of studies and evaluations.

Table 1. Methodological approximation used to decide actuations to manage submerged cultural heritage sites soundly.

Criterion (Used References)	Question	Assigned Value and Meaning
C1—Historical [1,21,28–30]	Is it important to study and manage the site, given its historical relevance?	1. Very low importance, ≤100 yr. 2. Low importance, >100 yr, ≤200 yr. 3. Medium importance, >200 yr, ≤300 yr. 4. High importance, >300 yr, ≤400 yr. 5. Very high importance, >400 yr.
C2—Geographic [14,31]	How deep and how difficult is it to gain access to the wreck? (The shallower the wreck, the easier the access and greater the need for a management plan)	1. Depth >1000 m, very difficult access. 2. Depth between 200 and 1000 m, difficult to access. 3. Depth between 50 and 200 m, complex access. 4. Depth <50 m, access of moderate difficulty. 5. Located in the intertidal zone, very easy access.
C3—Shipwreck condition [32–36]	Do the remains observed/mapped on the sea floor by means of visual inspections or geophysical investigations correspond with a shipwreck (categories according to Gibbs [36])?	1. Insignificant, none of the categories is observed. 2. Moderately correspond, one category is observed. 3. Medium compatible, two categories are observed. 4. Extremely compatible, three categories are observed. 5. Totally compatible, four categories are observed.
C4—Oceanographic [37–39]	Are the physical, chemical, and biological water parameters potentially unfavourable for the conservation of the shipwreck (according to the existing literature)? (The larger the negative effect of the environmental conditions on the wreck, the greater the need for a management plan)	1. Minimal effects, one variable is unfavourable. 2. Low effects, two variables. 3. Medium effects, three variables. 4. High effects, four variables. 5. Very high effects, five variables are unfavourable.
C5—Socioeconomic [21,40–43]	How many of the most frequent uses reported by UNESCO [31] in terms of Marine Spatial Planning are carried out near Underwater Cultural Heritage sites?	1. Minimal risk of affection, less than three activities observed, and none of them is considered potentially dangerous. 2. Reduced risk of affection, between three and six activities, two to three are potentially dangerous. 3. Average risk of affection, between seven and eleven activities, four to five are potentially dangerous. 4. High risk of affection, between twelve and sixteen activities, six to seven are potentially dangerous. 5. Very high risk of affectation; between sixteen and twenty activities, eight or more are potentially dangerous.

The assessment of mentioned criteria is useful to identify sound actions/strategies to manage/preserve the heritage sites adequately. The five proposed criteria concern the historical and geographical aspects of the wreck, the shipwreck conditions, the oceanographic aspects of the environment in which the wreck is located and the socioeconomic activities carried out in nearby areas. Each criterion is scored from 1 (Low relevance, i.e., low risk for the wreck) to 5 (Very high relevance, Table 1). The total score obtained is used to decide the best management option: a score <15 indicates favourable conditions, i.e., no action is required, while a score >15 indicates the necessity of adopting sound conservation strategies (*in situ*, *ex situ*, or relocation option). Last, the method was tested at four shipwrecks placed in the Cartagena de Indias Bay, Colombia.

3.1. Historical Criterion

The five intervals proposed in this paper reflect the historical importance of the shipwreck according to its period of submergence, a relevant aspect considered by UNESCO [1] (Table 1). Concerning the study cases in the Bay of Cartagena de Indias, the methodology proposed by Quintana-Saavedra et al. [28] was used to understand the origin of the shipwrecks and their historical significance. In the referenced study, different aspects were considered, such as the context of the battle, the participating countries, the dimensions, and other relevant characteristics of the ships. To reconstruct the cultural context of the shipwrecks, were examined different databases, including documents from the General Archive of the Indies in Seville (Spain) and the Luis Angel Arango Library in Bogota (Colombia). Similarly, the National Library of France (Acronym Gallica), the Osher Map Library, and the Smith Center for Cartographic Education Smith (OML) web pages were consulted. All the documents and maps indicate the particular perspective of the authors; therefore they have a component of bias. This material was rigorously analysed and compared with different sources to reduce author bias and place it in the proper context [21].

3.2. Geographic Criterion

In this paper, in order to quantify in an objective and numerical way the geographic criterion, it was taken into account the depth at which the shipwreck is located, which is a relevant issue according to Maarleveld et al. [21]. Five possibilities were proposed (Table 1). The 50 m water depth limit is established due to the safe physiological limits of autonomous diving [44]. In this study case, the geographical location of the UCH sites is indicated in Figure 1. Based on cartographic information, aspects such as the wrecks' depths, their proximity to the coastline and their location in relation to two still existing colonial forts in the Bay, i.e., San Fernando Fort, in Bocachica and Santa Cruz Fort in the Inner Bay (Figure 1).

3.3. Shipweck Condition Criterion

Different techniques and tools exist to characterise shipwreck conditions. In this paper, two technics were used:

- Non-intrusive inspection with autonomous diving. The purpose of this inspection was to recognise the elements associated with the shipwrecks and their state of conservation, both in Bocachica and in the Inner Bay. For the purposes of this work, diving was carried out following the guidelines of the Nautical Archaeological Society (NAS).
- Hydrographic and geophysical characterisation. A MultiBeam EchoSounder (MBES Konsberg 2040C) and Side Scan Sonar (SSS Pulsar 200) were used to map the seabed. Methodological details are given by Quintana-Saavedra et al. [28].

The characteristics according to which a shipwreck is defined (Table 1) are based on the categories proposed by Gibbs [36] (Table 2). These categories are not strictly hierarchical and allow to determine if remains on the seabed are from a "real" wreck, e.g., the presence on the sea bottom of rocks used as ballast is not necessarily linked to a shipwreck. Direct visual examination (by diving) and indirect inspections (by means of MultiBeam and/or Side Scan Sonar) allow for determining the presence and physical conditions of the different

categories proposed by Gibbs [36]. It is not always possible to identify all mentioned categories at a determined wreck. Special attention has to be devoted to locating the main structures of the shipwreck and their present general state. If possible, other specific and detailed investigations are recommended to assess the chemical state of conservation of the different parts of the wreck [45].

Table 2. Categories constituting a shipwreck, adapted from Gibbs [36].

Presence/Absence	Materials
Cargo and Contents	Removable elements, including the ship's boats and life-rafts
Fixtures and Fittings	Minor fixed items, fittings, yards, chains, anchors and cannons, minor mechanical items and equipment
Minor Structural	Items not normally removed but whose removal would not compromise the integrity of the hull, such as bulkheads, decks, masts, superstructure, major mechanical items, and equipment
Major Structural	Elements of the ship whose removal would affect the integrity of the ship, including hull planking, ribs, and other structural items

3.4. Oceanographic Criterion

The oceanographic criterion concerns the physical, chemical, and other characteristics of the water column, which define the environmental conditions in which the wreck rests. In this paper, chemical, physical, and biological variables of the water column were assessed in two seasons and by different techniques (Tables 1 and 3). Data recorded during March and August correspond to the oceanographic conditions characterising the dry and wet seasons, respectively.

Table 3. Techniques used to measure considered physicochemical and biological variables in the investigated sites. Their effects on the shipwrecks are also presented.

		Technics			Intervals That Generate Changes in Shipwrecks		
Variable	**Unit**	**Technical**	**Method**	**Method**	**Interval**	**Effect**	**Source**
Temperature (T °C)	°C	Parametric sensor	In Situ	CTD	≥10 °C	Degradation processes are accelerated	[46]
pH	Unit pH	Parametric sensor	In Situ	SM4500-H + B/CTD	7.4 and 8.3	White rot process in wood and process of corrosion of metallic materials	[47]
Total Suspended Solids (TSS)	mg/L	Gravimetry	Filtration and Drying 104 °C ± 1 °C	SM 2540 D. Pp 2–66 a 2–67	Unknown	Changes in the coverage rate of the sites	[48]
Dissolved Oxygen (DO)	mg/L	Parametric sensor	In Situ	SM 4500-O-G Pp 4–143 a 4–145./CTD	≤4 mg/L	Proliferation of organisms adhering to objects and growth of *Teredo Navalis*	[46]
Salinity (Sal.)	Adimensional	Parametric sensor	In Situ	SM 2520 B./CTD	17 and 39	Increase of the degradation processes of materials that alter their stability (according to the availability of different ions), generating corrosion or concretion processes; favour the growth of organisms, e.g., woodworms	[45]

Two sources of data were used to describe the general oceanographic conditions in Cartagena Bay. First, oceanic data was collected in 2006, 2010, and 2014 and are available from Colombia's Maritime Authority (DIMAR in Spanish) repository (https://cecoldo.dimar.mil.co/web, accessed 3 February 2020). Second, data were obtained during two sampling campaigns in the four wreck sites in November 2017 and March 2018. Data were collected at depths of 1, 10, and 15 m, as described in Table 3.

3.5. Socioeconomic Criterion

This is an essential criterion related to UCH management as it allows the evaluation of socioeconomic activities that takes place in the actual surroundings of the shipwrecks and may constitute a risk for the site. The greater the number of activities or their intensity, the greater the risk for the UCH site. Therefore, an understanding of the present marine activities is necessary to define adequate management/protection measurements.

Marine spatial planning is an important tool for coordinating multiple activities carried out simultaneously in the same maritime space. This essential tool has been recently used to manage UCH sites [31,41], this way confirming the relevance of harmonising the conservation of UCH sites according to the socioeconomic activities carried out in nearby areas.

To assess this criterion, were suggested two complementary approaches. First, assess the presence/absence in correspondence of the shipwreck sites of the 20 most frequent activities in the maritime territory listed by the Marine Spatial Planning policy [31]. Second, assess potentially dangerous activities observed at the site, which are referenced in Maarleveld et al. [21].

4. Results

A management model for submerged cultural heritage seeks its protection and conservation by reducing the impact related to the present use given to the aquatic space where it is placed [49]. Although each country is free to determine its own UCH management methodological proposal, there are several academic approximations regarding the minimum aspects that must be considered. This paper proposes a management model based on five criteria that were applied to four shipwrecks placed in the Cartagena de Indias Bay in order to establish sound management/conservation strategies.

4.1. Historical Criterion

Historical information was collected from different sources to establish a general view of the shipwrecks' importance [23,24,50]. The documents written by De Lezo [29] and Beatson [30] that narrate the A.D. 1741 Battle of Cartagena de Indias from a Spanish and English perspective are of special relevance. Such texts state that on the 13 March 1741, two English ships were identified on the horizon crossing the Caribbean Sea, heading toward the Bay. On the 5 April, De Lezo, who was in charge of the city defence, decided to sink the ships *San Carlos* and *África* to block access to the Bay through the colonial channel in the Bocachica sector. On the 11 April, the ships *Conquistador* and *Dragón* were sunk to block the military channel through which the Inner Bay is accessed [29]. The historical cartography from Bellin et al. [51–54] is also very useful, as it describes the characteristics of the ships involved in the battle, indicating their condition after the confrontation (i.e., if they sunk or were still afloat), the location of both the Spanish and English fleets and the name of the ships of the Spanish fleet.

It was assigned a score of 3 (medium importance) to the historical criterion (Table 4) since the wrecks were Spanish ships from the eighteenth century and participated in the battle of A.D. 1741. Therefore these wrecks sunk between 200 and 300 years ago.

4.2. Geographic Criterion

Addressing the geographical context in which the shipwrecks in Cartagena Bay are found consisted of understanding their spatial location, depth, position with respect to the continental margin, and other points of cultural interest [2,31]. Table 5 shows a description of the location of the wrecks, including their proximity to the coastline and the depth at which they are found. Their exact geographic positions are not reported herein to preserve the wrecks.

In accordance with the information available, a value of 4 is assigned to this criterion, following the guidelines in Table 1. Since the wrecks are found at a depth < 50 m, the score

indicates that the access to the UCH sites is of moderate difficulty and, therefore, of high risk for conservation (Table 4).

Table 4. Values of considered criterion for the Cartagena Bay study cases.

	Inner Bay			Bocachica Sector		
Criterion	***Conquistador***	***Dragón***	**Assigned Value and Meaning**	***África***	***San Carlos***	**Assigned Value and Meaning**
C1—Historical	3	3	Medium importance, >200 yr, ≤300 yr	3	3	Medium importance, >200 yr, ≤300 yr
C2—Geographic	4	4	Depth < 50 m− moderate access	4	4	Depth < 50 m—moderate access
C3—State of the shipwrecks	4	4	High, extremely compatible—three categories are observed	3	3	Medium compatible—two categories are observed
C4—Oceanographic	5	5	Very high effects, five variables are unfavourable	5	5	Very high effects, five variables are unfavourable
C5—Socioeconomic	4	4	High risk of affection, between twelve and sixteen activities, six to seven are potentially dangerous	4	4	High risk of affection, between twelve and sixteen activities, six to seven are potentially dangerous
Total	**20**	**20**		**19**	**19**	

5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
No intervention required													**Need to conserve**							

Table 5. Geographical description of the areas associated with the four shipwrecks.

	Inner Bay		Bocachica	
Description	***Conquistador***	***Dragón***	***San Carlos***	***África***
Distance to a known point since the 18th century	477 m from Santa Cruz de Castillo Grande Fort	384 m from Santa Cruz de Castillo Grande Fort	292 m from San Fernando Fort	319 m from San Fernando Fort
Average Depth	15.6 m	20 m	29.7 m	23.3 m
Distance between wrecks	57 m		98 m	

4.3. Shipwreck Condition Criterion

Once the geographic and historical context has been identified, visual inspection and the use of geophysical sensors are used to describe the wrecks' conditions, such as their type and dimensions, the size of the investigated area, and the presence/relevance of sedimentation processes [32,33]. Despite the fact that the shipwrecks investigated have been submerged for about 280 years, it was possible to identify and characterize their remains on the seabed by means of different tools.

Non-intrusive inspection with autonomous diving. The sites have evidence of organic material (wood) and inorganic material (ballast rocks). Additionally, encrusting organisms are observed, such as sponges and algae, to have adhered to the wooden structures, which indicates the presence of a consolidated biofilm (Figure 2) that can affect the chemical conditions of the woody elements. This aspect needs to be deeper evaluated in future investigations. However, the wrecks still retain their shape, which is partly due to the exigent Spanish regulations at the time of their construction, for example, in the selection of materials, in this case, in wood of excellent quality [34,55,56]. Lastly, it is important to mention that no objects with precious metals or with high commercial value were observed; therefore, the material found has a cultural value (Figure 2) exclusively.

Hydrographic and geophysical characterisation. Data obtained by means of MBES and SSS investigations showed a different level of sedimentation for the two places where the wrecks are located. Figure 3 shows MBES images. In the case of the Inner Bay, the materials associated with the wrecks are exposed on the seabed. In Bocachica, materials are partially covered, which indicates that the sedimentation dynamics are different in the two areas [57].

Figure 2. Natural context of the ship, El Conquistador, in the Inner Bay in Cartagena Bay. In the image, a wooden piece of the shipwreck is observed.

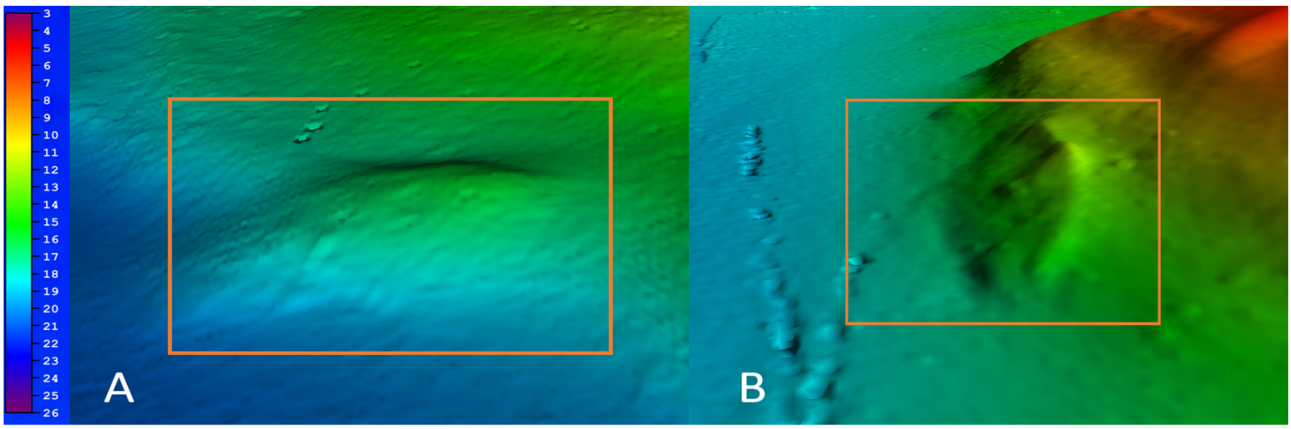

Figure 3. Bathymetric surface surveyed with an MBES. In the image, two ships are visible with respect to coverage; note the differences in the orange colouring in Box (**A**). Bocachica, the ship (*África*) is covered. In Box (**B**), the ship in the Inner Bay (Conquistador) is uncovered. The colour scale indicates the depth in metres.

Table 6 shows the different elements and characteristics associated with the shipwrecks. The lengths of the wrecks range between 30.9 and 40.5 m depending on the formation conditions of each site. In summary, it is possible to affirm that the investigated remains belong to four shipwrecks. According to Gibbs [36], it was observed that three of the four categories were found in two shipwrecks, and only two categories were observed in the other two. Therefore, *Dragón* and *Conquistador* obtained a score of 4 and *África* and *San Carlos* a score of 3 (Table 4).

Table 6. Inventory of elements associated with the external context.

Category	Method	Attribute/Ship	Conquistador **	*Dragón* **	*África* **	*San Carlos* **
1. Cargo and Contents	Visual inspection	Inorganic materials	Ballast rock	Ballast rock	NF	NF
	MBES-SSS	NF	NF	NF	NF	NF
2. Fixtures and Fittings	SSS	Inorganic materials (Cannons)	≥8	≥6	≥5	≥7
3. Minor Structural	NF	NF	NF	NF	NF	NF
4. Major Structural (Ship's hull)	Visual inspection	Organic materials	Wood	NV	NV	NV
	MBES-SSS	Width Ship's hull *	14 m	14.4 m	13.2 m	11.2 m
		Length Ship's hull *	40.3 m	40.5 m	30.9 m	38.3 m

* from Gibbs [36]; ** from Quintana-Saavedra et al. [28]. NF = Not Found; NV: Null Visibility.

4.4. Oceanographic Criterion

Oceanographic variables are not usually considered in archaeological prospection processes; however, their analysis becomes very important in establishing sound conservation protocols [58]. These characteristics can be investigated at different depths and spatial and temporal scales [38,59,60].

In this study, dissolved oxygen, pH, temperature, salinity, and total suspended solids (TSS) data were collected at each shipwreck site during the wet and dry seasons at different depths of the water column. In Table 6, data collected at 15 m depth are shown as it indicates the oceanic properties closest to the wrecks.

In terms of dissolved oxygen (DO), all the values observed are within the water quality limits established for marine waters in Colombia (4 mg/L). Fluctuations in the DO concentrations affect the preservation of the sites, increasing the physical deterioration of the materials and favouring the growth of aerobic or anaerobic populations of organisms. For example, an environment with DO concentrations < 4 mg/L facilitates the growth of larvae and adults of *Teredo navalis* [46] (Tables 1 and 7). Variations in pH influence the proliferation of different types of microorganisms, as well as the process of metallic materials corrosion [47] or the facility of adherence of colonies of algal sponges (Figure 2). Regarding the preservation of materials, the white rot process in wood is favoured by a pH between 7.4 and 8.3 (Tables 1 and 7).

Table 7. Oceanographic variables and associated risk for the shipwrecks investigated in the Bay of Cartagena de Indias. Data recorded at 15 m water depth.

	Bocachica Sector		Inner Bay Sector				
Considered Variable	Recorded Values (Dry Season)	Recorded Values (Wet Season)	Recorded Values (Dry Season)	Recorded Values (Wet Season)	Critical Values	Observations	Risk (Yes/No)
DO (mg/L)	5.9	5.1	6.8	3.6	≤4 mg/L	Perforated wood.	Yes, Inner Bay, Wet season
T °C	24	29.9	27.4	29.7	≥10 °C	Perforated wood.	Yes
pH	8.1	7.3	8.1	6.8	7.4 and 8.3	Process of corrosion of metallic materials.	Yes, both sectors in Wet season.
Salinity	33.9	26.2	34.6	27.3	17 and 39	Proliferation of organisms that adhere to objects.	Yes
TSS (mg/L)	51.1	14.0	6.1	15.9	Unknown	The shipwrecks located in Bocachica are more covered than those of the Internal Bay.	Yes, because of the coverage level and exposure.

Salinity differences are observed within the Bay being higher values recorded in the dry season and lower in the wet season. Such changes influence the materials' degradation processes [39] because their stability is affected by the availability of different ions able to generate corrosion or concretion processes [45] (Table 7). Therefore, it is a relevant aspect

that must be considered for materials conservation. As an example, salinities between 17 and 39 favour the growth of organisms in wood elements, such as woodworms [60], and it was the case observed in the shipwrecks in the Bay of Cartagena (Tables 1 and 7).

In the dry season, the total suspended solids in the bottom layers had a higher concentration (51.1 mg/L) in the Bocachica sector than in the Inner Bay sector (6.1 mg/L). Therefore, water turbidity and sedimentation rates are higher in Bocachica than in the Inner Bay. As a consequence, shipwrecks in the former sector are more susceptible to being buried [61].

The results indicate that, despite the materials being well preserved and in homeostasis with the Bay environment, the risk of deterioration exists, and it is associated with the spatial and temporal changes of the chemical properties (pH, dissolved oxygen, and TSS) and/or the physical properties (changes of temperature and salinity) in the water column. In both cases, the organism types and population surrounding the sites can be affected [48,62]. As unfavourable oceanic conditions for the preservation of the wreck are found in the Cartagena de Indias Bay (Table 7), this criterion was scored 5, according to Table 4, and a regular monitoring program for the Bay is recommended. Such a monitoring program is easily/inexpensively developed in shallow areas close to the coast but is more complicated/expensive as depths increase [10,26].

4.5. Socioeconomic Criterion

The comprehensive management of submerged cultural heritage involves understanding the current rules of land use and its social and economic dynamics because the omission of these aspects may negatively or positively impact the conservation of wrecks. It should be noted that, in recent years, Colombia has made efforts to strengthen its national strategy. In this regard, the consolidation of two instruments stands out: (i) the Special Plan for the Management and Protection of the Fortifications of the Bay of Cartagena (PEMP Fort Bahía), which was approved by the National Heritage Council in June 2022 and implemented at the end of 2022 and (ii) the Colombian Marine Spatial Planning Law with a Maritime Authority Vision (OMC-VAM), based on the UNESCO guidelines [31,40,41,55]. However, to realise its improvement, the integration of new inputs and the formation of expert technicians in cultural matters at the head of the Colombian National Maritime Directorate (DIMAR), at the Colombian National Navy, the Colombian Ministry of Culture, and at the Colombian Institute of Anthropology and History (ICANH) are still necessary [55,63].

In addition to its historical importance, Cartagena de Indias is a maritime port of the highest interest for Colombia. The Maritime Spatial Planning policy indicated by UNESCO [1] describes the 20 most frequent uses of maritime space in Europe, Asia, North America, and Latin America [31]. Based on these guidelines, 12 occurring uses are identified in Cartagena de Indias [22,42,43,64,65] (Table 8). It is not within the aim of this paper to identify which of these activities are the most or least important but only report their existence.

Cartagena Bay has many assets of historical value including the shipwrecks investigated and other sites of cultural heritage interest such as the forts of Santa Cruz, San Sebastian del Pastelillo and San José [24]. In the Bocagrande area there are also some military defense structures that, to date, are submerged such as the castle of San Matías [64] or the submerged breakwater of Bocagrande [25].

Seven of the 20 activities mentioned have been reported as potentially dangerous for UCH sites. These are (i) oil and gas because of induced seismic activities or spilling due to extraction/bunkering processes; (ii) Fisheries, especially trawling, can produce severe damage to shipwrecks because of entanglement [21]; (iii) Tourism and leisure by the potential uncontrolled diving and pillage [21]; (iv) Scientific research, when intrusive investigations are carried out (e.g., unauthorized object removal) [21]; (v) Coastal protection, e.g., the emplacement of protection structures, can affect coastal dynamics and sediment transport locally; (vi) Industry, e.g., dumping of chemical residuals [66]; (vii) Ports, e.g., dredging activities [67,68].

Table 8. Maritime activities/uses described by UNESCO [31,41,55]. Uses present in Cartagena Bay, Colombia. In bold potentially dangerous activities for UHC. Source: * [31]; ** [41]; A. [64]; B. [43]; C. [65]; D. [42]; E. [22].

USE	UK	FINLAND	GERMANY	CANADA	MEXICO	ARGENT.	CHINA	PERú	COLOM.	CARTAG.
1. Underwater cultural heritage	*	*	*	*	*		*		**	A
2. Mining		*	*			*	*	*		
3. Oil and gas (seismic activities, extraction)				*	*	*	*	*		
4. Offshore renewable energy (wind power, seawater energy)	*			*			*			
5. Shipping	*	*		*	*	*	*	*	**	B
6. Fisheries (trawling)	*	*	*	*	*	*	*	*	**	D
7. Tourism and leisure (uncontrolled diving and pillage)	*	*		*	*	*	*	*	**	D
8. Protection of the marine environment			*						**	C
9. Scientific research (intrusive methods)		*	*	*	*	*	*	*	**	E
10. Military	*	*	*	*	*	*		*	**	B
11. Cables and pipelines (during the installation phase)	*	*	*	*	*	*	*	*	**	D
12. Nature conservation	*	*				*		*	**	D
13. Coastal protection	*		*	*	*	*	*	*	**	D
14. Industry									**	B
15. Ports (dredging)	*	*		*	*	*	*	*	**	D
16. Ammunition storage		*	*	*						
17. Radars		*	*	*						
18. Traditional indigenous uses		*	*	*						
19. Aquaculture	*	*	*	*						
20. Marine aggregates extraction	*									

At least 12 (out of the 20 activities proposed by UNESCO [31]) coexist in Cartagena Bay, and at least six of them are potentially dangerous for UCH conservation. Consequently, a score of 4 was assigned to the four wrecks under the socioeconomic criterion.

5. Discussion

5.1. Analysis and Integration of the Scores Obtained in the Cartagena Bay Sites

At an international level, the suggested methodological proposal is aligned with holistic projects such as MACHU (Managing Cultural Heritage Underwater) carried out in the United Kingdom, https://www.southampton.ac.uk/research/projects/, accessed on 23 February 2023), Virtual Exploration of Underwater Sites (VENUS) in France, (https://cordis.europa.eu/project/id/034924, accessed on 23 February 2023), Wreck Protect project in the Baltic Sea (Sweden, Denmark, the Netherlands, http://wreckprotect.org/index.php?id=12679, accessed on 25 February 2023) and the project ARQUA, founded by the National Museum of Underwater Archaeology, in Spain (https://www.culturaydeporte.gob.es/cultura/, accessed on 25 February 2023). The latter project produced the "Green Book", which is supported by the three submarine archaeological institutes of Andalusia, Cataluña, and Valencia, several regional administrations, universities, and the Spanish Ministry of Culture via the National Museum of Underwater Archaeology (ARQUA).

In Colombia, the National Maritime Authority is working on the establishment of a methodology for the registration of submerged cultural heritage. This project is in phase two out of four and will probably constitute one of the first comprehensive tools for the sound management of submerged heritage [67]. All these projects seek the protection, management, and dissemination of the UCH. However, as a common factor, their development depends on the capacity and policies of each country that set the bases for UCH sustainability over time [68].

Colombia needs to generate new tools to advise decision-makers. This article offers a starting point for the management of shipwrecks in the Bay of Cartagena based on a simple quantitative method that helps decide how to act in each case. Additionally, it offers some

practical management considerations. This methodological proposal evaluates five criteria that can be useful to assess the state of risk of a wide variety of wrecks. Based on the case study analysis, a value was assigned to each criterion (Table 4), obtaining a total score of 20 (out of 25) for the shipwrecks located in the Inner Bay and 19 for the shipwrecks located in the Bocachica sector. Considering that the limit for the proposed management action is 15 out of 25, it presses the need to manage the sites by applying conservation actions, i.e., *in situ* conservation, *ex situ* conservation, or possible controlled relocation.

Concerning the results obtained in Table 4, criteria 1, 2, 3, and 4 do not change very much over time and are easy to quantify. The first criterion refers to shipwrecks' antiquity, the second to the depth at which wrecks are located, the third to the number of materials categories observed at each site and the fourth, despite seasonal variations, is relatively constant over time.

Regarding criterion 5, it is probably the most dynamic at decadal scale since it depends on the development and socioeconomic projection of the country/city. Therefore, it requires special attention. It was found that the four shipwrecks considered in this paper require conservation actions since both considered locations (e.g., the Inner Bay and Bocachica) yielded a value of 20 and 19, respectively (Table 4). It is recommended that *in situ* conservation should prevail within the conservation categories proposed by Maarleveld et al. [21] because this option has the lowest impact on the shipwreck sites. Although the four wrecks are actually relatively well preserved, the initiation of a conservation plan is required. As a first step and depending on each site condition, it is important to protect the elements exposed on the seabed with different techniques such as sandbags, cloth covers and nets. The final decision will be given in accordance with the recommendations made by specialized personnel such as conservators working together with underwater archaeologists [21].

5.2. Other Transversal Management Requirements for the Cartagena Bay Sites

The present paper analyses five proposed criteria to elaborate a sound management plan for submerged cultural heritage in Cartagena Bay; nevertheless, other aspects are relevant and should be considered too. These other management requirements focus on two main components. The first deals with legal requirements that must be considered when formalizing or defining management guidelines, including the organizations involved. The second considers the way management actions can be implemented in a practical/efficient way.

5.2.1. Legal Aspects and Involved Organizations

Colombia has a legal framework with a hierarchy that begins with the national political constitution, laws, decrees, resolutions, and plans, among others. This framework is developed in accordance with the state powers of the Ministry of Culture of Colombia, the Colombian Institute of Anthropology and History (ICANH), and the Colombian National Maritime Directorate (DIMAR) for issues related to the UCH. Furthermore, the regulatory framework is integrated by local instruments such as maritime and spatial planning, i.e., the one generated by the maritime authority based on the UNESCO Marine Spatial Planning principles [41]. This instrument, created to strengthen territorial management actions, currently works to integrate different layers of information, but until now, cultural contexts are not considered.

Figure 4 indicates some instruments that Colombia has developed since 1983 in the different matters that make up the legal protection of the nation's cultural heritage. Within a total of 26 legal tools, 6 are the result of the integration of international agreements and the rest corresponds to national and local decrees/laws; the most relevant are cited in this study. It is important to indicate that Colombia signed—but has not yet ratified—the United Nations Convention on the Law of the Sea (UNCLOS), and it is not part of the Convention on the Protection of the Underwater Cultural Heritage of UNESCO [1].

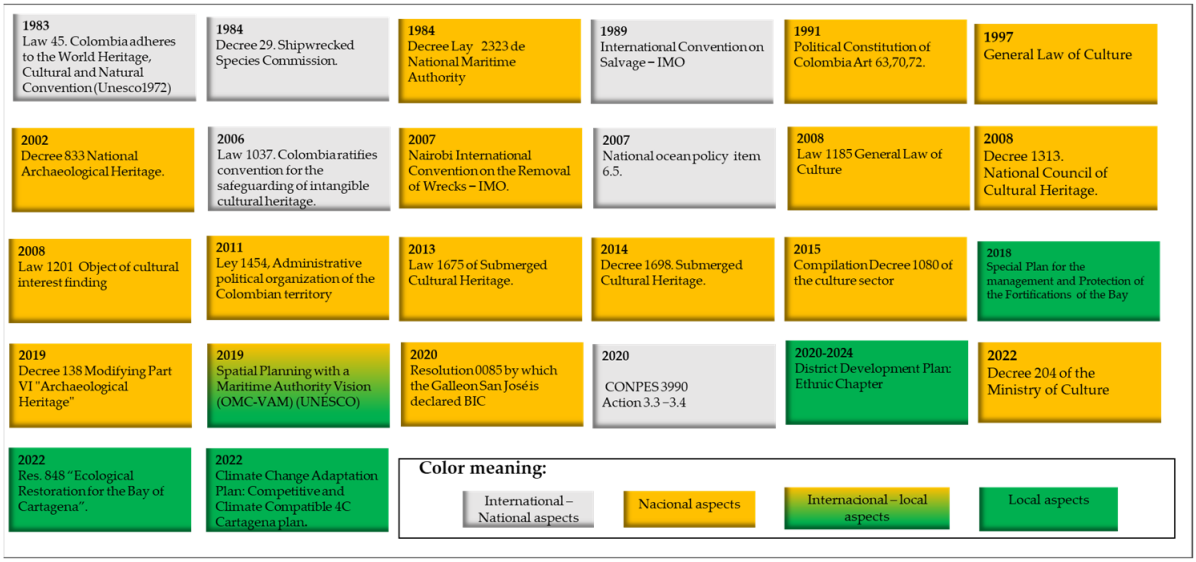

Figure 4. International, national, and local contests of some legal instruments concerning marine cultural heritage in Colombia.

Concerning the coordination of organizations, in the case of Cartagena Bay, the Ministry of Culture, ICANH and DIMAR are involved. Better coordination among the mentioned entities will benefit the development of exploration campaigns and the elaboration of maps of the sites, including an inventory of objects to be conserved, among other activities cited in Decree 204/2022 of the Ministry of Culture.

Regarding the regulations in terms of land management policies, governments play a key role in the administration, protection and private use of maritime space [69]. In Cartagena, it is specifically required that the port authority is informed of all the phases of projects associated with or that might affect UCH in the Bay.

5.2.2. Handling and Practical Management Actions

In accordance with the results indicated in Section 5.1, this section proposes other practical management actions that should be considered in order to complement the management of the UCH sites.

- Delimitation of the area of interest: The cultural and maritime authorities must establish a specific area for the management of wrecks to regulate, control and define the levels of intervention with the purpose of guaranteeing their long-term preservation, to advance research actions, as well as the dissemination and conservation of the submerged heritage. Based on the case study results, the creation of a minimum area of protection and conservation is suggested with a radius no greater than 500 m with each shipwreck as its center. The area should include seawater and seabed. Care must be taken not to affect the use or transit of merchant ships on the surface through the established navigation channels.

The final radius must be reconciled with the competent authorities not to raise any conflict of use. In the particular case of the four wrecks in Cartagena Bay, they are located in a place that would not interrupt the development of other activities. This is evidenced by the fact that, to date, conflicts of use have not been reported. Conversely, wreck relocation, or *ex situ* conservation, is not considered necessary.

It is recommended that the maritime authority include the location of the shipwrecks on the nautical chart COL 261 according to the nomenclature indicated by the International Hydrographic Organization for "non-dangerous shipwrecks with known depth".

- Monitoring coordinating entity: To carry out conservation activities, it is important to have a base work site from where semi-annual oceanographic and hydrographic

campaigns are launched. If relocation of material is required, a contiguous maritime area must be provided whose conditions are similar to the original one.

- Preventive conservation: Considering that some organic elements are exposed on the seabed, it is suggested the burial option is a preventive conservation action to avoid their deterioration [21,37].
- Disclosure: The disclosure of sites associated with the UCH to the general public involves the publication of scientific articles and guided tours, among other activities [21,70]. Worldwide, there are sites that have been opened to the public, such as the L'Océan shipwreck in Portugal [71] and Formentera and Es Cap 1 in Spain [72]. Therefore, it is suggested, as a management action, to make a section of the *Conquistador* ship available to the community for guided and controlled diving visits. This action will strengthen the recognition of submerged cultural assets by the public, also enhancing their relationship with scientific research centres.
- Staff competencies: Considering the specificity of the subject, the participating staff in management activities must be interdisciplinary, be supervised by suitable professionals in archaeological matters [73] and have a safety regime at work in terms of diving. Additionally, the experience will be required in metric plan survey techniques, analysis of hydrographic data from remote sensors and the sampling and handling of oceanographic equipment, among others.

6. Conclusions

In this paper, a methodological proposal for the management of submerged cultural heritage sites is presented. Five criteria are proposed to assess the UCH site condition and importance from different perspectives: historical, geographic, shipwreck condition, oceanographic and socioeconomic. Based on the assessment, a numeric value is assigned to each criterion (1–5) and a total score is finally obtained that helps to define the actions/strategies to manage/preserve a specific UHC site adequately. This methodology is applied to evaluate four colonial shipwrecks located in the Cartagena de Indias Bay (Colombia). All the shipwrecks obtained a score of 3 or more at all criteria. The greater threat to UCH conservation is linked to the oceanographic conditions scored 5 points at the four sites. The sum of all criteria gave a score of 20 to the shipwrecks placed in the Inner Bay, while the ones placed in the Bochachica sector scored 19. As obtained scores were greater than 15, management actions to preserve the sites are suggested.

The proposed methodology is easy to apply and useful for assessing different perspectives of the shipwrecks' conditions, giving a clear picture of their state and level of risk. This comprehensive assessment provided the information necessary to propose guidelines to ensure the UHC conservation and management models. These recommendations include legal and management activities such as site delimitation and description, access constraints, monitoring and preventive conservation measurements, disclosure of cultural information, and the conformation of a group of supporting staff with different skills and particular profiles.

The implementation of these recommendations is expected to improve the interdisciplinary and inter-institutional management activities that should derive into an improved protection and conservation plan for the submerged cultural heritage sites. To achieve this goal, the political structure and organizations of the country where the UHC is placed must be considered. In the Cartagena de Indias case study, some important governmental institutions, such as the Ministry of Culture, the Colombian Institute of Anthropology and History (ICANH), the Colombian National Maritime Directorate (DIMAR), and Colombia's Navy, need to work together to ensure that all measurements effectively help to protect the UCH sites and conserve them to future generations.

Therefore, the methodology and management measurements assessed through this paper are useful and may help other countries interested in protecting their underwater cultural heritage.

Author Contributions: Conceptualization and methodology, D.M.Q.-S., R.G.-M., R.R.T.-P., G.A., B.J.-A. and J.J.M.-P.; formal analysis, D.M.Q.-S., R.R.T.-P. and R.G.-M.; investigation, D.M.Q.-S., R.G.-M. and R.R.T.-P.; resources, SV.; data curation D.M.Q.-S., R.G.-M. and S.V.; writing—original draft preparation, D.M.Q.-S., R.R.T.-P. and G.A. writing—review and editing D.M.Q.-S., R.R.T.-P., G.A., J.J.M.-P. and B.J.-A.; visualization, R.G.-M.; project administration, D.M.Q.-S. and S.V.; funding acquisition, D.M.Q.-S., S.V., J.J.M.-P. and B.J.-A. All authors have read and agreed to the published version of the manuscript.

Funding: This research was financed part by the National Maritime Directorate of Colombia C-1504-0100-9-0-1504013-02 code and for the doctoral scholarship associated with the doctoral program in marine sciences between the Jorge Tadeo Lozano University Framework Agreement–Colombian Maritime Authority (DIMAR). The APC and editing were supported by the University of Cadiz.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: In order to preserve shipwrecks, data associated with geographic information is not shared. The oceanographic information on the bay is available at https://cecoldo.dimar.mil.co/web (accessed on 20 February 2023). These data must be requested by means of an official letter addressed to DIMAR. The other information presented in this paper can be consulted accordingwith the reference cited.

Acknowledgments: The authors especially thank the former ex-director of DIMAR, Vice Admiral José Joaquín Amézquita García, and the former ex-director of the Center for Oceanographic and Hydrographic Research, CN German Escobar. This work is a contribution to the PAI Andalucia Research group RNM-328 and to the Red Proplayas netwrork and the Underwater Cultural Heritage Group of DIMAR.

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

References

1. Unesco. La Convención de la Unesco sobre la Protección del Patrimonio Cultural Subacuático. Conv. Sobre Protección Patrim. Cult. Subacuático. 2001. 26p. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000126065_spa498 (accessed on 23 February 2023).
2. Manders, M.R. Guidelines for Protection of Submerged Wooden Cultural Heritage 2011. reckProtect. European Commission's Seventh Framework Program. Available online: http://wreckprotect.org/typo3temp/tx_ncstaticfilecache/wreckprotect.org//index.php/ (accessed on 28 February 2023).
3. Bethencourt, M.; Fernández-Montblanc, T.; Izquierdo, A.; González-Duarte, M.; Muñoz-Mas, C. Study of the influence of physical, chemical and biological conditions that influence the deterioration and protection of Underwater Cultural Heritage. *Sci. Total Environ.* **2018**, *613–614*, 98–114. [CrossRef] [PubMed]
4. O'Shea, J. The archaeology of scattered wreck-sites: Formation processes and shallow water archaeology in western Lake Huron. *Int. J. Naut. Archaeol.* **2002**, *31*, 211–227. [CrossRef]
5. Ward, I.; Larcombe, P.; Veth, P. A new process-based model for wreck site formation. *J. Archaeol. Sci.* **1999**, *26*, 561–570. [CrossRef]
6. Fernández-Montblanc, T.; Quinn, R.; Izquierdo, A.; Bethencourt, M. Evolution of a Shallow Water Wave-Dominated Shipwreck Site: Fougueux (1805), Gulf of Cadiz. *Geoarchaeology* **2016**, *31*, 487–505. [CrossRef]
7. Grenier, R.; Nutley, D.; Cochran, I. *Heritage at Risk: Special Edition—Underwater Cultural Heritage at Risk: Managing Natural and Human Impacts*; ICOMOS: Paris, France, 2006.
8. Gusick, A.E.; Dodds, T.; Jaffke, D.; Meniketti, M.; Ball, D. Defining Maritime Cultural Landscapes in California. *Calif. Archaeol.* **2019**, *11*, 139–164. [CrossRef]
9. UNESCO. Underwater Cultural Heritage in Latin America and the Caribbean. 2015. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000232319_eng (accessed on 3 December 2022).
10. Bickler, S.; Clough, R.; Macready, S. The impact of climate change on the archaeology of New Zealand's coastline: A case study from the Whangarei District. *Sci. Conserv.* **2013**, 1–54.
11. Agapiou, A.; Lysandrou, V. Remote sensing archaeology: Tracking and mapping evolution in European scientific literature from 1999 to 2015. *J. Archaeol. Sci. Rep.* **2015**, *4*, 192–200. [CrossRef]
12. Jigena-Antelo, B.; Berrocoso, M.; Torrecillas, C.; Vidal, J.; Barbero, I.; Fernandez-Ros, A. Determination of an experimental geoid at Deception Island, South Shetland Islands, Antarctica. *Antarct. Sci.* **2016**, *28*, 277–292. [CrossRef]
13. Osorio-Granada, A.M.; Jigena-Antelo, B.; Vidal Pérez, J.M.; Hernández-Pardo, O.; León-Rincón, H.; Muñoz-Pérez, J.J. Potential fields modeling for the Cayos Basin (Western Caribbean Plate): Implications in basin crustal structure. *Mar. Geol.* **2022**, *449*, 106819. [CrossRef]
14. Mattei, G.; Rizzo, A.; Anfuso, G.; Aucelli PP, C.; Gracia, F.J. A tool for evaluating the archaeological heritage vulnerability to coastal processes: The case study of Naples Gulf (southern Italy). *Ocean Coast. Manag.* **2019**, v179. [CrossRef]

15. MacCready, P.; Geyer, W.R. Advances in estuarine physics. *Ann. Rev. Mar. Sci.* **2010**, *2*, 35–58. [CrossRef] [PubMed]
16. González-Duarte, M.M.; Fernández-Montblanc, T.; Bethencourt, M.; Izquierdo, A. Effects of substrata and environmental conditions on ecological succession on historic shipwrecks. *Estuar. Coast. Shelf Sci.* **2018**, *200*, 301–310. [CrossRef]
17. Church, R.; Warren, D.; Cullimore, R.; Johnston, L.; Schroeder, W.; Patterson, W.; Shirley, T.; Kilgour, M.; Morris, N.; Moore, J. Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico: Artificial Reef Effect in Deep Water. *OCS Study MMS* **2007**, *15*, 387. Available online: https://www.boem.gov/ESPIS/4/4239.pdf (accessed on 31 November 2022).
18. Balletti, C.; Beltrame, C.; Costa, E.; Guerra, F.; Vernier, P. 3D reconstruction of marble shipwreck cargoes based on underwater multi-image photogrammetry. *Digit. Appl. Archaeol. Cult. Herit.* **2016**, *3*, 1–8. [CrossRef]
19. Harkin, D.V.; Davies, M.; Hyslop, E.; Fluck, H.; Wiggins, M.; Merritt, O.; Barker, L.; Deery, M.; McNeary, R.; Westley, K. Impacts of climate change on cultural heritage. *Mar. Clim. Chang. Impacts Partnersh.* **2020**, *16*, 24–39. [CrossRef]
20. Daire, M.Y.; Lopez-Romero, E.; Proust, J.N.; Regnauld, H.; Pian, S.; Shi, B. Coastal Changes and Cultural Heritage (1): Assessment of the Vulnerability of the Coastal Heritage in Western France. *J. Isl. Coast. Archaeol.* **2012**, *7*, 168–182. [CrossRef]
21. Maarleveld, T.; Guérin, U.; Egger, B. Manual Para Actividades Dirigidas Al Patrimonio Cultural Subacuático. 2013. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000220716 (accessed on 28 February 2023).
22. Molares, R.; Mestres, M. La influencia de la descarga del Canal del Dique en los niveles del mar de la Bahía de Cartagena-Colombia. *Bol. Cient. CIOH* **2012**, *45*, 13–28. [CrossRef]
23. Borrero Londoño, R. *Thesis Procesos de Formación de Sitios Arqueológicos Sumergidos en la Bahía de Cartagena de Indias Estudio Experimental Sobre Degradación de Materiales Orgánicos Empleados en la Construcción Naval y/o Contenidos en los Fletes Coloniales*; Bogotá-University of the Andes: Bogotá, Colombia, 2011.
24. Del Cairo Hurtado, C. Mentiras verdaderas o la topología de la guerra. Aproximación arqueológica a la cartografía colonial de Bocachica, Cartagena de Indias. *Apunt. Rev. Estud. Sobre Patrim. Cult.* **2014**, *26*, 186–203. [CrossRef]
25. Andrade, C.A.; Guzmán-Martinez, R.; Quintana-Saavedra, D.M. El avance de la línea de costa de las penínsulas de Bocagrande y Castillo grande debido a la construcción de la Escollera en 1758 en Cartagena de Indias. *Rev. Acad. Colomb. Cienc.* **2022**, *46*, 758–768. [CrossRef]
26. Manders, M.R. UNIT 9: In Situ Preservation. In *Training Manual for the UNESCO Foundation Course on the Protection and Management of Underwater Cultural Heritage in Asia and the Pacific*; UNESCO: London, UK, 2022; pp. 1–33.
27. Frigerio, A. *The Underwater Cultural Heritage: A Comparative Analysis of International Perspectives, Laws and Methods of Management*; IMT Institute for Advanced Studies: Lucca, Italy, 2013.
28. Quintana-Saavedra, D.M.; Andrade-Amaya, C.A.; Guzmán-Martínez, R.A.; Torres-Parra, R.; Prada-Rueda, P. Characterization of four shipwrecks from 1741 in Cartagena Bay. *Int. Hydrogr. Rev.* **2022**, *27*, 55–74. Available online: https://ihr.iho.int/issue-archive/ (accessed on 21 August 2022). [CrossRef]
29. De Lezo, B. Carta de D. Blas de Lezo al Marqués de Villarias, con un Diario de lo Acaecido en Cartagena de Indias Durante el Sitio, Desde el 13 de Marzo de 1741 hasta el 20 de Mayo Siguiente. 1741. Archivo Histórico Nacional, ESTADO,2335, Exp.2 España. Available online: http://pares.mcu.es/ParesBusquedas20/catalogo/show/12690215?nm (accessed on 25 November 2022).
30. Beatson, R. Naval and Military Memoirs of Great Britain, from 1727 to 1783. 1804. Available online: https://books.google.com.co/books?id=eNEHAAAAIAAJ&printsec=frontcover&hl=es&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false (accessed on 14 June 2020).
31. IOC-UNESCO. a. Marine Spatial Planning. 2022. Available online: https://www.mspglobal2030.org/es/msp-roadmap/la-pem-en-el-mundo/ (accessed on 23 February 2023).
32. Ødegård, Ø.; Sørensen, A.J.; Hansen, R.E.; Ludvigsen, M. A new method for underwater archaeological surveying using sensors and unmanned platforms. *IFAC-PapersOnLine* **2016**, *49*, 486–493. [CrossRef]
33. Westley, K.; Plets, R.; Quinn, R.; McGonigle, C.; Sacchetti, F.; Dale, M.; McNeary, R.; Clements, A. Optimising protocols for high-definition imaging of historic shipwrecks using multibeam echosounder. *Archaeol. Anthropol. Sci.* **2019**, *11*, 3629–3645. [CrossRef]
34. Rosato, V.; Traversa, L. *Bioalteración, Protección y Conservacion de Maderas*; Publicaciones Científicas y Tecnológicas: Buenos Aires, Argentina, 2017.
35. Grosso, M.; Elkin, D.; Murray, C.; Castro, M.Á. Evidencia arqueológica de naufragios en zonas costeras: El caso del Parque Nacional Monte León (provincia de Santa Cruz). *Magallania* **2015**, *43*, 93–118. [CrossRef]
36. Gibbs, M. Cultural site formation processes in maritime archaeology: Disaster response, salvage and Muckelroy 30 years on. *Int. J. Naut. Archaeol.* **2006**, *35*, 4–19. [CrossRef]
37. Andreu, R.; Ex, M. Ex situ o in situ: Dilemas de la conservación y protección del patrimonio cultural sumergido. *Bol. Cient. CIOH* **2021**, *40*, 121–128. Available online: https://ojs.dimar.mil.co/index.php/CIOH/article/view/598/498 (accessed on 7 September 2022).
38. Delgadillo-Garzón, Ó.; Zapata-Ramírez, P. Contexto natural del patrimonio cultural subacuático en la Bahía de Cartagena: Perspectivas de estudios interdisciplinarios y potencial de utilización. *Mem. Rev. Digit. Hist. Arqueol. Caribe* **2007**, *7*, 1–6.
39. Wheeler, A.J. Environmental controls on shipwreck preservation: The Irish context. *J. Archaeol. Sci.* **2002**, *29*, 1149–1159. [CrossRef]
40. IOC-UNESCO. Joint Roadmap to accelerate Maritime/Marine Spatial Planning processes worldwide (MSP). In Proceedings of the 2nd International Conference on Marine/Maritime Spatial Planning, Paris, France, 15–17 March 2017; p. 5.

41. IOC-UNESCO. b. Marine Spatial Planning. 2022. Available online: https://www.mspglobal2030.org/es/msp-roadmap/la-pem-en-el-mundo/americas/colombia/ (accessed on 23 February 2023).
42. Franco, F.A.; Molina Jiménez, M.P.; Pusquin Ospina, L.T.; Escobar Olaya, G.A.; Castro Mercado, I. Conflictos de uso en el proceso de ordenamiento marino costero: Visión de autoridad marítima. Departamento De Bolívar—Colombia. *Bol. Cient. CIOH* **2019**, *38*, 27–40. [CrossRef]
43. DIMAR. Dirección General Marítima. Estadística de Transporte Marítimo Internacional. Series Históricas. 2021. Available online: https://www.dimar.mil.co/operaciones-estadisticas/estadisticas-de-transporte-maritimo-internacional/series-historicas-estadisticas-de-transporte-maritimo-internacional (accessed on 17 June 2022).
44. Bass, G.F. Beneath the seven seas. In *Adventures with the Institute of Nautical Archaeology, George F.*; Institute of Nautical Archaeology; Thames & Hudson Inc.: New York, NY, USA, 2005; ISBN 9780500051368.
45. Voulgaris, A.; Mouratidis, C.; Vossinakis, A. Simulation and Analysis of Natural Seawater Chemical Reactions on the Antikythera Mechanism. *J. Coast. Res.* **2019**, *35*, 959. [CrossRef]
46. Oxley, L.; Keith, M. Introduction: Site formation processes of submerged shipwrecks. In *Site Formation Processes of Sub Merged Shipwrecks*; Keith, M.E., Ed.; University of Florida: Gainesville, FL, USA, 2016; p. 13.
47. Björdal, C. Evaluation of microbial degradation of shipwrecks in the Baltic Sea. *Int. Biodeterior. Biodegrad.* **2012**, *70*, 126–140. [CrossRef]
48. Grosso, M. Post-depositional processes studies of wooden artifacts from the 18th century Swift shipwreck site (Patagonia, Argentina). *Intersecc. Antropol.* **2014**, *15*, 55–69.
49. Papageorgiou, M. Underwater cultural heritage facing maritime spatial planning: Legislative and technical issues. *Ocean. Coast. Manag.* **2018**, *165*, 195–202. [CrossRef]
50. Aldana, J. Propuesta Metodológica para la Construcción de una Matriz de Indicadores Arqueológicos e Históricos para la Identificación de Naufragios: El Caso de un Navío Colonial Ubicado en el Canal de Bocachica (Cartagena de Indias). Bacherlor's Thesis, Universidad Externado de Colombia, Bogotá, Colombia, 2019.
51. Bellin, J. Baye de Carthagene: Dans l'Amerique meridionale. Paris. 1764. Available online: https://babel.banrepcultural.org/digital/collection/p17054coll13/id/25/ (accessed on 20 May 2022).
52. Durell, P. Plan and Prospect of the Harbour Town & Castles of Carthagena/Most Humbly. p. 1. 1741. Available online: http://catalogue.bnf.fr/ark:/12148/cb442267721 (accessed on 7 April 2022).
53. Laws, W. A New Plan of the Harbour, City and Forts of Cartagena; with The Progress of the Brettish Fleet in the Several Stations & Attack from the 4th. of March 1741 the 1st. April When Capt. Laws Came Away. Sent over by Mr. Richardson form on Board the Norfolk. Paris. 1741. Available online: https://gallica.bnf.fr/ark:/12148/btv1b53122178n/f1.item.zoom# (accessed on 20 May 2022).
54. Laws, W. Most Humbly Inscribed to the Rt. Honble. Sir Charles Wager, First Lord Commissioner of the Admiralty, This Plan of the Harbour, Town and Several Forts of Cartagena/Will. Laws; W. H. Toms, Sculp. S. Harding, London 1741. Available online: http://catalogue.bnf.fr/ark:/12148/cb442163794 (accessed on 20 May 2022).
55. Ehler, C. Marine spatial planning. *Offshore Energy Mar. Spat. Plan.* **2018**, 6–17. [CrossRef]
56. Aragón-Ruano, Á.; Elizalde, Ó.R. ¿Un proyecto quimérico? Suministros forestales desde los pirineos occidentales para la Real Armada en el siglo XVIII. *Stud. Hist. Hist. Mod.* **2021**, *43*, 13–45. [CrossRef]
57. Restrepo, J.; Orejarena, A.F.; Torregroza, A.C. Suspended sediment load in northwestern South America (Colombia): A new view on variability and fluxes into the Caribbean Sea. *J. S. Am. Earth Sci.* **2017**, *80*, 340–352. [CrossRef]
58. Bass, G.F. The Development of Maritime Archaeology. In *The Oxford Handbook of Maritime Archaeology*; Oxford University Press: Oxford, UK, 2012; Chapter 1.3; 22p. [CrossRef]
59. Andreou, G.; Opitz, R.; Manning, S.; Fisher, K.; Sewell, D.; Georgiou, A.; Thomes, U. Integrated methods for understanding and monitoring the loss of coastal archaeological sites: The case of Tochni-Lakkia, south-central Cyprus. *J. Archaeol. Sci. Rep.* **2017**, *12*, 197–208. [CrossRef]
60. Borges, L.M.S.; Merckelbach, L.M.; Sampaio, Í.; Cragg, S.M. Diversity, environmental requirements, and biogeography of bivalve wood-borers (Teredinidae) in European coastal waters. *Front. Zool.* **2014**, *11*, 13. [CrossRef] [PubMed]
61. Grosso, M.; Trassens, M.; Murray, C.; Bastida, R. Relevancia de la matriz sedimentaria en los sitios arqueológicos subacuáticos. *Rev. Arqueol. Am.* **2013**, *31*, 206–246.
62. Bastida, R.; Grosso, M.; Elkin, D. The Role of Benthic Communities and Environmental Agents in the Formation of Underwater Archaeological Sites. In *Underwater and Maritime Archaeology in Latin America and the Caribbean*; Routledge: New York, NY, USA, 2016; pp. 173–186.
63. Del Cairo, C.; Quintana-Saavedra, D.M. Gobernanza y gestión del patrimonio cultural sumergido en Colombia. *Rev. Pais Mares* **2019**, *8*. Available online: https://cecoldodigital.dimar.mil.co/2504/3/dimar_2463-2449_2019_pais_de_mares_08.pdf (accessed on 20 July 2022).
64. Guzmán-Martínez, R.; Quintana-Saavedra, D.M.; Andrade, C.A. On the Discovery of a Sumerged Structure Related to Fort San Matias in the Bay of Cartagena de Indias. *Heritage* **2022**, *in press*.
65. MinAmbiente. Resolución 0848 de 2022. 2022. Available online: https://www.minambiente.gov.co/wp-content/uploads/2022/08/Resolucion-0848-de-2022.pdf (accessed on 23 February 2023).
66. Keith, M.E. *Site Formation Processes of Submerged Shipwrecks*; University Press of Florida: Gainesville, FL, USA, 2016.

67. DIMAR. Dirección General Marítima. Resolución Número (0192-2020) md-Dimar-Subdemar-Ginsem-Arinv 7 de Mayo de 2020, Resolución Número (0192-2020) md-Dimar-Subdemar-Ginsem-Arinv 7 de Mayo de 2020. 2020. Available online: https://www.dimar.mil.co/sites/default/files/normatividad/res0192-2020.pdf (accessed on 22 October 2022).
68. MacKintosh, R. Capacity in Maritime Archaeology: A Framework for Analysis. *J. Marit. Archaeol.* **2019**, *14*, 391–408. [CrossRef]
69. Claesson, S. An ecosystem-based framework for governance and management of maritime cultural heritage in the USA. *Mar. Policy* **2009**, *33*, 698–706. [CrossRef]
70. Sesana, E.; Gagnon, A.; Bertolin, C.; Hughes, J. Adapting Cultural Heritage to Climate Change Risks: Perspectives of Cultural Heritage Experts in Europe. *Geosciences* **2018**, *8*, 305. [CrossRef]
71. Martínez Alcalde, M.; García-Cano, J.M.; Blázquez Pérez, J.; Sanmartín, A.I. *Mazarrón II Contexto, Viabilidad y Perspectivas del Barco B-2 de la Bahía de Mazarrón*; Editores Universidad Autónoma de Madrid: Madrid, Spain, 2017.
72. Núñez, E.A.; Pandozi, J.R.; Llabrés, S.M. Investigación y Gestión del Patrimonio Cultural Subacuático en las Islas Baleares: La Carta Arqueológica Subacuática de Formentera y el Pecio Romano de Porto Cristo. 2016. Available online: http://hdl.handle.net/10498/18446 (accessed on 5 January 2023).
73. DAFP. Decreto_138_de_2019. 2019. Available online: https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=90526 (accessed on 28 February 2023).