Contents lists available at ScienceDirect



# Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag



# Machine learning in management of precautionary closures caused by lipophilic biotoxins

Andres Molares-Ulloa<sup>a,\*</sup>, Enrique Fernandez-Blanco<sup>b</sup>, Alejandro Pazos<sup>b,c</sup>, Daniel Rivero<sup>b</sup>

<sup>a</sup> Universidade da Coruña, Department of Computer Science and Information Technology, Faculty of Computer Science, 15071 A Coruña, Spain
 <sup>b</sup> Centro de investigación CITIC, Department of Computer Science and Information Technology, University of A Coruña, 15071 A Coruña, Spain
 <sup>c</sup> Biomedical Research Institute of A Coruña (INIBIC), University Hospital Complex of A Coruna (CHUAC), A Coruna 15006, Spain

#### ARTICLE INFO

Keywords: Machine Learning Harmful Algal Blooms Mussels Aquaculture Diarrhoeic Shellfish Poisoning

#### ABSTRACT

Mussel farming is one of the most important aquaculture industries. The main risk to mussel farming is harmful algal blooms (HABs), which pose a risk to human consumption. In Galicia, the Spanish main producer of cultivated mussels, the opening and closing of the production areas is controlled by a monitoring program. In addition to the closures resulting from the presence of toxicity exceeding the legal threshold, in the absence of a confirmatory sampling and the existence of risk factors, precautionary closures may be applied. These decisions are made by experts without the support or formalisation of the experience on which they are based. Therefore, this work proposes a predictive model capable of supporting the application of precautionary closures. Achieving sensitivity, accuracy and kappa index values of 97.34%, 91.83% and 0.75 respectively, the kNN algorithm has provided the best results. This allows the creation of a system capable of helping in complex situations where forecast errors are more common.

## 1. Introduction

Global mussel production has steadily increased to 2.2 million tonnes in 2018, more than double the amount produced ten years ago (FAO, 2 February 2022). Nearly 94% of global mussel production comes from aquaculture (Avdelas et al., 2021). Young mussels are harvested from the sea and may be grown on suspended ropes; these ropes, which are covered with mussel seed held in place with nylon nets, are suspended either from rafts, or wooden frames, or from longlines with floating plastic buoys. A substantial portion of EU production is farmed on suspended ropes, a technique that can be extended further offshore and which, although very sensitive to plankton blooms, is the only one that could allow further increases in production.

One of the main risks of mussel farming is Harmful Algal Blooms (HABs). HABs are episodes of high concentrations of algae, including some cyanobacteria and microalgae that are potentially toxic for human consumption. This is because there is a risk of poisoning by consuming filter-feeding bivalve molluscs such as mussels that feed on these algae, accumulating the toxins in their meat. To monitor these episodes, there are programs set up in mussel production areas. For the early detection of high toxicity events, these monitoring programmes have fixed sampling points strategically located in the production areas. These high toxicity events can lead to a temporary suspension of mussel harvesting and marketing. The most common toxin-producing species are those of Diarrhoeic Shellfish Poisoning (DSP) type. The most abundant of which is the dinoflagellate *Dinophysis acuminata*) (Vilas et al., 2008).

The opening and closing of the production areas is based on the analysis of the toxicity of the mollusc meat, as established by European legislation (UE6, 2019). Within the monitoring programme, sampling planning uses expert knowledge based on information on endogenous and exogenous factors influencing the proliferation of potentially toxic phytoplankton species. The most compromising point of this process is the absence of sampling during non-working days or when inclement weather does not allow it to be carried out. This leads to situations where it is impossible to collect the data to support an effective closure. If there are indications of a potential increase in toxicity levels, the competent authority is legally entitled to proceed with 'precautionary closures' of bivalve mollusc production areas.

Precautionary closures may become effective after a subsequent analysis verifying the presence of toxins, otherwise, the closure will be lifted. The application or non-application of these measures creates two possible problem scenarios. In the first scenario the precautionary closure is applied even though toxicity values above the legal threshold are not reached. This scenario could lead to economic losses for

\* Corresponding author. E-mail address: andres.molares@udc.es (A. Molares-Ulloa).

https://doi.org/10.1016/j.compag.2022.106956

Received 20 August 2021; Received in revised form 9 March 2022; Accepted 8 April 2022 Available online 15 April 2022

0168-1699/© 2022 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Computers and Electronics in Agriculture 197 (2022) 106956



Fig. 1. Schematic representation of the machine learning-based system for predicting harmful algal bloom closures and aiding decision making in mussel farming. This graphic has been designed with resources from Flaticon.com.



Fig. 2. Map of the production areas of cultivated molluscs in the Vigo estuary. Source: http://193.144.46.136/EstadoZonas/Default.aspx?tmapa = 0.

producers because they are prohibited from working while the area remains closed. In the second scenario no indications of a high toxicity event are detected, but a subsequent analysis shows the presence of toxins. The latter is a much more dangerous situation than the previous one because, during this period of extraction activity, there is a potential risk of introducing contaminated shellfish into the market, with the consequent risk to public health. Today, the implementation of precautionary closures is based on the experience of monitoring experts. The existence of a predictive model could help them make the right decisions in complex situations.

Harmful algal blooms are not only a potential risk to public health, they are also a major problem for the production sector. Work such as that of Di Jin and Porter Hoagland (Jin and Hoagland, 2008) has shown that the development of predictive systems can lead to significant improvements in management strategy and profits for the farming sector. So far, numerous studies have attempted such predictions around the



Fig. 3. Map of oceanographic stations located in the Vigo estuary. Source: http://www.intecmar.gal/Ctd/Default.aspx.

# Table 1Table of variables (2004–2018).

Source	Variable	Number of locations	Features generated	Frequency
INTECMAR	Temperature	7	14	Weekly
	Salinity	7	7	Weekly
	Oxygen	7	7	Weekly
	Chlorophyll-a concentration	7	7	Weekly
	Dinophysis acuminata cells abundance	7	7	Weekly
	Dissolved ammonium	7	7	Weekly
	Dissolved phosphate	7	7	Weekly
	Dissolved nitrate	7	7	Weekly
	Dissolved nitrite	7	7	Weekly
	State of production areas	1	1	Daily
METEOGALICIA	Solar irradiation	1	1	Daily
	Sunshine hours	1	1	Daily
	Insolation	1	1	Daily
IEO	Upwelling index	1	1	Daily
-	Seasonality	1	1	Daily

world, notably off the coasts of South Korea (Lee and Lee, 2018), Hong Kong (Yu et al., 2021) and the Persian Gulf (Gholami et al., 2019), in general, these works have focused their efforts on predicting biomarkers such as the concentration of toxic phytoplankton in the water or chlorophyll-a (Deng et al., 2021; Liu et al., 2009). There are studies for the specific case of the Spanish coast (Velo-Suárez and Gutiérrez-Estrada, 2007) and specifically for the Galician coast (Vilas et al., 2014; Aguilar Calderon, 2017; Molares et al., 2020). For the creation of this type of predictive models, the use of different classical techniques has been compared with ML techniques to try to find the co-figuration that best suits this problem (Cruz et al., 2021; Liu et al., 2009). It was determined that ML techniques outperform classical methods. The success of applying machine learning techniques to harmful algal blooms lies in the selection of harmful algal blooms is influenced by many

factors, the most important of which are: temperature, water flow, upwelling, light, nutrients and salinity.

A higher water temperature favours algae proliferation, as well as thermocline stratification favours their concentration (Davis et al., 2009). Excessive water flow and circulation disperses algae concentrations, reducing the occurrence of blooms (Li et al., 2013). The light is necessary for phytoplankton to photosynthesise (Paerl and Paul, 2012). Dissolved nutrients in the water create a favourable environment for algal growth (Paerl and Paul, 2012). The salinity plays an important role in the formation of phytoplankton communities (Gasinaite et al., 2005).

The best results were obtained using the combined CNN and LSTM spatio-temporal classification technique to classify and discriminate between HAB and non-HAB events produced in Florida coastal waters by the algae *Karenia brevis* (Hill et al., 2020). But it is difficult to have such a large volume of data on a regular basis, and even impossible for many

Descriptive analysis of input features.

					•					
	Maximum	D. acuminata	Ammonium in	Phoenhate in			Average	Thermocline	Average	Halocline
	chlorophyll 'a'	concentration	V1	V1	Nitrate in V1	Nitrite in V1	temperature	stratification	dissolved	stratification
	in V1	in V1	•1	••			in V1	index in V1	oxygen in V1	index in V1
No. of samples	744	754	752	752	752	751	616	615	614	594
Average value	3.41	276	1.20	0.41	3.73	0.33	14.68	0.63	3.93	1.69
Maximum value	42.76	12040	5.42	1.43	16.62	1.69	20.18	4.42	7.92	6.55
Minimum value	0.07	0	0.05	0.03	0.01	0.01	0	0	0	0
	Maximum	D. acuminata	Ammonium in	Phosphate in			Average	Thermocline	Average	Halocline
	chlorophyll 'a'	concentration	V2	V2	Nitrate in V2	Nitrite in V2	temperature	stratification	dissolved	stratification
	in V2	in V2					in V2	index in V2	oxygen in V2	index in V2
No. of samples	745	756	754	754	754	754	610	610	608	589
Average value	2.61	134	2.07	0.58	4.39	0.42	14.83	0.67	3.75	1.99
Maximum value	22.62	8720	7.55	2.07	19.60	1.82	20.18	4.36	9.35	8.30
Minimum value	0.07	0	0.15	0.08	0.01	0.02	11.22	0	0.00	0
	Maximum	D. acuminata	Ammonium in	Phosphate in	114		Average	Thermocline	Average	Halocline
	chiorophyli a	concentration	V3	V3	Nitrate in V3	Nitrite in V3	temperature	stratification	dissolved	stratification
No. of complex	742	111 V 3	761	607	75.3	751	III V 3	index in v3	oxygen in v3	index in V3
Average value	743	/55	/51	08/	/52	/51	15.02	598	2.62	5//
Maximum value	2.33	22	10.29	0.85	4.63	2.25	21.62	0.00	5.02	2.30
Minimum value	22.74	960	10.38	2.33	22.00	2.25	21.02	9.78	-16.24	33.53
winimum value	Maximum	D acuminata	0.15	0.15	0.22	0.00	0.90	Thormoclino	-10.54 Average	Haloclino
	chlorophyll 'a'	concentration	Ammonium in	Phosphate in	Nitrate in V4	Nitrite in V4	temperature	stratification	dissolved	stratification
	in V4	in V4	V4	V4	initiate in 14	1111110 111 14	in V4	index in V4	oxygen in V4	index in V4
No. of samples	744	755	753	746	753	753	613	613	612	592
Average value	2.32	70	2.62	0.70	4.75	0.47	14.94	0.68	3.72	1.93
Maximum value	26.18	9080	8.66	1.61	19.87	2.27	20.21	5.64	9.00	10.90
Minimum value	0.07	0	0.23	0.08	0.03	0.03	11.17	0	0.01	0
	Maximum	D. acuminata		mb b - t - t -			Average	Thermocline	Average	Halocline
	chlorophyll 'a'	concentration	Ammonium in	Phosphate in	Nitrate in V5	Nitrite in V5	temperature	stratification	dissolved	stratification
	1		V5	V 3						
	in V5	in V5					in V5	index in V5	oxygen in V5	index in V5
No. of samples	714	<u>in V5</u> 743	742	742	742	741	in V5 613	index in V5 613	oxygen in V5 612	index in V5 593
No. of samples Average value	714 2.94	10 V5 743 236	742	742	742 3.56	741 0.30	in V5 613 14.50	index in V5 613 0.56	oxygen in V5 612 3.90	index in V5 593 1.44
No. of samples Average value Maximum value	714 2.94 25.15	10 V5 743 236 14840	742 0.83 4.69	742 0.36 1.33	742 3.56 17.16	741 0.30 1.50	in V5 613 14.50 20.73	index in V5 613 0.56 3.84	oxygen in V5 612 3.90 8.78	index in V5 593 1.44 7.16
No. of samples Average value Maximum value Minimum value	714 2.94 25.15 0.09	IN V5 743 236 14840 0	742 0.83 4.69 0.07	742 0.36 1.33 0.03	742 3.56 17.16 0.02	741 0.30 1.50 0.01	in V5 613 14.50 20.73 10.95	index in V5 613 0.56 3.84 0	oxygen in V5 612 3.90 8.78 0.01	index in V5 593 1.44 7.16 0
No. of samples Average value Maximum value Minimum value	714 2.94 25.15 0.09 Maximum	10 V5 743 236 14840 0 D. acuminata	742 0.83 4.69 0.07	742 0.36 1.33 0.03 Phosphate in	742 3.56 17.16 0.02	741 0.30 1.50 0.01	in V5 613 14.50 20.73 10.95 Average	index in V5 613 0.56 3.84 0 Thermocline	0xygen in V5 612 3.90 8.78 0.01 Average	index in V5 593 1.44 7.16 0 Halocline
No. of samples Average value Maximum value Minimum value	11 V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a'	IN V5 743 236 14840 0 D. acuminata concentration	742 0.83 4.69 0.07 Ammonium in V6	742 0.36 1.33 0.03 Phosphate in V6	742 3.56 17.16 0.02 Nitrate in V6	741 0.30 1.50 0.01 Nitrite in V6	in V5 613 14.50 20.73 10.95 Average temperature	index in V5 613 0.56 3.84 0 Thermocline stratification	oxygen in V5 612 3.90 8.78 0.01 Average dissolved	index in V5 593 1.44 7.16 0 Halocline stratification
No. of samples Average value Maximum value Minimum value	11 V5 714 2.94 2.94 0.09 Maximum chlorophyll 'a' in V6	In V5 743 236 14840 0 D. acuminata concentration in V6	742 0.83 4.69 0.07 Ammonium in V6	742 0.36 1.33 0.03 Phosphate in V6	742 3.56 17.16 0.02 Nitrate in V6	741 0.30 1.50 0.01 Nitrite in V6	in V5 613 14.50 20.73 10.95 Average temperature in V6	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6	0xygen in V5 612 3.90 8.78 0.01 Average dissolved oxygen in V6	index in V5 593 1.44 7.16 0 Halocline stratification index in V6
No. of samples Average value Maximum value Minimum value	11 VS 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 720	IN V5 743 236 14840 0 <i>D. acuminata</i> concentration in V6 749	742 0.83 4.69 0.07 Ammonium in V6 748	742 0.36 1.33 0.03 Phosphate in V6 748	742 3.56 17.16 0.02 Nitrate in V6	741 0.30 1.50 0.01 Nitrite in V6 746	in V5 613 14.50 20.73 10.95 Average temperature in V6 614	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614	0xygen in V5 612 3.90 8.78 0.01 0xygen in V6 613	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593
No. of samples Average value Maximum value Minimum value No. of samples Average value	11 V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49	in V5 743 236 14840 0 D. acuminata concentration in V6 749 268	742 0.83 4.69 0.07 Ammonium in V6 748 0.92	742 0.36 1.33 0.03 Phosphate in V6 748 0.36	742 3.56 17.16 0.02 Nitrate in V6 747 3.50	741 0.30 1.50 0.01 Nitrite in V6 746 0.31	in V5 613 14.50 20.73 10.95 Average temperature in V6 614 14.65	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614 0.60	oxygen in V5 612 3.90 8.78 0.01 Average dissolved oxygen in V6 613 3.96	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value	11 V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30	in V5 743 236 14840 0 <b>D. acuminata</b> concentration in V6 749 268 9160	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48	742 0.36 1.33 0.03 Phosphate in V6 748 0.36 1.24	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73	in V5 613 14.50 20.73 10.95 Average temperature in V6 614 14.65 20.28	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614 0.60 5.22	0xygen in V5 612 3.90 8.78 0.01 Average dissolved 0xygen in V6 613 3.96 8.11	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54 6.84
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value	IN VS           714           2.94           25.15           0.09           Maximum           chlorophyll 'a'           in V6           720           3.49           43.30           0	in V5 743 236 14840 0 <i>D. acuminata</i> concentration in V6 749 268 9160 0 0	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.05	742 0.36 1.33 0.03 Phosphate in V6 748 0.36 1.24 0.03	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73 0.01	in V5 613 14.50 20.73 10.95 Average temperature in V6 614 14.65 20.28 11.03	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614 0.60 5.22 0 0	oxygen in V5 612 3.90 8.78 0.01 Average dissolved oxygen in V6 613 3.96 8.11 0.00	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54 6.84 0
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value	III V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' 720 3.49 43.30 0 Maximum chlorophull 'a'	in V5 743 236 14840 0 <b>D. acuminata</b> concentration 749 268 9160 0 <b>D. acuminata</b> concentration	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.05 Ammonium in	742 0.36 1.33 0.03 Phosphate in V6 748 0.36 1.24 0.03 Phosphate in	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7	741 0.30 1.50 0.01 Nitrite in V6 0.31 1.73 0.01	in V5 613 14,50 20,73 10,95 Average temperature in V6 614 14,65 20,28 11.03 Average	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614 0.60 5.22 0 Thermocline etratification	oxygen in V5 612 3.90 8.78 0.01 Average dissolved oxygen in V6 613 3.96 6.13 3.96 8.11 0.00 Average diseolved	index in V5 593 1.44 7.16 0 Halocline stratification 1.54 6.84 0 Halocline stratification
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value	in VS 714 2.94 2.5.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30 0 Maximum chlorophyll 'a' in V7	in V5 743 236 14840 0 0, acuminata concentration in V6 9160 0, acuminata concentration in V7	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.95 4.48 0.05 Ammonium in V7	742 0.36 1.33 0.03 Phosphate in V6 748 0.36 1.24 0.03 Phosphate in V7	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7	in V5 613 14,50 20,73 10,95 temperature in V6 614 14,65 20,28 11,03 Average temperature in V7	index in V5 613 0.56 3.84 0 0 Thermocline stratification 614 0.60 5.20 0 Thermocline stratification	oxygen in V5 612 3.90 8.78 0.01 Average dissolved oxygen in V6 613 3.96 8.11 0.00 Average dissolved oxygen in V7	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54 6.84 0 Halocline stratification index in V7
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value	in V5 714 2,94 25.15 0.09 Maximum chlorophyll 'a' 0 43.30 0 Maximum chlorophyll 'a' in V7 558.	in V5 743 236 14840 0 0. acuminata concentration in V6 749 2688 9160 0 0. acuminata concentration in V7 576	742 0.83 4.69 0.07 <b>Ammonium in</b> V6 748 0.92 4.48 0.05 Ammonium in V7	742 0.36 1.33 0.06 1.34 V6 748 0.36 1.24 0.03 Phosphate in V7	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7	in V5 613 14.50 20.73 10.95 Average temperature in V6 614 14.65 20.28 11.03 Average temperature in V7 541	index in V5 613 0.56 3.84 00 Thermocline stratification 5.22 0 Thermocline stratification index in V7	oxygen in V5 612 3.90 8.78 0.01 Average dissolved oxygen in V7 613 3.96 6.11 0.00 Average dissolved oxygen in V7	index in V5 593 1.44 7.16 Halocline stratification index in V6 Halocline stratification index in V7 541
No. of samples Average value Maximum value Minimum value No. of samples Average value Minimum value No. of samples Average value	in V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30 0 0 Maximum chlorophyll 'a' in V7 588 2 95	in VS 743 236 14840 0 <i>D. acuminata</i> concentration <i>in V6</i> 749 268 9160 0 <i>D. acuminata</i> concentration <i>in V7</i> 576 311	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.88 0.05 Ammonium in V7 574	742 0.36 1.33 0.03 Phosphate in V6 0.33 1.24 0.33 1.24 0.03 Phosphate in V7 574	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 574	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.36	in V5 613 14,50 20,73 10,95 <b>Average</b> temperature in V6 614 14,65 20,28 <b>Average</b> temperature in V7 541	index in V5 613 0.56 3.84 0 0 Thermocline stratification 614 0.60 5.22 0 Thermocline stratification index in V7	oxygen in VS 612 3.90 8.78 0.01 Average dissolved oxygen in V6 8.11 0.00 Average dissolved oxygen in V7 541	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 6.84 6.84 Malocline stratification index in V7 541
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value No. of samples Average value	in V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V7 Maximum chlorophyll 'a' in V7 568 2.95 211 on	in VS 743 236 14840 0 0. acuminata concentration in V6 9160 0. acuminata concentration in V7 576 311 7280	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.95 4.48 0.05 Ammonium in V7 574 1.88 80 80	742 0.36 1.33 0.03 <b>Phosphate in</b> V6 748 0.35 1.24 0.03 <b>Phosphate in</b> V7 574 0.46 115	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 574 4.43 2151	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.36 140	in V5 613 14.50 20.73 10.95 Average temperature in V6 614 14.65 20.28 11.03 Average temperature in V7 541 14.71 20.22	index in V5 613 0.56 3.84 0.56 3.84 0.57 5.22 0 Thermocline 5.22 0 0 Thermocline 5.22 0 0 Thermocline 5.24 0 5.22 0 0 Thermocline 5.24 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0	oxygen in V5 612 3.90 8.78 0.01 Average dissolved 0xygen in V6 613 3.96 8.11 0.00 Average dissolved 0xygen in V7 541 3.73 9.44	index in V5 593 1.44 7.16 Halocline stratification index in V6 Halocline stratification index in V7 Halocline 541 1.75 7.08
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value No. of samples Average value Maximum value	in V5 714 2.94 2.51 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30 0 Maximum chlorophyll 'a' in V7 568 2.95 2.190 0.07	in VS 743 236 14840 0 0. acuminata concentration in V6 749 268 9160 0 0 0. acuminata concentration in V7 576 3111 7280 0 0	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.92 4.48 0.92 574 Kamonium in V7 574 8.85 5.00 70 574	742 0.36 1.33 0.03 Phosphate in V6 748 0.36 1.24 0.36 1.24 0.36 1.24 0.36 1.24 0.36 1.24 0.46 1.15 0.46 0.46 0.15 0.07	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 574 4.43 21.51	741 0.30 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 Nitrite in V7	in V5 613 14,50 20,73 Average temperature in V6 614 14,65 20,28 614 14,65 20,28 614 14,65 20,28 10,05 20,28 10,05 20,28 11,07 541 14,71 20,22 11,27	index in V5 613 0.56 3.84 0 Thermoclines stratification index in V6 614 0.60 5.22 0 Thermoclines stratification stratification index in V7 0.63 4.21 0.63 4.21 0.63	oxygen in VS 612 3.90 8.78 0.01 Average dissolved oxygen in VS 613 3.96 8.11 0.00 Average dissolved oxygen in V7 541 3.71 3.9.44 0.00	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 6.84 0 Halocline stratification index in V7 541 1.75 7.08
No. of samples Average value Maximum value Minimum value No. of samples Average value Minimum value No. of samples Average value Maximum value Minimum value	in V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 43.30 0 Maximum chlorophyll 'a' in V7 568 2.95 2.190 0.07	in V5 743 2256 14840 0 0 0. acuminata concentration in V6 9 268 9160 0 0 0. acuminata concentration in V7 9 0. acuminata concentration in V7 0 0. acuminata concentration 0 0 0. acuminata concentration 0 0 0. acuminata concentration 0 0 0. acuminata concentration 0 0 0. acuminata concentration 0 0 0. acuminata 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.95 Ammonium in V7 574 1.88 8.05 0.07	742 0.36 1.33 0.03 1.33 0.03 748 0.36 1.24 0.03 Phosphate in V7 574 0.46 1.15 0.07 Upwellina	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 574 4.43 21.51 0.03	741 0.30 1.50 0.01 Nitrite in V6 0.31 1.73 0.01 Nitrite in V7 574 0.36 1.40 0.03	in V5 613 14.50 20.73 10.95 Average temperature in V6 11.03 Average temperature in V7 541 14.71 20.22 541 14.71 20.22 11.27 Canaa G	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 5.22 0 0 Thermocline stratification index in V7 0.633 4.21 0.0	oxygen in VS 612 3.90 8.78 0.01 Average dissolved oxygen in VG 613 3.96 8.11 0.00 0xygen in V7 oxygen in V7 541 3.73 9.44 0.00 Canas C	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54 6.84 0 Halocline stratification index in V7 Halocline Stratification index in V7 7.08 541 1.75 7.08 0 0 Cangas D
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value Maximum value Minimum value	in V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30 0 Maximum chlorophyll 'a' in V7 558 2.190 0.07 Daylight hours	in VS 743 236 1880 0 0 0. acuminata concentration in V6 0. acuminata 9160 0 0. acuminata concentration in V7 576 311 7280 0 0 0 1nsolation	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.05 Ammonium in V7 574 1.88 8.05 577 1.87 574	742 0.36 1.33 0.03 Phosphate in V6 748 0.35 1.24 0.03 Phosphate in V7 574 0.46 1.15 574 0.46 1.15 0.07	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 574 4.43 21.51 0.3 Week of the year	741 0.30 1.50 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.36 1.40 0.33 Cangas F state	in V5 613 14,50 20,73 10,95 Average temperature in V6 614 14,65 20,28 Average temperature in V7 541 14,71 20,22 541 14,71 20,22 541 14,71 20,23 541 14,71 20,23 541 14,71 20,23 541 14,71 20,23 541 14,71 20,23 541 14,71 20,73 20,75 20,7	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614 0.60 5.22 0 Thermocline stratification index in V7 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 6.64 0.65 6.65 6.65 6.65 6.65 6.65 6.65 6.65	oxygen in VS 612 3.90 8.78 dissolved oxygen in VG 613 3.96 8.11 0.00 Average dissolved oxygen in V7 633 3.73 9.44 0.00 Cangas C state	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 Halocline stratification index in V7 Halocline Stratification index in V7 0 Cangas D state
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value Minimum value Minimum value No. of samples	in V5 714 2.94 25.15 2.95 0.90 Maximum chlorophyll 'a' in V6 4.330 4.330 0 0 Maximum chlorophyll 'a' in V7 568 2.95 2.190 0.07 Daylight hours 247	in V5 743 2236 1.840 00 0. acuminata concentration in V6 00 0. acuminata concentration in V7 0 0. acuminata concentration in V7 311 7280 0 0 Insolation	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.05 Ammonium in V7 574 1.88 8.05 0.07 Irradiation 247	742 0.36 1.33 0.33 Phosphate in V6 748 0.36 1.24 0.33 Phosphate in V7 574 0.46 1.15 0.07 Upwelling index 763 763	742 3.56 1.7.16 0.02 Nitrate in V6 Nitrate in V7 Nitrate in V7 Nitrate in V7 0.03 Week of the year 7722	741 0.30 0.01 Nitrite in V6 0.31 1.73 0.01 Nitrite in V7 574 0.03 0.01 Nitrite in V7 574 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.0	in V5 613 14.50 20.73 20.73 20.73 20.75 4.Verage temperature in V5 20.28 20.28 20.28 20.28 20.28 20.28 20.28 20.22 20	index in V5 613 0.56 3.84 0 0 Thermocline stratification index in V6 5.22 0 Thermocline stratification index in V7 0 Cangas H state 782	oxygen in VS 612 3.90 638 649 649 613 3.96 613 614 3.73 9.44 0.00 614 3.73 7.82 7.85	index in V5 593 1.44 7.16 0 Halocine stratification index in V6 Halocine stratification index in V7 Halocine stratification 541 1.75 541 1.75 7.08 0 Cangas D state 782
No. of samples Average value Maximum value Minimum value No. of samples Average value Minimum value Minimum value Minimum value Minimum value Minimum value Minimum value	in VS 714 2.94 25.15 0.09 Maximum chlorophyll vi in V7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	in V5 743 236 14840 0 0. acuminata concentration in V6 0 0. acuminata concentration 0 0 0. acuminata concentration in V7 576 311 7280 0 1nsolation 247 54.05	742 0.83 4.69 0.07 Ammonium in V6 Ammonium in V7 574 1.88 8.85 0.07 Irradiation 247 1517.67	742 0.36 1.33 0.03 Phosphate in V6 748 0.03 Phosphate in V7 574 0.46 1.15 0.07 Vpwelling index 763 70.40	742 3.56 3.76.16 0.02 Nitrate in V6 747 3.50 3.50 3.50 3.50 747 0.02 Nitrate in V7 574 4.43 21.515 0.03 Vitrate in V7 574 4.43 21.515 742 742 742 742 742 742 742 742 742 742	741 0.30 0.55 0.01 Nitrite in V6 746 0.33 0.31 0.33 0.01 Nitrite in V7 574 0.36 0.40 0.35 0.40 0.03 0.40 0.40 272 28 28 272 272 272 272 272 272 272 2	in VS (513) (450) (207) (2	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 0 Thermocline stratification index in V7 10.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 0.52 0.63 0.52 0.64 0.52 0.65 0.52 0.53	oxygen in VS 612 3.90 8.78 0.01 Average dissolved oxygen in VS 6.11 0.00 Average dissolved oxygen in V7 541 3.73 9.44 0.00 Cangas C 5.82 0.00 Canga C 8.82 0.00 0.00 Canga C 8.82 0.00 0.00 0.00 Canga C 8.82 0.00 0.00 0.00 0.00 0.00 0.00 0.00	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54 6.84 0 0 Halocline stratification 1.54 6.84 0 0 Cangas D state 782 0 2 8 2 8 2 8 2 8 2 8 2 8 2 8 2 8 2 8
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value Minimum value Minimum value No. of samples Average value	in vs 714 2.94 25.15 25.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30 0 43.30 0 0 Maximum chlorophyll 'a' in V7 7588 2.95 2.190 0.07 Daylight hours 247 6.78 13.84	in V5 743 2236 18840 00 0. acuminata concentration in V6 749 286 9160 0 0 0. acuminata concentration in V7 0 0 1nsolation 247 54.05 91.90	742 0.83 4.66 0.07 Ammonium in V6 748 0.92 4.48 0.95 0.92 4.48 8.05 0.97 74 4.48 8.05 0.07 174 1.88 8.05 0.07 174 1.57 6 74 1.57 74 1.57 74 1.57 74 1.57 74 1.57 74 1.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 8.57 74 74 8.57 74 8.57 74 74 8.57 74 8.57 74 74 8.57 74 8.57 74 74 8.57 74 74 74 74 74 74 74 74 74 74 74 74 74	742 0.36 0.33 0.03 Phosphate in V6 748 0.36 0.36 0.24 V7 Phosphate in V7 0 Upwelling index 757 0.07 754 0.67 753 70.40 337741	742 3.56 17.16.10 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 0.03 Nitrate in V7 0.03 Week of the year 22 NA 53	741 0.30 0.55 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.35 1.40 0.03 1.40 0.03 0.03 240 0.63 1.40 0.03 1.40 0.03 1.40 0.03 0.01 Nitrite in V6	in VS 6133 14.50 20.73 10.95 Kverage temperature in VS 614 14.65 20.28 20.28 20.28 20.28 20.28 20.28 20.28 20.28 20.28 11.03 541 4.477 20.22 20.22 541 4.477 20.22 20.28 541 4.477 20.22 20.28 541 4.477 20.28 541 4.477 20.28 541 4.478 20.27 541 541 541 541 541 541 541 541 541 541	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 5.22 0 Thermocline stratification index in V7 541 0.64 4.21 0 0 Cangas H state 782 NA 1	oxygen in VS 612 3.90 8.78 0.01 dissolved oxygen in V8 613 3.96 613 613 3.96 613 3.96 613 3.96 613 3.96 613 3.96 613 3.96 613 613 3.96 613 613 3.96 613 613 3.96 613 613 3.96 613 613 3.96 613 613 613 613 614 613 615 615 615 617 617 617 617 617 617 617 617	index in V5 593 1.44 7.16 0 Halocine stratification index in V6 593 1.54 6.84 0 Halocine stratification index in V7 541 1.75 841 1.76 841 2.782 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 841 7.84 844 844 7.84 844 844 844 844 844 844 844 844 844
No. of samples Average value Maximum value Minimum value No. of samples Average value Minimum value Minimum value No. of samples Average value Minimum value No. of samples Average value Maximum value Minimum value	in vs 714 2.94 2.51 2.51 0.09 Maximum chlorophyll a' in v7 720 3.49 4.3.30 0.07 Maximum chlorophyll a' in v7 568 2.150 0.07 Daylight hours 247 6.78 1.3.84 0.39	in V5 743 236 14840 0 0. acuminata concentration in V6 0. acuminata concentration 0 0. acuminata concentration 1756 311 7280 0 1insolation 2447 54.05 91.90 0 0	742 0.83 4.69 0.07 Ammonium in V6 Ammonium in V7 A Ammonium in V7 574 1.88 8.05 0.07 1rradiation 247 1517.67 3100	742 0.36 1.33 Phosphate in V6 Phosphate in V7 Phosphate in V7 Phosphate in V7 Phosphate in V7 748 0.46 1.5 1.5 747 1.5 763 70.04 0.3 547.41 1.378.70 1.025 1	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 18.67 19.51 19.51 19.51 19.51 19.51 19.51 19.51 19.51 19.51 19.51 19.57 19.51 19.57 19.51 19.57 19.51 19.57 19.51 19.57	741 0.30 0.55 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.36 1.40 0.35 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40	in VS in Signa Control	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 5.22 0 Thermocline stratification index in V7 0.633 4.21 0.0 Cangas H state 782 NA 1 0 Canga L state	oxygen in VS 612 3.90 8.78 0.01 Average dissolved oxygen in VG 613 3.96 6.811 0.00 0 Average dissolved oxygen in V7 6.41 3.73 9.44 0.00 Cangas C 782 8.11 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 593 1.54 6.84 0 0 Halocline stratification index in V7 7.08 541 1.75 7.08 0 Cangas D state 782 NA 1 0
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value Minimum value Minimum value No. of samples Average value Maximum value	in vs 714 2.94 2.51 2.51 0.99 Maximum chlorophyll 'a' in v6 720 3.49 4.330 0 Maximum chlorophyll 'a' in v7 588 2.95 2.190 0.07 Daylight hours 247 6.78 1.384 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	in V5 743 235 14840 00. <i>acuminata</i> concentration <i>in V6</i> 00. <i>acuminata</i> concentration <i>in V7</i> 00. <i>acuminata</i> concentration <i>in V7</i> 00. <i>acuminata</i> concentration <i>in V7</i> 00. <i>acuminata</i> concentration <i>in V5</i> 00. <i>acuminata</i> concentration <i>in V5</i> 00. <i>acuminata</i> concentration <i>in V5</i> 00. <i>acuminata</i> concentration <i>in V5</i> 00. <i>acuminata</i> <i>concentration</i> 00. <i>acuminata</i> <i>concentration</i> 00. <i>acuminata</i> <i>concentration</i> 00. <i>acuminata</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentration</i> <i>concentra</i>	742 0.83 4.69 0.07 Ammonium in V6 748 0.92 4.48 0.92 4.48 8.05 5.76 Ammonium in V7 174 1.88 8.05 0.07 174 1.51,767 3110 25 Redondela B	742 0.36 0.33 0.33 Phosphate in V6 748 0.36 0.24 Phosphate in V7 Phosphate in V7 574 0.03 574 0.04 0.47 0.04 0.57 70.40 3547.41 70.40 3547.41 70.40 3547.41 70.40 3547.41 70.40 3547.41 70.40 3547.41 70.40 3547.41 70.40 3547.41 70.40 70	742 3.56 17.16.10 0.02 Nitrate in V6 3.50 18.67 0.02 Nitrate in V7 574 4.43 0.03 Week of the year 782 NA 782 NA 8 Redondela D	741 0.30 0.55 0.01 Nitrite in V6 0.31 0.746 0.31 0.31 0.01 Nitrite in V7 574 0.36 0.33 0.01 0.37 0.02 0.33 Cangas F 574 0.40 0.03 0.40 0.40 0.40 0.40 0.40 0.4	in VS 6133 14.50 20.73 10.95 Average temperature 14.65 20.28 20.29 20.20	index in V5 613 0.56 3.84 0 Thermocline stratification index in V5 614 0.60 5.22 0 Thermocline stratification index in V7 index in V7 0 Cangas H state 782 NA 1 0 0	oxygen in VS 612 3.90 8.78 0.01 613 3.96 613 613 3.96 613 3.96 613 3.96 613 3.96 613 3.96 613 5.11 5.11 5.11 5.73 9.44 0.00 613 5.73 9.44 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.94 0.00 613 5.71 3.71 0.44 0.00 613 5.71 1.00 1.00 614 1.00 1.00 614 1.00	index in V5 593 1.44 7.16 0 Halocine stratification index in V6 6.84 0 Halocine stratification index in V7 541 1.57 7.08 Cangas D state NA 1 0 0 Cangas D
No. of samples Average value Maximum value Minimum value No. of samples Average value Minimum value Minimum value Minimum value No. of samples Average value Maximum value No. of samples Average value	in V5 714 2.94 25.15 0.09 Maximum chlorophyll 'a' in V6 720 3.49 43.30 0 Maximum chlorophyll 'a' in V7 568 2.95 2.190 0.07 Daylight hours 247 6.78 1.384 0.07 Daylight start 3.49 0.07 Daylight start 3.49 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.0	in V5 743 2236 14840 00 0. acuminata concentration in V6 268 29160 00 0. acuminata concentration in V7 0. acuminata concentration in V7 17280 0 insolation 247 54.05 91.90 0 Redondela A state	742 0.83 4.66 0.07 <b>Ammonium in</b> <b>V6</b> 748 0.92 4.48 0.05 0.07 <b>X7</b> 8 <b>Ammonium in</b> <b>V7</b> <b>S74</b> 1.88 8.007 <b>X7</b> <b>1</b> 88 8.007 <b>X7</b> <b>1</b> 78 <b>1</b> 88 8.007 <b>X7</b> <b>1</b> 88 1.88 8.007 <b>X7</b> <b>1</b> 89 <b>1</b> 89 <b>1</b> 89 <b>1</b>	742 0.36 0.33 0.03 Phosphate in V6 748 0.36 0.24 0.36 0.42 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	742 3.56 17.16.16 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 574 4.43 2.151 574 4.43 2.151 87 80 80 80 80 10 10 10 10 10 10 10 10 10 10 10 10 10	741 0.30 0.001 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.36 1.40 0.35 1.40 0.35 0.40 0.33 0.40 0.33 0.40 0.35 0.40 0.35 0.40 0.35 0.40 0.35 0.40 0.35 0.40 0.35 0.40 0.45 0.45 0.45 0.45 0.45 0.45 0.4	in VS 6133 14.50 20.73 10.95 Kerenge temperature in VS 614 14.65 20.28 20.29 20.28 20.29 20.20.20 20.2	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 5.22 0 Thermocline stratification index in V7 0.63 4.21 0.63 4.21 0.0 Cangas H state 782 NA 1 0 0	oxygen in VS 612 3.90 8.78 0.01 Average dissolved oxygen in VG 613 3.96 6.8.11 0.00 0xygen in V7 541 3.73 9.44 0.00 Cangas C state 782 NA 1 0 0	index in V5 593 1.44 7.16 1.44 7.16 9 1.54 6.84 6.84 6.84 6.84 6.84 6.84 0 0 Halocline stratification index in V7 7.08 541 1.75 7.08 7.02 7.08 7.02 8 1.54 1.77 7.08 7.08 7.02 7.02 7.02 7.02 7.02 7.02 7.02 7.02
No. of samples Average value Maximum value Minimum value No. of samples Average value Maximum value Minimum value Minimum value Minimum value Minimum value Mo. of samples	in vs 714 2.94 2.51 2.51 0.09 Maximum chlorophyll 'a' in v7 Maximum chlorophyll 'a' in v7 568 2.95 2.190 0.07 Daylight hours 247 6.78 13.84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	in V5 743 235 14840 00 0. acuminata concentration in V6 0. acuminata concentration in V7 0. acuminata concentration in V7 17280 00 11solation 247 54.05 91.90 00 100 100 100 100 100 100 100 100 10	742 0.83 4.69 0.07 Ammonium in V6 748 0.05 Ammonium in V7 574 1.88 8.05 0.07 7 Irradiation 247 1517.67 1517.67 25 Redondela B state 782	742 0.36 0.33 0.33 Phosphate in V6 748 0.35 1.24 0.33 2 Phosphate in V7 748 0.35 1.24 0.33 748 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	742 3.56 17.16 0.02 Nitrate in V6 747 3.55 0.02 Nitrate in V7 574 4.43 2.15 0.03 757 4.43 8.67 0.02 Nitrate in V7 8.77 8.67 8.67 8.67 8.67 8.67 8.67 8.6	741 0.30 0.55 0.01 Nitrite in V6 0.31 0.01 Nitrite in V7 574 0.35 1.40 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.000 0.000 0.000 0.000 0.000000	in VS 6133 14.50 20.73 <b>Average</b> temperature 614 645 20.28 20.29 20.20.20 20.2	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 614 0.522 0 0 Thermocline stratification index in V7 index in V7 541 0.64 0.542 0 0 Cangas H state 782 NA 1 0 0	oxygen in VS 3.90 8.78 0.01 Average dissolved oxygen in VE 613 3.96 6.11 0.00 Average dissolved oxygen in V7 541 3.73 9.44 0.00 Cangas C 8.11 3.73 9.44 0.00 Cangas C 8.11 0.00 Average dissolved 0.00 Average 0.00 Ave	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 6.84 0 Halocline stratification index in V7 541 1.57 7.08 0 Cangas D state 782 NA 1 0 0
No. of samples Average value Maximum value Minimum value No. of samples Average value Minimum value Minimum value Minimum value Minimum value No. of samples Average value Maximum value Minimum value Minimum value	in vs 714 2.94 25.15 25.15 2.0.90 Maximum chlorophyll 'a' in v6 720 3.49 4.330 0 4.330 0 4.330 0 4.330 0 0 0 720 2.190 0.07 Daylight hours 247 6.78 1.384 1.384 1.384 0 0 Cangas E state 782 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	in VS 743 235 14840 00 0. acuminata concentration in V6 749 268 9160 0 0 0. acuminata concentration in V7 0 0 insolation 247 54.05 91.90 0 0 Redondela 8 state 782 0 8	742 0.83 4.66 0.07 Ammonium in V6 748 0.92 4.48 0.92 4.48 0.92 4.48 0.92 748 0.92 748 0.92 748 0.92 747 1517.67 3110 247 7517 1517.67 3110 25 Redondela B 782 8.58 8.59 8.518 7.82 7.82 7.82 7.82 7.82 7.82 7.82 7.8	742 0.36 0.33 0.03 Phosphate in V6 748 0.36 0.24 0.36 0.24 V7 Phosphate in V7 0.40 0.57 44 0.67 0.40 0.37 744 0.67 0.40 0.37 7.40 7.40 7.40 7.40 7.40 7.40 7.40 7.4	742 3.56 3.76 10.002 Nitrate in V6 747 3.50 18.67 0.02 Nitrate in V7 Nitrate in V7 0.03 Nitrate in V7 8.44 4.43 21.51 0.03 0.02 Nitrate in V7 8.44 4.43 21.51 0.03 1.51 0.03 1.51 0.03 1.51 0.03 1.51 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.0	741 0.30 0.55 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.574 0.63 1.40 0.03 0.03 Cangas F state Redondela E 782 NR	in VS 6133 14.50 20.73 10.95 Average in VS 6141 14.65 20.28 20.28 20.28 10.37 40.427 10.37 541 14.77 20.22 11.27 541 14.77 20.22 11.27 20.22 11.27 20.22 11.27 20.22 11.27 20.22 11.27 20.22 11.27 20.22 20.22 20.22 20.25 20.	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 5.22 0 Thermocline stratification index in V7 0 Cangas H state 782 NA 1 0 0	oxygen in VS 612 3.90 8.78 0.01 4.verage dissolved 0.01 6.13 3.96 6.13 3.96 6.13 3.96 6.13 3.96 6.13 3.96 6.13 3.96 6.13 3.96 6.13 3.94 0.00 Cangas C state 782 NA 1 0 0 0 0 0 0 0 0 0 0 0 0 0	index in V5 593 1.44 7.16 Halocine stratification index in V6 593 1.54 6.84 0 Halocine stratification index in V7 541 1.75 7.08 0 Cangas D state 782 NA 1 0 0
No. of samples Average value Maximum value Minimum value	in VS 714 2.94 2.515 0.09 Maximum chlorophyll 'a' in VO Maximum chlorophyll 'a' in VT 568 2.95 2.150 0.07 Daylight hours 2.95 2.150 0.07 0.07 0 0 0 0 0 0 0 0 0 0 0 0 0 0	in VS 743 235 14840 00 0. acuminata concentration in V6 0. acuminata concentration in V7 0. acuminata concentration in V7 111 7280 0 0 1nsolation 247 54.05 91.90 0 1nsolation 247 54.05 91.90 0 0 Redondela A state 782 NA	742 0.83 4.69 0.07 Ammonium in V6 0.92 4.48 0.05 Ammonium in V7 5.74 1.88 8.05 0.07 7 Irradiation 247 1517.67 310 25 Redondela B state 782 178 247 178 247 117 25 27 27 28 28 20 20 20 20 20 20 20 20 20 20 20 20 20	742 0.36 1.33 9Phosphate in V6 748 0.63 1.24 0.03 9Phosphate in V7 9Phosphate in V7 9Phosphate in V7 9Phosphate in V7 9 9Phosphate in V7 9 9Phosphate in V7 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	742 3.56 17.16 0.02 Nitrate in V6 747 3.50 0.02 Nitrate in V7 574 4.43 2.15 0.03 752 82 N4 84 84 782 N4 84 782 N4 84 782 N4 84 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N4 782 N5 782 N4 782 N4 782 N5 782 N5 782 N5 782 N5 782 N5 782 N5 782 N5 782 N5 787 N5 N5 N5 N5 N5 N5 N5 N5 N5 N5 N5 N5 N5	741 0.30 0.01 Nitrite in V6 746 0.31 1.73 0.01 Nitrite in V7 574 0.36 1.40 0.03 Cangas F state state state Redondela E state 140 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.0	in VS 6133 14.50 20.73 14.50 20.73 14.50 14.50 20.28 20.28 20.28 20.28 20.28 20.28 20.28 20.22 2	index in V5 613 0.56 3.84 0 Thermocline stratification index in V6 0 Thermocline stratification 0 0 Thermocline stratification 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 4.21 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.65 0.	oxygen in VS 3.90 8.78 0.01 4.04 0issolved 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.05	index in V5 593 1.44 7.16 0 Halocline stratification index in V6 8tratification stratification index in V7 541 1.75 7.08 0 Cangas D state 782 NA 1 0 0

regions. Therefore, we have studied the effect of sample size (Guallar et al., 2016) and modelling with feature reduction (Rahman and Shahriar, 2013).

As mentioned above, chlorophyll-a concentration is one of the most recurrent biomarkers of potentially toxic phytoplankton proliferation (Rahman and Shahriar, 2013). Chlorophyll-a is related to the concentration of phytoplankton containing this pigment, but not only biotoxinproducing phytoplankton contain it. Therefore, this biomarker may be in error when algal blooms are of non-harmful algae. On the other hand, if the objective is to close mussel production areas as a result of exceeding the legal threshold for the presence of biotoxins (Molares et al., 2020), this could lead to a significant improvement in the accuracy of the prediction.

For this reason, the objective of this study is the creation of a predictive model of high toxicity events in mussel production areas. Consequently, the classification of mussel production areas will focus on whether the presence of lipophilic toxin in mussel flesh exceeds the legal threshold or not. To do this, a comparison of solutions will be carried out, applying different machine learning techniques to predict the state of production areas affected by DSP-type toxins. Taking into account previous studies carried out in the field (Cruz et al., 2021), a total of 6 classification techniques were selected: Artificial Neural Network (ANN), Support Vector Machines (SVMs), k-Nearest Neighbour (kNN), XGBoost, Random Forest and Naïve Bayes. This model can be used by government agencies with responsibilities in the control of shellfish production areas and its use can be of benefit to the mussel industry and the consumer. A workflow of the proposed system can be seen in Fig. 1.

The structure of this paper is defined as follows: It starts with a section on advances in the field of HAB prediction, and in particular in the use of ML techniques for this purpose. In Section 2 the techniques used as well as the configuration of the techniques used are presented. The results of these models can be found in Section 3 and will be interpreted in Section 4. Finally, in Sections 5 and 6 the conclusions obtained and the lines of future work are presented.

Table 3

Distribution of the status of	production areas. Non-	-null sample values refer	r to samples in which	there are no missing values.
	1	1	1	0

	CangasF	CangasG	CangasH	CangasC	CangasD	CangasE	RedondelaA	RedondelaB	RedondelaC	RedondelaD	RedondelaE	VigoA
Samples	783	783	783	783	783	783	783	783	783	783	783	783
Openings	52% (405)	54% (420)	59% (459)	71% (559)	71% (555)	84% (657)	90% (704)	95% (745)	96% (749)	94% (737)	90% (703)	76% (597)
Closures	48% (378)	46% (363)	41% (324)	29% (224)	29% (228)	16% (126)	10% (79)	5% (38)	4% (34)	6% (46)	10% (80)	$\underset{(186)}{24\%}$
Non-null samples	175	175	175	175	175	175	175	175	175	175	175	175
Non-null openings	45% (78)	46% (81)	54% (95)	65% (113)	66% (115)	80% (140)	82% (143)	90% (158)	93% (162)	89% (155)	86% (151)	68% (119)
Non-null closures	55% (97)	54% (94)	46% (80)	35% (62)	34% (60)	20% (35)	18% (32)	10% (17)	7% (13)	11% (20)	14% (24)	32% (56)

		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
CANGAS F	DSP PSP ASP												
CANGAS G	DSP PSP ASP												
CANGAS H	DSP PSP ASP												
CANGAS C	DSP PSP ASP												
CANGAS D	DSP PSP ASP												
CANGAS E	DSP PSP ASP												
REDONDELA	A PSP ASP												
REDONDELA	B DSP ASP												
REDONDELA	C PSP ASP						•						
REDONDELA	D PSP ASP												
REDONDELA	E DSP PSP ASP												
VIGO A	DSP PSP ASP												

Fig. 4. Distribution of closure episodes caused by HAB in mussel production areas in the Vigo Estuary (2016). Source: http://www.intecmar.gal/Informacion/biotoxinas/Evolucion/DiagramaBateas.aspx.

Summary table of the models parameter values used in the grid search.

General	Settings

Validation strategy	10-fold cross-validation
Data normalisation	Yes
Artificial Neural Networks	
Number of input neurons	Number of influencing factors
Output neurons	1
Number of hidden layers	1 and 2
Number of neurons in a one hidden layer network	2, 8 and 14
Number of neurons in a two hidden layers network	[10,10] and [10,20]
Activation function output layer	Sigmoid
Hidden layers activation function	Relu
Optimizer	Adam
Learning rate	0,001
Loss function	Binary crossentropy
Batch size	5
Number of epochs	10
Class weighting	Yes
Support Vector Machines	
Kernel type	Lineal, Gaussian and Polynomial
C value	1
Gamma value (gaussian kernel)	0.2, 0.3, 0.4, 0.5, 0.6, 0.7 and 0.8
Grade (polynomial kernel)	2
XGBoost	
Gbtree	
Max depth	6
Learning rate	0,3
Dart	
Sample type	uniform
Normalise type	forest
Gblinear	
Updater	coord_descent
k-Nearest Neighbor	
k value	1, 2, 3, 4, 5, 6, 7, 8, 9 and 10
Random Forest	
Number of trees	100, 500, 1000, 1500 and 2000
Naïve Bayes	
Algorithm	Gaussian, Multinomial, Complement and Bernoulli

#### 2. Materials and Methods

#### 2.1. Dataset and its construction

The production status (open/closed) of the crop areas has been used as the target variable. This status of crop areas is assigned according to

whether or not the presence of toxin in the mussel tissue exceeds the legal threshold. If the threshold is exceeded, extraction activities in that crop area will cease (closure of the crop area) or, if not, extraction activity will be allowed (opening of the crop area). It was decided to focus the study on predicting the state of the cultivation areas each Monday. This is because no toxin presence analysis is carried out on the previous days (Saturday and Sunday), which is one of the most compromised points of the existing monitoring system. Twelve out of thirteen mussel production areas of the Vigo estuary (Galician coast, Spain) have been selected: Cangas F, Cangas G, Cangas H, Cangas C, Cangas D, Cangas E, Vigo A, Redondela A, Redondela B, Redondela C, Redondela D and Redondela E (see Fig. 2) excluding from this study the production area of Baiona A because it is a polygon that remains unsampled for long periods of time. As the areas are managed independently, and as input variables, we have used a set of environmental and oceanographic data of different nature, recorded by different institutions between 2004 and 2018. The network of sampling points for phytoplankton monitoring coincides, to a large extent, with the stations set up to determine oceanographic conditions, Fig. 2. Weekly, an oceanographic vessel takes samples from points V1, V2, V3, V4, V5, V6 and V7, located in the Vigo estuary. Their distribution can be seen in the Fig. 3). In each sampling point, integrated samples of water between 0 and 15 metres deep to count phytoplankton cells and determine nutrients dissolved in water, were taken. Simultaneously, a multiparametric probe measures the physico-chemical parameters of the water column. The different variables collected in these oceanographic stations, as well as other constant variables for the whole estuary obtained thanks to METEOGALICIA (met, 2021) and the IEO (IEO, April 27, 2021), are shown in the Table 1. All oceanographic stations have been taken into account in order to know which ones offer the data most related to the occurrence and concentration of HAB, as this depends directly on the functioning of factors such as the morphological configuration of the estuary itself or sea currents. By analysing the data collected, it is determined that the sampling frequency of the data collected is mainly weekly, so this metric will be used as a reference for the creation of the models.

The pre-processing of the input data was as follows:

• The weekly information on chlorophyll-a is collected in three samples divided by depth bands: mean chlorophyll-a between 0 and 5 metres, between 5 and 10 metres and between 10 and 15 metres. Since the presence of toxicity in mussel from any part of the culture rope means the total closure of the production area, the maximum value between the three depths was chosen.



Fig. 5. Summary table with the occurrence of the features after the feature selection processes. Where each point represents the likelihood of a variable being selected as an input feature for a particular production area.



Fig. 6. Combination of recall, accuracy and kappa in the different production zones for each algorithm. The average values for each metric across all folds are shown. In each case, the best performing configurations are represented.

- The count of *Dynophysis acuminata* is a single, weekly value, so information from all available stations was used.
- Nutrient data are collected on a weekly basis and there is only a single piece of data per station, so the count from each oceano-graphic station was used.
- Environmental values, such as temperature and oxygen, were averaged to unify the information into a single measurement since the data are originally irregular measurements at depths between 0 and 25 metres. Only values up to 12 metres were used for averaging, as this is the length of the mussel ropes. In addition, with the temperature and salinity values, a differential was made between the mean of the first 6 metres and that of the following 6 metres, in order to be able to detect the presence of stratifications, both thermoclines and haloclines.
- The sun data, such as hours of incidence, insolation and irradiation, come from the Meteogalicia weather station, so the data are daily and common for the whole estuary. In order to simplify the input parameters, the weekly average of each of the parameters was calculated.
- The upwelling index data are calculated on a daily basis over four time periods: 00:00 h, 06:00 h, 12:00 h and 18:00 h. In order to simplify the data, the weekly average value was used, thus estimating the predominant value throughout the week.
- To simplify the seasonality into a single value, the date of sampling was transformed, using only the number of the week of the year.
- The specific value of toxins in mussel flesh is a value for which no regular records are covering the whole casuistry in a robust way. Instead, it was concluded that it was possible to classify the status of production areas according to whether the growing area was closed

or not. These closures are applied in case the level of toxicity in the mussel flesh exceeds the legal threshold. This information could be obtained by analysing INTECMAR's historical record of closures (INTECMAR, 2 February 2022).

The processing of the 15 years' data resulted in an input dataset of 783 samples. Each of the samples consists of 76 input features. For a more detailed analysis of the input parameters, see Table 2.

This dataset had incomplete samples with missing data for some of the features, so it was necessary to eliminate those rows with such inconsistencies in their data. These samples with missing values were referred to as null samples. After this filtering, a resulting dataset of 175 samples was left. The distribution in the labelling of the samples can be seen in the Table 3. As can be seen in this table, toxicity episodes are more common in the crop areas located in the outer part of the estuary, while their frequency decreases towards the inner parts of the estuary. Fig. 4 shows the behaviour of the HABs that occurred in 2016. An input dataset was created for each of the twelve crop zones; these matrices share 75 of the 76 input features, with the exception of the Friday opening or closing status of the zone to be estimated.

#### 2.2. Machine Learning Models

Based on previous literature, a total of 6 machine learning techniques have been considered: Artificial Neural Networks, Support Vector Machines, XGBoost, k-Nearest Neighbor, Random Forest and Naïve Bayes. These techniques will be tested in order to check which method is the most suitable for the approach proposed in this study. These well-known techniques will be briefly presented below.



Fig. 7. Combination of recall, accuracy and kappa in the production zones for each algorithm. The average values for each metric across all folds are shown. In each case, the best performing configurations are represented. 1/2.



Fig. 8. Combination of recall, accuracy and kappa in the production zones for each algorithm. The average values for each metric across all folds are shown. In each case, the best performing configurations are represented. 2/2.

Summary table of the first approach with the models defined as the best in each of the production zones.

			Approach	1						
					Rec	all	Accu	racy	Кај	opa
Production zone	Corelation filter cuartile	Random Forest filter cuartile	Algorithm	Number of neighbors	μ	σ	μ	σ	μ	σ
Cangas F	-	50	kNN	2	100,00%	0,00%	91,38%	6,37%	0,79	0,14
Cangas G	25	25	kNN	4	99,17%	2,50%	88,50%	7,23%	0,75	0,13
Cangas H	75	75	kNN	2	99,50%	1,50%	91,98%	3,56%	0,83	0,08
Cangas C	50	75	kNN	2	97,61%	2,97%	89,23%	3,64%	0,76	0,09
Cangas D	-	-	kNN	2	96,39%	7,86%	89,23%	6,79%	0,76	0,14
Cangas E	-	-	kNN	2	100,00%	0,00%	92,61%	5,02%	0,80	0,12
Vigo A	50	75	kNN	2	96,32%	3,83%	88,70%	4,01%	0,73	0,09
Redondela A	-	-	kNN	2	100,00%	0,00%	93,93%	3,76%	0,83	0,11
Redondela B	-	-	kNN	2	90,83%	20,56%	90,83%	6,90%	0,64	0,27
Redondela C	50	75	kNN	2	92,50%	16,01%	96,42%	1,92%	0,69	0,13
Redondela D	50	75	kNN	2	93,67%	12,69%	93,69%	3,62%	0,65	0,19
Redondela E	50	75	kNN	2	98,33%	5,00%	93,63%	5,15%	0,82	0,15
Average					97,03%	6,08%	91,68%	4,83%	0,76	0,14

#### Table 6

Summary table of the second approach with the models defined as the best in each of the production zones.

			Approact	12	Rec	all	Accu	racy	Kaj	ppa
Production zone	Corelation filter cuartile	Random Forest filter cuartile	Algorithm	Number of neighbors	μ	σ	μ	σ	μ	σ
Cangas F	-	-	kNN	2	100,00%	0,00%	88,10%	7,52%	0,75	0,15
Cangas G	25	-	kNN	2	99,09%	2,73%	87,73%	11,46%	0,74	0,21
Cangas H	50	75	kNN	2	99,50%	1,50%	92,35%	3,54%	0,84	0,08
Cangas C	50	75	kNN	2	97,61%	2,97%	89,98%	3,92%	0,77	0,09
Cangas D	75	75	kNN	2	96,39%	2,58%	87,35%	3,91%	0,73	0,08
Cangas E	-	-	kNN	2	100,00%	0,00%	92,58%	5,09%	0,80	0,14
Vigo A	-	25	kNN	2	95,42%	10,28%	87,71%	6,93%	0,71	0,15
Redondela A	-	-	kNN	2	100,00%	0,00%	94,48%	3,36%	0,84	0,11
Redondela B	-	50	kNN	2	95,42%	10,28%	95,59%	3,20%	0,64	0,24
Redondela C	50	75	kNN	2	92,50%	16,01%	96,60%	1,64%	0,69	0,12
Redondela D	50	25	kNN	2	94,67%	11,08%	95,39%	2,57%	0,73	0,14
Redondela E	-	-	kNN	2	97,50%	7,50%	94,03%	4,43%	0,80	0,16
Average					97,34%	5,41%	91,83%	4,80%	0,75	0,14

#### 2.2.1. Artificial Neural Networks

Artificial neural networks (ANNs) are massively parallel interconnected networks of simple (usually adaptive) elements and hierarchical organisation. Artificial neural networks are part of a data analysis technique that, compared to their more rigid and complicated alternatives, offers greater flexibility in processing large volumes of multivariate, non-linear data (White et al., 1992).

#### 2.2.2. Vector Support Machines

The classification-regression method Support Vector Machines (SVM) was first proposed by Cortes and Vapnik in 1995 (Cortes and Vapnik, 1995), within the field of computer science. The machine conceptually implements the idea that input vectors are mapped non-linearly into a very high-dimensional feature space. A linear decision surface is constructed in this feature space. The special properties of the decision surface guarantee a high generalisation ability of the learning machine.

#### 2.2.3. XGBoost

XGBoost or Extreme Gradient Boosting is an extensible, state-of-theart application of gradient boosting machines and has been shown to overcome the limits of the computational power of Boosted tree algorithms. Boosting is an ensemble technique in which new models are added to correct errors in existing models. Models are added recursively until no noticeable improvement is found. Gradient boosting is an algorithm in which new models are created to predict the residuals of previous models and then added together to produce a final prediction. It uses a gradient descent algorithm to minimise losses when adding new models (Friedman, 2001).

#### 2.2.4. k-Nearest Neighbour

The *k*-*Nearest Neighbor* (kNN) classifier is an unsupervised machine learning technique for classifying unlabeled observations by assigning them to the class of the most similar labelled examples. The features of the observations are collected for both training and test dataset. The most commonly used metric in the calculations is the Euclidean distance. Another concept is the parameter *k*, which decides how many neighbours will be chosen for the kNN algorithm. The appropriate choice of *k* has a significant impact on the diagnostic performance of the kNN algorithm (Lantz, 2015).

#### 2.2.5. Random Forest

*Random Forest* is an ensemble method, which builds many decision trees that will be used to rank a new instance based on the majority vote. Each node of the decision tree uses a subset of features randomly selected from the original set of features. In addition, each tree uses a different bootstrap data sample, in the same way as bagging. Bagging methods are almost always more accurate than single classifiers. On the other hand, boosting methods can be more accurate than bagging methods but are very sensitive to noise. Random Forest is more robust to noise than boosting methods; performs as well as boosting and sometimes better; and does not overfit (Segal, 2004).

#### 2.2.6. Naïve Bayes

Today, the *Naïve Bayes* classifier is used in many applications due to its simple but powerful principle of (Lewis, 1998) accuracy. Bayes' theorem finds the probability of an event occurring given the probability that another event has already occurred. However, this classifier does not take into account the number of occurrences, which is a potentially useful source of additional information. They are called "naïve" because the algorithm assumes that all terms occur independently of each other.

#### 2.3. Performance mesuares

For the analysis of the trained models and their subsequent comparison, 6 statistics were taken into account that were considered relevant when assessing the results (average accuracy, average sensitivity, average kappa coefficient, minimum accuracy, minimum sensitivity and minimum kappa coefficient). In the confusion matrix used to calculate the statistics, closures were defined as positive and openings as negative. Thus, True Positives (*TP*) correspond to those closures correctly classified as closures, True Negatives (*TN*) identify openings classified as such, False Positives (*FP*) represent those openings wrongly classified as closures and, finally, False Negatives (*FN*) are those closures that have been classified as openings.

Calculated according to Eq. (1) accuracy estimates how correctly a binary classification test identifies or excludes a condition. As this is a binary classification paper, this parameter is considered relevant.

$$\frac{TP+TN}{TP+FP+FN+TN} \tag{1}$$

Not performing a closure when the toxin is present in the mussel poses a higher risk, prioritising the human factor over the economic one. Sensitivity (Eq. (2)) prioritises avoiding misclassifying closures as openings. Sensitivity was therefore the benchmark statistic in this study.

$$\frac{TP}{TP + FN} \tag{2}$$

Cohen's kappa coefficient, calculated according to Eq. (3), is a statistical measure that adjusts for the effect of chance on the proportion of observed agreement between two experts. In this equation, Pr(a) represents the relative observed agreement between the observers, while Pr(e) is the hypothetical probability of agreement by chance. In this study, the model outputs were compared with the labelling performed by the experts to analyse the effect of chance on the models.

$$K = \frac{Pr(a) - Pr(e)}{1 - Pr(e)}$$
(3)

The criteria taken into account when selecting the best models were the values explained above (accuracy, sensitivity and kappa coefficient), as well as the number of features used to make the prediction. A smaller number of input variables would make it easier to make predictions, even on days when certain data are missing. Sensitivity is the most important factor to be taken into account due to the absolute priority of minimising false negatives (as they pose a risk to public health).

#### 2.4. Experimentation setup

By using the strategy of *K*-folds strategy, specifically 10-fold, yields 10 values of each statistic. The *K*-fold cross-validation procedure randomly divides a dataset into *k* disjoint blocks of approximately equal size, and each block is in turn used to test the model induced from the other k - 1 blocks by a classification algorithm. The performance of the classification algorithm is evaluated by the average of the *k*-precisions resulting from the cross-validation of *k*-blocks. This method avoids choosing models with good averages but which perform poorly on certain training blocks, thus ensuring the robustness of the models. The minimum values of the statistics explained above are also taken into account.

Significance analysis was deemed necessary to ensure the robustness of the classification. First, a normality analysis was performed, to ensure that a parametric test can be performed (Sheskin, 2003). When the sample size is at most 50, normality can be tested with the Shapiro–Wilk test test. The Anderson–Darling statistic measures how well the data follow a specific distribution. For a particular data set and distribution, the better the distribution fits the data, the lower this statistic will be. Both the Shapiro–Wilk test and the Anderson–Darling test showed that the sensitivity data for all areas are normal. ANOVA analysis allows multiple means to be compared by studying variances. This was followed by pairwise comparison, in the specific case of this project, with the Tukey–Kramer test. The significance was estimated according to Copenhaver-Holland (Copenhaver and Holland, 1988).

For this study two sets of features were used: one with all 76 input features and another one where the most redundant features were filtered out. In order to do this, a correlation analysis was carried out between the features, and those with a correlation of more than 90% between them were eliminated. This was an empirical approach in which preliminary tests were carried out to eliminate only those variables that really had a very close relationship and leave it to a more purely objective process such as a ranking system to use or assign importance to each. Through this process, influential factors have been sought in less common variables. In this second approach, the 76 input features were reduced to 50.

Then, in each approach, starting from the raw data, a feature selection process was conducted. This has several advantages. Firstly, we make our model easier to interpret. Secondly, we can reduce the variance of the model and thus the overfitting. Finally, we can reduce the computational cost (and time) of training a model. To carry out the feature selection process, the features were ordered using a ranking process. Two ranking techniques were used for this process:

- Applying a filtering method such as correlation with the variable to be forecast. Using the statistical value to rank order the features, three sets of tests were proposed: one with 25% of the best ranking features, one with 50% and the last one with 75%.
- Use of an embedded method such as the Random Forest algorithm. The tree-based strategies used by Random Forest are naturally ranked according to how they improve node purity. This means a decrease in impurity over all trees (called Gini impurity). Nodes with the highest decrease in impurity occur at the beginning of the trees, while notes with the lowest decrease in impurity occur at the end of the trees. Thus, by pruning the trees below a particular node, we can create a subset of the most important features. After applying this ranking, three sets of tests were proposed: one with 25% of the best ranking features, one with 50% and the last one with 75%.

Different experiments have been defined based on the application of one, both or none of the ranking methods mentioned above. To ensure the reliability of the results, the tests were carried out with a cross-validation strategy of *10-fold*. In order to determine the configuration of the best performing models, a grid search was performed and the parameter values of the models used in the training were adjusted as shown in the Table 4.

#### 3. Results

During the feature selection process, the combined Pearson Correlation and Random Forest techniques were applied. Thanks to this, it was possible to extract the importance that these methods give to the features for the classification process. Fig. 5 shows a summary of the behaviour of these methods throughout the production zones, reflecting the percentage of persistence of each variable after the selection processes. It can be seen that the state of the production zone in the week before the prediction day is the most important characteristic, followed by the concentration of *D. accuminata* and the concentration of dissolved nutrients such as nitrate and nitrite. For each of the production zones, a more detailed overview of the feature selection process can be found in Tables 7–18. These tables show how the data collected at each oceanographic station have a different effect on nearby areas. This is due to how marine currents affect the estuary and how certain stations gain importance over others concerning each production area.

By applying each of the 6 machine learning techniques to the 12 production zones independently, it has been possible to observe the comparative solutions offered by each of these methodologies. In Fig. 6 the values of sensitivity, accuracy and kappa obtained by the best models trained with each algorithm and for each production zone can be seen. Algorithms such as kNN or NB obtain more stable results for all the zones, while algorithms such as SVM, RF and XG, although they show certain stability in the values of accuracy, show great variability in the sensitivity values depending on the production zone. The ANN algorithm is presented as the algorithm with the greatest variability in its results.

For a detailed analysis of how the algorithms behave in each of the production zones, please refer to the Figs. 7 and 8. In these graphs it can be seen that the models perform better in the production areas of Cangas F, Cangas G, Cangas H and Redondela A. While the areas where the models have more difficulties in making predictions are: Redondela B, Redondela C and Redondela D.

The models defined as the best in each of the production zones during the first approach are shown on Table 5 and those of the second approach on Table 6. These tables show the sensitivity, accuracy and kappa values. When applying the ten-folds strategy, it is necessary to show the results as the tuple of mean value and standard deviation of the values obtained in each fold.

# 4. Discussion

The study of the predictor variables for ML models in the prediction of HAB episodes has been one of the most critical points raised in the literature. To date, there is still no consensus on which are the most influential features, varying considerably depending on the geographical region where it is applied and the ML techniques studied. Chlorophyll-a concentration is one of the most relevant features (Deng et al., 2021; Yu et al., 2021), as it is directly related to phytoplankton abundance, but in this study, it has been clearly surpassed by the concentration of *D. accuminata*. This is due to the fact that this marker is more accurate when estimating the lipophilic toxin, this dinoflagellate being one of its main producers. It is also necessary to highlight the importance of nutrients such as nitrate and nitrite (Yu et al., 2021) and environmental factors such as temperature and salinity (Yñiguez and Ottong, 2020).

The results offered by the kNN machine learning algorithm have been the best for the problem analysed in this work, which is the creation of a predictive model of high toxicity events in mussel production areas (reaching mean sensitivity, mean accuracy and mean kappa index values of 97.34%, 91.83% and 0.75 respectively). Its best values of sensitivity, accuracy and kappa have been higher than those obtained with Random forest, ANN, SVM, Naïve Bayes and XGBoost techniques (see Fig. 6). It should be noted that the average kappa value obtained (0.75) has a substantial degree of agreement according to the scale of values proposed by Landis and Koch (Landis and Koch, 1977).

In the Fig. 5, it can be seen how the SVM, ANN, Random Forest and XGBoost algorithms are more susceptible than kNN and Naïve Bayes to the frequency and duration of mussel harvesting prohibition periods in the production areas. This relationship can be seen in the decrease of the sensitivity values in the areas where these periods are less common (Redondela B, Redondela C and Redondela D), while the values of accuracy remain stable. It is necessary to highlight how the performance of the ANNs tends to offer high values of accuracy and low values of sensitivity for the areas where the state of prohibition of extraction is less common, while in the areas where the number of days of prohibition increases (Cangas F and Cangas G), the model offers an improvement in the values of sensitivity to the detriment of accuracy.

These results reflect the imbalance present in the input data which, in areas such as Redondela C, reach a difference of 7% of positives compared to 93% of negatives. Therefore, areas such as Cangas F,

Cangas G and Cangas H, which have a distribution of closures of around 60–40%, always obtain better results than areas where FAN is less frequent and where there are fewer cases for the analysis of this study, such as Redondela B, Redondela C and Redondela D, which have a ratio of closures of around 10%.

#### 5. Conclusions

Although the work carried out to date has obtained good results in predicting biomarkers of FAN, the control of the state of the production areas is conditioned by other external factors, which means that the definition of the problem changes. Some work has used real-time prediction of shellfish and fish mortality events as HAB markers (Yñiguez and Ottong, 2020). But real-time prediction does not provide reaction time to these events. However, in this study we have achieved 3-day predictions while maintaining good results. For this we have used the presence of a toxin level above the risk threshold as a HAB marker. In the Galician coast, some previous works seek to solve this problem (Molares et al., 2020), achieving sensitivity and accuracy values of 67.4% and 83% in the production area of "Vigo A" by applying the ANN technique, while in the present work a significant improvement in the results has been achieved.

The approach of the study has shown that it is possible to estimate the status of production areas affected by marine biotoxin events using machine learning techniques. For this purpose, an extensive historical record of variables related to the occurrence of episodes of high toxicity in mussels has been used. The estimates obtained with the models studied have achieved high values of sensitivity and accuracy, so that the expectations initially set out in this study have been met. It has been found that the machine learning algorithm that offers the best results for the resolution of this specific problem in all the production areas of the estuary is the kNN technique. Its best sensitivity and accuracy values have been superior to those obtained with the techniques of Random forest, ANN, SVM, Naïve Bayes and XGBoost.

The models developed during the study can be used to assess the robustness of the decisions taken by experts when managing the opening or closure of production areas in the absence of recent sampling. This dual assessment mechanism can help experts in complex situations where forecast errors are more likely.

#### 6. Future Works

In this work, 6 different machine learning algorithms were studied to solve the problem. It is proposed to compare the results obtained with other alternative algorithms that can approach the problem from another perspective, such as hybrid machine learning algorithms (Behera et al., 2016).

The study has focused only on the Vigo estuary, as it is one of the most important Galician estuaries for the production of mussels, and because of its geomorphological characteristics that give it a behaviour in the distribution and evolution of algal blooms of great scientific interest. However, the study is continuing with the aim of supporting the rest of the Galician estuaries with mussel production.

In this study, variables identified as relevant in the state of the art have been selected. However, other new variables (e.g. wind, currents, other toxic phytoplankton species, etc.) could be considered as input parameters in the training of machine learning algorithms.

One of the limiting factors in conducting this study has been the amount of missing data from the time series used as data sets. It is therefore considered that the creation of a system capable of obtaining or generating (synthetic data (Chen et al., 2021)) such data could lead to a significant improvement in the results obtained.

#### **Declaration of Competing Interest**

The authors declare that they have no known competing financial

#### A. Molares-Ulloa et al.

interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgments

The authors want to acknowledge the support from INTECMAR, who have provide mostly data for this work and CESGA, who allows to conduct the tests on their installations. Funding for open access charge: Universidade da Coruña/CISUG. This work is supported by the "Collaborative Project in Genomic Data Integration (CICLOGEN) PI17/ 01826 funded by the Carlos III Health Institute in the context of the Spanish National Plan for Scientific and Technical Research and Innovation 2013–2016 and the European Regional Development Funds (FEDER)—"A way to build Europe." This project was also supported by

the General Directorate of Culture, Education and University Management of Xunta de Galicia (Ref. ED431G/01, ED431D 2017/16), the "Galician Network for Colorectal Cancer Research" (Ref. ED431D 2017/ 23), Competitive Reference Groups (Ref. ED431C 2018/49) and the Spanish Ministry of Economy and Competitiveness via funding of the unique installation BIOCAI (UNLC08-1E-002, UNLC13-13–3503) and the European Regional Development Funds (FEDER). Enrique Fernandez-Blanco would also like to thank NVidia corp., which granted a GPU used in this work for the preliminary tests.

# Appendix A

Tables 7–18

#### Table 7

Table with the input features associated with each test block in the Cangas F zone. The check marks when the feature was used.

								Α	ppro	Dac	h 1													Ap	pro	acl	12						
Fosturo	Oceanographic	-				_	-	E		_	_	0		_	Co	rrel	atio	n Q	Quar	tile			2	6		_	_			_	_		
Feature	station	-		0				:5		-	5		uart	tile	of ra	ande	om	fore	esto	u disc	rimi	inat	or 2	5				50				5	
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	1	1	1	$\checkmark$													1	1	1													
Daylight hours	-	1				1												$\checkmark$				$\checkmark$	_										
Insolation	-	V	1	1	-	1			-	1	1	-	-	-	-			-	-				_	_		_			_	-	_	-	
Upwelling index		V		V	-	~		-	-	~		-	-		-	-		1						_	_	_		-	-	-		-	
Zone state	-	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$															
	V1	1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$										
	V2	$\checkmark$	V.	$\checkmark$	~	$\checkmark$	$\checkmark$	$\checkmark$	~	$\checkmark$	~	~	$\checkmark$	$\checkmark$	~	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	~												
Maximum	V3 V4	V	1	1	1	1	1	1	-	1	1	-	-	-	-	-		1	1	1		1	1	1		1		-	-	-	-	-	
chlorophyll	V5	1	1	1	<u> </u>	1	· √	1		1	1	1	-	1				-	-	-			-	-		Ť							
	V6	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$																							
	V7	1	1	$\checkmark$	1	1	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$		_	$\checkmark$	$\checkmark$	1		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		~	$\checkmark$	1	$\checkmark$	$\checkmark$		1	$\checkmark$	$\checkmark$	
	V1 V2	V ./	./	-	-	~		-	-	-	-	-	-		-	-		~	-	-		~	_			_		-	-	-		-	
-	V3	V	V	1	1	1	$\checkmark$																	_									
D. acuminata	V4	1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$					
concentration	V5	1	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		1			
	V6	$\checkmark$	$\checkmark$	1	1	1	1	1	1	1		1				_		1	1	1	1	1	1	1		1	1						
	V/ V1	V ./	V	V ./	V	V	✓ √	V ./	V ./	V ./	V	V ./	1	1	./			V	V ./	V ./	√ √	✓ √	V	✓ √	.1	√ √	V ./	./	_	./	./		
	V2	V	V	×		V	V	~	×	V	×		-		-			V	V	V	~	V V	V	-	~	V	V	V	-	· ·	×	-	
	V3	1	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	1	1		$\checkmark$	$\checkmark$		
Ammonium	V4	1				$\checkmark$												$\checkmark$				$\checkmark$											
	V5	$\checkmark$					_				<u> </u>		_					$\checkmark$	$\checkmark$			_	-									<u> </u>	
	V6 V7	V ./	V ./	-	-	V ./	~	-	-	-	-	-	-	-	-	-		V ./	V ./	~		✓ √	V ./	~		~		-	-	-	-	-	
	V1	V	V			V	$\checkmark$	$\checkmark$		1	1			1				V	V	1		V V	~	-	_	$\checkmark$	$\checkmark$	1		1			
	V2	$\checkmark$	$\checkmark$															$\checkmark$															
	V3	1	$\checkmark$															$\checkmark$	$\checkmark$														
Phosphate	V4	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	V		$\checkmark$	_	$\checkmark$	$\checkmark$	~		-	-				_			_			-	-	<u> </u>	-	
	V5 V6	V	1	1	J	J	V V	V 1	1	1	1	J	-	1	1	1		-	-				_	_		-		-	-	-	-	-	
	V7	1				1							-					1				$\checkmark$											
	V1	$\checkmark$	$\checkmark$															$\checkmark$	$\checkmark$														
	V2	1	1	$\checkmark$		1	✓			$\checkmark$	$\checkmark$	$\checkmark$						<ul> <li>✓</li> </ul>	✓	1		✓	$\checkmark$	$\checkmark$		<b>√</b>							
Nitrato	V3	$\checkmark$		-	-	$\checkmark$	$\checkmark$	1		/	-	-	-	-	-	-			V			$\frac{}{}$	_			$\checkmark$	V	~	_	-	<u> </u>	-	
Withdie	V4 V5	V	1	-	-	v	-	~	-	-	-	-	-	-	-	-		V	1			×				~	~		-	-	-	-	_
	V6	1	1	$\checkmark$		1	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$										
	V7	1	1	1	1	1	$\checkmark$	1	$\checkmark$	$\checkmark$	1	1	$\checkmark$	$\checkmark$																			
	V1	$\checkmark$		$\checkmark$	$\checkmark$	~	_	1	1								_							_		<u> </u>							
	V2 V3	V	~	V	-	V	~	V		~	-	-	-	~	V			1						_					-	-		-	
Nitrite	V4	V	1										-		-			*						_									
	V5	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$																					
	V6	1																$\checkmark$	<ul> <li>✓</li> </ul>														
	V7			~	~	V	$\checkmark$	~	~	~	V	~	~	~	~	~	~		V	V	~	$\frac{}{}$	~	V	~	~	~	~	~	~	~	V	
	V1 V2	V	1	1	-	V	V V	-	-	1	-	-	-	-	-	-		1	V	V		V V	~	~		1		-	-	-	-	-	
Average	V3	1	1	1		1	1	1		1	1			1	1			1	1	1	1	1	1	1		1	1	1		1	1		
temperature	V4	1	1			1				1				Ĺ				1				1				1							
	V5	1	1	1		1	1			1	1							1	1	1		1	~	1		$\checkmark$	1						
	V0 V7	V		-					-		-			-				V		-										-			
	V1	1	1	1		1	$\checkmark$																										
	V2	1	$\checkmark$			1	$\checkmark$											1	$\checkmark$			1	$\checkmark$	1									
Thermocline	V3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	$\checkmark$	1	1	1	1	1	1	
index	V4	V	V	1	-	1	1	1	-	1	-	-	-	-	-		-	1	1	1	_	1	1	1		1			-	-		-	_
IIIdex	V6	V	V	V	-	V	$\checkmark$	$\checkmark$	-	V	1		-	1	-			~	V	~		~	~	V		v		-	-			-	
	V7	1	Ĺ			1	1			1				É																			
	V1	1	$\checkmark$	1		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																						
Aug-10-10-10-10-10-10-10-10-10-10-10-10-10-	V2	1																1	1			1											
dissolved	V3	1	1			1	1				-			-					-											-			_
oxygen	V5	1	1			1	-											1				1											
,	V6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	$\checkmark$	1	1	1	1	1	1	$\checkmark$
	V7	$\checkmark$	1	1		1	$\checkmark$	$\checkmark$										$\checkmark$	$\checkmark$	$\checkmark$		1	$\checkmark$	$\checkmark$									
	V1	1	1	1	1	1	1	1	1	1	1	1		1	-			1	1			1	~			$\checkmark$	1						
Halocline	V2 V3	1	1	1	1	1	~	~	1	1	V	1	-	V	-		-	-	-		_						-		-	-		-	
stratification	V4	1	1	1		V	$\checkmark$			1	1	1		-	-			-											-				_
index	V5	1	Ĺ			1						Ĺ						1				1											
	V6	$\checkmark$	$\checkmark$																														
	V7	1	$\checkmark$			$\checkmark$	$\checkmark$																										

Table with the input features associated with each test block in the Cangas G zone. The check marks when the feature was used.

								Α	ppro	oac	h 1				_									Ap	pro	acl	h 2						
Feature	Oceanographic	⊢		0				25		_		50		T	Co	orrel	atio	on Q	uar	tile n			2	5		_		50		_	7	5	-
reature	station	F		<u> </u>		-				<u> </u>	-	ç	uar	tile	of r	and	om	fore	esto	disc	rimi	nat	or	<u> </u>						<u> </u>	-	-	
		0	25	50	75	0	25	50	75	0	25	50	75	i 0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	$\checkmark$	$\checkmark$	1	<u> </u>					<u> </u>	<u> </u>		-	-		<u> </u>		$\checkmark$	$\checkmark$	$\checkmark$		,					_						-
Daylight hours	-	V /	V /	-	-	V/	1	-		-	-	-	-	-	-	-		~	~	-		~	~			~	-		<u> </u>				-
Insolation		V ./	V ./		+	1	V ./	-	-	./	1		+	+	-	-	-	-	-	-		_		_		-	-	-	-	-			-
Upwelling index	-	V	1		$\vdash$					-		-	$\vdash$	+				1				_					-						
Zone state	-	1	1	1	1	1	1	1	$\checkmark$	1	1	1	1	1	1	$\checkmark$	1	1	1	1	$\checkmark$	1	1	1	$\checkmark$	$\checkmark$	1						
	V1	$\checkmark$	$\checkmark$			$\checkmark$												$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$										
	V2	$\checkmark$				$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$						
Maximum	V3	1	<ul> <li>✓</li> </ul>			1							-	-				1	$\checkmark$	$\checkmark$		1	$\checkmark$										-
chlorophyll	V4	V	$\checkmark$	-	-	$\checkmark$	$\checkmark$			<u> </u>	-		-	-		-		$\checkmark$	$\checkmark$			~	~			$\checkmark$	$\checkmark$	_					-
	V5	V	V	-	+	1	1	-	_	-	-	-	+	+	-	-	-	V	V	-		1	1	1		-	-	-	-	-			-
	V7	V	1 V	-	+	1 V	J	-	-	-	-	-	+	+	-	-	-	V	V	1		v √	V V	~		1	1	-	-	-			
	V1	V	V	1	1	V	V	1	$\checkmark$	1	1	1	1	1	1	$\checkmark$	1	V	V	V	$\checkmark$	v	· √	$\checkmark$	$\checkmark$	V	V	1	1	$\checkmark$	$\checkmark$	$\checkmark$	1
	V2	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$			$\checkmark$												
D acuminata	V3	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$				$\checkmark$			
concentration	V4	$\checkmark$	1			$\checkmark$				1								✓				√				$\checkmark$				✓			
	V5	$\checkmark$	$\bigvee$	V.	V.	V,	$\checkmark$	V.	V	V.	V.	$\checkmark$	V.	V.	$\checkmark$	$\bigvee$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	✓ ✓	V	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	V.	V	$\checkmark$	~
	V6	V 1	V	V	V V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V ./	V /	V ./	V /	V	V	V	V	V	V	V	V	-
	V1	V ./	1	1	×	V	V	V	~	V		V		- V	~		~	V 1	1	V	~	~	~	~	~	V	~	~	V	V	~	V	
	V2	V	Ť		-	+			-	-		-	+	+	-				Ť	-			_				-	-		-			
	V3	1	1	1									$\square$	$\square$				$\checkmark$	1														
Ammonium	V4	$\checkmark$																$\checkmark$	$\checkmark$														
	V5	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$									
	V6	$\checkmark$	$\checkmark$		-			-			-		-	-				$\checkmark$									_						-
	V7	$\checkmark$	$\checkmark$	V	V	V.	$\checkmark$		~				-	-		-		$\checkmark$	$\checkmark$	<b>√</b>	~		✓ ✓	✓ ✓	~	1		_	-				-
	V1 V2	V ./	V ./	1	-	V	V ./	V	-	V	-	-	-	+	-	-	-	V ./	V ./	~		V ./	V ./	~		~	~	-	-	-			-
	V3	V	1	ľ	-	×			-			-	$\vdash$	+	-			V	1	-		•	~	_			-						
Phosphate	V4	1	1		$\vdash$								$\vdash$	-				1	1	1		1	$\checkmark$										
	V5	$\checkmark$				1				$\checkmark$								1	$\checkmark$			$\checkmark$				$\checkmark$							
	V6	$\checkmark$				$\checkmark$	$\checkmark$			$\checkmark$								$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$							
	V7	$\checkmark$	$\checkmark$	1		$\checkmark$	✓											$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$					
	V1	$\checkmark$	V V	V.	V.	V.	V		/	V V	V V	$\checkmark$	-	V	-	-	-	1	1	/	1	1	1	1		1	1	1		1	1		-
	V2 V2	V	V	V	×	V.	V	V	~	V	V	V	-	V	-	-	-	V	V	V	~	~	~	~		~	~	~	-	V	~		-
Nitrate	V4	1	1 V	1 V	1	1 J	J.	V V	1	V V	V V	1	-	V	1	-	-	-		-		_					-	-	-	-			
	V5	1	1	1	1	1	1	1	-	1	1	<u> </u>		1	1			1	1	1	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	1		$\checkmark$	$\checkmark$		
	V6	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																		
	V7	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$																							
	V1	$\checkmark$	$\checkmark$	✓	-	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$		-	-																			-
	V2	$\checkmark$	V V	V.	-	V	V	1		V	-	-	+	+	-	-	_	~	~	~		~	~	~		$\checkmark$	~	-	-	-			-
Nitrite	V3	V ./	V ./	V ./	1	1	V ./	V ./	_	V ./	1		+	+	-	-	-	-	-	-		_				-	-	-	-	-			-
	V5	V	Ť	v	1 V	V	V	V	-	V	1 V	-	$\vdash$	+	-			1	1			1	1	_		1	-						
	V6	1	1		$\square$	1	1			1			$\square$	-				-	-			-				-							
	V7	$\checkmark$				$\checkmark$				$\checkmark$																							
	V1	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$								
	V2	$\checkmark$	$\checkmark$	<b>√</b>		$\checkmark$	$\checkmark$	<b>√</b>	✓ ✓	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	<b>√</b>	$\checkmark$	<b>√</b>		$\checkmark$	$\checkmark$	$\checkmark$	~	~	~	~	$\checkmark$	-							
Average	V3	$\checkmark$	V V	V.	V.	V.	V		V	V V	V V	V V	V	V.	V		-	-	-	-		_		_		-	-	-	-	-			-
temperature	V4 V5	1	1	1	1	1	1	1	V	1	1	1		V	V	V		1	1	1	1	1	1	1	1	1	1	1		-			
	V6	V	V	V	Ť	V	V	1		1	V	V		1	1	1		×	1	-			-	-		ľ	1	-					
	V7	1	1	1	1	1	1	1	1	1	1	1		1	1	1																	
	V1	$\checkmark$				$\checkmark$												$\checkmark$	$\checkmark$			$\checkmark$											
	V2	$\checkmark$				$\checkmark$												1	$\checkmark$			1	$\checkmark$										
Thermocline	V3	$\checkmark$	-	-	-	$\checkmark$	-			<u> </u>			-	-		-		V	<u> </u>			~					_						-
index	V4	V /	-	+	+	-	-	-	_	-	-	-	+	+	-	-	<u> </u>	V /	-	-		_				-	-	-	-	-			-
index	V6	V ./	./	-	+	1		-	_	-	-	-	+	+		-	<u> </u>	V ./	-	-		./				-	-	<u> </u>	-				-
	V0	V	1		$\vdash$	V			-				+	+				V				v	1				-						
	V1	1	1																														
	V2	$\checkmark$																1															
Average	V3	$\checkmark$																$\checkmark$															
dissolved	V4	1	1																														
oxygen	V5	V		-														1															
	V6	V	1	-	-	-	-				-	-	-	-	-			-												-			
	V/	V	V	-	-	1	1				-	-	-	-	-			-												-			-
	V2	V	1	1		1	1	1					-	-				1	1	1		1	1	1		1	1	1					
Halocline	V3	1	V	V		V	1	1		1	1	1						V	V	1		· √	1	1		1	1	1					
stratification	V4	1	1	1		1	1	1		1	1	1																					
index	V5	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																						
	V6	1	$\checkmark$	1		$\checkmark$	$\checkmark$	1		1	1	$\checkmark$																					
	V7	V	V			V	V																										1

Table with the input features associated with each test block in the Cangas H zone. The check marks when the feature was used.

Description         Description <thdescription< th=""> <thdescription< th=""></thdescription<></thdescription<>			L						Α	ppro	oac	h 1						-			411-				A	opro	acl	h 2						
visition	Fosturo	Oceanographic	⊢		0		T		25		_		:0		_	Co	rrel	atio	n Q	uar	tile				5		_		:0		_		/6	_
Image: Second	reature	station	H		0		-	-				-	0	uar	tile	of ra	and	om	fore	esto	disc	rimi	inat	or							-	- '	-	
			0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
bay is not into into into into into into into	Week of the year	-	$\checkmark$	$\checkmark$															$\checkmark$	$\checkmark$														
Image: Description         Image:	Daylight hours	-	√		-		$\checkmark$												$\checkmark$	$\checkmark$			$\checkmark$											
Image: Dec:	Insolation	•	$\checkmark$		-						-	-		-	-	_					_					_		_					<u> </u>	-
Out one size         ·        ·         · <th< th=""><th>Irradiation</th><th>•</th><th>V</th><th>V</th><th>-</th><th>-</th><th>~</th><th>~</th><th>-</th><th></th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th>1</th><th>1</th><th>-</th><th></th><th></th><th></th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th><th><u> </u></th><th>-</th><th>-</th></th<>	Irradiation	•	V	V	-	-	~	~	-		-	-	-	-	-	-	-	-	1	1	-				-	-	-	-	-	-	-	<u> </u>	-	-
Nome         V	Zone state		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	× ./	v ./	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum         Work         V        V         V         V	Lone state	V1	1	1	Ť	Ť	1	1	Ť		Ť	1		1 ×	Ť	-	-		V V	v V	1		Ĭ,	*			-			-	ľ		ľ	-
Haximum         Vi         V        V         V         V </th <th></th> <th>V2</th> <th>1</th> <th>1</th> <th>1</th> <th></th> <th>1</th> <th>1</th> <th></th> <th>V</th> <th>V</th> <th>1</th> <th></th> <th>1</th> <th><math>\checkmark</math></th> <th></th> <th>-</th> <th><math>\checkmark</math></th> <th>1</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>		V2	1	1	1		1	1											V	V	1		1	$\checkmark$		-	$\checkmark$	1						
Horizonti	Maximum	V3	$\checkmark$	1			$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$										
Web       U <thu< th=""> <thu< th=""> <thu< th=""></thu<></thu<></thu<>	chlorophyll	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$							
Image: marked interval         Image: marked interval<	omorophyn	V5	$\checkmark$	$\checkmark$															$\checkmark$	✓														
Model         Model <th< th=""><th></th><th>V6</th><th><math>\checkmark</math></th><th>V.</th><th>-</th><th></th><th>V.</th><th><math>\checkmark</math></th><th><u> </u></th><th></th><th><u> </u></th><th><u> </u></th><th></th><th>-</th><th>-</th><th></th><th></th><th></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th>_</th><th></th><th><math>\checkmark</math></th><th>✓ ✓</th><th><math>\checkmark</math></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th><u> </u></th><th>-</th></th<>		V6	$\checkmark$	V.	-		V.	$\checkmark$	<u> </u>		<u> </u>	<u> </u>		-	-				$\checkmark$	$\checkmark$	_		$\checkmark$	✓ ✓	$\checkmark$								<u> </u>	-
D. acuminata concentrata         V <thv< th="">         V        V         <thv< th=""></thv<></thv<>		V7	V		1	1	V /	1	1	1	1	1	1	1	1	1	1	1	V /	1	1	1	V /	V /	1	1	1	1	1	1	1	1	1	-
D. Acuminate concentration         V        V         V         V <th></th> <th>V1 V2</th> <td>V ./</td> <td>V ./</td> <td>V ./</td> <td>V ./</td> <td>1</td> <td>V ./</td> <td>V ./</td> <td>× ./</td> <td>1</td> <td>V ./</td> <td>v ./</td> <td>V ./</td> <td>V ./</td> <td>./</td> <td>V ./</td> <td>V ./</td> <td>V ./</td> <td>v ./</td> <td>V ./</td> <td>v ./</td> <td>× ./</td> <td>V ./</td> <td>1</td> <td>V ./</td> <td>V ./</td> <td>V ./</td> <td>V ./</td> <td>V ./</td> <td>1</td> <td>V ./</td> <td>V</td> <td>-</td>		V1 V2	V ./	V ./	V ./	V ./	1	V ./	V ./	× ./	1	V ./	v ./	V ./	V ./	./	V ./	V ./	V ./	v ./	V ./	v ./	× ./	V ./	1	V ./	V ./	V ./	V ./	V ./	1	V ./	V	-
D. accominata concentration         Via         V        V         V         V		V3	V	1	V		V				V	L.			V				V	V	V		Ż	V			V	V			V			-
Concentration       Vis       I	D. acuminata	V4	$\checkmark$	1	1		$\checkmark$	1	$\checkmark$		$\checkmark$	1	$\checkmark$		$\checkmark$				$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$			
vis       v	concentration	V5	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$															
Normal     Normal <th></th> <th>V6</th> <th><math>\checkmark</math></th>		V6	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																
Mamonium         Vi         V        V         V         V<		V7	√	✓	1	$\checkmark$	✓	$\checkmark$																										
Ammonium         Vice         Vice        Vice         Vice        <		V1	V		V		-	<u> </u>	-		<u> </u>	-		-	-	_			$\checkmark$	$\checkmark$	_					_		_					<u> </u>	-
Ammonium         93         3         4        4         4         4<		V2	V	1	-	-	-	-	-	_	-	-	-	-	-	-	-	-	1	1	-					-		-	-	-	-	-	-	-
Number Number         V        V         V <t< th=""><th>Ammonium</th><th>V3</th><th>V ./</th><th>- V</th><th>-</th><th></th><th>-</th><th>-</th><th>-</th><th></th><th>-</th><th>-</th><th></th><th>-</th><th>-</th><th>-</th><th>-</th><th></th><th>V ./</th><th>~</th><th>-</th><th></th><th></th><th></th><th></th><th>-</th><th></th><th>-</th><th></th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th></t<>	Ammonium	V3	V ./	- V	-		-	-	-		-	-		-	-	-	-		V ./	~	-					-		-		-	-	-	-	-
N6         X <thx< th="">         X         X         X</thx<>	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	V5	1 V	1	+	-	1	1	-	-	-	-		-	+	-	-		V	1	-		1	1	-	-		-		-	-		-	-
V7         V7         V		V6	1	† ·	1		1	<u> </u>											1	-						-								
V1         V1<		V7	$\checkmark$	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$	$\checkmark$													
V2         V		V1	$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$								$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$							
Phosphate         V3         V        V         V         V		V2	1	1			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$							
Phosphate         Va         Va        Va         Va         <	Dhaanhata	V3	$\checkmark$	V.			$\checkmark$				<u> </u>	-		-	-	_			$\checkmark$	(			$\checkmark$										<u> </u>	-
No.         No. <th>Phosphate</th> <th>V4</th> <th>V</th> <th>×,</th> <th>V</th> <th>-</th> <th>V</th> <th>V</th> <th>V</th> <th></th> <th>1</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>_</th> <th>-</th> <th></th> <th>V /</th> <th>V /</th> <th>~</th> <th></th> <th>V /</th> <th>V /</th> <th></th> <th>_</th> <th>V /</th> <th>_</th> <th></th> <th>-</th> <th>-</th> <th>_</th> <th>-</th> <th>-</th>	Phosphate	V4	V	×,	V	-	V	V	V		1	-	-	-	-	_	-		V /	V /	~		V /	V /		_	V /	_		-	-	_	-	-
Nitrate         Normal Arrow		V6	1	1 V	-	-	1	1	-	-	1	-	-	-	+	-	-	-	V 1	V 1	1		V V	V 1	1	-	1	1	-	-	-	-	-	-
Nitrate         Nit         I		V7	V	1,			V	V	1		V	1		-	$\vdash$				Ż	V	1		Ż	V		-	V							-
Nitrate         V        V         V         V <th></th> <th>V1</th> <th><math>\checkmark</math></th> <th>1</th> <th>1</th> <th></th> <th>1</th> <th>1</th> <th><math>\checkmark</math></th> <th></th> <th>1</th> <th>1</th> <th></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th>		V1	$\checkmark$	1	1		1	1	$\checkmark$		1	1			$\checkmark$	$\checkmark$																		
Nitrate         V3         V        V         V         V </th <th></th> <th>V2</th> <th><math>\checkmark</math></th> <th>1</th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th></th> <th></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th></th>		V2	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$		
Nitrate         V4         V        V         V         V </th <th></th> <th>V3</th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th></th> <th><math>\checkmark</math></th> <th></th>		V3	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																			
Vis         V	Nitrate	V4	$\checkmark$	✓	V		$\checkmark$	✓	V	$\checkmark$	V	✓	$\checkmark$		$\checkmark$	✓												_						
Nitrite         Vis         V        V         V         V<		V5	V	V.	V	V	V.	V	V		V	V.		-	V	V	~		~	~	$\checkmark$	~	~	~	~	~	$\checkmark$	~	~		$\checkmark$	~		-
Nitrite         No         No <t< th=""><th></th><th>V0 \/7</th><th>V</th><th></th><th>V</th><th>V</th><th>V.</th><th>V</th><th>V /</th><th>1</th><th>V</th><th>V /</th><th>-</th><th>-</th><th>V</th><th>V</th><th>-</th><th>-</th><th></th><th></th><th>-</th><th></th><th></th><th></th><th>_</th><th>-</th><th>-</th><th>-</th><th></th><th>-</th><th>-</th><th>-</th><th>-</th><th>-</th></t<>		V0 \/7	V		V	V	V.	V	V /	1	V	V /	-	-	V	V	-	-			-				_	-	-	-		-	-	-	-	-
Nitrite         Normal and the second se		V1	V	1 J	1 V	· ·	J	V	×	v	V	1 V		-	~	v		-	-		-	_		_	_	_			-	-		-	-	
Nitrite         V3         V        V         V         V </th <th></th> <th>V2</th> <th>1</th> <th>1</th> <th>1</th> <th>1</th> <th>1</th> <th>1</th> <th></th> <th></th> <th>1</th> <th>1</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th>1</th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th>1</th> <th></th> <th></th> <th></th> <th></th> <th></th>		V2	1	1	1	1	1	1			1	1							$\checkmark$	$\checkmark$	1		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	1					
Nitrite         V4         V        V         V         V </th <th></th> <th>V3</th> <th><math>\checkmark</math></th> <th>1</th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th>		V3	$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$																					
V5         V	Nitrite	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																						
V6         V		V5	√		-		$\checkmark$				1								$\checkmark$				$\checkmark$				$\checkmark$	_						
V/1         V		V6	$\checkmark$	V	-		V.	<u> </u>			V	-		-	-											_		_						-
Average temperature         Vi         V		V7	V	1	1	1	V	1	1	1	V	1	1	1	1	1			1	1	1	1	1	.1	1	1	1	1	1		1	1		-
Average temperature         V3         V		V1 V2	1	1	1 V		1	1	1	× ./	1	1	1		V /	1	-	-	× ./	v ./	×	v ./	× ./	v ./	1	V	×	×	V ./	-	1	×	-	-
Average temperature         V4         V		V3	V	V	1	1	V	V	V	V	V	V	V	-	V	V	$\checkmark$		-	-	-		-		-	-		-			<u> </u>			
V5       V	Average	V4	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$																			
V6         V	temperature	V5	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		V6	1	✓			$\checkmark$	1	1	$\checkmark$	1	✓	$\checkmark$																					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		V7	V	V	V		V.	$\checkmark$	$\checkmark$		~	$\checkmark$							-	(			-			_		_						-
V2         V		V1	V	-	+	-	V	1	-	_	-	-	-	-	-	-	-	-	V	V /	-		V /	1	_	-	-	-	-	-	-		-	-
Stratification index       V4       V <th>Thermocline</th> <th>V2 V3</th> <th>1</th> <th>-</th> <th>+</th> <th>-</th> <th>1</th> <th>V</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>+</th> <th>-</th> <th></th> <th></th> <th>× ./</th> <th>v ./</th> <th>-</th> <th>_</th> <th>× ./</th> <th>v</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th>-</th> <th></th> <th>-</th> <th>-</th>	Thermocline	V2 V3	1	-	+	-	1	V	-	-	-	-	-	-	+	-			× ./	v ./	-	_	× ./	v	-	-	-	-	-	-	-		-	-
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	stratification	V4	V		+		<u> </u>							-	-				$\overline{\checkmark}$		-					-								
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	index	V5	1	1															$\checkmark$	$\checkmark$														
V7     V </th <th></th> <th>V6</th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th> <th><math>\checkmark</math></th> <th><math>\checkmark</math></th> <th></th>		V6	$\checkmark$	$\checkmark$															$\checkmark$	$\checkmark$														
V1 $$		V7	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$											$\checkmark$				$\checkmark$	$\checkmark$										
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		V1	1	1	$\checkmark$		$\checkmark$	$\checkmark$																										
Average         V3         V		V2	$\checkmark$		-		-		<u> </u>			-		-	-				$\checkmark$	$\checkmark$			_										<u> </u>	-
Unsolved oxygen         V4         V	Average	V3	$\checkmark$	Į√,	-	-	-	<u> </u>	-		<u> </u>	-		-	-	_	_		~	~	<u> </u>		~	~				_		<u> </u>	-		<u> </u>	-
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	oxygen	V4 V5	1	V		-	-					-	-	-	-				1	1											-			
Halocline         V1         V <th< th=""><th>oxygen</th><th>V6</th><th>1</th><th>1</th><th></th><th></th><th>-</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>V</th><th>V</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>	oxygen	V6	1	1			-												V	V														
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		V7	V	V																														
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		V1	1	1	1		1	1	1																									
Halocline         V3         ✓ <th✓< th=""><th></th><th>V2</th><th>1</th><th>1</th><th>1</th><th><math>\checkmark</math></th><th>1</th><th>1</th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th></th><th></th><th></th><th></th><th></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th>1</th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th><math>\checkmark</math></th><th>1</th><th></th><th></th><th></th><th></th><th></th></th✓<>		V2	1	1	1	$\checkmark$	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$						$\checkmark$	$\checkmark$	1	$\checkmark$	1											
Stratification index         V4         V	Halocline	V3	$\checkmark$	1	1		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$						$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$					
V5         V	stratification	V4	$\checkmark$	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																									
	index	V5	V	V	V	V	V	1	1		1	1	1													-		-						-
		V6	V	1	1	V	V	1	1		1	V	1		-	-									-						-		-	-

# A. Molares-Ulloa et al.

# Table 10

Table with the input features associated with each test block in the Cangas C zone. The check marks when the feature was used.

								Α	ppr	oacl	h 1													Ap	opro	bacl	12						
_	Oceanographic			_							_				Co	rrel	atio	n Q	uar	tile				_				_					
Feature	station	<u> </u>		0			2	25			5	50 0	uar	tile	7 of r	′5 and	om	fore	esto	0 disc	rim	nat	2 or	5			5	0			7	'5	_
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	√																√															
Daylight hours	-	$\checkmark$				$\checkmark$	<u> </u>			<u> </u>	<u> </u>					<u> </u>	<u> </u>	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										-
Irradiation	-	$\checkmark$		-		1	1															_											-
Upwelling index	-	1	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										
Zone state	-	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
	V1	$\checkmark$		1		1	1	1		<u> </u>	<u> </u>			-		-	-	$\checkmark$		1		✓ ✓	✓ ✓	1									-
	V2 V3	$\checkmark$	V			$\checkmark$	V			-	-		-			-	-	V	$\checkmark$	$\checkmark$		<ul> <li>✓</li> </ul>	~	~	-			_	_		-	-	-
Maximum	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$										$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$					
cinorophyn	V5	1																1															
	V6	√ √	V	-		./	1			<u> </u>	<u> </u>		<u> </u>			-	-	V ./	1			./	./									<u> </u>	-
	V1	$\checkmark$	$\checkmark$	1	1	$\checkmark$	$\checkmark$	$\checkmark$	1	1	1	$\checkmark$	1	1	1	1	1	$\checkmark$	$\checkmark$	1	$\checkmark$	× √	~	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	~	$\checkmark$	$\checkmark$	1	$\checkmark$
	V2	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
D. acuminata	V3	1	1	1	1	1	1			1	1			1				1	1	1		1				1				1			
concentration	V4	√ √	$\checkmark$	V	V ./	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	V 1	$\checkmark$	$\checkmark$	1	$\checkmark$	V	$\checkmark$	✓ √	√ √	√ √	✓ √	V	V ./	✓ √	$\checkmark$	./	√ √	1	1	_
	V6	$\checkmark$	$\checkmark$	$\overline{\checkmark}$	$\checkmark$	$\checkmark$	$\overline{\checkmark}$	$\checkmark$	$\overline{\checkmark}$	$\overline{\checkmark}$	$\overline{\checkmark}$	$\checkmark$	$\overline{\checkmark}$	$\checkmark$	$\checkmark$	$\overline{\checkmark}$	$\overline{\checkmark}$	V	$\checkmark$	$\checkmark$	$\checkmark$	× √	~	✓ ✓	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\overline{\checkmark}$	$\checkmark$	$\overline{\checkmark}$	V	$\checkmark$
	V7	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		
	V1	1																$\checkmark$	$\checkmark$			1											
	V2	$\checkmark$				$\checkmark$			<u> </u>	<u> </u>	<u> </u>					<u> </u>	<u> </u>	1	1	1													-
Ammonium	V3 V4	$\checkmark$																$\overline{\checkmark}$	$\checkmark$	~		_	_						_				-
	V5	1	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										
	V6	1																$\checkmark$															
	V7	$\checkmark$	V			1				1								$\checkmark$	$\checkmark$			√ √	1			1	1		_				-
	V1 V2	$\checkmark$	$\overline{\checkmark}$	$\checkmark$		$\checkmark$	1	$\checkmark$		$\checkmark$	1	$\checkmark$						$\checkmark$	$\checkmark$	$\checkmark$		✓ ✓	✓ ✓		-	$\checkmark$	$\checkmark$	_	_		-		-
	V3	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$											$\checkmark$				$\checkmark$											
Phosphate	V4	1				1												1	1			√				1							
	V5	$\checkmark$	$\checkmark$	-		$\checkmark$	<u> </u>			$\checkmark$	<u> </u>		<u> </u>			-	-	$\checkmark$	$\checkmark$			√ ∕	~			$\checkmark$						<u> </u>	-
	V0 V7	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$						-	-	$\checkmark$	$\checkmark$			<ul> <li>✓</li> </ul>	$\checkmark$		-	$\checkmark$			_		-	-	-
	V1	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																			
	V2	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			1	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	√	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$		
Nitrate	V3 V4	√ √				√ √	✓ ✓	./	./	✓ ✓	✓ ✓	✓ √	<u> </u>	V ./	~	<b>↓</b>		-				_										-	-
initiate	V5	$\checkmark$	V	V		V	V	$\checkmark$	· ·	V	V	$\checkmark$		$\checkmark$				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$		_	$\checkmark$			-
	V6	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																						
	V7	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$				$\checkmark$	$\checkmark$																		-
	V1 V2	$\checkmark$	$\overline{\checkmark}$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$				$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$		-
	V3	V	1	1		√	1			1	1																						
Nitrite	V4	1	$\checkmark$	$\checkmark$		1	$\checkmark$	$\checkmark$		1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																		
	V5	$\checkmark$	1			$\checkmark$				$\checkmark$								$\checkmark$				√	~			<b>√</b>							-
	V0 V7	$\checkmark$	V			$\checkmark$				$\checkmark$															-								-
	V1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$		
	V2	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$					
Average	V3 V4	V	V	V	V	1	V	1	V	V	V		V	V	V	V																	
temperature	V5	1	<u> </u>	<u> </u>		√												$\checkmark$				$\checkmark$	$\checkmark$			$\checkmark$							
	V6	1	$\checkmark$			1	1	$\checkmark$		1	1																						
	V7	$\checkmark$	$\bigvee$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$						1	1												_		-
	V1 V2	V	- V													-	-	V	V			_			-								-
Thermocline	V3	1	$\checkmark$															$\checkmark$	$\checkmark$	$\checkmark$													
stratification	V4	1	1															1															
index	V5	$\checkmark$	$\checkmark$	1													-	$\checkmark$	$\checkmark$														-
	V0 V7	$\checkmark$																$\checkmark$				_											-
	V1	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																									
	V2	1	$\checkmark$			$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$			√	✓										
Average	V3	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$									<u> </u>	$\checkmark$	$\checkmark$	~		√	~			~	~	~					-
oxygen	V5	1	1			1	√ √	1										$\checkmark$	1	1		1	1										
	V6	1	1			1																											
	V7	1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																									
	V1 V2	1	1	1	1	V V	V 1	1		1	1	1						1	1	1		1	1	1		1	1	1					-
Halocline	V3	1	1	1		1	1	1	1	1	1	√ \						1	1	1	$\checkmark$	<ul> <li>✓</li> </ul>	<ul> <li>✓</li> </ul>	<ul> <li>✓</li> </ul>		1	√ √	√ √					
stratification	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																						
index	V5	1	$\checkmark$	$\checkmark$		1	1			1	1																						
	V6 V7	V V	V	V		V V	V	1	-	1	1	1													_						-		-

Table with the input features associated with each test block in the Cangas D zone. The check marks when the feature was used.

								Α	ppr	oac	h 1													A	opro	acl	h 2						
Feature	Oceanographic	-		0		_		25		_		:0		_	Co	orrel	latio	on Q	uar	tile		_		5				:0		_	- 7	15	
reature	station	-		0			-	10		L		0 Q	uar	tile	of r	and	om	fore	esto	disc	rim	inat	or	5			;	0			-	5	
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	1	1															1	1			1	$\checkmark$										
Daylight nours		V ./	V 1	1		V	-	-	-	-	-	-	-	-	-	-		~	~	-		V		-	-		-	-	-				-
Irradiation	-	V	V	1 ×	-	1	1			-			-											-	-	-	-						
Upwelling index	-	$\checkmark$																$\checkmark$															
Zone state	-	1	1	1	$\checkmark$	1	1	1	1	1	1	1	$\checkmark$	1	1	1	$\checkmark$	1	1	$\checkmark$	1	1	$\checkmark$	~	1	1	1	1	1	1	$\checkmark$	$\checkmark$	1
	V1	V	1	1	1	1	1	1	1	-	-		-		-	-		V /	$\checkmark$	1	1	1	1	1			_	-	<u> </u>	-			-
	V2 V3	V	V	ľ		V	V	1 V	×	-	-	-	+	-	-	-		V	V	×	×	V	~	-	-		-	-	-	-			
Maximum	V4	1	1	$\checkmark$	$\checkmark$	1	1	$\checkmark$	$\checkmark$									1	1	$\checkmark$		1	$\checkmark$	$\checkmark$									
chlorophyn	V5	1																1															
	V6	$\overline{\checkmark}$	1	-		-	<u> </u>	-	<u> </u>	-	-	-	-		-	-		$\checkmark$	1	<u> </u>		1	1					<u> </u>	<u> </u>	-			-
	V1	V	V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V	V	1	1	V	V	$\checkmark$	1	1	$\checkmark$	1	1	1	$\checkmark$	$\checkmark$	1
	V2	1	1	1	1	1	1	$\checkmark$	1	1	1	1	1	1	1	$\checkmark$	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
D. acuminata	V3	1	1	1		1	1			1	$\checkmark$	1		1				$\checkmark$	$\checkmark$	$\checkmark$		1	$\checkmark$			1	1			1			
concentration	V4	$\checkmark$	$\bigvee$		$\bigvee$	$\bigvee$				$\bigvee$	$\downarrow$	$\bigvee$	$\checkmark$	$\checkmark$	$\checkmark$			V	$\checkmark$		$\checkmark$	$\checkmark$	V	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	V		$\checkmark$	$\checkmark$		-
	V5	1	J	1 V	J	V	1 V	1 V	1 V	1 V	1 V	1 V	1	V	1 V	1 V	1	V	V V	1	V	V	V	V	V	V	V V	V	1 V	V	V	1	
	V7	1	1	1	1	1	1	1	1	1	1	1	1	1	√	1		1	1	1		√	1	1		√	1	1	1	1	1	1	
	V1	1	$\checkmark$															$\checkmark$	$\checkmark$														
	V2	$\checkmark$				-	<u> </u>		<u> </u>	-	-		-			<u> </u>						_			_		_						-
Ammonium	V3 V4	1	V	V	-	-	-	-	-	-	-	-	-	-	-	-		V 1	~	V		-			_		-	-	-	-			-
	V5	V	1			1	1						-					V	$\checkmark$			1	$\checkmark$		-		-						
	V6	1	$\checkmark$															$\checkmark$	$\checkmark$														
	V7	$\checkmark$	$\checkmark$			$\checkmark$	1	1					_					1	$\checkmark$	1		1	$\checkmark$		_	,							-
	V1 V2	V ./	V ./	1		V ./	./	./	-	V ./	1	./	-	./	-	-	-	V ./	V ./	1		V ./	./	./	-	V ./	V ./	-	-	./			-
	V3	V	V	ľ		V	×			· ·	1 V	v	-	v				V	V	×		V	$\checkmark$	•		v				~			
Phosphate	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		1	$\checkmark$			$\checkmark$	$\checkmark$						
	V5	1	$\checkmark$	$\checkmark$		1	$\checkmark$			1	1							1	1			1			_	1							
	V6	V ./	1	-	-	V ./	./	-	-	~	-	-	-	-	-	-		1	V ./	-		√ √	1		_	√ ./	_	-	-	-			-
	V1	V	V			V	V			1	1							V	×			•	~			v							
	V2	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$		1	$\checkmark$			$\checkmark$				$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$								
	V3	1	1	1		1	1			1	1			1	1																		
Nitrate	V4	$\checkmark$	$\checkmark$	$\checkmark$		V	$\checkmark$	-	<u> </u>	$\checkmark$	$\checkmark$	$\checkmark$	-	V	V	-		1	1	/		1				1	/			_			-
	V6	V	1	-		V	1	-	-	V	ľ	-	-	×	-	-		×	V	×		×			-	×	×	-	-	-			
	V7	1	1			1	-			1	$\checkmark$																						
	V1	1	1			1	1			1	1																						
	V2	$\checkmark$	$\checkmark$		$\checkmark$	$\bigvee$		1	$\checkmark$	$\checkmark$	$\checkmark$	-	-	V	$\checkmark$	-		$\checkmark$	~	$\checkmark$		~	$\checkmark$	$\checkmark$	_	~	~	~	-	~	$\checkmark$		-
Nitrite	V3	V	1	1	×	V	1	1	-	V	1	-	-	V	1	-				-		-		-	-	-	-	-	-	-			
	V5	1	1	-		1	1			1	-							$\checkmark$				1				$\checkmark$							
	V6	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$																						
	V7	$\checkmark$	$\checkmark$	1		$\checkmark$	$\checkmark$			$\checkmark$				1	1			1	1	1	1	1	1	1	_	1	1	1		1	1		-
	V1 V2	1	1			1	1	1	-	V	1 V	1	-	V	1	-		V	1	1	~	V	V V	1	-	1	1 V	1	-	~	~		-
A. 10 10 10	V3	1	1	1	1	1	1	1		1	1	1		1	1	1				-							-	-					
temperature	V4	1	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$																							
	V5	$\checkmark$	1	-		V			<u> </u>	-	-		-			<u> </u>		$\checkmark$	$\checkmark$			~	~			$\checkmark$				_			-
	V8 V7	V	V	1		V	×	-	-	1	-	-	-	-	-	-				-		-			-		-	-	-	-			
	V1	1																$\checkmark$															
	V2	1																1															
Thermocline	V3	$\checkmark$	$\checkmark$	-		-	<u> </u>	-	<u> </u>	-			-			-		V		_									<u> </u>	_			-
index	V4 V5	V	V	1		$\vdash$	-	-	-	-	-	-	-	-	-	-		V	$\checkmark$	-	-	1	1	-	-		-	-	-	-			-
	V6	1	1	1														1	1			√											
	V7	1																$\checkmark$															
	V1	1	1	1		1	1											1	1	1		1	1			1	1						
Average	V2 V3	V	J	1		V	V		-	-	-	-	-	-				J	V	V		V	V			V	V						
dissolved	V4	1	1	1		1	1	1										Ľ				-											
oxygen	V5	$\checkmark$	1			1	1											1	$\checkmark$	1		$\checkmark$	$\checkmark$	$\checkmark$									
	V6	1				1	1																										
	V7 V1	1	1	1	1	1	V	1	1	1	1	1	-	H	-	-	-	-		-					-					-			
	V2	V	V	V	V	V	1	V	1	V	V	V						1	1	1	1	1	1	1	1	1	1	1			-		
Halocline	V3	1	1	1		1	1	1	1	1	1	1						1	1	1	1	1	1	1	1	1	1	1					
stratification	V4	1	1	1	1	1	1	1		1	1	1																					
index	V5	1	1	V	1	V	1	1	-	1	1	1	-	-	-	-	-	-		-		-		-	-		-		-				
	V7	1	V	V	1 V	V	1	V	1	V	V	V												-					-		-		

Table with the input features associated with each test block in the Cangas E zone. The check marks when the feature was used.

		L						A	ppr	oac	h 1									411-				Ap	opro	acl	h 2						
Feature	Oceanographic	⊢		0		_		25		<u> </u>		50		-	Co	orrel	atio	on Q	uar				2	5				50		_	- 7	5	_
reature	station	F		<u> </u>		-				-	-	ç	uar	tile	of r	and	om	fore	esto	disc	rimi	inat	or	<u> </u>			-		_			<u> </u>	
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	1										<u> </u>		<u> </u>				1				√											-
Daylight hours	•	V ./	V	-	-	V	~	-	-	-	-	-	-	-	-	-	-	~	~	-		~	~	_	-	-	-	-	-	-		-	-
Irradiation		V	V	-	-	1	-	-	-	-	-	+	-	$\vdash$	-	-			-	-		-		_	-		-	-	-	-		-	$\vdash$
Upwelling index	-	1	1															$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										
Zone state		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
	V1	$\checkmark$		-	-	-	<u> </u>	-		-	<u> </u>	<u> </u>	-	-	<u> </u>	-		$\checkmark$	$\checkmark$	-							_						-
	V2 V3	1	1	-	-	-	-	-	-	-	-	-	-	+	-	-		V 1	1	1							-	-	-	-		-	-
Maximum	V4	V	V	1				-		-	-	<u> </u>	-	$\vdash$		-		1	V	V		1	$\checkmark$	1	-		-	-		-		-	
chiorophyli	V5	$\checkmark$	$\checkmark$															$\checkmark$															
	V6	1	1															1	$\checkmark$														
	V7	V	$\checkmark$	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	V1 V2	V	1 V	1	1 V	1	1	1	V	1 V	1	1	1 V	1×	1	V	V	V	1	1	V V	V	V	V V	V	V	V	V	1	V	V V	1 V	-
D. acuminata	V3	$\checkmark$	1	1	1	1	1	1	$\checkmark$	1	1	1		1				1	1	$\checkmark$		1	1	1		1	1	1		1			
concentration	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$		$\checkmark$									
	V5	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	V.	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		✓ ✓	✓ ✓	✓ ✓	1	$\checkmark$	$\checkmark$	1		1	$\checkmark$		-
	V6 V7	V	1	1	1	V	1	1	V	1	1	1	1	V	1	V	~	1	1	1	~	√ √	√ √	√ √	√ √	√ √	1	1	V	V	V J	1	-
	V1	V		×	Ť	V					1 V	×	ľ					1	V	ľ		v √	~	~	~	V		×			v	-	
	V2	$\checkmark$				$\checkmark$																											
	V3	$\checkmark$																$\checkmark$	$\checkmark$														
Ammonium	V4	$\checkmark$	$\checkmark$	-		-	<u> </u>	-		-	-	-	-	-	<u> </u>	-		$\checkmark$	$\checkmark$	-										_			-
	V6	V	1	-	-	1	1	-	-	-	-	+	-	+	-	-		1	-	-		J	J	_	-	-	-	-	-	-		-	-
	V7	1	<b>_</b>			ľ												1	1														
	V1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
	V2	$\checkmark$	$\checkmark$	_		$\checkmark$	$\checkmark$	_		$\checkmark$	$\checkmark$	_	_	-				$\checkmark$	$\checkmark$	$\checkmark$		1	$\checkmark$			1							-
Phosphate	V3	V	-	-	-	V	-	-	-	-	-	-	-	+	-	-		V	1	-		V	.1		_	1	-	<u> </u>	<u> </u>	-		_	-
Filosphate	V4 V5	V	1	1		V	-	-	-	1	-	+	-	$\vdash$	-	-		V	V	-		V	~	_	-	V	-	-	-	-		-	+
	V6	1	1	-		1	1			1								1	1			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$						
	V7	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$								$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$							
	V1	$\checkmark$	$\checkmark$	V.		V	$\checkmark$	V,		$\checkmark$	V.	V.	-	V.	$\checkmark$	$\checkmark$		1			1	1	1	1	1	1					/	/	-
	V2 V3	1	1	1	V	1	1	1	V	1	1	1	-	1	1	1		V	V	V	~	~	~	~	~	~	~	×	-	~	~	~	-
Nitrate	V4	V	V	V	1	V	V	V	1	V	V	V	-	V	V	V	$\checkmark$			-					-		-	-		-		-	
	V5	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$		
	V6	1	✓	<ul> <li>✓</li> </ul>	$\checkmark$	1	1	<ul> <li>✓</li> </ul>	$\checkmark$	✓	$\checkmark$	$\checkmark$		-																			-
	V7	$\checkmark$	$\checkmark$	$\checkmark$	1	V		$\downarrow$		$\checkmark$	1	1		1	1	1									_		_					_	-
	V1 V2	V	V	V		V	V	V	-	V	V	V	-	V	V		-	1	1	1	1	1	1	1	-	1	1	1	1	1	$\checkmark$	1	-
	V3	1	1			1	1			1	1																						
Nitrite	V4	1	1	1		1	1	1		1	$\checkmark$			1	$\checkmark$																		
	V5	$\checkmark$	$\checkmark$	V,	<u> </u>	$\checkmark$	$\checkmark$	V,	-	$\checkmark$	V,	-	-	V				$\checkmark$	$\checkmark$	$\checkmark$		~	$\checkmark$	~	_	$\checkmark$	$\checkmark$		<u> </u>	$\checkmark$	$\checkmark$		-
	V6 V7	V	1	1	-	V	1	V	-	1	V	-	-	~	~	-		-	-	-		_			-		-	-	-	-		-	+
	V1	1	1	1	1	1	1	1		1	1							1	1	1	1	1	$\checkmark$	$\checkmark$		1	$\checkmark$	1					
	V2	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
Average	V3	V	1	<ul> <li>✓</li> </ul>		1	1			1	$\checkmark$			<u> </u>																			-
temperature	V4	V ./	V	V	-	V	V	-	-	V	-	-	-	+	-	-	-	1	1	1		1	./	_		-	-	-	-	-		-	-
	V6	V	Ť	-		V	V	-	-	-	-	-	-	$\vdash$		-		-	Ť			Ť	~		-		-	-		-		-	
	V7	1	1	1		1	1			1	1																						
	V1	1																1				1											
Thermocline	V2	$\checkmark$	-	-	-	V	-	-	-	-	-	-	-	-	<u> </u>	-		V /	-	-		$\checkmark$			_		-	<u> </u>	<u> </u>	-		_	-
stratification	V3	V	-	-	-	V	-	-		-	-	+	-	$\vdash$	-	-		V	-	-		~			-	-	-		-	-		-	+
index	V5	1	1											$\vdash$				1															
	V6	$\checkmark$																$\checkmark$	$\checkmark$														
	V7	$\checkmark$												-		_		$\checkmark$				~			_		_			_		_	-
	V1 V2	V	1	1	-	V	V	1		1	1	1		-		-		1	1	1		1	1	1		1	1						-
Average	V3	1	1	1	1	1	1	1		1	1	1		F				1	1	1	1	1	1	1		1	1	1					F
dissolved	V4	1	1	1		1	1	1																									
oxygen	V5	$\checkmark$	$\checkmark$	1		1	1	$\checkmark$										$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
	V6	1	1	1		1	1			-			-																				
	V7	1	V	1	-	1	1	1	-	-	-	-	-	F	-	-	-	-		-										-			-
	V2	V	V	1	1	V	1	V		1	1	1			-			1	1	1	1	1	1	1	1	1	1	1					
Halocline	V3	1	1	1	Ĺ	1	1	1		Ľ								1	1	1	1	1	1	1	1	1	1						
stratification	V4	$\checkmark$	$\checkmark$	1	1	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																					
index	V5	1	1	1	1	1	1	V																									-
	V0 V7	1	1	1		1	V	1		1	1	1	1			-		-					-	_		-	-		-	-	-	-	-

Table with the input features associated with each test block in the Redondela A zone. The check marks when the feature was used.

								Α	ppr	oac	h 1													Ap	pro	acl	h 2						
Feature	Oceanographic	-		0		_	-	25		_		50		<u> </u>	- CO	orrei 75	atio	on Q	uar				2	5		<u> </u>		50			7	5	-
, outure	station											Q	uar	tile	of r	and	om	fore	est d	disc	rimi	inat	or						_				
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	V	-	-		V	<u> </u>	-	<u> </u>	-	-		-		<u> </u>	-		V	1	_		$\checkmark$					_					_	-
Insolation		V	-	-	-	V	-	-	-	-	-	-	-	-	-	-		V	V	-		V		_			-					-	-
Irradiation	-	1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																							
Upwelling index	-	1																1									_						
Zone state	-	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	~	$\checkmark$	$\checkmark$	~	V.	$\checkmark$	$\checkmark$	$\checkmark$	~	~	~	$\checkmark$	$\checkmark$	$\checkmark$	~	$\checkmark$	$\checkmark$	~	$\checkmark$	~
	V1 V2	1	1	-	-	-	-	-	-	-	-		-	-	-	-		1		-				_			-					-	-
	V3	1	1			$\vdash$												1	1	1							-					-	
chlorophyll	V4	$\checkmark$	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$														
omorophyn	V5	$\checkmark$				_												$\checkmark$															-
	V6	V ./	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V ./	~	-							-					-	-
	V1	V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V	$\checkmark$	1	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	1	$\checkmark$	$\checkmark$	1	1	1
	V2	1	$\checkmark$	$\checkmark$	1	$\checkmark$	1	$\checkmark$																									
D. acuminata	V3	1	✓	✓		1	1			1	<ul> <li>✓</li> </ul>	$\checkmark$		1				✓	✓	✓		√	✓	✓		✓	✓			✓			
concentration	V4	V	V	V	1	V	V	V	<u> </u>	V	V	1	-	1	1	-	<u> </u>	V	$\checkmark$	V	1		$\checkmark$	√ √		$\checkmark$	$\checkmark$	1		$\checkmark$	.1		-
	V6	V	V	1V	V	V	V	1	-	V	1	V	-	V	V	1	-	V	V	V	V	V	V	V	1	V	V	V	1	V	~	-	-
	V7	1	1	1	1	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$	1		1	$\checkmark$	1	1	1	1	1	1	1	$\checkmark$	$\checkmark$	
	V1	1				1												$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$							
	V2	$\checkmark$		-		$\checkmark$	<u> </u>	-	<u> </u>	<u> </u>	-		-		<u> </u>	-			1			1					_						-
Ammonium	V3 V4	1	1	-		-	-	-	-	-	-		-	-	-	-		1	V 1	-		√ √	1	_			-					-	-
	V5	1	L.			$\vdash$												1									-					-	
	V6	$\checkmark$				$\checkmark$												$\checkmark$				$\checkmark$											
	V7	$\checkmark$	$\checkmark$	-									-					$\checkmark$	$\checkmark$													_	-
	V1 V2	√ √	V 1	1	V	V ./	V 1	1	-	V ./	V 1	1		./	1	-	-	V ./	✓ √	V 1	./	√ √	✓ √	✓ √		√ √	✓ √	./		./	1	-	-
	V2 V3	V	V	ľ	-	V	V	1 V	-	V		V	-	V	V	-		V	V	×	v	V	V	~		v	v	v		~	~	-	-
Phosphate	V4	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$								$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$							
	V5	1	1			1				1								1	1	1		1	1			1							
	V6	$\overline{\checkmark}$	$\bigvee$	-	-	V	~	~	-	V	-	-	-	-	<u> </u>	-	_	V /	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	~		$\checkmark$	~	_				-	-
	V1	V	V	1		V	1			V	1	1						×	~	-		~	~			~					_		
	V2	1	1	1	1	1	1	$\checkmark$		1	1	1		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	1	1	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
	V3	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																	
Nitrate	V4	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																-
	V5 V6	1	1	1	1	1	1	1	1	1	1	1	1	~	V	-		~	~	V	~	~	~	~	~	~	~	~		~	~	~	-
	V7	1	1	1	L.	1	1	1	<u> </u>	1	L.		<u> </u>																				
	V1	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$																		
	V2	$\checkmark$	$\checkmark$	V,	$\checkmark$	V	$\checkmark$	V.	$\checkmark$	$\checkmark$	V,	$\checkmark$		V	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$	~	~	~	~	$\checkmark$	$\checkmark$	$\checkmark$	~	$\checkmark$	$\checkmark$	~	$\checkmark$	-
Nitrite	V3	1	1	1	1	V	1	1	1	1	1	J	1	1	1	1	J			-				_		-	-	-				-	-
	V5	1	1			1	1			1	1			1				1	1	1		1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
	V6	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$																		
	V7	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			1									1			1	1		_	1				_	_	_	
	V1 V2	1	V V	-		V	1	-	-	V	<b>↓</b>		-	-	-	-	-	1	V 1	-		√ √	✓ ✓	_		√ √	~	-		_		-	-
Augrago	V3	1	1	1		1				1																							
temperature	V4	1	$\checkmark$			1				$\checkmark$																							
	V5	1				V							-					1	~			~	~										
	V0 V7	1	1	-		1	-	-	-	-	-		-	-	-	-		-		-							-			_		-	
	V1	1	Ľ			Ĺ												1				1											
	V2	$\checkmark$																$\checkmark$	$\checkmark$			$\checkmark$											
Thermocline	V3	$\checkmark$	1	-	-	$\checkmark$	~	-	<u> </u>	<u> </u>	-		-		<u> </u>	-		1	$\checkmark$	_		~											-
index	V4 V5	1	1 V	-	-	$\vdash$	-	-	-	-	-		-	-	-	-	-	1		-		_				-	-	-		_		-	-
	V6	1	1															1	$\checkmark$														
	V7	1	1															1				$\checkmark$											
	V1	1	1	1		1	1			1	1							1		1		1	1	1		1	1						
Average	V2 V3	1	V	V	-	V	V	1		1	1	-	-	-		-		V	1	V		V	1	~		V	1						F
dissolved	V4	V	V	×		V	1			1	Y							V	Y	V		Y	*			v	v						
oxygen	V5	1	1			1	1											1	1			1	$\checkmark$										
	V6	1	1	1		1	1																										
	V7	1	1	V	-	1	1	1			-	-	-	-		-																	
	V1 V2	1	1	1	1	1	1	1	-		-	-	-	-	-			1	1	1	1	1	1	1	1	1	1	1				-	-
Halocline	V3	1	1	1	Ľ	1	1	1		1	1	1	1					1	1	1	1	1	1	1	1	1	1	1					
stratification	V4	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	1		$\checkmark$	1	$\checkmark$																					
index	V5	1	1	1		1	1																										
	V6 V7	1	1	1		V	V	V	-	1	1			-	-			-												-	-	-	-

Table with the input features associated with each test block in the Redondela B zone. The check marks when the feature was used.

		L						Α	ppro	Dac	h 1													Ap	pro	acl	h 2						
Fosturo	Oceanographic	⊢		0		T		25		_	-	:0		_	Co	rrel	atio	n Q	uar				2	5		_		:0		_		15	
reature	station	H		0		-	-	.5			-	0	uar	tile	ofr	ande	om	fore	esto	, lisc	rimi	inat	or	5						<u> </u>	- '	5	
		0	25	5 50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	$\checkmark$				$\checkmark$												$\checkmark$				$\checkmark$											
Daylight hours	-	$\checkmark$	1			$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										
Insolation	-	<b>√</b>	-	-										-													_						
Irradiation	-	V		-	-	$\checkmark$	$\checkmark$	_		~	$\checkmark$	-	-	-	<u> </u>	_											_		_	-		_	
Opweiling Index	•	V	×,	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V /	1	1	1	V /	1	1	1	1	1	1	1	1	1	1	1
Zone state		V	1 V	V	×	×	V	V	~	~	×	V		V	V	V	~	V ./	v ./	~	~	~	~	~	~	×	~	V	×		V	V	V
	V2	V	1	-	-	$\vdash$			-	-	-		-	$\vdash$				V				$\checkmark$	1				-		-	-		-	-
	V3	1	1			$\vdash$								$\vdash$				$\checkmark$	$\checkmark$														
Maximum	V4	$\checkmark$	1	1														$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$									
cinorophyn	V5	$\checkmark$	$\checkmark$															$\checkmark$	$\checkmark$														
	V6	<b>√</b>	✓			-							<u> </u>	<u> </u>				✓	$\checkmark$														
	V7	$\checkmark$	V.					1										$\checkmark$	(	1		-	,		,				_				
	V1	V	×,	V .	V /	V.	V /	V /	1	V	V /	V	-	V	V /	~		V /	V /	V	V /	V /	V /	V /	V /	V	V	V /	1	V /	V /	_	-
	V2 V3	1	×	1	v	1	1	V	V	./	×	1	-	1	V			v ./	v ./	× ./	v ./	× ./	× ./	× ./	v	×	×	V ./	v	1	v	-	-
D. acuminata	V4	V	Ť	1	1	V	V	$\checkmark$	$\checkmark$	V	1	V		V	1	1		$\checkmark$	V	V	v V	V V	V	V	$\checkmark$	v	v	V		v	1	$\checkmark$	
concentration	V5	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1		$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	1	$\checkmark$	$\checkmark$	1	1	1	$\checkmark$	1	1	1	
	V6	$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$			
	V7	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$			
	V1	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$							$\checkmark$		$\checkmark$	$\checkmark$												
	V2	$\checkmark$		-	-	V.	$\checkmark$				<u> </u>		-	-	<u> </u>							_					_			-			-
Ammonium	V3	V	×,	-	-	V /	V /	_		-	<u> </u>		-	-	<u> </u>	_		V /	V /			V	V /							-			-
Annonium	V4 \/5	V	V I	-	-	1	V ./			-	-		-	+	-			V ./	V ./	./		× ./	V ./				-		-	-		-	-
	V6	V	1 v	-	-	1	V	1	-	1	1		-	$\vdash$	-	-		V	V	V		v V	V			1	1		-	-	-	-	-
	V7	1	V			1	<u> </u>	-			<u> </u>			$\vdash$				1	V														
	V1	$\checkmark$	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$				$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$								
	V2	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$								$\checkmark$		$\checkmark$	$\checkmark$												
	V3	$\checkmark$				$\checkmark$												$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										
Phosphate	V4	$\checkmark$				$\checkmark$	$\checkmark$			✓ ✓	$\checkmark$		_	-				$\checkmark$	$\checkmark$	✓ ✓		$\checkmark$	✓ ✓			$\checkmark$							
	V5	V	L.	V.	-	V	V /	1	_	V	1	1	-	-	-	-		V /	V /	V	1	×	V	V		V	V	V	1	-	-	-	-
	V0 V7	V ./	×	V 1	-	V ./	V ./	~	_	V ./	V ./	V	-	+	-	-		V ./	V ./	V ./	~	× ./	V ./	~		V ./	V ./	~	~	-		-	-
	V1	V	1 J	1 V	1	1	V	1	1	J	1	1	1	1	1	1		~	~	~		~	~			×							
	V2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
	V3	$\checkmark$	1	1	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	1	1	$\checkmark$	$\checkmark$	$\checkmark$																
Nitrate	V4	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																
	V5	1	$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																						
	V6	$\checkmark$		V	$\checkmark$	<b>√</b>	✓	✓	$\checkmark$	✓	✓	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$										_						
	V7	$\overline{\checkmark}$	×,		V .	V.	V /	V /	1	V	V .	1		V	V /	_						_	_				-		_	-		_	
	V1 V2	1	1	1	V 1	1	1	V ./	V ./	1	1	1	-	1	1			1	1	1	1	1	1	1		1	1	1	1	1	1	-	-
	V2 V3	V	Ť	1v	1 V	1	V	V	~	V	1	1 V	1	ľ	V			v	~	v	~	~	~	~		~	V	v	-		~	-	-
Nitrite	V4	1	V	V	1	V	1	1	$\checkmark$	1	1	1	1	1	1	1																	
	V5	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$											
	V6	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																	
	V7	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$																						
	V1	V,	V.	-	-	V.	$\checkmark$	_		V	<u> </u>		-	-	<u> </u>			$\checkmark$	$\checkmark$	~		$\checkmark$				$\checkmark$	_		_	-			-
	V2 V2	V		1	-	V	1	-	_	V /	1		-	+	-	-		~	~	_	_	~	_			~	-	-	-	-	-	-	-
Average	V3	V	1 J	1 V	-	1 J	×	-	-	1	×	-	-	+	-	-				_			_			-	-		-	-	-	-	-
temperature	V5	1	V			1	1			1								$\checkmark$	1	1		1	1	1		1	1						
	V6	$\checkmark$	1	1		$\checkmark$	$\checkmark$			$\checkmark$																							
	V7	$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$																							
	V1	1	$\checkmark$	_														$\checkmark$															
where the second s	V2	$\checkmark$	-	-	_						_		-	-				$\checkmark$									_						
rnermocline	V3	V	1	-	-	V	-			-	-	-	-	-	-			V /				~				-	-	-	-	-		_	
index	V4 \/5	v ./	×	1		+	-		-	-	-	-	-	$\vdash$	-			V ./	./							-	-	-	-	-	-	-	-
macx	V6	V	Ť		-	+			-	-	-		-	$\vdash$				$\checkmark$	~								-					-	
	V7	1	1			$\vdash$			-				-	$\vdash$				1									-						
	V1	1				1																											
	V2	$\checkmark$	1			$\checkmark$												$\checkmark$				$\checkmark$											
Average	V3	1	1			1	1											$\checkmark$	$\checkmark$			1	1			1	1						
dissolved	V4	V																															
oxygen	V5	V			-	1												$\checkmark$															
	V6	V	V		-	V							-	-																-			-
	V1	1	1			1	1																										-
	V2	1	1V	1		1	1							-				1	1	1		1	1										
Halocline	V3	1	V	V		V	1											1	1	1		1	1	$\checkmark$		1	$\checkmark$						
stratification	V4	1	1	1		1																											
index	V5	$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$																										
	V6	1	1			1	1	$\checkmark$																									
	V7	1.1	1./		1	1.1	1.1			1	1	1	1	1	1															1			1

# A. Molares-Ulloa et al.

# Table 15

Table with the input features associated with each test block in the Redondela C zone. The check marks when the feature was used.

								Α	ppro	oac	h 1													A	opro	back	12						
Fosturo	Oceanographic			0		_		25				:0		_	Co	orrel	atio	n Q	uar	tile				5				:0		_		76	
reature	station			0		I	-	10		<u> </u>	-	Q	uart	tile	of r	and	om	fore	esto	disc	rim	inat	or	.5		I		0		I	-	5	
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Davlight hours	-	$\checkmark$	✓	<b>√</b>		$\checkmark$	✓	-	-	-			-					$\checkmark$	$\checkmark$			✓ ✓	✓								-		
Insolation	-	1																															
Irradiation	-	$\checkmark$	$\checkmark$			1	$\checkmark$																								<u> </u>		
Zone state	-	$\checkmark$		1	1	1	1	1	1	1	1	1	1	1	1	1	1		$\checkmark$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	V1	√	√															√					<u> </u>										
	V2	1	$\checkmark$															1	1														
Maximum	V3 V4	√ √	1	1					-		<u> </u>			-	<u> </u>				$\checkmark$	1		1	1								-		
chlorophyll	V5	√																√				•											
	V6	1	$\checkmark$															$\checkmark$	$\checkmark$														
	V7 V1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	V2	√	√	✓	✓	√	√	✓	✓	✓	√	✓	✓	√	√	✓	√	√	$\checkmark$	√	$\checkmark$	√	√	√	√	√	√	√	•	√	$\checkmark$	$\checkmark$	
D. acuminata	V3	√				√	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$				√	$\checkmark$	√		<	<b>√</b>			<				1			
concentration	V4	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	-	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		V 1	$\checkmark$	$\checkmark$	$\checkmark$	√ √	1	$\checkmark$	$\checkmark$	$\checkmark$	√ √	✓ √	$\checkmark$	$\checkmark$	1		
	V6	$\checkmark$	$\checkmark$	$\checkmark$	1	<ul> <li>✓</li> </ul>	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$				$\checkmark$	$\checkmark$	√	$\checkmark$	× √	√ √	V	1	<ul> <li>✓</li> </ul>	✓	$\checkmark$		$\checkmark$	$\checkmark$		
	V7	1	$\checkmark$	$\checkmark$	1	1	$\checkmark$	1	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	1			$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	1	$\checkmark$	
	V1	1	1			1	1											1	1	1		$\checkmark$	$\checkmark$			$\checkmark$							
	V2 V3	1	1			~												1				$\checkmark$											
Ammonium	V4	1	$\checkmark$															1	$\checkmark$			√	$\checkmark$										
	V5	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$			√ √	√								<u> </u>		
	V6 V7		$\checkmark$	1		✓ ✓			-					-					$\checkmark$			~									-		
	V1	√	√	$\checkmark$		$\checkmark$				$\checkmark$								√	$\checkmark$	•		$\checkmark$				$\checkmark$							
	V2	√	$\checkmark$			1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$							$\checkmark$	✓	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$						
Phosphate	V3	√ √	./	./	-	./	./	./						-				√ √	✓ √	./		./	./	./		./	./	./			-		
Theophate	V5	v √	$\checkmark$			v √	~			$\checkmark$								$\checkmark$	$\checkmark$	•		<ul> <li>✓</li> </ul>	√ √	•		<b>√</b>	~	~					
	V6	1	$\checkmark$			1				$\checkmark$								$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$						
	V7	$\checkmark$	$\checkmark$	1		$\checkmark$	$\checkmark$			$\checkmark$	1			1				$\checkmark$	$\checkmark$			✓	√	$\checkmark$		✓					-		
	V1 V2	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$			$\checkmark$	V V	1		$\checkmark$	1			1	$\checkmark$	1	1	$\checkmark$	$\checkmark$	1	1	$\checkmark$	$\checkmark$	1	1	1	1		
	V3	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$																	
Nitrate	V4	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			1	1	1	1	1	/		1	1	/					
	V5 V6	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	1	1		1	1	1		V	~	✓		~	V	~		<ul> <li>✓</li> </ul>	~	~			-		
	V7	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$																							
	V1	$\checkmark$	$\checkmark$		1	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	1		$\checkmark$				1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	V2 V3	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\overline{\checkmark}$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			V	~	V	<b>▼</b>	<b>v</b>	V	~	~	V	~	~	~	V	~		
Nitrite	V4	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																	
	V5	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	<u> </u>	$\checkmark$	$\checkmark$	1		1				$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		✓	$\checkmark$				-		
	V6 V7	✓ ✓	V	$\overline{\checkmark}$		$\checkmark$	$\overline{\checkmark}$	1	-	$\checkmark$	1			V	-			-													-		
	V1	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$								$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$				$\checkmark$	$\checkmark$						
	V2	$\checkmark$	$\checkmark$			$\checkmark$												1	$\checkmark$	√		$\checkmark$	$\checkmark$			✓	√				<u> </u>		
Average	V3 V4	V	V		H	V	V	H	H	V	V	H	H	F		H		H															F
temperature	V5	1	1			1												$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$							
	V6	1	1			1	$\checkmark$																										
	V/ V1	V	~			~												$\checkmark$															
	V2	√																√				$\checkmark$											
Thermocline	V3	1				$\checkmark$												1				$\checkmark$											
index	V4 V5		1	1					-		-			-	-				1					-				-			-		-
	V6	$\checkmark$	√ \															<b>√</b>				$\checkmark$											
	V7	1																$\checkmark$															
	V1 V2	1	1			1	1											1	1			1	1										F
Average	V3	1	1	1		1	~	1		$\checkmark$	1	$\checkmark$						1	√ √	1	1	<ul> <li>✓</li> </ul>	√ √	1		$\checkmark$	$\checkmark$	1					
dissolved	V4	1	$\checkmark$			1	$\checkmark$																										
oxygen	V5	1	1	$\checkmark$		1	1	1										1	1	1		$\checkmark$	√	$\checkmark$									
	V6 V7	V V	V V	V		V V	~																										
	V1	1	1	$\checkmark$		1	$\checkmark$	1		$\checkmark$	1	$\checkmark$																					
Liele allin a	V2	1	1	1	$\checkmark$	1	1	1	$\checkmark$	$\checkmark$	1	$\checkmark$			1	1		$\checkmark$	1	1	$\checkmark$	1	1	1	1	$\checkmark$	1	1		1	1	$\checkmark$	
stratification	V3 V4	1	1	1	1	1	1	1	1	1	1	V	1	V	1	1		1	1	1	V	$\checkmark$	1	1		1	V	1		1	1		
index	V5	1	√	1	1	~	√	1		$\checkmark$	1	1																					
	V6	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	1	$\checkmark$																					
	V7	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																					

Table with the input features associated with each test block in the Redondela D zone. The check marks when the feature was used.

								Α	ppr	oac	h 1													A	opro	bacl	h 2						
Feature	Oceanographic	⊢		0		_		25		_		:0		_	Co	orrel	atio	n Q	uar					25		_		50		_	-	/6	_
reature	station	F		<u> </u>		-						~ Q	uar	tile	of n	and	om	fore	esto	, lisc	rimi	nat	or			-				-		<u> </u>	
		0	25	50	75	i 0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year		1	1	$\checkmark$		1												$\checkmark$				1	$\checkmark$										
Daylight hours	•	V	-	-	-	V	$\checkmark$	<u> </u>	<u> </u>		-		-	-		-		$\checkmark$				~					<u> </u>	-	<u> </u>	-		<u> </u>	-
Irradiation		1	1	1	-	1	-	-	-	1	1		+	+	-	-	-					-		-	-		-	-	-	+	-	-	-
Upwelling index		V	V	Ť		V	1				1	-	$\vdash$	$\vdash$				$\checkmark$	$\checkmark$			1	$\checkmark$		-			1					-
Zone state	-	$\checkmark$	1	$\checkmark$	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
	V1	$\checkmark$	1															$\checkmark$															
	V2	V	V.	-	-	+	<u> </u>	-	<u> </u>	-	-		-	-		-		$\checkmark$	$\checkmark$	/		_			_		-	-		-		<u> </u>	-
Maximum	V3	1	1	1	1	1	1	1	-	-	+	-	+	+	-	-	-	V 1	V 1	V 1		1	J		-		-	-	-	+	-	-	-
chlorophyll	V5	V	V	Ľ	1	1		1			$\vdash$		$\vdash$	$\vdash$				$\checkmark$	-						-			1					
	V6	$\checkmark$	1															$\checkmark$	$\checkmark$														
	V7	1	✓	<u> </u>		<u> </u>					<u> </u>		<u> </u>	L .	_			✓	✓						_					<u> </u>			-
	V1	V	L.	V.	L.	×,				$\checkmark$	L.	$\checkmark$	V.	Į√	V		~	$\checkmark$	$\checkmark$	V	$\checkmark$	V	V	$\checkmark$	~	V	$\downarrow$	V		I√.	$\checkmark$	$\checkmark$	$\checkmark$
	V2 V3	V	1	1 V	1	1	1	1	1	1	1	J		1	1	1	-	V 1	V J	V V	V J	V J	V J	1	J	V	V V	1	V	1 V	1	1	-
D. acuminata	V4	1	V	V	V	V	1	V	1	1	V	1	1	1	1	V	1	$\checkmark$		1	1	V	~	1	1	1	V	V	1	V	1	V	1
concentration	V5	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$						$\checkmark$		$\checkmark$	$\checkmark$												
	V6	1	<b>√</b>	V	$\checkmark$	1	1	1		1	<ul> <li>✓</li> </ul>	$\checkmark$		1	✓			✓	✓	$\checkmark$	1	√	✓	✓	$\checkmark$	1	✓	$\checkmark$		1	$\checkmark$		_
	V7	V	V.	V	-	V			✓	$\checkmark$	L.	-	-	~	~			$\checkmark$	$\checkmark$	1		√ ∕	~	✓	_	V /	$\downarrow$	-		V			-
	V1 V2	V		+	$\vdash$	1 J	×	-	-	V		-	+	+	-	-		~	~	~		V			-	~		-	-	+	-	-	-
	V3	1	1		$\vdash$	1							$\vdash$	$\vdash$				$\checkmark$	$\checkmark$	$\checkmark$		1	$\checkmark$		-			-					
Ammonium	V4	$\checkmark$	1			1	$\checkmark$											$\checkmark$				$\checkmark$											
	V5	1	1															$\checkmark$				1			_								
	V6	$\checkmark$	V.	_	-	$\checkmark$	$\checkmark$				-		-	-		<u> </u>		$\checkmark$	$\checkmark$			~	$\checkmark$			$\checkmark$		-		-		<u> </u>	-
	V7	1	1	1	1	1	1	1	-	1	1		-	1	-	-	-	V 1	V 1	1	1	1	1	1	-	1	1	-	-	1	-	-	-
	V2	V	V	V	V	V	1	V	1	1	V	1		1	1	1		$\checkmark$	$\checkmark$	1	$\checkmark$	· /	~	1	1	1	<u> </u>			1	1		-
	V3	$\checkmark$	1	$\checkmark$		1	$\checkmark$			$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$						
Phosphate	V4	1	✓	1	$\checkmark$	1	$\checkmark$	1		1	$\checkmark$	$\checkmark$						✓	✓	✓	1	√	√	$\checkmark$	_	1	1	$\checkmark$					_
	V5	V	V.	V.	-	V	1	1	<u> </u>	V		-	-	-	-	-		$\checkmark$	$\checkmark$	V	1	V	V	1	_	V	$\checkmark$	1	-	-	<u> </u>	<u> </u>	-
	V0 V7	1	1	1 V	$\vdash$	1	1	1	-	1	1	-	$\vdash$	$\vdash$	-	-	-	V 1	V 1	V V	~	V J	V 1	~	-	1	1	V	-	+	-	-	-
	V1	V	V	V	1	1	1	1		1	V	1							-								1						
	V2	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																								
	V3	1	<b>√</b>	V	L .	1	✓	✓	✓	✓	<ul> <li>✓</li> </ul>	<ul> <li>✓</li> </ul>	<u> </u>	1	✓										_					-			-
Nitrate	V4	V	$\downarrow$	V.		×,				$\checkmark$	L.	$\checkmark$	$\downarrow$	V.	$\overline{}$		~	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	V6	V	1 J	1 V	1	1	V	1	1 V	J	1 V	V	1 V	1	V	1 V		v	V	v	v	v	v	V	v	v			V		×		-
	V7	1	1	1	1	1	1	1		1																							
	V1	$\checkmark$	1	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																			
	V2	$\checkmark$	L.	V.	L.	L.	$\checkmark$	V.		$\checkmark$	V.	$\checkmark$		$\checkmark$	$\checkmark$	<u> </u>		$\checkmark$	$\checkmark$	$\checkmark$	~	~	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	<u> </u>	$\checkmark$	$\checkmark$	$\checkmark$	-
Nitrite	V3 V4	V 1	1	1	1	1	1	1	1	1	V	1	1	1	1	1	1					_		-	-		-	-	-	-	-	-	-
	V5	V	V	V	ľ	V	V	Ť		V	V	Ť	Ť	V		1 V	v	$\checkmark$	$\checkmark$	1		1	$\checkmark$	1		1	1			-			-
	V6	$\checkmark$	1	$\checkmark$	1	1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$																			
	V7	1	$\checkmark$	$\checkmark$		1	$\checkmark$			1	$\checkmark$																						
	V1	$\checkmark$	· ,	-	-	V.		<u> </u>	<u> </u>	$\checkmark$	-		-	-		<u> </u>		$\checkmark$	$\checkmark$			✓ ✓	1			$\checkmark$	<u> </u>	-		-		<u> </u>	-
	V2 V3	1	1	-	+	1	1	-	-	1	-		+	+	-	-		~	~			~	~		-	~	-	-	-	-	-	-	-
Average	V4	1	V			1	ŕ			1																							
temperature	V5	$\checkmark$	1			1												$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$							
	V6	V				V				1																							
	V/	V	V	-	-	V	-	-	-	~	-	-	-	-	-	-		1	_			_			-		-	-	-	-	-	-	-
	V2	V		1	-	1	-		-		-			-	-			1								-		-	-			-	-
Thermocline	V3	1																$\checkmark$				$\checkmark$											
stratification	V4	$\checkmark$	1															$\checkmark$															
index	V5	$\checkmark$		V	-	+	<u> </u>	<u> </u>	<u> </u>	-	-	-	-	-	_	<u> </u>		$\checkmark$	~	$\checkmark$		_			_		<u> </u>	-	<u> </u>	-		<u> </u>	-
	V6	1		1	-	+	-	-	-	-	-	-	-	-	-	-	-	V						-	-	-	-	-	-	-		-	-
	V1	V	1	1		1	1											V															
	V2	1	1			1	1											$\checkmark$	1	1		1	1										
Average	V3	1	1	$\checkmark$		1	1	1	1	1	1	1						$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	1	$\checkmark$					
dissolved	V4	1	1			1	1													-		-											
oxygen	V5	V	V	1		V	V			-								1	~	1		1	1										-
	V6 V7	1	1	1		1	V																										
	V1	1	ľ	-		ľ	-																										
	V2	1	1			1	1											$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$										
Halocline	V3	1	1			1												$\checkmark$	1	1		1	1										
stratification	V4	1	V		-	1	1				-	-			-										-								
index	V5	1	V	-	-	-	-	-	-	-	-	-	-	-	-	-									-	-	-	-	-	-		-	-
	V7	1	1		-	1	1			-	-		1	-	-	-				-						-	-	-		-			-

Table with the input features associated with each test block in the Redondela E zone. The check marks when the feature was used.

		L						Α	ppr	oac	h 1													Ap	pro	back	h 2						
Feature	Oceanographic	⊢		0				25		_		50		_	C0	rrel	atio	n Q	uar	tile			2	5				50		_	- 7	/5	
reature	station	H		•		-	-				-	0	uart	tile	of ra	and	om	fore	esto	disc	rimi	nat	or	5							- '	-	
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	$\checkmark$				$\checkmark$												$\checkmark$				$\checkmark$											
Daylight hours	-	$\checkmark$	1			$\checkmark$	$\checkmark$											$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	~										
Insolation	-	V.	V				1	-	<u> </u>	1	1		-							_		_					_		<u> </u>	-			-
Irradiation	•	V	V	V	-	V	V	1	-	~	V	-	-	-	-	-		1		-		1					-	-	-	-		-	-
Zone state		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	× ./	1	1	1	1	1	1	1	1	1	1	1
Lone state	V1	1	Ť		Ť	ľ	-	Ť	-	1 ×	1		ľ	-	-	-	*	1	J	-		Ť	-	·	•	Ť		· ·	-	Ť	*	Ť	×
	V2	V	1															1				_					-						
Maximum	V3	$\checkmark$	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$	$\checkmark$													
chloronhyll	V4	$\checkmark$	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$	$\checkmark$													
chiorophyn	V5	$\checkmark$	$\checkmark$															$\checkmark$	$\checkmark$			_											
	V6	V.	$\checkmark$			-												$\checkmark$				_											
	V/	V /	V /	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V	1	1	1	/	1	1	1	1	1	1	1	1	1	1	1
	V1 V2	V ./	V 1	V ./	V ./	V ./	V ./	V ./	V ./	V ./	V ./	V ./	V	V ./	~	~	~	1	V ./	V ./	V ./	× ./	V ./	V ./	V ./	V ./	V ./	V ./	V	V ./	~	~	V
	V2 V3	V V	1 V	V V	J.	1 J	V	1 V	J.	1 V	V V	J	-	J	1	-		J	V J	V V	V J	Ť.	× √	v 1	V 1	V	V V	J	1	V	1	-	-
D. acuminata	V4	1	1	1	1	V	1	V	1	V	V	1		1	1			1	1	1	1	1	1	1	1	1	1	V	<u> </u>	V	1		
concentration	V5	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$																									
	V6	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$		$\checkmark$	$\checkmark$																						
	V7	$\checkmark$			$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																								
	V1	$\checkmark$	$\checkmark$			<b>√</b>	<u> </u>			$\checkmark$								$\checkmark$	$\checkmark$	$\checkmark$		~	~			$\checkmark$	_						
	V2	V.		-	-	$\checkmark$	$\checkmark$	-	<u> </u>	<u> </u>	-		<u> </u>						1			1					_	-		-		<u> </u>	-
Ammonium	V3	V	V /	-	-	-	<u> </u>	-	<u> </u>	<u> </u>	-		-	-		_		V	$\checkmark$	V		×	1					-		-		<u> </u>	-
Annonium	V4 V5	V	V	-	-	+	-	-	-	-	-		-	-	-			V	V	-		× ./	~				-	-	-	-		-	-
	V6	V V	-	-	-	1	1	-	-	-	-		-	-	-	-		V V		-		ý.	1	_			-	-	-	-		-	-
	V7	V	1			<b>_</b>	-	-		-	-					-		V	$\checkmark$			-	-				-			-		-	-
	V1	$\checkmark$	1	1		$\checkmark$				1								$\checkmark$	$\checkmark$	1		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
	V2	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$						
	V3	$\checkmark$																$\checkmark$	$\checkmark$														
Phosphate	V4	$\checkmark$	✓			1				✓								✓	✓			√	✓			$\checkmark$	_						
	V5	V	V			V		-	<u> </u>	V	V		-	-				V	$\checkmark$			~	V			✓ ✓				-			-
	V6	V /	V .	V.	-	V	V /	-	<u> </u>	V /	V	-	-	-	_	-		V	$\checkmark$	~	~	×	V /	~		✓ /	~	-	<u> </u>	-		<u> </u>	-
	V/1	V	V ./	V	-	V	V ./	1		V ./	1							V	V			-	~			~							-
	V2	V	1 V	1	1	1	V	1	1	V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	V3	V	V	V	Ť	V	V	V	-	V	V	V	Ľ	V	V	V		-		-		-	-	-			-	<b>•</b>	-	1		-	-
Nitrate	V4	$\checkmark$	1	$\checkmark$	1	1	1	1	1	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																	
	V5	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$		$\checkmark$																					
	V6	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																											
	V7	$\checkmark$		$\checkmark$	$\checkmark$																												
	V1	$\checkmark$	$\checkmark$	V	$\checkmark$	V	V	V	✓	$\checkmark$	$\checkmark$			$\checkmark$																			
	V2	$\checkmark$	$\checkmark$	V.	$\checkmark$	V,	$\checkmark$	V.	$\checkmark$	$\checkmark$	V.	V	V.	$\checkmark$	$\checkmark$			$\checkmark$	~	$\checkmark$	~	~	~	~	~	$\checkmark$	~	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	-
Nitrite	V3	V ./	V	V	V ./	V	V	V	V	V	V	V ./	V	1	./	1		-		-		-	_	_			-		-	-		-	-
Marte	V4 V5	1	V V	V V	1	V V	1	V V	V V	1	V V	1	V I	1	1	V		1	1	1	1	1	1	1	1	1	1	1	-	1	1	-	-
	V6	V	V	V	V	V	V	V	V	V	V	V		1	V	1						-		•	•						•		
	V7	1	1	1	1	1	1	1	1	1	1	1			-	-																	
	V1	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$							$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$						
	V2	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$								$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$						
Average	V3	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$				$\checkmark$												_					_						
temperature	V4	$\checkmark$	$\checkmark$	-	-	V.	V	-	<u> </u>	$\checkmark$	-	-	-	-	_	_		/	1	_		1				1	/	-	<u> </u>	-		-	-
	VS	V				1				1								V	V			V				V	V						-
	V7	1	1			1				1																							
	V1	V	· ·							-					_		_	1				$\checkmark$	_	_	_								
	V2	1	1															1	$\checkmark$			1	1										
Thermocline	V3	$\checkmark$	$\checkmark$			$\checkmark$												$\checkmark$				$\checkmark$											
stratification	V4	$\checkmark$	$\checkmark$															$\checkmark$															
index	V5	$\checkmark$	✓															✓	$\checkmark$			_					_						
	V6	1	V			-												1									-			-			
	V7	$\checkmark$	$\checkmark$	-		1	1			1	1				_	_		$\checkmark$		_		_		_	_		_			-			-
	V1 \/2	V	V		-	V	V			V	V							1	1			1	1							-			-
Average	V2	1	1	1		1	1			1	1	1		-				1	1	1		V	1			1	1			1			
dissolved	V4	1	V	1		V	1			-	1	-						-		-						-							
oxygen	V5	1	1			1	-											1	1			1	1										
	V6	1	1			1	1																										
	V7	1	1	1		1	1																										
	V1	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$																									
	V2	1	1	1		1	1											$\checkmark$	$\checkmark$	$\checkmark$		1	1	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$					
Halocline	V3	1	1	1		1	1	1										1	1	1		1	$\checkmark$	$\checkmark$		$\checkmark$	1						
stratification	V4	1	1	1		1	V																										
index	V5	V	V	V	-	V	1																										
	V6	1	V	-	-	V	V	-	-	-	-	-	-	-	-		-	-		-							-	-	-	-	-	-	-

Table with the input features associated with each test block in the Vigo A zone. The check marks when the feature was used.

								Α	ppro	oacl	h 1													Ap	pro	acl	۱2						
<b>F</b> +	Oceanographic			_				-		_					Co	rrel	atio	n Q	uar	tile		_		_		_					_	_	
Feature	station	⊢		0			2	:5			5		uart	ile	of ra	5 ando	om	fore	esto	) disc	rim	inat	or 2	5				50				5	_
		0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75	0	25	50	75
Week of the year	-	$\checkmark$	$\checkmark$															$\checkmark$	$\checkmark$														
Daylight hours	-	1				1												$\checkmark$	$\checkmark$			$\checkmark$											
Insolation	-	V	-	-		1	1		_	-	-	-	-	-	-								_	_		_				-			
Upwelling index		V	1	-		V	~		_	-	-	-	-	-	-			$\checkmark$				1		_		-		-		-			
Zone state	-	1	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$																				
	V1	$\checkmark$																$\checkmark$	$\checkmark$														
	V2	$\checkmark$	$\checkmark$	$\checkmark$		√	~	~			<u> </u>		_					$\checkmark$	$\checkmark$	$\checkmark$		1	1	1									
Maximum	V3	V ./	V ./	./		./	./	./		-	-	-	-	-	-			V ./	√ √	V ./		V ./	V ./	./		_		-		-			
chlorophyll	V5	V	Ť			•	~	~		-	-		-		-			$\overline{\checkmark}$	~	~		·	~	•						-			
	V6	$\checkmark$																$\checkmark$															
	V7	1	1	1														$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$									
	V1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	✓ ✓	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	V.	$\checkmark$	$\checkmark$	V	$\checkmark$	$\checkmark$	✓ ✓	$\checkmark$	$\checkmark$	~	~	V	$\checkmark$	V	1	(	1	V	~	$\checkmark$
	V2 V3	1	1	V ./	~	V ./	V ./	~	~	V ./	~	~	~	V ./	~	~	~	✓ √	V ./	V ./	~	V ./	V ./	~	~	√ √	~	~	~	V ./	~		
D. acuminata	V4	V	V	V		<b>√</b>	V	$\checkmark$		V	1	1		1	$\checkmark$			$\checkmark$	$\checkmark$	V		V V	V	1	-	v √	$\checkmark$	1		1			
concentration	V5	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$															
	V6	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																
	V7	1	1	1	$\checkmark$	1	1	1	1	1	1	1	1	1	1	$\checkmark$	1	1	$\checkmark$	1	1	1	~	1	1	$\checkmark$	1	1	~	1	1	1	
	V1 V2	V				1												~															
	V2 V3	V	1			V												$\checkmark$	$\checkmark$														
Ammonium	V4	1	<u> </u>										-					·	V														
	V5	$\checkmark$	$\checkmark$			$\checkmark$												$\checkmark$				$\checkmark$											
	V6	$\checkmark$																$\checkmark$															
	V7	V	V	1		V 1	~	_	_	1	-	-	-	-	_	_		$\checkmark$	~			V /	1	_		1		_		-		_	-
	V1 V2	V	V	V		V	-	-		V	-	-	-	-	-			$\checkmark$	1	1	-	V	V	_	_	V		-		-			-
	V3	1	1	Ľ.														· ~				1	-										
Phosphate	V4	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$											$\checkmark$				$\checkmark$				$\checkmark$							
	V5	1	1			1	$\checkmark$											$\checkmark$				1	$\checkmark$			<b>√</b>	$\checkmark$						
	V6	$\checkmark$	$\bigvee$	1		√ /	1	1		~	-	<u> </u>	-	-	-			$\checkmark$	1			$\checkmark$	_			$\checkmark$				-			
	V1	J	J	1 V		V	1	1		1	1			1				~	~			~				~							
	V2	V	V	V		1	V	1		V	V		-	1	-			$\checkmark$	$\checkmark$	$\checkmark$	1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	1		1	$\checkmark$		
	V3	1	1	$\checkmark$		1	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			1	$\checkmark$																		
Nitrate	V4	1	1			1	1			1	1			$\checkmark$																			
	V5	V.	V.			V	V.	$\checkmark$		V.	$\checkmark$		_	V.	V.	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	~	~		$\checkmark$	~			$\checkmark$	~		
	V6 V7	V	V ./	./		V ./	V ./	V ./	_	V ./	V ./	-	-	V	~								_	_		_		-		-			-
	V1	V	V	Ľ		v √	V		_	V	V			-			_			_	_			_	_		_				_	_	
	V2	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$					
	V3	1	✓	1		1	✓			✓	1																						
Nitrite	V4	V	$\checkmark$	$\checkmark$		√ /	$\checkmark$	_		$\checkmark$	$\checkmark$	-	_	-	_			1	1			1	_			1				-			
	V5 V6	V ./	V ./	-		V ./	-	-		V ./	-	-	-	-	-			~	~			~	_			~		-		-			-
	V7	V	V			1	$\checkmark$			V															-								
	V1	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	
	V2	1	1	1		1	1	$\checkmark$		$\checkmark$	1	1	$\checkmark$	1	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	
Average	V3	1	1	1	1	1	1	1	1	1	1	1		1	1	$\checkmark$	1																
temperature	V4 V5	V	-	V		V	V			V	V							1	1			1				1	1						
	V6	1	1	1	$\checkmark$	1	1	1		1	1																						
	V7	1	1	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		$\checkmark$	1																						
	V1	1																1	1														
Thormoolino	V2	$\checkmark$	$\checkmark$	-		~	$\checkmark$	_			<u> </u>	<u> </u>	_					$\checkmark$	$\checkmark$			$\checkmark$	V										
stratification	V3 V4	J	J	-		-	-			-	-	-	-	-	-			V	V			~	~	_				-		-			
index	V5	1	1															·	$\checkmark$														
	V6	$\checkmark$	$\checkmark$	$\checkmark$														$\checkmark$	$\checkmark$	$\checkmark$													
	V7	1	1															$\checkmark$															
	V1	V	1			1	1											1	1	1		1	1			1	1						
Average	V2 V3	V	1	-		1	V											V	1	V		V	V			V	V						
dissolved	V4	V	V			1	1											v	v			Y	v			v	v						
oxygen	V5	1	1			1	1											$\checkmark$	1	1		1	1	$\checkmark$									
	V6	1				$\checkmark$																											
	V7	1	1	1		1	1	1																									
	V1	1	1	1	1	1	1	1	1	1	1	1	-	-	-		_	.1	.1	.1	1	1	1	1	.1	1	.1	1	1				
Halocline	V2 V3	V	J	J	V	V	V	1	V	V	V	1	1	-	-		-	V	1	V	1	V	V	V V	V	V	V	1	V		-		
stratification	V4	1	1	1	1	1	1	1	1	1	1	1									-				-			-					
index	V5	1	1	1	1	1	1	1		1	1	1																					
	V6	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$																											
	V7	V	1	1	$\checkmark$	1	1	$\checkmark$	1	$\checkmark$	1	1																					

#### References

- (2019) Commission implementing regulation (eu) 2019/627 of 15 March 2019 laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption in accordance with regulation (eu) 2017/625 of the european parliament and of the council and amending commission regulation (ec) no 2074/2005 as regards official controls. URL: http://data.europa.eu/eli/reg\_impl/2019/627/2021-01-01.
- (2021) Web page of meteogalicia. URL: https://www.meteogalicia.gal/observacion/ estacionshistorico/historico.action?idEst=14001.
- Aguilar Calderon, V.H., 2017. Predicción de las floraciones algales nocivas (fan) en poblaciones de dinophysis acuminata por redes neuronales artificiales.
- Avdelas, L., Avdic-Mravlje, E., Borges Marques, A.C., Cano, S., Capelle, J.J., Carvalho, N., Cozzolino, M., Dennis, J., Ellis, T., Fernandez Polanco, J.M., et al., 2021. The decline of mussel aquaculture in the european union: causes, economic impacts and opportunities. Rev. Aquacult. 13, 91–118.
- Behera, R.N., Roy, M., Dash, S., 2016. Ensemble based hybrid machine learning approach for sentiment classification-a review. Int. J. Comput. Appl. 146, 31–36.
- Chen, R.J., Lu, M.Y., Chen, T.Y., Williamson, D.F., Mahmood, F., 2021. Synthetic data in machine learning for medicine and healthcare. Nat. Biomed. Eng. 5, 493–497.
- Copenhaver, M.D., Holland, B., 1988. Computation of the distribution of the maximum studentized range statistic with application to multiple significance testing of simple effects. J. Stat. Comput. Simul. 30, 1–15. https://doi.org/10.1080/ 00949658808811082.
- Cortes, C., Vapnik, V., 1995. Support-vector networks. Mach. Learn. 20. https://doi.org/ 10.1023/A:1022627411411.
- Cruz, R.C., Reis Costa, P., Vinga, S., Krippahl, L., Lopes, M.B., 2021. A review of recent machine learning advances for forecasting harmful algal blooms and shellfish contamination. J. Mar. Sci. Eng. 9. https://doi.org/10.3390/jmse9030283.
- Davis, T.W., Berry, D.L., Boyer, G.L., Gobler, C.J., 2009. The effects of temperature and nutrients on the growth and dynamics of toxic and non-toxic strains of microcystis during cyanobacteria blooms. Harmful Algae 8, 8. https://doi.org/10.1016/j. hal.2009.02.004.

#### A. Molares-Ulloa et al.

- Deng, T., Chau, K.-W., Duan, H.-F., 2021. Machine learning based marine water quality prediction for coastal hydro-environment management. J. Environ. Manage. 284, 112051. https://doi.org/10.1016/j.jenvma.2021.112051. URL: https://www. sciencedirect.com/science/article/pii/\$0301479721001134.
- FAO (2 February 2022). Food and agriculture organization. URL: https://www.fao.org/ in-action/globefish/market-reports/resource-detail/ru/c/1199390/.
- Friedman, J.H., 2001. Greedy function approximation: A gradient boosting machine. Annals Stat. 29, 1189–1232. https://doi.org/10.2307/2699986. URL: http://www. jstor.org/stable/2699986.
- Gasinaite, Z.R., Cardoso, A.C., Heiskanen, A.S., Henriksen, P., Kauppila, P., Olenina, I., Pilkaityte, R., Purina, I., Razinkovas, A., Sagert, S., Schubert, H., Wasmund, N., 2005. Seasonality of coastal phytoplankton in the baltic sea: Influence of salinity and eutrophication. Estuar. Coast. Shelf Sci. 65. https://doi.org/10.1016/j. eccs.2005.05.018.
- Gholami, Z., Mortazavi, M.S., Karbassi, A., 2019. Environmental risk assessment of harmful algal blooms case study: Persian gulf and oman sea located at hormozgan province, Iran. Human Ecol. Risk Assess: An Int. J. 25, 271–296. https://doi.org/ 10.1080/10807039.2018.1501660. URL: https://doi.org/10.1080/ 10807039.2018.1501660. arXiv:https://doi.org/10.1080/ 10807039.2018.1501660.
- Guallar, C., Delgado, M., Diogène, J., Fernández-Tejedor, M., 2016. Artificial neural network approach to population dynamics of harmful algal blooms in alfacs bay (nw mediterranean): Case studies of karlodinium and pseudo-nitzschia. Ecol. Model. 338, 271–296. https://doi.org/10.1016/j.ecolmodel.2016.07.009.
- Hill, P.R., Kumar, A., Temimi, M., Bull, D.R., 2020. Habnet: Machine learning, remote sensing-based detection of harmful algal blooms. IEEE J. Select. Top. Appl. Earth Observ. Remote Sens. 13, 13. https://doi.org/10.1109/JSTARS.2020.3001445.

IEO (April 27, 2021). Web page of marnaraia proyect. URL: http://www. indicedeafloramiento.ieo.es/afloramiento.html.

- INTECMAR (2 February 2022). Historical status of cultivation areas. URL: http://www. intecmar.gal/Informacion/biotoxinas/EstadoZonas/Historico Batea.aspx.
- Jin, D., Hoagland, P., 2008. The value of harmful algal bloom predictions to the nearshore commercial shellfish fishery in the gulf of maine. Harmful Algae 7. https://doi.org/10.1016/j.hal.2008.03.002.
- Landis, J.R., Koch, G.G., 1977. The measurement of observer agreement for categorical data. Biometrics 33. https://doi.org/10.2307/2529310.
- Lantz, B., 2015. Machine Learning with R: Second Edition.
- Lee, S., Lee, D., 2018. Improved prediction of harmful algal blooms in four major south korea's rivers using deep learning models. International Journal of Environmental Research and Public Health, 15. URL: https://www.mdpi.com/1660-4601/15/7/ 1322. doi:10.3390/ijerph15071322.
- Lewis, D.D. (1998). Naive (bayes) at forty: The independence assumption in information retrieval. In: Nédellec, C., Rouveirol, C. (Eds.), Machine Learning: ECML-98 (pp. 4–15). Berlin, Heidelberg: Springer, Berlin Heidelberg. doi:10.1007/BFb0026666.

- Li, F., Zhang, H., Zhu, Y., Xiao, Y., Chen, L., 2013. Effect of flow velocity on phytoplankton biomass and composition in a freshwater lake. Sci. Total Environ. 447. https://doi.org/10.1016/j.scitotenv.2012.12.066.
- Liu, J., Zhang, Y., Qian, X., 2009. Modeling chlorophyll-a in taihu lake with machine learning models. doi:10.1109/ICBBE.2009.5163072.
- Molares, A., Fernandez-Blanco, E., Rivero, D., 2020. Application of artificial neural networks for the monitoring of episodes of high toxicity by dsp in mussel production areas in galicia. Proceedings, 54. doi:10.3390/proceedings2020054012.

Paerl, H.W., Paul, V.J., 2012. Climate change: Links to global expansion of harmful cyanobacteria. Water Res. 46. https://doi.org/10.1016/j.watres.2011.08.002.

Rahman, A., Shahriar, M.S., 2013. Algae growth prediction through identification of influential environmental variables: A machine learning approach. Int. J. Comput. Intell. Appl. 12. https://doi.org/10.1142/S1469026813500089.

Segal, M.R., 2004. Machine learning benchmarks and random forest regression,. Sheskin, D.J., 2003. Handbook of parametric and nonparametric statistical procedures.

- Chapman and Hall/CRC. doi:10.1201/9781420036268.
  Velo-Suárez, L., Gutiérrez-Estrada, J.C., 2007. Artificial neural network approaches to one-step weekly prediction of dinophysis acuminata blooms in huelva (western andalucía, spain). Harmful Algae 6. https://doi.org/10.1016/j.hal.2006.11.002.
- Vilas, F., Rey, D., Armesto, B.R., Bernabéu, A., Méndez, G., Durán, R., Mohamed, K., Rosón, G., Cabanas, J.M., Pérez, F.F., Castro, C.G., Ríos, A.F., Figueiras, F.G., Miranda, A., Riveiro, I., Vergara, A.R., Guisande, C., Reguera, B., Escalera, L., Pazos, Y., Ángeles Moroño, González, J.J., Álvarez, C., Beiras, R., Besada, V., Fumega, J., Ángeles Franco, M., Gómez, M., Quijano, A.G., Nunes, T., Prego, R., Sanz, A.S., Viñas, L., Peleteiro, J.B., Trujillo, V., Bañón, R., Ribó, J., Olmedo, M., Álvarez Blázquez, B., Rodríguez, J.L., Pazó, J., Otero, J.J., Ángel Guerra, Lens, S., Rocha, F., Rodríguez, M.X.V., Blanco, A.P., 2008. La ría de vigo: una aproximación integral al ecosistema marino de la ría de vigo. URL: http://hdl.handle.net/10261/170032.
- Vilas, L.G., Spyrakos, E., Palenzuela, J.M.T., Pazos, Y., 2014. Support vector machinebased method for predicting pseudo-nitzschia spp. blooms in coastal waters (galician rias, nw spain). Prog. Oceanogr. 124. https://doi.org/10.1016/j. pocean.2014.03.003.

White, H., et al., 1992. Artificial neural networks. Blackwell Cambridge, Mass. Yñiguez, A.T., Ottong, Z.J., 2020. Predicting fish kills and toxic blooms in an intensive mariculture site in the Philippines using a machine learning model. Sci. Total Environ. 707. 136173. https://doi.org/10.1016/j.scitotenv.2019.136173. UBL:

https://www.sciencedirect.com/science/article/pii/S0048969719361698.
Yu, P., Gao, R., Zhang, D., Liu, Z.-P., 2021. Predicting coastal algal blooms with environmental factors by machine learning methods. Ecol. Ind. 123, 107334. https://doi.org/10.1016/j.ecolind.2020.107334. URL: https://www.sciencedirect. com/science/article/pii/S1470160X20312760.