

[Description]

[Title of the Invention] PAINT SELECTION SYSTEM AND PAINT SELECTION METHOD

[Technical Field]

[0001]

The present disclosure relates to a paint selection system and a paint selection method. The present application is based on Japanese Patent Application No. 2021-136344 filed on August 24, 2021, the content of which is incorporated herein by reference.

[Background Art]

[0002]

It is known that underwater organisms are attached to a ship bottom or the like of a watercraft or the like exposed to seawater or the like for a long period of time (e.g., PTL 1). Biofouling increases the resistance when the watercraft operates, and therefore it reduces the speed of the watercraft or deteriorates the fuel consumption. Biofouling to the watercraft or the like contributes an increase in cleaning cost of the watercraft or the like, and may deteriorate durability of a target object such as the watercraft or the like. Generally, a paint having an antifouling property, which exhibits a property of suppressing attachment of organisms to the hull, is applied to the ship body.

[Citation List]

[Patent Literature]

[0003]

[PTL 1] JP 2018-167654 A

[Summary of Invention]

[Technical Problem]

[0004]

Evaluation regarding biofouling often requires an evaluation time of months to years. As an evaluation method regarding biofouling, a method with low accuracy such as visual evaluation is often used. For this reason, at present, it is difficult to select a paint corresponding to a watercraft or the like, and a paint is selected relying on so-called “seat of one's pants”. That is, it is a situation difficult to describe that a paint having an appropriate antifouling property has been selected. Such problem is common not only to watercrafts but also to paint used for any target objects such as fishing gear and piping used underwater. Therefore, a technology capable of selecting a paint having an appropriate antifouling property is desired.

[Solution to Problem]

[0005]

The present invention can be achieved in the following forms.

[0006]

(1) According to one form of the present invention, a paint selection system for selecting a paint is provided. This paint selection system includes: a storage unit that stores paint antifouling property data including a correspondence relationship between position information of an evaluation water area and antifouling properties of a plurality of paints; an input unit that receives an input of position information of a specific water area; a specification unit that specifies the paint to be used in the specific water area using the paint antifouling property data and the position information of the specific water area; and an output unit that outputs identification information of the paint specified, in which the paint antifouling property data is created by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the evaluation water area. According to the paint selection system of this form, since it includes the storage unit that stores the paint antifouling property data and the specification unit that specifies the paint to be used in the specific water area using the paint antifouling property data and the position information of a specific water area, it is possible to select a paint having an appropriate antifouling property in accordance with the target object to be used in the specific water area.

[0007]

(2) In the paint selection system of the above form, the storage unit may store price data corresponding to a price of each of the plurality of the paints, and the specification unit may specify the paint to be used in the specific water area by using the paint antifouling property data, the price data, and the position information of the specific water area. According to the paint selection system of this form, since the paint to be used in the specific water area is specified using

the price data in addition to the paint antifouling property data and the position information of the specific water area, it is possible to select an appropriate paint in consideration of the price.
[0008]

(3) In the paint selection system of the above form, the paint antifouling property data may include a plurality of pieces of position information of the evaluation water area, and the specification unit may determine whether or not the position information of the specific water area is same as any one piece of the plurality of pieces of position information of the evaluation water area, and if determining to be the same, may specify the paint based on the paint antifouling property data in the evaluation water area determined to be the same, and if determining not to be the same, may specify the paint based on the paint antifouling property data in the evaluation water area closest in distance to the specific water area among a plurality of the evaluation water areas. According to the paint selection system of this form, since if the position information of the specific water area is not the same as any one piece of the position information of the plurality of evaluation water areas, the paint is specified based on the paint antifouling property data in the evaluation water area closest in distance to the specific water area among the plurality of evaluation water areas, it is possible to select an appropriate paint also for a target object to be used in a water area not included in the paint antifouling property data.
[0009]

(4) In the paint selection system of the above form, the organism to be analyzed in creation of the paint antifouling property data may be a prokaryote. According to the paint selection system of this form, since the paint antifouling property data is created using a prokaryote having relatively uniform cell sizes as an index, it is possible to reduce an analysis error regarding an antifouling property, and as a result, it is possible to improve evaluation accuracy of the antifouling property.
[0010]

(5) In the paint selection system of the above form, the organism to be analyzed in creation of the paint antifouling property data may be a eukaryote. According to the paint selection system of this form, since the paint antifouling property data is created using a eukaryote as an index, an organism group, such as macroalgae, directly contributing to an increase in resistance when a target object such as a watercraft is used can be an index, and as a result, it is possible to select a paint using direct data regarding an antifouling property.
[0011]

(6) In the paint selection system of the above form, the organism to be analyzed in creation of the paint antifouling property data may be a prokaryote and a eukaryote. According to the paint selection system of this form, since the paint antifouling property data is created using a prokaryote and a eukaryote as indices, it is possible to select a paint using comprehensive paint antifouling property data with the prokaryote and the eukaryote as indices.
[0012]

(7) In the paint selection system of the above form, the paint may be a paint used for a watercraft. According to the paint selection system of this form, since a paint to be used for a watercraft is selected, it is possible to select a paint having an appropriate antifouling property in accordance with the watercraft. As a result, it is possible to suppress an increase in resistance when the watercraft operates due to biofouling, and therefore it is possible to suppress a speed decrease of the watercraft and to suppress deterioration of fuel consumption.
[0013]

(8) According to another form of the present invention, a paint selection method for selecting a paint is provided. This paint selection method includes: a process of creating paint antifouling property data including a correspondence relationship between position information of an evaluation water area and antifouling properties of a plurality of the paints by analyzing an organism attached to a sample that is applied in advance with the paint, the sample being immersed in the evaluation water area; a process of receiving an input of position information of a specific water area; a process of specifying the paint to be used in the specific water area by using the paint antifouling property data and the position information of the specific water area; and a process of outputting identification information of the paint specified.
[0014]

(9) According to another form of the present invention, a paint selection system for selecting a paint of a watercraft is provided. This paint selection system includes: a storage unit

that stores paint antifouling property data including a correspondence relationship between first organism species information that is information on an organism species attached to a sample applied in advance with the paint, the sample being immersed in an evaluation water area, and antifouling properties of a plurality of the paints; an input unit that receives an input of input data including second organism species information that is information on an organism species attached to the watercraft immersed in a use water area where the watercraft is used; a specification unit that specifies the paint to be applied to the watercraft by using the paint antifouling property data and the input data; and an output unit that outputs identification information of the paint specified. According to the paint selection system of this form, since the paint selection system includes the specification unit that specifies the paint to be applied to the watercraft by using the paint antifouling property data including the correspondence relationship between the first organism species information and the antifouling properties of the plurality of paints and the input data including the second organism species information that is information on the organism species attached to the watercraft in the use water area, and therefore it is possible to select a paint having an appropriate antifouling property for the organism species easily attached to the target watercraft. As a result, it is possible to select a paint having an appropriate antifouling property in accordance with the watercraft.

[0015]

(10) In the paint selection system of the above form, the storage unit stores price data corresponding to a price of each of the plurality of the paints, and the specification unit specifies the paint to be applied to the watercraft by using the paint antifouling property data, the price data, and the second organism species information. According to the paint selection system of this form, since the paint to be applied to the watercraft is specified using the price data in addition to the paint antifouling property data and the second organism species information, it is possible to select an appropriate paint in consideration of the price. As a result, it is possible to select a paint excellent in antifouling property and economic efficiency in accordance with the watercraft.

[0016]

(11) In the paint selection system of the above form, the first organism species information and the second organism species information may include information regarding a composition of an organism species. According to the paint selection system of this form, since the first organism species information and the second organism species information include information regarding the composition of the organism species, it is possible to select a paint having an appropriate antifouling property in accordance with the organism species composition in the use water area where the watercraft is used.

[0017]

(12) In the paint selection system of the above form, the first organism species information and the second organism species information may include information regarding a predetermined organism species. According to the paint selection system of this form, since the first organism species information and the second organism species information include information regarding a predetermined organism species, it is possible to select a paint having an appropriate antifouling property for any organism species or the like to be noted as an organism species attached to the watercraft.

[0018]

(13) In the paint selection system of the above form, the first organism species information and the second organism species information may be information regarding a prokaryotic species. According to the paint selection system of this form, since the first organism species information and the second organism species information are information regarding the prokaryotic species, the paint antifouling property data is created using a prokaryote having a relatively uniform cell size as an index. As a result, it is possible to select a paint by using paint antifouling property data having a small analysis error regarding the antifouling property and high evaluation accuracy of antifouling property.

[0019]

(14) In the paint selection system of the above form, the first organism species information and the second organism species information may be information regarding a eukaryotic species. According to the paint selection system of this form, since the first organism species information and the second organism species information are information regarding the eukaryotic species, the

paint antifouling property data is created using a eukaryote as an index. As a result, an organism group, such as macroalgae, directly contributing to an increase in resistance when a target object such as a watercraft is used can be an index, and as a result, it is possible to select a paint using direct data regarding an antifouling property.

[0020]

(15) In the paint selection system of the above form, the first organism species information and the second organism species information may be information regarding a prokaryotic species and a eukaryotic species. According to the paint selection system of this form, since the paint antifouling property data is created using a prokaryote and a eukaryote as indices, it is possible to select a paint using comprehensive paint antifouling property data with the prokaryote and the eukaryote as indices.

[0021]

(16) In the paint selection system of the above form, the paint antifouling property data may further include first speed information regarding an operation speed of the watercraft, and the input data may further include second speed information regarding an operation speed of the watercraft. According to the paint selection system of this form, since the first speed information regarding the operation speed of the watercraft is included in the paint antifouling property data and the second speed information regarding the operation speed of the watercraft is included in the input data, it is possible to select a paint having an appropriate antifouling property in accordance with the operation speed of the watercraft.

[0022]

(17) In the paint selection system of the above form, the paint antifouling property data may further include first frequency information regarding an operation frequency of the watercraft, and the input data may further include second frequency information regarding an operation frequency of the watercraft. According to the paint selection system of this form, since the first frequency information regarding the operation frequency of the watercraft is included in the paint antifouling property data and the second frequency information regarding the operation frequency of the watercraft is included in the input data, it is possible to select a paint having an appropriate antifouling property in accordance with the operation frequency of the watercraft.

[0023]

(18) According to another form of the present invention, a paint selection method for selecting a paint of a watercraft is provided. This paint selection method includes: a process of acquiring second organism species information that is information on an organism species attached to the watercraft by analyzing an organism attached to the watercraft applied with the paint, the watercraft being immersed in a use water area where the watercraft is used; a process of receiving an input of input data including the second organism species information; a process of specifying the paint to be applied to the watercraft by using paint antifouling property data including a correspondence relationship between first organism species information and antifouling properties of a plurality of the paints and the input data; and a process of outputting identification information of the paint specified, in which the paint antifouling property data is created by acquiring the first organism species information that is information on an organism species attached to a sample that is applied in advance with the paint, the sample being immersed in an evaluation water area, by analyzing an organism attached to the sample.

[0024]

Note that the present invention can be achieved in various forms, and for example, can be achieved in an aspect of a paint selection device, a program for executing a paint selection system, and the like.

[Brief Description of Drawings]

[0025]

Fig. 1 is a block diagram illustrating a schematic configuration of a paint selection system.

Fig. 2 is an explanatory diagram illustrating an example of a sample used for creating paint antifouling property data.

Fig. 3 is an explanatory diagram illustrating an example of the paint antifouling property data.

Fig. 4 is an explanatory diagram illustrating an example of price data.

Fig. 5 is a flowchart showing a procedure of a paint selection method.

Fig. 6 is a flowchart showing a procedure of a paint selection method in a second

embodiment.

Fig. 7 is an explanatory diagram illustrating an example of paint antifouling property data in a third embodiment.

Fig. 8 is an explanatory diagram illustrating another example of the paint antifouling property data.

Fig. 9 is a flowchart showing a procedure of a paint selection method in the third embodiment.

Fig. 10 is an explanatory diagram illustrating an example of paint antifouling property data in a fourth embodiment.

Fig. 11 is an explanatory diagram illustrating an example of paint antifouling property data in a fifth embodiment.

Fig. 12 is an explanatory diagram illustrating an attachment amount of ascidians and bryozoans in Ginowan Marina.

Fig. 13 is an explanatory diagram illustrating an attachment amount of ascidians and bryozoans in Yonabaru Marina.

Fig. 14 is an explanatory diagram illustrating a Shannon's index of diversity of a prokaryote in Ginowan Marina.

Fig. 15 is an explanatory diagram illustrating a Shannon's index of diversity of a prokaryote in Yonabaru Marina.

Fig. 16 is an explanatory diagram illustrating the transitions of the Shannon's index of diversity and the number of sequence variants in the prokaryote.

Fig. 17 is an explanatory diagram illustrating the transition of the rank of the antifouling property of the paint based on the result illustrated in Fig. 16.

Fig. 18 is an explanatory diagram illustrating an evaluation result of β diversity of a eukaryote in Ginowan Marina.

Fig. 19 is an explanatory diagram illustrating an evaluation result of β diversity of a eukaryote in Yonabaru Marina.

Fig. 20 is an explanatory diagram illustrating a panel taken out from the sea.

Fig. 21 is an explanatory diagram illustrating the total number of sequence variants derived from the prokaryote detected in each sample.

Fig. 22 is an explanatory diagram illustrating a scene of biofouling in a watercraft grounded after 6 months of painting.

[Description of Embodiments]

[0026]

A. First Embodiment

Fig. 1 is a block diagram illustrating a schematic configuration of a paint selection system 100 as one embodiment of the present invention. The paint selection system 100 of the present embodiment is used for selecting a paint to be applied to a target object such as a watercraft used underwater. Having focused on the fact that the organism species that live are different depending on water areas, and from the fact that the organism species that are likely to be attached to a target object such as a watercraft are different for each water area, the inventors of the present application have devised the invention of the present application on an assumption of selecting, and applying the target object with, a paint having an appropriate antifouling property in the water area. The target object applied with the paint is not limited to watercrafts and may also be any target objects used underwater such as fishing gear and piping of power plants. In the present description, the "watercraft" means a generic term for vehicles made for the purpose of moving on water or underwater with a person or an object regardless of the presence or absence of a propulsor. For this reason, the "watercraft" in the present description includes a submarine and a watercraft structure under construction that has been launched. In the present description, the "antifouling property" indicates performance of suppressing "contamination caused by attachment of an organism to a surface". Therefore, the "antifouling property of a paint" indicates "performance of suppressing attachment of an organism to the surface of a target object by applying the paint to the surface of the target object". In the present description, a certain specific water area where a target object is used is called a "specific water area". Specific examples of the specific water area can include, for example, a seaport where a watercraft is anchored and a course through which the watercraft navigates. Note that the specific water area is not limited to the sea, and may be a lake, a river, or the like. The paint selection system 100 of

the present embodiment selects a paint having an appropriate antifouling property in accordance with a target object to be used in a specific water area. The paint of the selection target is assumed to be applied mainly to the outer wall surface of the target object, and is assumed to be applied to the ship bottom particularly when the target object is a watercraft.
[0027]

The paint selection system 100 includes a storage unit 10, an input unit 20, a specification unit 30, and an output unit 40. The paint selection system 100 is implemented by a central processing unit (CPU) of a computer that operates in accordance with a program. The storage unit 10 includes a read only memory (ROM) and a random access memory (RAM), and stores in advance a paint selection program 12 for selecting a paint to be applied to a target object. The CPU functions as the specification unit 30 by executing the paint selection program 12 stored in advance in the storage unit 10.
[0028]

In addition to the paint selection program 12, the storage unit 10 stores paint antifouling property data 14 and price data 16. In the present embodiment, the paint antifouling property data 14 means data including a correspondence relationship between position information of an evaluation water area and antifouling properties of a plurality of paints. In the present description, the evaluation water area means a water area where the antifouling properties of the plurality of paints are evaluated in advance by an evaluation method described later. The position information of the evaluation water area may be information of, for example, a name or an address of a port or the like that is the evaluation water area, latitude and longitude of the evaluation water area, and the like. The position information of the evaluation water area may be information of, for example, a specific course, a sea area, and the like in which the antifouling property is evaluated. The paint antifouling property data 14 will be described in detail later. In the present description, the price data 16 means data corresponding to the price of each of the plurality of paints. The price data 16 will be described in detail later. Note that the storage unit 10 needs not store the price data 16. That is, the price data 16 may be omitted.
[0029]

The input unit 20 receives an input of the position information of the specific water area. A specific configuration of the input unit 20 is not particularly limited, but may be configured by, for example, an operation unit such as a keyboard, a button, or a screen of a touch panel, or may be configured by a microphone that receives a user's voice or the like. The input unit 20 may be configured by a communication device having a function of performing wireless communication or wired communication. The communication device may receive the position information of the specific water area input to a mobile information terminal or the like of the user, for example. The position information of the specific water area may be any information that can designate the position of the specific water area such as information on the name, the address, the latitude, and the longitude of a port. The position information of the specific water area may be any information that can designate the position of the specific water area such as a specific course or a sea area.
[0030]

The specification unit 30 specifies the paint to be used in the specific water area by using the paint antifouling property data 14 stored in the storage unit 10 and the position information of the specific water area received by the input unit 20. Specifying the paint to be used in the specific water area using the paint antifouling property data 14 and the position information of the specific water area corresponds to executing the paint selection program 12. Specification of the paint will be described in detail later.
[0031]

The output unit 40 outputs identification information of the paint specified by the specification unit 30. A specific configuration of the output unit 40 is not particularly limited, but may be configured by, for example, a display unit such as a screen of a monitor or a touch panel, or may be configured by a speaker or the like. The output unit 40 may be configured by a communication device having a function of performing wireless communication or wired communication. The communication device may output the identification information of the paint to the mobile information terminal or the like of the user, for example. The identification information of the paint is not particularly limited, but may be any information that can identify the paint such as a paint name or a paint identification number.

[0032]

The paint antifouling property data 14 is created by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the evaluation water area.

[0033]

Fig. 2 is an explanatory diagram illustrating an example of a sample used for creating the paint antifouling property data 14. In the example illustrated in Fig. 2, a panel 60 to which a plurality of samples 50 applied with respective paints is fixed is used. The sample 50 and the panel 60 are not particularly limited, but, for example, a metal plate such as an iron plate, a plastic plate, at least a part of the surface of a ship bottom of a watercraft, or the like can be used. As the sample 50, at least a part of a ship bottom of or the like of an actually operating watercraft may be used. Not only use of the panel 60 to which the plurality of samples 50 are fixed, but also each sample 50 may be immersed in the evaluation water area in an independent aspect. Note that the panel 60 may include, as a control, a sample not applied with a paint, a sample applied with a paint predicted not to have an antifouling property, and the like. The panel 60 may include a seawater sample of the water area of immersion as a control. The number of samples 50 applied with respective paints, that is, the number of paints used for evaluation is not particularly limited, but can be set to any number such as 10 types, 20 types, 30 types, and 40 types. In order to reduce the analysis error, one type of paint may be applied to a plurality of places.

[0034]

The evaluation water area means a water area used for the antifouling property evaluation of the paint. The evaluation water area is not particularly limited, but is preferably a water area where the target object is assumed to be used. For example, when the target object is a watercraft, a water area such as a seaport where the watercraft is assumed to anchor is preferable. Note that the evaluation water area is not limited to the sea, and may be a lake, a river, or the like. The period in which the sample is immersed in the evaluation water area (hereinafter, also called "immersion period" or "evaluation period") is not particularly limited, but can be set to any period such as 1 week, 2 weeks, 4 weeks, 6 weeks, and 10 weeks. The immersion period may be set to any period such as several months or one year. By immersing the sample in the evaluation water area, a plurality of types of organisms are attached to the surface of the sample. Note that the evaluation water area may be one water area or a plurality of water areas.

[0035]

Analysis of the organism attached to the sample is not particularly limited, but can be performed using, for example, a nucleic acid analysis method. Note that the analysis of the organism composition may be performed not only by the nucleic acid analysis method but also by any method such as an amino acid analysis method, or any method such as an amino acid analysis method and visual observation in addition to the nucleic acid analysis method may be combined. In the present description, the "nucleic acid analysis method" means a method for analyzing a base sequence contained in DNA or RNA. By performing analysis of an organism using the nucleic acid analysis method, it is possible to perform evaluation with high identification accuracy of the organism species and high detection sensitivity of the organism species in a short time. Examples of the nucleic acid analysis method include a method of not determining a base sequence and a method of determining a base sequence.

[0036]

Examples of the method for not determining the base sequence include, but are not particularly limited to, denaturing gradient gel electrophoresis (DGGE) and a gene detection method using a DNA chip. The DGGE method is a method of performing electrophoresis of PCR-amplified DNA using a gel containing a denaturant, and estimating the organism species composition from the obtained DNA band pattern. The gene detection method by a DNA chip is a method of hybridizing a nucleic acid to a DNA array in which a sequence specific to an organism species is spotted, and estimating the presence or absence of an organism based on the intensity.

[0037]

Examples of the method for determining the base sequence include, but are not particularly limited to, the next generation sequencing method, the Sanger method, and the Maxam-Gilbert method. In the present embodiment, the next generation sequencing method is used as the nucleic acid analysis method. In the present description, the "next generation sequencing method" indicates a method other than the Sanger method and the Maxam-Gilbert

method, and refers to a method of analyzing a base sequence contained in DNA or RNA of 1000 or more fragments in one analysis.
[0038]

By analyzing a large number of nucleic acids at a time by using the next generation sequencing method, it is also possible to identify a species having an extremely small abundance for the organism species contained in a test piece. Furthermore, by collating the base sequence of the nucleic acid having been obtained with a base sequence database by using the next generation sequencing method, it is possible to identify the organism species up to a fine rank in the biological classification.
[0039]

Examples of the next generation sequencing method include, but are not particularly limited to, the pyrosequencing method, the ion semiconductor sequencing method, the reversible terminator method, the single molecule real time sequencing method, and the nanopore sequencing method. Examples of the device used for the pyrosequencing method include, but are not particularly limited to, GS FLX manufactured by Roche Diagnostics K.K. Examples of the device used for the ion semiconductor sequencing method include, but are not particularly limited to, Ion PGM manufactured by Thermo Fischer Scientific K.K. Examples of the device used for the reversible terminator method include, but are not particularly limited to, MiSeq manufactured by Illumina, Inc. Examples of the device used for the single molecule real time sequencing method include, but are not particularly limited to, PacBio (registered trademark) RS II manufactured by Pacific Bioscience. Examples of the device used for the nanopore sequencing method include, but are not particularly limited to, MinION manufactured by Oxford Nanopore Technologies.
[0040]

The number of fragments of nucleic acid molecules to be analyzed per sample described above is not particularly limited, but is preferably 100 fragments or more, more preferably 1,000 fragments or more, and still more preferably 10,000 fragments or more. As the number of fragments of nucleic acid molecules to be analyzed per sample is larger, the presence of an organism species having an extremely small abundance can also be detected.
[0041]

The organisms to be analyzed in creation of the paint antifouling property data 14 may be only a prokaryote, may be only a eukaryote, or may be both a prokaryote and a eukaryote.
[0042]

The prokaryote is characterized by having a 70S ribosome. Examples of the prokaryote include, but are not particularly limited to, proteobacteria and cyanobacteria, which are eubacteria, and methane bacteria, which are archaeobacteria. The analysis of the organism species of the prokaryote can be performed by analyzing the base sequence of a gene preserved in a prokaryote such as 16S rRNA, for example. In evaluation of the antifouling property of the paint by analysis of the organism species of the prokaryote, for example, the less the organism species of the prokaryote attached to the sample is, the higher the antifouling property of the paint may be evaluated. The organism species of the prokaryote may be analyzed, for example, at the phylum level, or a detected sequence may be analyzed distinctively at the single base level, and may be indicated as a relative value (relative abundance) with respect to all the organism species attached to the sample. The organism species of the prokaryote may be analyzed at a specific level such as genus or order level, for example. Since the prokaryote has a relatively uniform cell size, the analysis error can be reduced in evaluation of the antifouling property using alpha diversity, for example. Therefore, by analyzing the prokaryote and creating the paint antifouling property data 14, it is possible to reduce an analysis error regarding the antifouling property and to enhance the evaluation accuracy of the antifouling property.
[0043]

The eukaryote is characterized by having an 80S ribosome. Examples of the eukaryote include, but are not particularly limited to, laminaria, an actinia, a shellfish, a shrimp, a barnacle, an ascidian, and a bryozoan. Analysis of the organism species of the eukaryote can be performed by analyzing the base sequence of genes preserved in the eukaryote such as 18S rRNA, for example. In evaluation of the antifouling property by analysis of the organism species of the eukaryote, for example, the more the organism species of the eukaryote attached to the sample is, the higher the antifouling property of the paint may be evaluated. The smaller the organism species composition ratio of a specific classification group with respect to the entire organism

species attached to the sample, such as macroalgae that adversely affect fuel consumption, is, the higher the antifouling property of the paint may be evaluated. The organism species of the eukaryote may be analyzed, for example, at the class level, or a detected sequence may be analyzed distinctively at the single base level, and may be indicated as a relative value (relative abundance) with respect to all the organism species attached to the sample. For example, the less the attachment amount of a predetermined organism species is, the higher the antifouling property of the paint may be evaluated. By evaluating the antifouling property using the composition of the organism species of the eukaryote, an organism group that directly contributes to an increase in resistance when using a target object, such as an increase in resistance when a watercraft operates, can be used as an index. Therefore, by analyzing the eukaryote and creating the paint antifouling property data 14, it is possible to select a paint by using the paint antifouling property data 14 indicating a direct result.

[0044]

The organism to be analyzed in the creation of the paint antifouling property data 14 may be both a prokaryote and a eukaryote. By creating the paint antifouling property data 14 using a prokaryote and a eukaryote as indices, it is possible to select a paint using the comprehensive paint antifouling property data 14 with the prokaryote and the eukaryote as indices.

[0045]

The organism to be analyzed in the creation of the paint antifouling property data 14 may be different for each evaluation water area. For example, when there is an organism group to be noted such as an ascidian, a bryozoan, a bivalve, a barnacle, and the like, the attachment amount of such specific organism group may be analyzed. More specifically, for example, in an evaluation water area where barnacles are easily attached to the target object such as a watercraft, the attachment amount of the barnacles may be analyzed to evaluate the antifouling property. For example, the antifouling property may be evaluated by analyzing the attachment amount of the ascidian, which is typical as an organism attached to the target object such as a watercraft. The organism to be analyzed in the creation of the paint antifouling property data 14 may be different for each type of the target object such as a target watercraft. That is, the organism to be analyzed in the creation of the paint antifouling property data 14 may be different in accordance with the purpose of the antifouling property.

[0046]

In the antifouling property evaluation of the paint, evaluation may be performed using an index of diversity of the organism composition. In the present description, the "index of diversity" indicates an index representing the diversity of an organism species. By performing the evaluation using the index of diversity, it is possible to quantitatively evaluate the antifouling property. Note that an index of diversity different for each evaluation water area may be used.

[0047]

The index of diversity is not particularly limited, but for example, (i) the total number of sequence variants occurred, (ii) the Simpson index or Shannon index, which is an index including information regarding the abundance for each sequence, (iii) the phylogenetic index of diversity of Faith calculated from the phylogenetic distance for each sequence, and the like can be used. As the index of diversity, an index indicating the diversity (so-called " α diversity") of organisms attached to one sample may be used, an index indicating the diversity (so-called " β diversity") among a plurality of samples may be used, or an index indicating the diversity (so-called " γ diversity") of the entire plurality of samples may be used. The Simpson index, the Shannon index, the phylogenetic index of diversity of Faith, the α diversity, the β diversity, and the γ diversity can be calculated the method described in Caporaso J.G. et al. "QIIME allows analysis of high-throughput community sequencing data" (Nat Methods. 2010 May; 7(5):335-6).

[0048]

Fig. 3 is an explanatory diagram illustrating an example of the paint antifouling property data 14. The paint antifouling property data 14 illustrated in Fig. 3 illustrates, as described above, the correspondence relationship between the position information of the evaluation water area and the antifouling property for each paint. In the paint antifouling property data 14 illustrated in Fig. 3, the names of ports where the antifouling properties of the plurality of paints have been evaluated in advance are used as the position information of the evaluation water area. More specifically, Fig. 3 illustrates the names of a port a, a port b, a port c, and the like. In the paint antifouling property data 14 illustrated in Fig. 3, the antifouling property of the paint is

indicated by numerical values ranked in order of evaluation of high antifouling property in the plurality of paints evaluated in the evaluation water area.
[0049]

The antifouling property of the paint in the paint antifouling property data 14 is not limited to numerical values by which the antifouling properties of the plurality of paints are ranked as illustrated in Fig. 3, and may be indicated by any parameters such as antifouling property levels of the paint or numerical values indicating the antifouling properties of the individual paints. The antifouling property level of the paint may be set, for example, by setting the top three types or the like of paints evaluated to have high antifouling properties among the plurality of paints evaluated in the evaluation water area to level 5 or the like, which is the highest level, and setting the next three types or the like of paints evaluated to have high antifouling properties to level 4, or the like. The antifouling property level of the paint may be set, for example, by setting a paint having a relative abundance and a value of the index of diversity within a predetermined range evaluated to have high antifouling property among the plurality of paints evaluated in the evaluation water area to level 5 or the like, which is the highest level, and setting a paint within a predetermined range next to it to level 4. The paint antifouling property data 14 is not limited to that in the table as illustrated in Fig. 3, and may be configured by any data including a correspondence relationship between the position information of the evaluation water area and the antifouling property of the paint obtained by the antifouling property evaluation, such as data indicated on a map, a graph, or a map. Note that the number of evaluation water areas included in the paint antifouling property data 14 may be any number of 1 or more.

[0050]

When the input unit 20 of the paint selection system 100 receives an input of position information “port a” as a specific water area, the specification unit 30 of the paint selection system 100 specifies a paint to be used in the port a using the paint antifouling property data 14 and the position information “port a”. In the case of the paint antifouling property data 14 illustrated in Fig. 3, since a paint B is presented as a paint having the highest antifouling property in the port a, the specification unit 30 specifies the paint B as the paint to be used in the port a. Thereafter, the output unit 40 outputs identification information of the paint B specified.

[0051]

Fig. 4 is an explanatory diagram illustrating an example of the price data 16. In the price data 16 illustrated in Fig. 4, the price (JPY/kg) for each paint is used as data corresponding to the price of each of the plurality of paints. Note that the price data 16 is not limited to the data of the price itself for each paint, and may be data by which a plurality of paints are ranked in ascending order of price, data in which the prices of the plurality of paints are leveled for each price range, or the like.

[0052]

In an aspect in which the storage unit 10 of the paint selection system 100 stores the price data 16, the specification unit 30 may specify the paint to be used in the specific water area using the paint antifouling property data 14, the price data 16, and the position information of the specific water area. When the input unit 20 receives an input of the position information such as the “port b” as a specific water area, the specification unit 30 specifies a paint to be used in the port b using the paint antifouling property data 14, the price data 16, and the position information “port b”. When the paint antifouling property data 14 illustrated in Fig. 3 and the price data 16 illustrated in Fig. 4 are used, a paint A and a paint D are presented as a paint having the highest antifouling property in the port b, and the price data 16 shows that the paint D is cheaper than the paint A. Therefore, the specification unit 30 specifies the paint D as the paint to be used in the port b. Thereafter, the output unit 40 outputs identification information of the paint D specified.

[0053]

Fig. 5 is a flowchart showing a procedure of the paint selection method. The paint selection method includes process (process P110) of creating paint antifouling property data, process (process P120) of receiving input of the position information of a specific water area, process (process P130) of specifying a paint to be used in the specific water area, and process (process P140) of outputting identification information of the specified paint. As described above, the paint antifouling property data created in process P110 is created by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the

evaluation water area. In process P130, the paint is specified using the paint antifouling property data and the position information of the specific water area. Note that in process P130, the paint may be specified using the price data as described above in addition to the paint antifouling property data and the position information of the specific water area.
[0054]

According to the paint selection system 100 in the first embodiment described above, since the paint antifouling property data 14 is created by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the evaluation water area, it is possible to create antifouling property data of the paint based on an organism species that lives for each water area. Since the paint selection system 100 includes the storage unit 10 that stores the paint antifouling property data 14 including the correspondence relationship between the position information of the evaluation water area and the antifouling properties of the plurality of paints, and the specification unit 30 that specifies the paint to be used in the specific water area by using the paint antifouling property data 14 and the position information of the specific water area, it is possible to select a paint having an appropriate antifouling property in accordance with the target object to be used in the specific water area.
[0055]

According to the aspect in which the price data 16 is stored in the storage unit 10 and the specification unit 30 specifies the paint to be used in the specific water area by using the paint antifouling property data 14, the price data 16, and the position information of the specific water area, it is possible to select an appropriate paint in consideration of the price. As a result, it is possible to select a paint excellent in antifouling property and economic efficiency in accordance with the target object to be used in a specific water area.
[0056]

B. Second Embodiment

The paint selection system of the second embodiment is different from the paint selection system 100 of the first embodiment in that the specific function of the specification unit is different from that of the specification unit 30 of the first embodiment. The other configurations are similar to those of the paint selection system 100 of the first embodiment, and thus a detailed description thereof will be omitted.
[0057]

The specification unit included in the paint selection system of the second embodiment determines whether or not the position information of the specific water area having been received is the same as any one piece of the position information of a plurality of evaluation water areas. When it is determined that the position information of the specific water area is the same as any one piece of the position information of the plurality of evaluation water areas, the paint is specified based on the paint antifouling property data in the evaluation water area determined to be the same. On the other hand, when it is determined that the position information of the specific water area is not the same as any one piece of the position information of the plurality of evaluation water areas, the paint is specified based on the paint antifouling property data in the evaluation water area closest in distance to the specific water area among the plurality of evaluation water areas. It is estimated that the composition of the organism species in the evaluation water area closest in distance to the specific water area is most similar to the composition of the organism species in the specific water area among the plurality of evaluation water areas. Note that the storage unit included in the paint selection system of the second embodiment stores in advance paint antifouling property data including a plurality of pieces of position information of the evaluation water area.
[0058]

Fig. 6 is a flowchart showing a part of the procedure of the paint selection method in the second embodiment. The paint selection method in the second embodiment is different from the paint selection method in the first embodiment in that process P130 of the paint selection method in the first embodiment includes processes P132 to P136 described below. The other processes are similar to those of the paint selection method in the first embodiment, and thus a detailed description thereof will be omitted.
[0059]

In the process (process P130) of specifying the paint to be used in the specific water area using the paint antifouling property data and the position information of the specific water area, it

is first determined whether or not the position information of the specific water area is the same as any one piece of the plurality of pieces of position information of the evaluation water area (process P132). When it is determined in process P132 that they are the same (process P132: YES), the paint is specified using the paint antifouling property data in the evaluation water area determined to be the same (process P134). When it is determined in process P132 that they are not the same (process P132: NO), the paint is specified using the paint antifouling property data in the evaluation water area closest in distance to the specific water area among the plurality of evaluation water areas (process P136). Thus, process P130 is completed. Note that also in the paint selection method of the fourth embodiment, similarly to the paint selection method of the second embodiment, price data may be used in process P130 in addition to the paint antifouling property data and the position information of the specific water area.

[0060]

According to the paint selection system of the second embodiment described above, since the paint antifouling property data in the evaluation water area closest in distance to the specific water area among the evaluation water areas included in the paint antifouling property data is used, it is possible to select an appropriate paint also in a water area not included in the paint antifouling property data. In other words, according to the paint selection system as the third embodiment, it is possible to select an appropriate paint also when a water area where the antifouling property of the paint is not evaluated is input as the specific water area.

[0061]

C. Third Embodiment

The paint selection system of the third embodiment is different from the paint selection system 100 of the first embodiment in a specific aspect of paint antifouling property data to be stored in the storage unit, an aspect of data to be received by the input unit, and a specific function of the specification unit. The other configurations are similar to those of the paint selection system 100 of the first embodiment, and thus a detailed description thereof will be omitted.

[0062]

The paint selection system of the third embodiment is used for selecting a paint to be applied to a watercraft used underwater. Having focused on the fact that the organism species that are likely to be attached are different depending on the paint, the inventors of the present application have devised the invention of the present application on an assumption of selecting, and applying the watercraft with, a paint having an appropriate antifouling property for the organism species that lives in the water area where the watercraft is used. In the present embodiment, a certain specific water area where a target watercraft is used is called a "use water area". Examples of the specific examples of the use water area include, but are not particularly limited to, a seaport where a watercraft is anchored and a course through which the watercraft navigates. Note that the use water area is not limited to the sea, and may be a lake, a river, or the like. The paint selection system of the third embodiment selects a paint having an appropriate antifouling property in accordance with the watercraft used in the use water area. It is assumed that the paint that becomes a selection target is applied mainly to an outer wall surface such as a ship bottom of a watercraft.

[0063]

The storage unit included in the paint selection system of the third embodiment stores paint antifouling property data. In the present embodiment, the paint antifouling property data means data including a correspondence relationship between the first organism species information and the antifouling properties of a plurality of paints. In the present embodiment, the first organism species information means information on the organism species attached to a sample immersed in the evaluation water area. This sample is applied with a paint in advance. The evaluation water area means a water area where the antifouling properties of the plurality of paints are evaluated in advance. Therefore, the first organism species information corresponds to information on organism species that are easily attached to respective paints in the water area where the antifouling property of the paint has been evaluated. The first organism species information and the paint antifouling property data will be described in detail later.

[0064]

The input unit included in the paint selection system of the third embodiment receives an input of input data including the second organism species information. In the present embodiment, the second organism species information means information on the organism species

attached to the watercraft immersed in the use water area. Therefore, the second organism species information corresponds to information on organism species that are easily attached to the watercraft in the use water area where the watercraft is used. The second organism species information and the input data will be described in detail later.
[0065]

The specification unit included in the paint selection system of the third embodiment specifies a paint to be applied to the watercraft by using the paint antifouling property data stored in the storage unit and the input data received by the input unit. Specifying the paint to be applied to the watercraft by using the paint antifouling property data and the input data corresponds to executing the paint selection program.
[0066]

The first organism species information is created by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the evaluation water area. The first organism species information is not particularly limited, but may be, for example, information regarding a predetermined organism species, information regarding the composition of the organism species, or information including both the composition of the organism species and the predetermined organism species. The information regarding the predetermined organism species may be information on any one type of organism species or information on any plurality of types of organism species. More specifically, for example, when the organism species to be noted as an organism species attached to the watercraft are an ascidian, a bryozoan, a bivalve, a barnacle, and the like, the information regarding the predetermined organism species may be information on only the ascidian or information on only the barnacle, or may be information as an organism group of the ascidian and the barnacle. The information regarding the composition of the organism species is not particularly limited, but may be, for example, information regarding the index of diversity of the organism composition, information regarding the number of organism species, or the like. The information including both the composition of the organism species and the predetermined organism species is not particularly limited, but may be, for example, information regarding the relative abundance of a predetermined organism species with respect to all the organism species attached to the sample.
[0067]

The method for acquiring the first organism species information, that is, the method for creating the paint antifouling property data is similar to that of the first embodiment. The paint antifouling property data in the third embodiment is created by specifying the correspondence relationship between the first organism species information and the antifouling property of respective paints based on the first organism species information having been acquired. Note that the first organism species information may be information regarding the prokaryotic species, information regarding the eukaryotic species, or information regarding the prokaryotic species and the eukaryotic species.
[0068]

The organism to be analyzed in the creation of the paint antifouling property data may be different for each type of the target watercraft. That is, the organism to be analyzed in the creation of the paint antifouling property data may be different in accordance with the purpose of the antifouling property. For example, the organism to be analyzed may be different in accordance with an operation speed, an operation frequency, and the like assumed in the target watercraft. For example, the organism to be analyzed may be different in accordance with the size of the target watercraft, the season in which the target watercraft is particularly operated, the speed of the current in the water area where the target watercraft operates, and the like. Thus, the first organism species information may be discretionarily set in accordance with the purpose of the antifouling property.
[0069]

Fig. 7 is an explanatory diagram illustrating an example of paint antifouling property data in the third embodiment. The paint antifouling property data illustrated in Fig. 7 illustrates, as described above, the correspondence relationship between the first organism species information and the antifouling property for each paint. In the paint antifouling property data illustrated in Fig. 7, the names of predetermined organism species are used as the first organism species information. More specifically, Fig. 7 illustrates the names of respective organism species such as a species a, a species b, and a species c.

[0070]

In the paint antifouling property data illustrated in Fig. 7, the antifouling property of the paint is indicated by numerical values ranked in order of evaluation of high antifouling property for the organism species in the plurality of paints evaluated in the plurality of respective evaluation water areas. The antifouling property of the paint for each organism species in the paint antifouling property data is not limited to numerical values by which the antifouling properties of the plurality of paints are ranked as illustrated in Fig. 7, and the antifouling property may be indicated by any parameters such as antifouling property levels of the paint or numerical values indicating the antifouling properties of the individual paints. The antifouling property level of the paint is not particularly limited, but may be set, for example, by setting the top three types or the like of paints evaluated to have high antifouling properties for each organism species among the plurality of paints evaluated in the plurality of respective evaluation water areas to level 5 or the like, which is the highest level, and setting the next three types or the like of paints evaluated to have high antifouling properties to level 4.

[0071]

Fig. 8 is an explanatory diagram illustrating another example of the paint antifouling property data. In the paint antifouling property data illustrated in Fig. 8, a symbol indicating the composition of the organism species is used as an example of information regarding the composition of the organism species as the first organism species information. More specifically, Fig. 8 illustrates symbols such as an organism species composition a, an organism species composition b, and an organism species composition c. Each organism species composition is not particularly limited, but may correspond to the composition of the organism species analyzed for each evaluation water area, for example, or may be a symbol or the like indicating the composition of the organism species in a plurality of evaluation water areas in which the compositions of the organism species are similar to each other. As the composition "corresponding to the composition of the organism species analyzed for each evaluation water area", for example, the composition of the organism species in the port a or a composition similar thereto may be the organism species composition a, the composition of the organism species in the port b or a composition similar thereto may be the organism species composition b, and the composition of the organism species in the port c or a composition similar thereto may be the organism species composition c. For example, the "symbol or the like indicating the composition of the organism species in a plurality of evaluation water areas in which the compositions of the organism species are similar to each other" may be set with reference to the ratio or the like of a plurality of specific organism species among all the analyzed organism species. More specifically, for example, the total content ratio of the ascidian, the barnacle, and the bryozoan that is equal to or greater than 90% may be the organism species composition a, the total content ratio of thereof that is equal to or greater than 70% and less than 90% may be the organism species composition b, and the total content ratio of thereof that is equal to or greater than 50% and less than 70% may be the organism species composition c. It is preferable that "the compositions of the organism species are similar to each other" is determined based on any index indicating that the compositions of the organism species are similar to each other, for example, in the β diversity of the composition of the prokaryote or the eukaryote, such as the Aitchison distance, the Bray-Curtis distance, the Unifrac distance, and the Jaccard distance.

[0072]

In the paint antifouling property data illustrated in Fig. 8, the antifouling property of the paint is indicated by numerical values ranked in order of evaluation of high antifouling property for the organism species composition in the plurality of paints evaluated in the plurality of evaluation water areas. The antifouling property of the paint for each organism species composition in the paint antifouling property data is not limited to numerical values by which the antifouling properties of the plurality of paints are ranked as illustrated in Fig. 8, and may be indicated by any parameters such as antifouling property levels of the paint or numerical values indicating the antifouling properties of the individual paints. The antifouling property level of the paint is not particularly limited, but may be set, for example, by setting the top three types or the like of paints evaluated to have high antifouling properties for each organism species composition among the plurality of paints evaluated in the evaluation water area to level 5 or the like, which is the highest level, and setting the next three types or the like of paints evaluated to have high antifouling properties to level 4. The antifouling property level of the paint for each organism

species may be set, for example, by setting a paint having a relative abundance and a value of the index of diversity within a predetermined range evaluated to have high antifouling property among the plurality of paints evaluated in the evaluation water area to level 5 or the like, which is the highest level, and setting a paint within a predetermined range next to it to level 4.

[0073]

The paint antifouling property data in the third embodiment is not limited to that in the tables as illustrated in Figs. 7 and 8, and may be configured by any data, such as a graph or a map, including a correspondence relationship between the first organism species information and the antifouling property of the paint obtained by the antifouling property evaluation. The paint antifouling property data may include any information such as an immersion period in which the sample is immersed in the evaluation water area. Note that the number of pieces of the first organism species information included in the paint antifouling property data may be any number of 1 or more.

[0074]

The second organism species information and the input data will be described below. It is desirable that the second organism species information is set as information in a format similar to that of the first organism species information described above. For example, in an aspect in which the first organism species information is information regarding a predetermined organism species, it is desirable that the second organism species information is also set as information regarding the predetermined organism species. More specifically, when the first organism species information is the name of a predetermined organism species as illustrated in Fig. 7, it is desirable that the second organism species information is also set as the name of the organism species. For example, in an aspect in which the first organism species information is information regarding the composition of the organism species, it is desirable that the second organism species information is also set as the information regarding the composition of the organism species. More specifically, when the first organism species information is a symbol indicating the organism species composition as illustrated in Fig. 8, it is desirable that the second organism species information is also set as a symbol indicating the organism species composition.

[0075]

The second organism species information can be acquired by analyzing the organism attached to an immersed watercraft in the use water area where the watercraft is used. The period in which the watercraft is immersed in the use water area is not particularly limited, but may be any period such as 3 days, 1 week, 2 weeks, or 4 weeks. As the period in which the watercraft is immersed is longer, a result close to the organism species attached when the watercraft is actually operated can be obtained. As the period in which the watercraft is immersed is shorter, the second organism species information can be easily acquired. The analysis of the organism attached to the watercraft can be performed by a similar method to the analysis method of the organism attached to the sample immersed in the evaluation water area as described above, such as the nucleic acid analysis method.

[0076]

The input data may be the second organism species information itself, and may include, in addition to the second organism species information, any information such as an immersion period in which the watercraft is immersed in the use water area.

[0077]

When the input unit of the paint selection system receives, as input data, the second organism species information of the “species a”, for example, the specification unit of the paint selection system specifies a paint having an appropriate antifouling property for the species a by using the paint antifouling property data and the input data of the “species a”. In the case of the paint antifouling property data illustrated in Fig. 7, since the paint B is presented as a paint having the highest antifouling property for the species a, the specification unit specifies the paint B as the paint to be applied to the watercraft. Thus, the specification unit specifies a paint having an appropriate antifouling property for the organism species easily attached to the watercraft in the use water area where the watercraft is used. Thereafter, the output unit outputs identification information of the paint B specified.

[0078]

When the input unit of the paint selection system receives, as input data, the second organism species information of the “organism species composition c”, for example, the

specification unit of the paint selection system specifies a paint having an appropriate antifouling property for the organism species composition c by using the paint antifouling property data as illustrated in Fig. 8 and the input data of the "organism species composition c". In the case of the paint antifouling property data illustrated in Fig. 8, since a paint Y is presented as a paint having the highest antifouling property for the organism species composition c, the specification unit specifies the paint Y as the paint to be applied to the watercraft. Thus, the specification unit specifies a paint having an appropriate antifouling property in accordance with the organism species composition in the use water area where the watercraft is used. Thereafter, the output unit outputs identification information of the paint Y specified.

[0079]

When the organism species composition as the second organism species information having been input does not correspond to any of the organism species compositions as the first organism species information included in the paint antifouling property data, the specification unit may specify the first organism species information in which the composition of the organism species is most similar. It is preferable that "the composition of the organism species is most similar" is defined based on any index indicating that the composition of the organism species is most similar, for example, in the β diversity of the composition of the prokaryote or the eukaryote, such as the Aitchison distance, the Bray-Curtis distance, the Unifrac distance, and the Jaccard distance.

[0080]

In an aspect in which the storage unit included in the paint selection system stores the price data as illustrated in Fig. 4, the specification unit may specify the paint to be used in the watercraft by using the paint antifouling property data, the price data, and the input data. When the input unit receives, as input data, the second organism species information of the "organism species b, for example, the specification unit a paint having an appropriate antifouling property for the organism species b and having a low price by using the paint antifouling property data, the price data, and the input data of the "organism species b". When the paint antifouling property data illustrated in Fig. 7 and the price data illustrated in Fig. 4 are used, the paint A and the paint D are presented as a paint having the highest antifouling property in the b, and the price data shows that the paint D is cheaper than the paint A. Therefore, the specification unit specifies the paint D as the paint to be applied to the watercraft. Thus, the specification unit specifies a paint having an appropriate antifouling property for the organism species easily attached to the watercraft in the use water area where the watercraft is used and having a low price. Thereafter, the output unit outputs identification information of the paint D specified.

[0081]

Fig. 9 is a flowchart showing the procedure of the paint selection method in the third embodiment. The paint selection method includes a process (process P210) of acquiring the second organism species information, a process (process P220) of receiving input data including the second organism species information, a process (process P230) of specifying a paint to be applied to the watercraft, and a process (process P240) of outputting identification information of the specified paint.

[0082]

In the paint selection method, paint antifouling property data is prepared in advance before the process (process P210) of acquiring the second organism species information. The paint antifouling property data is created by acquiring the first organism species information, which is information on an organism species attached to the sample, by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the evaluation water area. The paint antifouling property data includes a correspondence relationship between the acquired first organism species information and the antifouling properties of a plurality of paints. As described above, the second organism species information in process P210 is acquired by analyzing the organism attached to the watercraft applied with the paint, the watercraft being immersed in the use water area. In process P230, the paint to be applied to the watercraft is specified using the paint antifouling property data and the input data. Note that in process P230, the paint may be specified using the price data as described above in addition to the paint antifouling property data and the input data.

[0083]

The paint selection system in the third embodiment described above includes the storage

unit that stores paint antifouling property data including a correspondence relationship between the first organism species information and the antifouling properties of a plurality of paints, the input unit that receives an input of input data including the second organism species information, which is information on the organism species attached to the target watercraft in the use water area, and the specification unit that specifies a paint to be applied to the watercraft by using the paint antifouling property data and the input data. Therefore, it is possible to select a paint having an appropriate antifouling property for an organism species easily attached to the watercraft in the use water area where the watercraft is used. As a result, it is possible to select a paint having an appropriate antifouling property in accordance with the watercraft.
[0084]

According to the aspect in which the price data is stored in the storage unit and the specification unit specifies the paint to be applied to the watercraft by using the paint antifouling property data, the price data, and the second organism species information, it is possible to select an appropriate paint in consideration of the price. As a result, it is possible to select a paint excellent in antifouling property and economic efficiency in accordance with the watercraft.
[0085]

According to an aspect in which the first organism species information and the second organism species information include information regarding the composition of the organism species, it is possible to select a paint having an appropriate antifouling property in accordance with the organism species composition in the use water area where the watercraft is used. According to an aspect in which the first organism species information and the second organism species information include information regarding a predetermined organism species, it is possible to select a paint having an appropriate antifouling property for any organism species or the like to be noted as an organism species attached to the watercraft.
[0086]

According to an aspect in which the first organism species information and the second organism species information are information regarding the prokaryotic species, since the paint antifouling property data is created using a prokaryote having relatively uniform cell sizes as an index, it is possible to select a paint by using paint antifouling property data having a small analysis error regarding the antifouling property and high evaluation accuracy of the antifouling property. According to the aspect in which the first organism species information and the second organism species information are information regarding the eukaryotic species, since the antifouling property is evaluated with the eukaryote as an index, an organism species, such as macroalgae, that directly contributes to an increase in resistance when a watercraft operates can be used as an index, and as a result, it is possible to select a paint using paint antifouling property data indicating a direct result. According to the aspect in which the first organism species information and the second organism species information are information on the prokaryotic species and the eukaryotic species, it is possible to select a paint using comprehensive paint antifouling property data with the prokaryote and the eukaryote as indices.
[0087]

D. Fourth Embodiment

The paint selection system of the fourth embodiment is different from the paint selection system of the third embodiment in a specific aspect of paint antifouling property data and input data. The other configurations are similar to those of the paint selection system of the third embodiment, and thus a detailed description thereof will be omitted. The paint antifouling property data stored in the storage unit included in the paint selection system of the fourth embodiment further includes the first speed information regarding the operation speed of the watercraft. The input data in the fourth embodiment further includes the second speed information regarding the operation speed of the watercraft.
[0088]

The inventor of the present application has found that the organism species to be attached may be different in accordance with the operation speed of the watercraft. Based on such finding, the paint selection system of the fourth embodiment selects a paint having an appropriate antifouling property in accordance with the use speed, that is, the operation speed of the target watercraft.
[0089]

Fig. 10 is an explanatory diagram illustrating an example of paint antifouling property

data in the fourth embodiment. The paint antifouling property data illustrated in Fig. 10 indicates the antifouling property of the paint in which the first speed information regarding the operation speed of the watercraft is taken into consideration. In the example illustrated in Fig. 10, numerical values in a predetermined speed range are used as the first speed information. More specifically, numerical values in speed ranges such as a speed of less than 15 km/h, a speed of equal to or greater than 15 km/h and less than 30 km/h, and a speed of equal to or greater than 30 km/h are used. Note that the first speed information is not limited to such numerical value of the speed range, and may be any information such as a level indicating the operation speed. In Fig. 10, the names of predetermined organism species are used as the first organism species information, but information regarding the composition of the organism species or the like may be used. In Fig. 10, numerical values ranked in order of evaluation of high antifouling property are presented as the antifouling property of the paint, but the antifouling property may be presented by any parameter such as the antifouling property level of the paint or numerical values indicating the antifouling properties of individual paints.

[0090]

The paint antifouling property data in the fourth embodiment can be created by immersing a sample applied in advance with a paint in an evaluation water area, operating the watercraft at a plurality of operation speeds for a certain period of time, and then analyzing the organism attached to the sample. For example, evaluation may be performed with the panel 60 as illustrated in Fig. 2 attached to the ship bottom of a watercraft, a position buoy, or the like, evaluation may be performed with the ship bottom or the like of the watercraft separately painted with a plurality of paints, or evaluation may be performed using a plurality of watercrafts applied with a single paint. The influence of the operation speed of the watercraft may be evaluated without using the watercraft. For example, the influence of the operation speed of the watercraft may be evaluated by attaching the panel 60 to a rotary drum in contact with water and periodically operating the watercraft. Using a device that can flow seawater to flow at a predetermined speed by a screw or the like, the panel 60 or a test piece may be installed in a flow path thereof.

[0091]

It is desirable that the second speed information regarding the operation speed of the watercraft is set as information in a format similar to that of the first speed information described above. For example, in an aspect in which the first speed information is a numerical value of a predetermined speed range, it is desirable that the second speed information is also set by a numerical value of a predetermined speed range.

[0092]

The input data in the fourth embodiment may include the second organism species information acquired by immersing a watercraft in a use water area, operating the watercraft for a certain period at an operation speed indicated by the second speed information, and then analyzing an organism attached to the watercraft. That is, it may be an aspect including the second organism species information in which the second speed information is taken into consideration. According to such aspect, it is possible to obtain a result close to the organism species attached when the watercraft is operated at the actually used speed. The input data in the fourth embodiment may be an aspect including, independently from each other, the second organism species information, which is information on the organism species attached to the watercraft immersed in the use water area, and the second speed information. The input data in this aspect is not particularly limited, but may include, for example, the second organism species information acquired by leaving the watercraft still in the use water area and analyzing an organism attached to the watercraft after a lapse of a certain period of time, and information regarding an operation speed assumed in the watercraft.

[0093]

According to the paint selection system of the fourth embodiment described above, since the first speed information regarding the operation speed of the watercraft is included in the paint antifouling property data and the second speed information regarding the operation speed of the watercraft is included in the input data, it is possible to select a paint having an appropriate antifouling property in accordance with the operation speed of the target watercraft. Therefore, it is possible to select a paint having an appropriate antifouling property in accordance with the target watercraft, such as a tanker having a relatively low operation speed, a container vessel

having a medium operation speed, and a high-speed passenger ship and an escort ship having a relatively high operation speed.
[0094]

E. Fifth Embodiment

The paint selection system of the fifth embodiment is different from the paint selection system of the fourth embodiment in a specific aspect of paint antifouling property data and input data. The other configurations are similar to those of the paint selection system of the fourth embodiment, and thus a detailed description thereof will be omitted. The paint antifouling property data stored in the storage unit included in the paint selection system of the fifth embodiment includes the first frequency information regarding the operation frequency of the watercraft in place of the first speed information regarding the operation speed of the watercraft. The input data in the fifth embodiment includes the second frequency information regarding the operation frequency of the watercraft in place of the second speed information regarding the operation speed of the watercraft.

[0095]

The inventor of the present application has found that the organism species to be attached may be different in accordance with the operation frequency of the watercraft. Based on such finding, the paint selection system of the third embodiment selects a paint having an appropriate antifouling property in accordance with the use frequency, that is, the operation frequency, that is, the operation frequency of the target watercraft.

[0096]

Fig. 11 is an explanatory diagram illustrating an example of paint antifouling property data in the fifth embodiment. The paint antifouling property data illustrated in Fig. 11 indicates the antifouling property of the paint in which the first frequency information regarding the operation frequency of the watercraft is taken into consideration. The example illustrated in Fig. 11 presents the operation frequency such as only weekends, only weekdays, and every day as the first frequency information. Note that the first frequency information is not particularly limited, but may be indicated by a numerical value such as the number of days used per week or the continuous operation time, or may be any information such as a level indicating the operation frequency. In Fig. 11, the names of predetermined organism species are used as the first organism species information, but information regarding the composition of the organism species or the like may be used. In Fig. 11, numerical values ranked in order of evaluation of high antifouling property are presented as the antifouling property of the paint, but the antifouling property may be indicated by any parameter such as the antifouling property level of the paint or numerical values indicating the antifouling properties of individual paints.

[0097]

The paint antifouling property data in the fifth embodiment can be created by immersing a sample applied in advance with a paint in an evaluation water area, operating the watercraft at a plurality of operation frequencies for a certain period of time, and then analyzing the organism attached to the sample. For example, evaluation may be performed with the panel 60 as illustrated in Fig. 2 attached to the ship bottom of a watercraft or the like, evaluation may be performed with the ship bottom or the like of the watercraft separately painted with a plurality of paints, or evaluation may be performed using a plurality of watercrafts applied with a single paint.

[0098]

It is desirable that the second frequency information regarding the operation frequency of the watercraft is set as information in a format similar to that of the first frequency information described above. For example, in an aspect in which the first frequency information is a level indicating the operation frequency, it is desirable that the second frequency information is also set by a level indicating the operation frequency.

[0099]

The input data in the fifth embodiment may include the second organism species information acquired by immersing a watercraft in a use water area, operating the watercraft for a certain period at an operation frequency indicated by the second frequency information, and then analyzing an organism attached to the watercraft. That is, it may be an aspect including the second organism species information in which the second frequency information is taken into consideration. According to such aspect, it is possible to obtain a result close to the organism species attached when the watercraft is operated at the actually used frequency. The input data

in the fifth embodiment may be an aspect including, independently from each other, the second organism species information, which is information on the organism species attached to the watercraft immersed in the use water area, and the second frequency information. The input data in this aspect is not particularly limited, but may include, for example, the second organism species information acquired by leaving the watercraft still in the use water area and analyzing an organism attached to the watercraft after a lapse of a certain period of time, and information regarding an operation frequency assumed in the watercraft.

[0100]

According to the paint selection system of the fifth embodiment described above, since the first frequency information regarding the operation frequency of the watercraft is included in the paint antifouling property data and the second frequency information regarding the operation frequency of the watercraft is included in the input data, it is possible to select a paint having an appropriate antifouling property in accordance with the operation frequency of the target watercraft. Therefore, it is possible to select a paint having an appropriate antifouling property in accordance with the target watercraft, such as a pleasure craft operated only on weekends, a fishing vessel operated for a certain period of time only on weekdays, or a tanker operated day and night.

[0101]

F. Other Embodiments

The configuration of the paint selection system in each of the above embodiments is merely an example, and various modifications can be made. For example, it may be an aspect in which the paint antifouling property data further includes the first speed information regarding the operation speed of the watercraft and the first frequency information regarding the operation frequency of the watercraft, and the input data further includes the second speed information regarding the operation speed of the watercraft and the second frequency information regarding the operation frequency of the watercraft. According to such aspect, it is possible to select a paint having a more appropriate antifouling property in accordance with the target watercraft.

[0102]

G. Examples

Hereinafter, the present invention will be described more specifically with reference to examples, but the present invention is not limited to the following examples.

[0103]

In order to create paint antifouling property data, first, a sample applied with each of a plurality of paints was prepared. In the present example, eight panels of fiber-reinforced plastic plates were prepared. Each of the fiber-reinforced plastic plates was applied with a base paint and then provided with 24 sections of 7.5 cm square, and 22 types of antifouling paints were applied to each of the sections. As a control, a section (Ctrl-1: anticorrosive) applied with an anticorrosive paint having no antifouling effect and a section (Ctrl-2: no paint) applied with no antifouling paint was applied were also prepared. Note that the eight panels have the same configuration.

[0104]

Next, the sample applied with each of the plurality of paints was immersed in the evaluation water area. As the evaluation water area, Yonabaru Marina in Okinawa and Ginowan Marina in Okinawa were used. A total of four panels were moored at 1 m point under the sea in each of the ports of these two different evaluation water areas. The panels were taken out from the sea in 1, 2, 4, and 6 weeks after being sunk, and the attachment of the paint surface was scraped off using a melamine sponge, immediately immersed in an inactivation solution (DNA/RNA Shield, manufactured by Zymo Research), and cryopreserved. In each evaluation water area, seawater was filtered with a filter having a pore diameter of 0.22 μm , and then this filter was cryopreserved as a control (seawater). The volume of the seawater was 1 L.

[0105]

Next, the organism attached to each sample was analyzed. Specifically, analysis was performed using the nucleic acid analysis method. Each of the cryopreserved sample solutions was subjected to bead crushing treatment, and then DNA was purified using a DNA extraction kit (ZymoBIOMICS-96 DNA Kit, manufactured by Zymo Research). Using the purified nucleic acid as a template, the V3-V4 variable region of 16S rRNA and the V7-V8 variable region of 18S rRNA were amplified by PCR, and then the composition of the organism species attached to each sample

and the filter as a control was analyzed using a next generation sequencing method. As a primer of PCR for amplification, the following primers were used. That is, as primers of PCR for the V3-V4 variable region of 16S rRNA, a primer 341F:5'-TCGTCGGCAGCGTCAGATGTGTATAAGAGACAGCCTACGGGNGGCWGCAG -3' indicated in a sequence number 1 and a primer 805R:5'-GTCTCGTGGGCTCGGAGATGTGTATAAGAGACAGGACTACHVGGGTATCTAATCC -3' indicated in a sequence number 2 were used. As primers of PCR for the V7-V8 variable region of 18S rRNA, a primer F1183:5'-TCGTCGGCAGCGTCAGATGTGTATAAGAGACAGAATTTGACTCAACACGGG -3' indicated in a sequence number 3 and a primer R1631:5'-GTCTCGTGGGCTCGGAGATGTGTATAAGAGACAGTACAAAGGGCAGGGACG -3' indicated in a sequence number 4 were used. After the obtained PCR product was purified, an index sequence for sample identification was added by PCR, and the DNA thereof was purified. The base sequence of the obtained DNA was analyzed using the next generation sequencing method. MiSeq manufactured by Illumina, Inc. was used in the next generation sequencing method of the present example. Note that the V3-V4 variable region of 16S rRNA was used for the purpose of detecting the prokaryote, and the V7-V8 variable region of 18S rRNA was used for the purpose of detecting the eukaryote.

[0106]

Thereafter, classification information of the organism was acquired from the base sequence obtained by the next generation sequencing method using QIIME2, which is flora analysis software. Noise removal was performed using a DADA2 plugin and classification information was acquired with reference to an rRNA database (SILVA ver.138). The number of sequences was thinned to about 29,000 sequences for the 16S rRNA gene and about 16,000 sequences for the 18S rRNA per sample or seawater collected from each section, and then the composition of the attached organism was analyzed.

[0107]

Next, the antifouling property of each paint was evaluated using the analysis result of the composition of the organism, and paint antifouling property data indicating a correspondence relationship between the position information of the evaluation water area and the antifouling properties of the plurality of paints as used in the first and second embodiments was created. Similarly, the antifouling property of each paint was evaluated using the analysis result of the composition of the organism, and paint antifouling property data indicating a correspondence relationship between the first organism species information and the antifouling properties of the plurality of paints as used in the third to fifth embodiments was created. Hereinafter, an example of the antifouling property evaluation of each paint will be presented.

[0108]

Fig. 12 is an explanatory diagram illustrating the attachment amounts of an ascidian (class: ascidiacea) and a bryozoan (class: gymnolaemata) in Ginowan Marina. Fig. 13 is an explanatory diagram illustrating the attachment amounts of an ascidian and a bryozoan in Yonabaru Marina. In Figs. 12 and 13, the organism species attached to each sample in the evaluation period of 6 weeks are analyzed. The vertical axes in Figs. 12 and 13 indicate the relative abundance of the ascidian or the bryozoan when the total amount of organisms attached to each sample is 1. The results illustrated in Figs. 12 and 13 indicate that the attachment amount of the ascidian greatly varies depending on the type of paint in the evaluation water areas of any of Ginowan Marina and Yonabaru Marina. Comparison of the results of the two evaluation water areas indicate that the attachment amount of the ascidian varies also with the same paint. It was found that the attachment amount of the bryozoan greatly varies in the two evaluation water areas. More specifically, attachment of the bryozoan was hardly seen in Ginowan Marina, whereas in Yonabaru Marina, the relative abundance of the bryozoan was close to 1 in the control sample not applied with the paint, and it was found that Yonabaru Marina was a water area where the bryozoan was easily attached. It was found that the attachment amount of the bryozoan varies depending on the type of paint in Yonabaru Marina. For this reason, in Yonabaru Marina, it was found that a paint having a smaller attachment amount of the bryozoan may be evaluated to have a higher antifouling property.

[0109]

As paint antifouling property data created from the results illustrated in Figs. 12 and 13, the following are assumed. As the paint antifouling property data used in the first and second

embodiments, for example, in Ginowan Marina, a paint F may be ranked first, the paint D may be the second, a paint C may be the third, the paint A may be the fourth, and a paint V and a paint S may be the fifth in descending order of the antifouling property with the attachment amount of the ascidian as an index. The paints F, D, C, and A may be level 5, which is the highest level of the antifouling property, and the paints V, S, U, and O may be level 4. For example, in Yonabaru Marina, paints I, E, and M may be level 5, which is the highest level of the antifouling property, and paints N, L, K, R, and G may be level 4 in descending order of the antifouling property with the attachment amount of the bryozoan as an index.

[0110]

As the paint antifouling property data used in the third to fifth embodiments, for example, as a paint effective for the ascidian as the first organism species information, a paint having a reduced attachment amount of the ascidian in both marinas may be selected and the paint C may be ranked first, the paint A may be the second, the paint D may be the third, the paint F may be the fourth, and the paint O and the paint S are the fifth, or the paints C, A, D, and F may be level 5, which is the highest level of antifouling property, and the paints O, S, U, and V may be level 4. For example, as a paint effective for the bryozoan as the first organism species information, with reference to the test results in Yonabaru Marina, the paints I, E, and M may be level 5, which is the highest level of the antifouling property, and the paints N, L, K, R, and G may be level 4 in descending order of the antifouling property.

[0111]

Using the created paint antifouling property data, a paint to be applied to the watercraft was selected. More specifically, biofouling of a watercraft anchored in a specific port was collected, and analysis of the organism species was performed by a method similar to that for the above sample, and it was found that the bryozoan has priority. Therefore, by inputting the input data of "bryozoan" as the second organism species information, among the paints I, E, and M having a high antifouling property effect on the bryozoan as the first organism species information, the paint I, which is particularly low in price, was specified and output. Biofouling of a watercraft navigating another course was collected, analysis of the organism species was performed by a method similar to the above sample, and as a result, it was found that priority was given to the ascidian. Therefore, by inputting the input data of "ascidian" as the second organism species information, the paint C having a high antifouling property effect on the ascidian as the first organism species information was specified and output.

[0112]

Fig. 14 is an explanatory diagram illustrating the Shannon's index of diversity obtained by analysis of the prokaryote in Ginowan Marina in comparison for each sample. Fig. 15 is an explanatory diagram illustrating the Shannon's index of diversity obtained by analysis of the prokaryote in Yonabaru Marina in comparison for each sample. In Figs. 14 and 15, the diversity (α diversity) of the prokaryote attached to each sample is analyzed in each sample of the evaluation period of 6 weeks. The lower the value of the Shannon's index of diversity is, the more effective on the prokaryote the paint is. Therefore, it was found that the paint G, the paint E, and a paint J may be evaluated to be particularly high in the antifouling property in Ginowan Marina. Similarly, it was found that the paint S, the paint N, and the paint E may be evaluated to be particularly high in the antifouling property in Yonabaru Marina. It was found that the paint G, the paint E, and a paint J may be evaluated to be particularly high in the antifouling property regarding the biofouling composition of Ginowan Marina. Similarly, it was found that the paint S, the paint N, and the paint E may be evaluated to be particularly high in the antifouling property regarding the biofouling composition of Yonabaru Marina.

[0113]

As paint antifouling property data created from the results illustrated in Figs. 14 and 15, the following are assumed. As the paint antifouling property data used in the first and second embodiments, for example, in Ginowan Marina, the paint G may be ranked first, the paint E may be the second, the paint J may be the third, the paint I may be the fourth, and the paint L may be the fifth in the descending order of the antifouling property with the Shannon's index of diversity of the prokaryote as an index. Similarly, in Yonabaru Marina, the paint S may be ranked first, the paint N may be the second, the paint E may be the third, a paint H may be the fourth, and the paint G may be the fifth in descending order of the antifouling property.

[0114]

As the paint antifouling property data used in the third to fifth embodiments, for example, for the first organism species information regarding the biofouling composition of Ginowan Marina, the paint G may be ranked first, the paint E may be the second, the paint J may be the third, the paint I may be the fourth, and the paint L may be the fifth in descending order of the antifouling property with the Shannon's index of diversity of the prokaryote as an index. Similarly, for the first organism species information regarding the biofouling composition of Yonabaru Marina, the paint S may be ranked first, the paint N may be the second, the paint E may be the third, the paint H may be the fourth, and the paint G may be the fifth in descending order of the antifouling property.

[0115]

Using the created paint antifouling property data, a paint to be applied to the watercraft was selected. More specifically, biofouling of a specific watercraft was collected, and analysis of the organism species was performed by a method similar to the above sample. When the input data of the organism species composition was input as the second organism species information based on the analysis result, the organism species composition was specified to be very similar to the organism species composition in Ginowan Marina, and the paint G having a high antifouling property effect on the biofouling composition of Ginowan Marina was specified and output.

Biofouling of a watercraft navigating another course was collected, and analysis of the organism species was performed by a method similar to the above sample. When the input data of the organism species composition was input as the second organism species information based on the analysis result, the organism species composition was specified to be very similar to the organism species composition in Yonabaru Marina, and the paint S having a high antifouling property effect on the biofouling composition of Ginowan Marina was specified and output.

[0116]

Fig. 16 is an explanatory diagram illustrating the transitions of the Shannon's index of diversity obtained by analysis of the prokaryote and the number of observed sequence variants. In the four graphs illustrated in Fig. 16, each horizontal axis indicates the evaluation period, the graph at the upper left of the figure indicates the transition of the Shannon's index of diversity in Ginowan Marina, and the graph at the upper right of the figure indicates the transition of the Shannon's index of diversity in Yonabaru Marina. The graph at the lower left of the figure indicates the transition of the total number of sequence variants observed in Ginowan Marina, and the graph at the lower right of the figure indicates the transition of the total number of sequence variants observed in Yonabaru Marina. The result illustrated in Fig. 16 indicates that the longer the evaluation period becomes, the more the diversity gradually increases, and the index of diversity is similar between the evaluation period of 4 weeks and the evaluation period of 6 weeks. In the case of analyzing the prokaryote, it was found that the influence of the number of sequenced sequences is small, and thus it is suitable for evaluation of paints due to diversity.

[0117]

Fig. 17 is an explanatory diagram illustrating the transition of the rank of the antifouling property of the paint based on the result illustrated in Fig. 16. In the four graphs illustrated in Fig. 17, each horizontal axis indicates the evaluation period, the graph at the upper left of the figure indicates the rank based on the Shannon's index of diversity in Ginowan Marina, and the graph at the upper right of the figure indicates the rank based on the Shannon's index of diversity in Yonabaru Marina. The graph at the lower left of the figure indicates the rank based on the total number of sequence variants observed in Ginowan Marina, and the graph at the lower right of the figure indicates the rank based on the total number of sequence variants observed in Yonabaru Marina. From the result illustrated in Fig. 17, since the paint E and the paint G tend to have a low diversity throughout the evaluation period as compared with the other paints, the rank of the antifouling property of the paint was high. Therefore, it was found that the paint E and the paint G are possibly excellent in antifouling property in the evaluation water areas of both Ginowan Marina and Yonabaru Marina. Therefore, it was found that the paint E and the paint G are possibly excellent in antifouling property for the organism species composition in the evaluation water areas of both Ginowan Marina and Yonabaru Marina.

[0118]

As paint antifouling property data created from the results illustrated in Figs. 16 and 17, the following are assumed. As the paint antifouling property data used in the first and second embodiments, for example, in Ginowan Marina, the paint J may be ranked first, the paint G may

be the second, the paint E may be the third, the paint H may be the fourth, and the paint L may be the fifth in descending order of the antifouling property with the number of sequence variants observed in the sixth week of the evaluation period as an index. Similarly, in Yonabaru Marina, a paint Q may be ranked first, the paint N may be the second, the paint A may be the third, the paint H may be the fourth, and the paint G may be the fifth in descending order of the antifouling property.

[0119]

As the paint antifouling property data used in the third to fifth embodiments, for example, for the first organism species information regarding the biofouling composition of Ginowan Marina, the paint J may be ranked first, the paint G may be the second, the paint E may be the third, the paint H may be the fourth, and the paint L may be the fifth in descending order of the antifouling property with the number of sequence variants observed in the sixth week of the evaluation period as an index. Similarly, for the first organism species information regarding the biofouling composition of Yonabaru Marina, the paint Q may be ranked first, the paint N may be the second, the paint A may be the third, the paint H may be the fourth, and the paint G may be the fifth in descending order of the antifouling property.

[0120]

Using the created paint antifouling property data, a paint to be applied to the watercraft was selected. More specifically, a panel was installed on a specific watercraft, and the organism species composition in the first week of evaluation was examined by the method described above. When the organism species composition in the first week of the evaluation as the second organism species information and the input data of "one week" as the immersion period were input, the organism species composition was specified to be very similar to the organism species composition in the first week of Ginowan Marina, and as a result, it was estimated that a change in biofouling similar to that of Ginowan Marina accompanied. Therefore, the paint G having the highest antifouling property effect for the organism species composition in the sixth week of evaluation of Ginowan Marina was specified and output.

[0121]

Fig. 18 is an explanatory diagram illustrating an evaluation result of β diversity of the eukaryote by PCA analysis of the Aitchison distance in Ginowan Marina. Fig. 19 is an explanatory diagram illustrating an evaluation result of β diversity of the eukaryote by PCA analysis of the Aitchison distance in Yonabaru Marina. In Figs. 18 and 19, the diversity among a plurality of samples is analyzed by analyzing the eukaryote attached to each sample for 6 weeks of the evaluation period. According to this analysis, it can be said that the farther the plot distance from the control sample is, the more effective on the entire eukaryote the paint is. Therefore, as illustrated in Figs. 18 and 19, it was found that a paint positioned in a range surrounded by a broken line in each evaluation water area may be evaluated to have a high antifouling property. For the first organism species information regarding the biofouling composition in each evaluation water area, it was found that a paint positioned in a range surrounded by a broken line may be evaluated to have a high antifouling property.

[0122]

Using the created paint antifouling property data, a paint to be applied to the watercraft was selected. More specifically, biofouling of a specific watercraft was collected, and analysis of the organism species was performed by a method similar to the above sample. When the input data of the species composition of the eukaryote was input as the second organism species information based on the analysis result, the species composition was specified to be very similar to the organism species composition in Ginowan Marina, and the paints E, H, and J having a high antifouling property effect on the biofouling composition of Ginowan Marina was specified and output.

[0123]

As another example, a paint selected based on the evaluation result of the antifouling property was applied to a watercraft, and after a lapse of several months, an organism attached to the watercraft was confirmed. Details of the test will be described below.

[0124]

In order to create paint antifouling property data, first, a sample applied with each of a plurality of paints was prepared. In the present example, one panel of fiber-reinforced plastic plate was prepared. The fiber-reinforced plastic plate was applied with a base paint and then

provided with 96 sections of 5 cm square, and 31 types of antifouling paints (A to Z and a to f) were each applied to arbitrary 3 sections. As a control, three sections (Ctrl) applied with no antifouling paint were provided.

[0125]

Next, the panel containing the sample applied with each of the plurality of paints was immersed in the evaluation water area. As the evaluation water area, Laguna Marina in Gamagori City, Aichi Prefecture was used. The panel was moored at 1 m point under the sea and taken out from the sea after 4 weeks. Fig. 20 is an explanatory diagram illustrating the panel taken out from the sea. Thereafter, the attachment of the paint surface was scraped off using a melamine sponge, stored in a refrigerator, and brought back to the laboratory. The attached organism having been scraped off was then suspended in ultrapure water and a part of the suspension was immediately cryopreserved.

[0126]

Next, the organism attached to each sample was analyzed. Specifically, analysis was performed using the nucleic acid analysis method. Each of the cryopreserved sample solutions was subjected to bead crushing treatment, and then DNA was purified using a DNA extraction kit (DNeasy 96 Blood&Tissue Kit, manufactured by Qiagen). Using the purified DNA as a template, the V3-V4 variable region of 16S rRNA was amplified by PCR using primers indicated in the sequence numbers 1 and 2. Thereafter, the obtained PCR product was purified, an index sequence for sample identification was added by PCR, and the DNA was purified. Thereafter, the base sequence of the obtained DNA was sequenced using MiSeq manufactured by Illumina, Inc., and the composition of the prokaryote attached to each sample was analyzed.

[0127]

Thereafter, classification information of the prokaryote was acquired from the base sequence obtained by the next generation sequencing method using QIIME2, which is flora analysis software. Noise removal was performed using a DADA2 plugin and classification information was acquired with reference to an rRNA database (SILVA ver.138). The number of sequences was thinned to about 39,000 sequences per sample collected from each section, and then the composition of the attached organism was analyzed.

[0128]

Fig. 21 is an explanatory diagram illustrating the total number of sequence variants derived from the prokaryote detected in each sample. In Fig. 21, the horizontal axis indicates samples applied with the 31 types of antifouling paints and samples applied with no antifouling paint, and the vertical axis indicates the total number of sequence variants derived from the prokaryote attached to the surface of the sample. Fig. 21 illustrates the analysis result of each of the three sections for each sample as a box plot. Based on the result of Fig. 21, the paint G having the smallest total number of detected variants was selected as a best paint in Laguna Marina. Among the paints frequently used in general as a paint of a watercraft, a paint W having a relatively large total number of detected variants was selected as a paint having a low effect in Laguna Marina, that is, a control paint in Laguna Marina.

[0129]

Subsequently, the effect of the antifouling property in the selected paint was confirmed in an actual watercraft. The paint G and the paint W were separately applied to a rear and a front, respectively, of the ship bottom of a center console boat (manufactured by Yamaha, total length of 21 feet) operated in Laguna Marina. The watercraft was operated and, 2 months after painting, 4 months after painting, and 6 months after painting, hoisted by a crane, and the degree of biofouling was visually checked.

[0130]

Fig. 22 is an explanatory diagram illustrating a scene of biofouling in the watercraft grounded after 6 months of painting. The right half of the photograph illustrated in Fig. 22 illustrates a region applied with the paint G, and the left half of the photograph illustrates a region applied with the paint W. In the region applied with the paint G selected as the best paint, attachment of the barnacle was little in any of 2 months after painting, 4 months after painting, and 6 months after painting. In other words, in the region applied with the paint G, the attachment of the barnacle was clearly suppressed. On the other hand, in the region applied with the paint W selected as the control paint, attachment of many barnacles was seen. In other words, in the region applied with the paint W, the attachment of the barnacle was not suppressed.

These results indicate that the best paint selected by DNA analysis is useful for biofouling prevention of the ship bottom of the actual watercraft positioned at the point.
[0131]

The present invention is not limited to the above-described embodiments, and can be achieved by various configurations in a scope not departing from the gist of the present invention. For example, the technical features in the embodiments and examples corresponding to the technical features in the respective forms described in Summary of Invention section can be appropriately replaced or combined in order to solve some or all of the above-described problems or achieve some or all of the above-described effects. If the technical features are not described as essential in the present description, they can be deleted as appropriate.

[Reference Signs List]

[0132]

10	Storage unit
12	Paint selection program
14	Paint antifouling property data
16	Price data
20	Input unit
30	Specification unit
40	Output unit
50	Sample
60	Panel
100	Paint selection system

Claims

1. A paint selection system for selecting a paint, the paint selection system comprising:
a storage unit that stores paint antifouling property data including a correspondence relationship between position information of an evaluation water area and antifouling properties of a plurality of paints;
an input unit that receives an input of position information of a specific water area;
a specification unit that specifies the paint to be used in the specific water area using the paint antifouling property data and the position information of the specific water area; and
an output unit that outputs identification information of the paint specified, wherein the paint antifouling property data is created by analyzing an organism attached to a sample applied in advance with the paint, the sample being immersed in the evaluation water area.
2. The paint selection system according to claim 1, wherein
the storage unit stores price data corresponding to a price of each of the plurality of the paints, and
the specification unit specifies the paint to be used in the specific water area by using the paint antifouling property data, the price data, and the position information of the specific water area.
3. The paint selection system according to claim 1 or 2, wherein
the paint antifouling property data includes a plurality of pieces of position information of the evaluation water area, and
the specification unit determines whether or not the position information of the specific water area is same as any one piece of the plurality of pieces of position information of the evaluation water area, and
if determining to be the same, specifies the paint based on the paint antifouling property data in the evaluation water area determined to be the same, and
if determining not to be the same, specifies the paint based on the paint antifouling property data in the evaluation water area closest in distance to the specific water area among a plurality of the evaluation water areas.
4. The paint selection system according to any one of claims 1 to 3, wherein
the organism to be analyzed in creation of the paint antifouling property data is a prokaryote.
5. The paint selection system according to any one of claims 1 to 3, wherein
the organism to be analyzed in creation of the paint antifouling property data is a eukaryote.
6. The paint selection system according to any one of claims 1 to 3, wherein
the organism analyzed in creation of the paint antifouling property data is a prokaryote and a eukaryote.
7. The paint selection system according to any one of claims 1 to 6, wherein
the paint is a paint used for a watercraft.
8. A paint selection method for selecting a paint, the paint selection method comprising:
a process of creating paint antifouling property data including a correspondence relationship between position information of an evaluation water area and antifouling properties of a plurality of the paints by analyzing an organism attached to a sample that is applied in advance with the paint, the sample being immersed in the evaluation water area;
a process of receiving an input of position information of a specific water area;
a process of specifying the paint to be used in the specific water area by using the paint antifouling property data and the position information of the specific water area; and
a process of outputting identification information of the paint specified.

9. A paint selection system for selecting a paint of a watercraft, the paint selection system comprising:
a storage unit that stores paint antifouling property data including a correspondence relationship between first organism species information that is information on an organism species attached to a sample applied in advance with the paint, the sample being immersed in an evaluation water area, and antifouling properties of a plurality of the paints;
an input unit that receives an input of input data including second organism species information that is information on an organism species attached to the watercraft immersed in a use water area where the watercraft is used;
a specification unit that specifies the paint to be applied to the watercraft by using the paint antifouling property data and the input data; and
an output unit that outputs identification information of the paint specified.
10. The paint selection system according to claim 9, wherein
the storage unit stores price data corresponding to a price of each of the plurality of the paints, and
the specification unit specifies the paint to be applied to the watercraft by using the paint antifouling property data, the price data, and the second organism species information.
11. The paint selection system according to claim 9 or 10, wherein
the first organism species information and the second organism species information include information regarding a composition of an organism species.
12. The paint selection system according to any one of claims 9 to 11, wherein
the first organism species information and the second organism species information include information regarding a predetermined organism species.
13. The paint selection system according to any one of claims 9 to 12, wherein
the first organism species information and the second organism species information are information regarding a prokaryotic species.
14. The paint selection system according to any one of claims 9 to 12, wherein
the first organism species information and the second organism species information are information regarding a eukaryotic species.
15. The paint selection system according to any one of claims 9 to 12, wherein
the first organism species information and the second organism species information are information regarding a prokaryotic species and a eukaryotic species.
16. The paint selection system according to any one of claims 9 to 15, wherein
the paint antifouling property data further includes first speed information regarding an operation speed of the watercraft, and
the input data further includes second speed information regarding an operation speed of the watercraft.
17. The paint selection system according to any one of claims 9 to 16, wherein
the paint antifouling property data further includes first frequency information regarding an operation frequency of the watercraft, and
the input data further includes second frequency information regarding an operation frequency of the watercraft.
18. A paint selection method for selecting a paint of a watercraft, the paint selection method comprising:
a process of acquiring second organism species information that is information on an organism species attached to the watercraft by analyzing an organism attached to the watercraft applied with the paint, the watercraft being immersed in a use water area where the watercraft is used;

a process of receiving an input of input data including the second organism species information;

a process of specifying the paint to be applied to the watercraft by using paint antifouling property data including a correspondence relationship between first organism species information and antifouling properties of a plurality of the paints and the input data; and

a process of outputting identification information of the paint specified, wherein the paint antifouling property data is created by acquiring the first organism species information that is information on an organism species attached to a sample that is applied in advance with the paint, the sample being immersed in an evaluation water area, by analyzing an organism attached to the sample.