EUROPEAN CHEMICALS AGENCY

Consultation of the BPC Working Group Environment

Analysis of EU freshwater marina scenarios and proposals for a PEC calculation tool

Date of document: 23 June 2017	First discussion at WG-III-2017

Contents

1. Introduction

This document presents the results on the development of a harmonised exposure scenario that can be applied at product authorisation and mutual recognition procedures of PT21 antifouling biocidal products within the EU. The work deals with scenario development for freshwater marinas.

The intention for harmonisation in the PT21 field was already discussed at AHEE-1 (Amsterdam, April 2016) and is also part of the draft PT21 product authorisation manual [1]. The goal is to reach agreement on a minimum set of required scenarios that applicants will have to run when applying for mutual recognition (MR) applications. Agreement on the required scenario(s) by the Member States involved, is intended to facilitate the MR process, reduce requirement differences between MS as much as possible and hence reduce the burden of work for both applicants and CAs.

Comparable work has been carried out (and is still ongoing) on harmonisation of the saltwater pleasure craft marina scenarios, led by UK, and discussed at several WGs after initiation of discussions at AHEE-1 [2].

A working plan was presented at WG II ENV in March 2017. See document WGII2017_ENV_7-5_PT21_harmonised freshwater scenarios_C.docx [3]. After WG II 2017 this working plan was slightly adapted and circulated between ECHA and the MS that had indicated their interest to participate in the development process. At WG III ENV 2017, the first results were presented and discussed: WGIII2017_ENV_8-6b_Analysis of fw marina scenarios_C.docx [4]. General agreement was reached on the results presented and the WG agreed to proceed towards development of substance specific Excel spreadsheets for freshwater to be used in regulatory assessments.

This document is an updated version of the document presented at WG III ENV 2017. Issues solved are the zero PEC outcomes that were observed in some of the marinas (see section 2.3.2 in the WG III version of this document). This has led to a slightly different and reduced marina data set, which is explained in section 2.1.1. As a consequence of these changes, calculations needed to be repeated.

The current document reflects these changes.

2. Methods

2.1 Data collection

Five MS CAs submitted data on freshwater marinas in the format that was provided within document WGII2017_ENV_7-5_PT21_harmonised freshwater scenarios. In total, a set of 50 freshwater marinas was compiled containing marinas from Austria (7), Switzerland (9), Germany (10), The Netherlands (19) and the United Kingdom (5).

2.1.1 Repair of MAMPEC zero outcomes

In the previous version of this document WGIII2017_ENV_8-6b_Analysis of fw marina scenarios_C.docx [4], we described that MAMPEC returned a PEC value of zero for some marinas. There were two different types of zero outcomes, both with a different cause.

The first type of zero PECs were $PEC_{sediment}$ values being zero. This occurred in three marinas: nrs. 20 (DE21-1), 27 (DE46-1) and 29 (DE38-1), and were caused by a POC (particulate organic carbon) concentration of 0 mg/L in the data set. As can be inferred from section 6.5 in the MAMPEC Handbook [5], the POC concentration in water is used in the calculation of $PEC_{sediment}$. The solution was therefore, to replace the POC values of 0 mg/L with a meaningful value. DE proposed, after reviewing their data set, to replace the zero values with a POC concentration of 0.1 mg/L, representing half of the lowest POC value which was observed in the DE data. This adaption would ensure that $PEC_{sediment}$ values may be derived for these marinas while ensuring that as much site specific information as possible could be retained in order to take the difference between each site into account.

The second type of zero PECs occurred only in the surrounding environment. This happened with 4 marinas: nr. 8 (CH1), 15 (CH8), 16 (CH9) and 33 (NL5). We discussed this with MAMPEC modellers and they concluded that this is likely caused by a bug/error in the software. The lateral diffusion coefficient D_y has an unexpected limit value or is unjustly rounded. The error occurs when there is only wind driven exchange at very low total exchange (<1%). This issue is currently under investigation at Deltares and an updated version of the software is likely to be released this year (2017). Since the update would not be ready in time for this project, it had to be decided to exclude the four marinas from the data set. Maintaining the PEC outcomes inside the marina in that PEC distribution was not a valid option, since the PEC inside the marina will change once lateral diffusion is taken into account correctly.

This effectively reduced the data set to a total of 46 freshwater marinas.

2.2 Creating MAMPEC 'Environments

The compiled data submitted by the MS CA experts and the MAMPEC Environments that were created based on these data are provided in Appendix B. Details provided by MS experts on the selection procedure for the submitted marina data are also included in Appendix B.

The current section describes further details on how the marina data were entered in MAMPEC to create the 'Environments' used for modelling.

2.2.1 Hydrodynamic input parameters

Tidal period was set to 12.41 h for all marinas which is already default in the MAMPEC OECD-EU marina scenario. Of the 46 marinas for which data were collected, one was characterised with a tidal difference (0.63 m for Freshwater marina 49–UK nr.1). All other marinas were freshwater marinas without tidal influence. The values for the hydrodynamics parameters 'maximum tidal density difference' and 'non tidal daily water level change' were zero for all 46 marinas. Flow velocity in the water adjacent to the marina was zero for 13 out of the 46 marinas, 10 of these marinas bordered a large lake, while 3 marinas (AT) are located along the river Danube. The distribution of flow velocity values for the remaining 33 marinas is shown graphically in Figure 1.

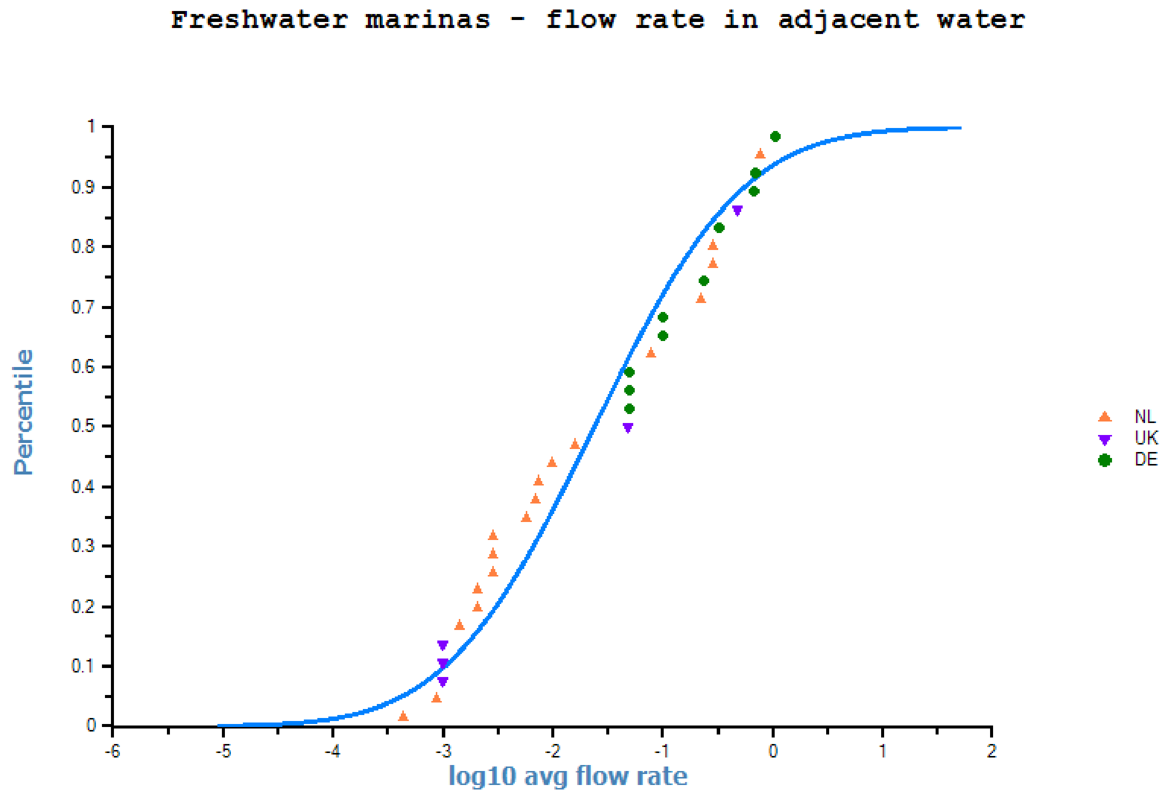


Figure 1. Log_{10} normal distribution of flow rates in adjacent waters available for 33 of 46 freshwater marina scenarios. For 13 marinas a flow rate of 0 m/s was submitted, these data are not shown since zero values do not exist in a logarithmic distribution.

It is noted that flow velocity is an important parameter in the exposure assessment for marinas that have no tidal exchange, since flow velocity, together with wind driven exchange and the marina geometry, are the parameters that influence exchange of water inside the marina with the adjacent water body. The highest flow rate was 1.07 m/s, the lowest value 4.4×10^{-4} m/s.

2.2.2 Water characteristics

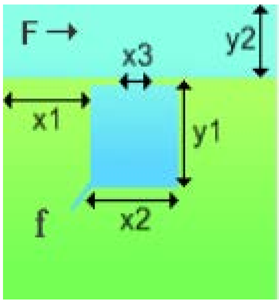
The specific values used for the water characteristics parameters (SPM, POC, DOC, chlorophyll, salinity, pH) for each marina can be seen in the Excel file embedded in Appendix B (FreshwaterMarinaData_EU_v2.xlsx). In the analysis performed on saltwater marina scenarios [2] (Table 2 therein), an average value was used per parameter for all marinas within one region, e.g. an average of 3.2 mg DOC/L was used for all 47 Atlantic marinas, an average of 31 psu (salinity) was used for all 47 Atlantic marinas, etc.

This is different in the current freshwater analysis. Some MS provided specific values for each of the six parameters for each marina, whereas others submitted average values per parameter, as done for the saltwater marina analysis. The final data set is therefore a mix of aggregated (average) values for a specific Member State and of specific values per marina.

2.2.3 Marina lay out

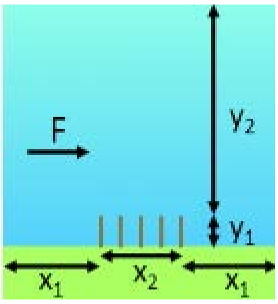
Of the marina data submitted, 45 were of the enclosed type that corresponds with the Environment 'Marina' in MAMPEC. One marina in the UK data set (nr. 3), is an open type marina, for which the Environment 'Open harbour' was used.

MAMPEC Environment type 'Marina'



Marina length (x2), width (y1), mouth width (x3) and width of the adjacent water (y2) were provided by the MS experts. x1 was kept equal to x2 in all marinas. This corresponds with earlier analyses performed on saltwater marinas [2]. In contrast to saltwater marinas that often border large water bodies, freshwater marinas may more often be situated along smaller water bodies (e.g. canals, rivers). The MAMPEC manual [6] (v. 3.1, p. 16) advises to round off x1, y1 and y2 to 'at least 10 m'. We interpret that this means that the lower limit is also 10 m. The manual also advises for the Environment type 'marina', y2 should be set to y1 or 50% of y1. However, for many marinas, the real value of y2 was smaller than the marina width y1 or even smaller than 0.5*y1. In order not to compromise these situations, we used the realistic value for y2 even if it was <0.5*y1. None of the marinas submitted had values for y2 below 10 m.

MAMPEC Environment type 'Open harbour'



For the one open type marina (Open harbour in MAMPEC), the advised maximum ratio of y2/y1 is limited by a factor of 4 (MAMPEC manual [6]). For the UK marina nr. 3, this ratio was slightly exceeded by the dimensions provided (y1=50.5 m, y2=210.56 m), hence y2 was set at 4x50.5=202 m.

The correctness of data entry in the 46 MAMPEC Environments was checked by exporting all MAMPEC environments to a .csv file. Ratios of all values in this export file and corresponding values in the Excel table with all marina data submitted by MS experts were calculated. Entry errors were shown by ratios ≠ 1, which were repaired and a new export file was compared again with the original data. In some instances, small differences in ratios remained (deviations from 1 were <0.01) due to the fact that rounded values were entered in MAMPEC, while original values may have had more digits, e.g. an SPM concentration entered as 0.33 while the provided value was 0.32942.

2.2.4 Wind and flush

Most MS (AT, CH, DE, NL) submitted an average wind speed which was set equal for all marinas submitted per MS, as well as one value for 'fraction of time perpendicular', i.e. the fraction of time the wind is perpendicular to the marina mouth. The UK submitted some more detail in these parameters and provided different values per marina.

There was only one marina (Freshwater marina 13-CH6) for which a 'flush' was present in the geometry. In MAMPEC terms, this means that a small stream is entering the marina and the flow rate f (m^3/s) for this stream should be entered. For all other 45 marinas, no flush stream was present and f was set at zero.

2.2.5 Existing regulatory freshwater marina scenarios

Two extra freshwater marina scenarios were created in MAMPEC: the Swiss scenario that is described in section 4.5.3 of OECD ESD Nr. 13 for PT21 [7] and the scenario that is currently used for product authorisation in the Netherlands. The latter scenario is described in section 3.3 of Van der Meulen et al [8].

Since the Swiss scenario parametrisation was presented for a much older version of MAMPEC, some parameters currently requested in MAMPEC are not reported in the OECD ESD. These parameters are indicated with a footnote in the table below, the note describes how this data gap was filled.

Table 1. MAMPEC Environment files for OECD-Swiss and NL scenarios.

Category	Parameter	Unit	OECD Swiss scenario	NL scenario
Hydrodynamics	Tidal period	h	12.4	12.41
	Tidal difference	m	0.1	0
	Max. density difference tide	kg/m^3	0	0
	Non tidal water level change	m	0[a]	0
	Flow velocity	m/s	0	0.2
Water characteristics	SPM concentration	mg/L	35	8
	POC concentration	mg/L	1.0	0.53
	DOC concentration	mg/L	5.1[b]	5.6
	Chlorophyll	µg/L	0.0037[c]	5
	Salinity	psu	0	0.2
	Temperature	°C	15	12
	pH		8	8
Lay out	Length x1	m	50	125
	Length x2	m	50	125
	Width y1	m	100	131
	Width y2	m	100	131
	Depth	m	2	2.2
	Mouth width x3	m	10	26
General	Latitude	°	47[d]	50
	Cloud coverage		5[e]	0[e]
Sediment	Depth mixed sediment layer	m	0.03[f]	0.03
	Sediment density	kg/m^3	1000[f]	1000

Category	Parameter	Unit	OECD Swiss scenario	NL scenario
	Degr. Organic carbon in sediment	/d	0[f]	0
	Nett sedimentation velocity	m/d	0.5[f]	0.5
Wind	Average wind speed	m/s	2.1[c]	3.3
	Fraction of time wind perpendicular		0.1[c]	0.1
Flush	Flush (f)	m^3/s	0	0
	Max. density difference flush	kg/m^3	0	0
Harbour lay-out data, used for density flow exchange	Height of submerged dam	m	0	0
	Width of submerged dam	m	0	0
	Depth-MSL in harbour entrance h0	m	2	2.2

Footnotes

[a] Non tidal water level change set at zero.
[b] The DOC concentration was calculated by multiplying the POC concentration of 1 mg/L with the ratio of mean values for DOC and POC from the Swiss data provided for this exercise:
DOC = 1×1.70/0.33 = 5.1 mg/L
[c] Parameter value set equal to that in Swiss data provided for this exercise.
[d] Northern latitude of 47° entered, representative for the middle of Switzerland (Lake Lucerne).
[e] A value for cloud coverage was missing in both scenario descriptions. A value of 5 was entered for the OECD Swiss scenario as this is the value selected in the other freshwater Environments, a value of 0 was used for the NL scenario as this value is currently used at NL national level.
[f] Parameter values set equal to the other freshwater Environments.

Table 2. MAMPEC Emission files for OECD-Swiss and NL scenarios.

Category	Parameter	Unit	OECD Swiss scenario	NL scenario
Calculate emission – Service life	Length class	m	0-10	8.9
	Surface area	m^2	10	17.8
	Nr. ships at berth	/d	75	218
	Nr. ships moving	/d	0	0
	Application factor	%	50	90
Calculate emission – Application / removal	List of parameters for application and removal of antifouling paints		All parameters set to zero	All parameters set to zero
Other	Dummy leaching rate (at berth)	$\mu g/cm^2/d$	2.5	2.5
	Dummy leaching rate (moving)	$\mu g/cm^2/d$	2.5	2.5
	Dummy emission from ships at berth	g/d	9.375[a]	87.309[b]

Footnotes

[a] $Elocal_{water}$, following OECD ESD Nr. 13: $75 \times 10 \times 2.5 \times 10^{-2} 0.5$ = 9.375 g/d.
[b] $Elocal_{water}$, following OECD ESD Nr. 13: $218 \times 17.8 \times 2.5 \times 10^{-2} 0.9$ = 87.309 g/d.

2.3 MAMPEC runs and data treatment

2.3.1 MAMPEC

MAMPEC modelling was performed similar to the analysis of regional saltwater pleasure craft marina scenarios, performed by the UK CA [2].

We used MAMPEC v3.1 [9] for all analyses. Within the Multiple Run option in MAMPEC, we combined the 46 'Environments' created as described in the previous section, with two contrasting dummy substances that were already available as 'Compound' files in MAMPEC: one rapidly degrading substance (dichlofluanid) and one persistent compound (irgarol). The file Dummy_100_boats_emission developed by the UK CA for the saltwater marina analysis was used as 'Emission' scenario. This scenario contains 100 boats with a default surface area of 30.7 m^2 in the length class 1-50 m, a dummy leaching rate of 2.5 µg/cm^2/d and an application factor of 0.9. Added is a daily load of 69.075 g/d for $Elocal_{water}$, i.e. the emission from ships at berth. This value was calculated following OECD ESD Nr. 13 [7]:

$$Elocal_{water} = AREA_{ship} \cdot N_{ship,\,berth} \cdot Fappl \cdot kleach$$

with $30.7 \times 100 \times 0.9 \times 2.5 \times 10^{-2} = 69.075$. Note that the leaching rate needs to be converted to units of g/m^2/d, it therefore has the value of 2.5×10^{-2}. The generic use of 100 boats allows easy use of the multiple run option in MAMPEC. The resulting PEC values have to be corrected for the specific nr of boats (berths) for each marina upon processing the data in Excel (post MAMPEC).

In addition to the collected EU marina scenarios, the appended OECD Swiss freshwater marina scenario and the Dutch national marina scenario were run in MAMPEC. For these scenarios separate Emission files were created. Input parameters are shown in Table 2.

2.3.2 Data treatment

Results of the MAMPEC runs were exported as .csv files and from these, the average freely dissolved concentration (µg/L) for both inside the marina and in the surrounding area was transferred to an Excel spreadsheet. This resulted in an array of 46 PEC values. Cumulative probability distributions were constructed from the results. The three goodness-of-fit tests contained in the Webfram (https://webfram.com) software were applied to the distributions of exposure concentrations: Anderson Darling, Kolmogorov-Smirnov, Cramer von Mises. These tests indicate whether the data are log normally distributed. A graph showing the cumulative distribution of the log normally transformed data was constructed using ETX 2.1 software. The 50th and 90th percentile of the non-transformed data were calculated using the PECENTILE.INC function included in Microsoft Excel™. The PECs inside and outside the marina, calculated for the appended OECD Swiss and NL national scenario were expressed as percentile of the PEC distribution of the 46 EU PEC values.

Characteristics of each distribution calculated within Excel are the minimum, maximum, their ratio, arithmetic mean, the 50th and the 90th percentile. It was also determined which individual marina was closest to the 90th percentile.

For the two single 'regulatory' marina scenarios (appended OECD Swiss scenario and NL national scenario), we calculated
1) the percentile of the distribution that corresponded with the PEC of the single marina

scenario,
2) the number of marinas from the distribution that had a PEC higher than the PEC from the regulatory scenario, and 3) the ratio between the 90^{th} percentile of the distribution and the PEC from the regulatory scenario.

2.4 Limitations of the work

Marinas occur in a wide variety of shapes or geometries. The marina Environments that can be modelled with MAMPEC are limited to rectangular shapes. E.g. marinas with two harbour mouths are regularly encountered in reality, but cannot be modelled. Also, the shape of marinas is not often rectangular, but (e.g.) curved, with one or more skewed sides, with elongated entries, etc. For modelling in MAMPEC, the dimensions have to be 'reduced' to that of a rectangle or the marinas have to be left out of the modelling.

During the Dutch selection procedure of freshwater marinas it was very regularly observed that marinas do not occur in isolation That is, marinas in the Netherlands are often clustered or even 'direct neighbours' and connected to –and thus emitting to- the same adjacent water. In the NL data set this occurred for 27 of 42 marinas. This is also described for Berlin, Germany by Daehne et al. [10]. This aspect is currently not addressed in this approach. Would this be taken into account in the modelling, it is expected that this will rather lead to increased concentrations in the adjacent waters than to increased concentrations within marinas.

Obtaining values representative for water characteristics parameters per marina is challenging although in many EU Member States, monitoring programmes are in place from which these data can be extracted. As it will be difficult to provide specific values for each marina, an averaging approach needs to be applied. Using the same –average- value for a range of marinas will reduce some of the variation in calculated PEC values with MAMPEC analyses. However, for freshwater marinas without tidal exchange, the flow rate of the adjacent water is probably one of the more influential parameters. We have accepted and used the data submitted by MS experts since it would not be possible within the time frame of this project to derive data sets with detailed site specific information for all marinas.

We cite the conclusion drawn by the UK CA [2] as it also applies to the work presented in this paper: 'However it should be noted that this further supports the idea that these simulations should be considered as representing more virtual scenarios rather than being accurate representations of any of the named scenarios. No formal 'validation' of model parameters was undertaken as part of this work. The results here should therefore be considered a form of blind simulation, with no detailed calibration or parameterisation performed.'

Only one open type marina was present in the current data set. It is expected that open marinas will be flushed more easily, resulting in high exchange volumes and lower concentrations inside the marina. The current data set represents a set of marinas with a more or less closed geometry, which is likely to be a conservative population of all marinas that can be modelled within MAMPEC.

It should be realised that the current construction of a distribution of PECs is not so much a neat approximation of reality, but rather gives more insight in the distribution of exposure concentrations modelled with the same assessment tool (MAMPEC) but taking account of the greater diversity in geometry, hydrology and water characteristics. It thus provides a better insight as to where a realistic worst-case PEC estimate lies when taking variations in marinas into account. In addition, it provides the possibility to illustrate how a fixed regulatory scenario performs against this distribution.

Within the time frame available and the work plan as proposed, a comparison of the modelled concentrations with monitored concentrations was not foreseen.

2.5 Adaptations post WG III

- POC values of 0 mg/L in marinas 20 (DE21-1), 27 (DE46-1) and 29 (DE38-1) were set to 0.1 mg/L (see section 2.1.1).
- Four marinas were removed from the data set: 8 (CH1), 15 (CH8), 16 (CH9) and 33 (NL5) (see section 2.1.1).

3. Results

3.1 General results

Table 3 shows the results of the MAMPEC modelling of the 46 European freshwater marinas and the two regulatory scenarios (appended OECD Swiss scenario and NL scenario). Summary statistics and calculated percentiles are shown at the bottom of the table. The corresponding PEC distributions are presented in Figure 2-Figure 5.

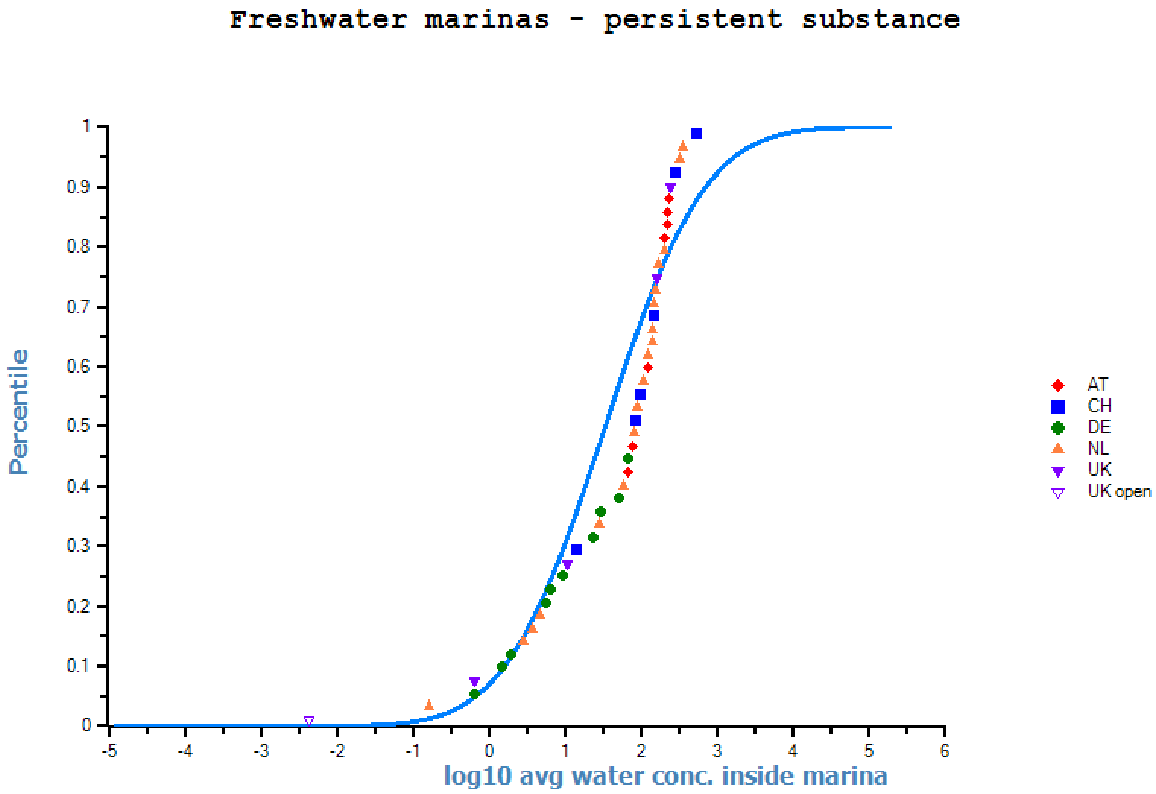
The Excel file with outcomes and calculations presented in Table 3 is included as a link.

https://echa.europa.eu/documents/10162/23464933/WGIV2017_ENV_8-8_Analysis_of_marina_scenarios_INFOpag12.xlsx

Table 3. Results of MAMPEC 3.1 modelling for the freshwater marinas (exposure values represent the average total steady state concentration).

Scenario	PEC_{water} inside marina (µg/l)	PEC_{water} surrounding marina (µg/l)	PEC_{water} inside marina (µg/l)	PEC_{water} surrounding marina (µg/l)
	Persistent compound		Rapidly degrading compound	
OECD Swiss marina (appended)	9.32E+00	9.04E-04	6.58E-02	3.05E-05
NL national scenario	3.04E+00	5.52E-03	1.84E-01	7.64E-04
Freshwater marina 1 (AT1)	2.25E+02	9.28E-03	6.18E-01	1.20E-04
Freshwater marina 2 (AT2)	2.25E+02	1.46E-02	6.92E-01	2.09E-04
Freshwater marina 3 (AT3)	6.65E+01	2.10E-02	9.46E-01	1.17E-03
Freshwater marina 4 (AT4)	2.35E+02	3.75E-02	8.60E-01	6.02E-04
Freshwater marina 5 (AT5)	7.73E+01	2.66E-03	6.90E-01	1.11E-04
Freshwater marina 6 (AT6)	2.07E+02	3.02E-03	4.52E-01	2.82E-05
Freshwater marina 7 (AT7)	1.22E+02	9.95E-03	5.34E-01	2.18E-04
Freshwater marina 9 (CH2)	9.79E+01	6.39E-04	1.53E-01	2.28E-06
Freshwater marina 10 (CH3)	1.45E+02	1.40E-03	2.71E-01	8.94E-06
Freshwater marina 12 (CH5)	8.45E+01	6.68E-04	1.67E-01	4.98E-06
Freshwater marina 13 (CH6)	1.43E+01	1.35E-03	2.32E-01	8.44E-05
Freshwater marina 18 (CH11)	5.42E+02	5.79E-04	8.93E-01	1.35E-05
Freshwater marina 19 (CH12)	2.82E+02	4.49E-03	4.59E-01	1.31E-05
Freshwater marina 20 (DE21-1)	5.09E+01	6.07E-03	1.88E-01	1.18E-04
Freshwater marina 21 (DE22-1)	5.50E+00	1.81E-03	2.05E-01	1.96E-04
Freshwater marina 22 (DE43-1)	6.84E+01	7.49E-03	1.54E-01	5.75E-05
Freshwater marina 23 (DE49-1)	2.31E+01	3.55E-03	4.71E-02	1.90E-05
Freshwater marina 24 (DE19-1)	1.91E+00	2.59E-04	5.84E-03	3.89E-06
Freshwater marina 25 (DE45-1)	1.49E+00	2.75E-03	3.96E-02	2.22E-04
Freshwater marina 26 (DE33-1)	6.49E+00	5.99E-03	3.02E-01	7.44E-04
Freshwater marina 27 (DE46-1)	9.23E+00	1.11E-03	4.05E-02	2.26E-05
Freshwater marina 28 (DE50-1)	2.88E+01	5.63E-03	3.91E-01	3.12E-04
Freshwater marina 29 (DE38-1)	6.45E-01	1.02E-03	1.59E-01	3.55E-04
Freshwater marina 30 (NL1)	2.03E+02	1.38E-02	7.66E-01	2.65E-04
Freshwater marina 31 (NL3)	1.55E+02	2.69E-03	3.60E-01	2.87E-05
Freshwater marina 32 (NL4)	3.22E+02	5.23E-03	8.08E-01	5.67E-05
Freshwater marina 34 (NL6)	1.22E+02	1.09E-02	3.57E-01	1.40E-04
Freshwater marina 35 (NL7)	5.81E+01	2.34E-03	4.45E-01	8.47E-05
Freshwater marina 36 (NL8)	8.17E+01	1.03E-02	4.22E-01	2.71E-04
Freshwater marina 37 (NL14)	1.50E+02	9.86E-03	4.80E-01	1.52E-04
Freshwater marina 38 (NL17)	1.66E-01	9.60E-04	3.16E-02	2.70E-04
Freshwater marina 39 (NL21)	2.79E+01	9.55E-03	2.93E-01	4.25E-04

Scenario	**PEC$_{water}$ inside marina (µg/l)**	**PEC$_{water}$ surrounding marina (µg/l)**	**PEC$_{water}$ inside marina (µg/l)**	**PEC$_{water}$ surrounding marina (µg/l)**
Freshwater marina 40 (NL26)	1.41E+02	5.32E-03	2.36E-01	1.59E-05
Freshwater marina 41 (NL30)	3.52E+02	3.61E-03	6.33E-01	2.52E-05
Freshwater marina 42 (NL34)	1.40E+02	1.41E-02	2.65E-01	6.06E-05
Freshwater marina 43 (NL40)	4.65E+00	7.33E-03	1.96E-01	8.09E-04
Freshwater marina 44 (NL42)	3.72E+00	1.08E-02	3.13E-01	1.82E-03
Freshwater marina 45 (NL44)	1.68E+02	9.76E-03	3.24E-01	6.64E-05
Freshwater marina 46 (NL45)	2.81E+00	5.62E-03	2.70E-01	1.05E-03
Freshwater marina 47 (NL46)	8.82E+01	1.50E-03	1.53E-01	6.53E-06
Freshwater marina 48 (NL48)	1.08E+02	4.38E-03	2.55E-01	4.69E-05
Freshwater marina 49 (UK1)	6.57E-01	1.22E-03	2.05E-01	4.95E-04
Freshwater marina 50 (UK2)	1.63E+02	1.47E-03	2.63E-01	3.69E-06
Freshwater marina 51 (UK3)	4.23E-03	2.52E-04	4.14E-03	2.46E-04
Freshwater marina 52 (UK4)	1.09E+01	3.30E-03	5.18E-01	4.16E-04
Freshwater marina 53 (UK5)	2.47E+02	6.17E-04	4.90E-01	4.51E-06
Summary	**Persistent compound**		**Rapidly degrading compound**	
n (PECs, zero values excluded)	46	46	46	46
maximum	542	3.75E-02	0.946	1.82E-03
minimum	4.23E-03	2.52E-04	4.14E-03	2.28E-06
ratio maximum/minimum	128038	149	228	796
arithmetic mean	110	6.04E-03	0.361	2.48E-04
50th percentile	83.1	4.00E-03	0.298	1.14E-04
90th percentile	241	1.23E-02	0.729	6.73E-04
Marina closest to 90th percentile	marina 4 (AT4)	marina 34 (NL6)	marina 2(AT2)	marina 4 (AT4)
percentile represented by appended OECD Swiss scenario	25	13	12	31
nr of marinas with PEC> appended OECD Swiss scenario	34	40	40	31
ratio between 90 P and appended OECD Swiss scenario	26	14	11	22
percentile represented by NL scenario	14	59	24	92
nr of marinas with PEC>NL scenario	39	19	35	4.0
ratio between 90 P and PEC NL scenario	79	2.2	4.0	0.88



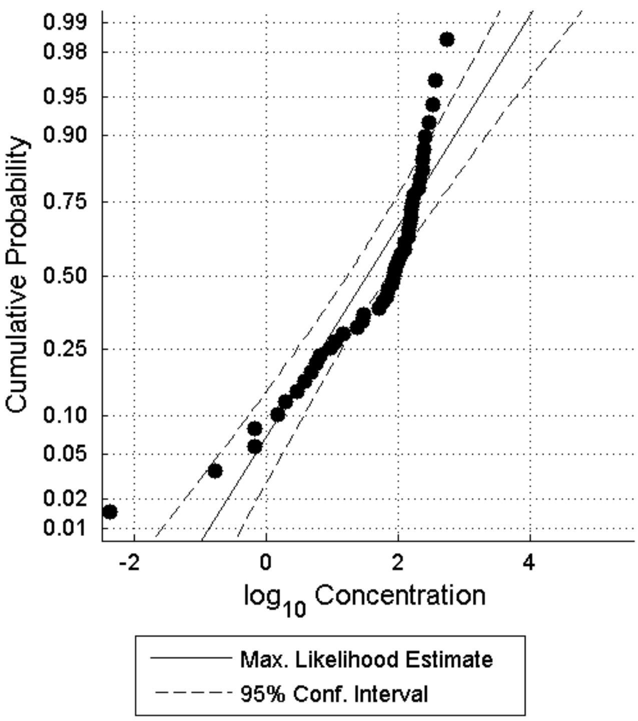
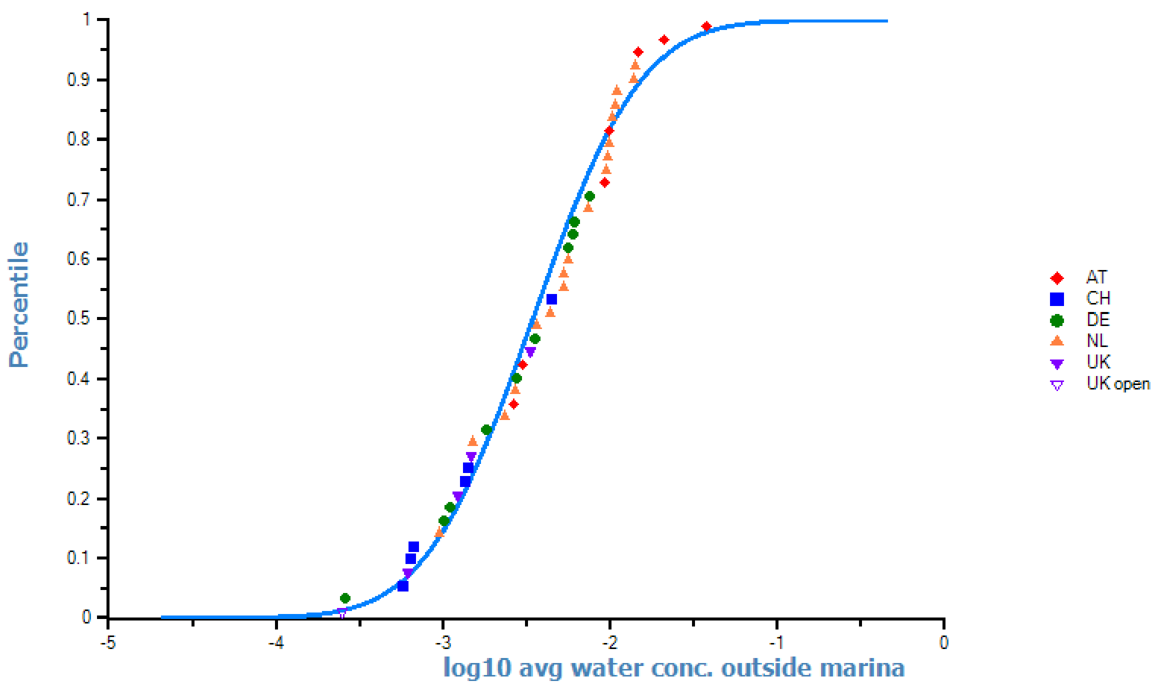


Figure 2. PECs for 46 freshwater marina scenarios and log normal distribution. Shown are the results for the average dissolved concentration inside the marina for the persistent substance.

Freshwater marinas - persistent substance



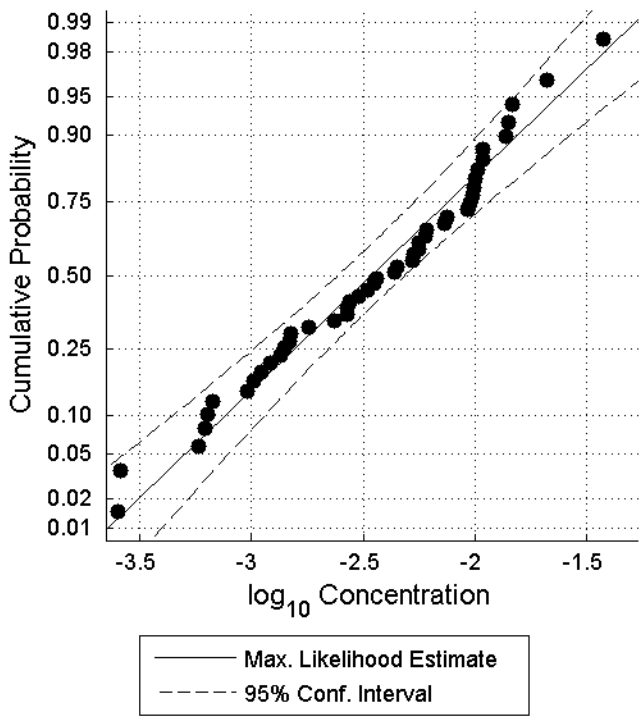
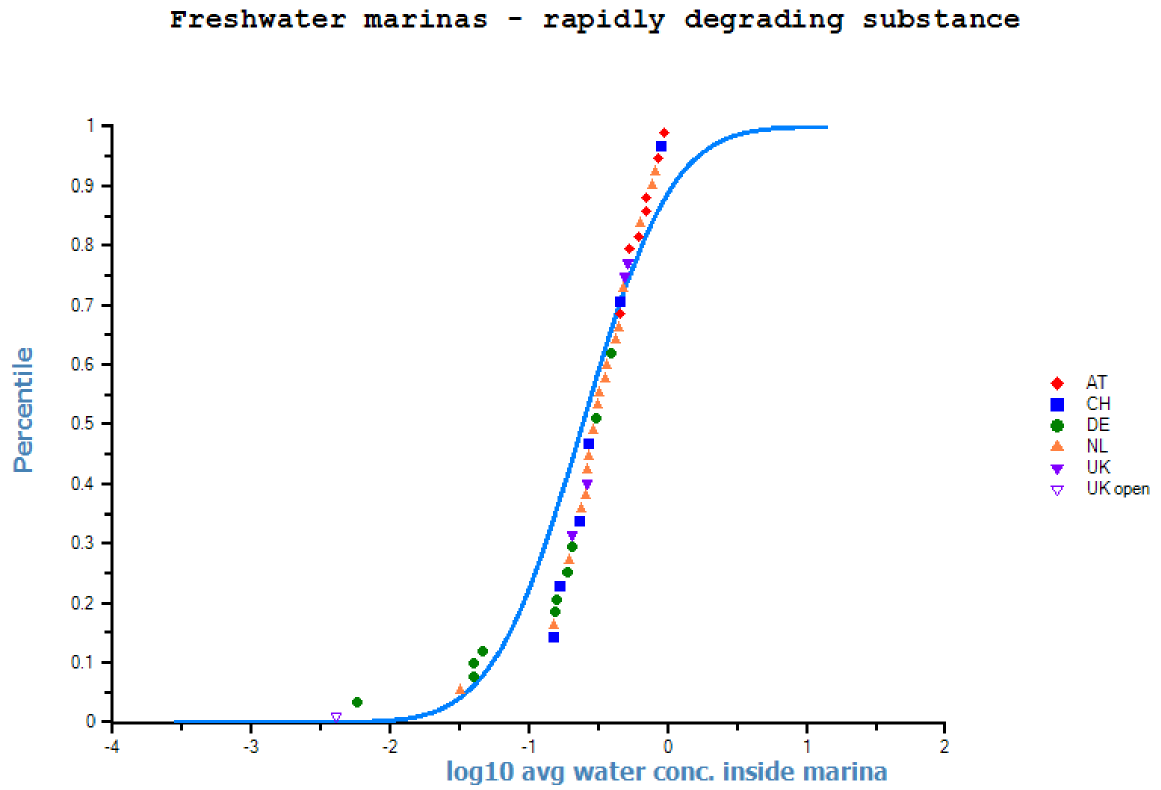


Figure 3. PECs for 46 freshwater marina scenarios and log normal distribution. Shown are the results for the average dissolved concentration outside the marina for the persistent substance.



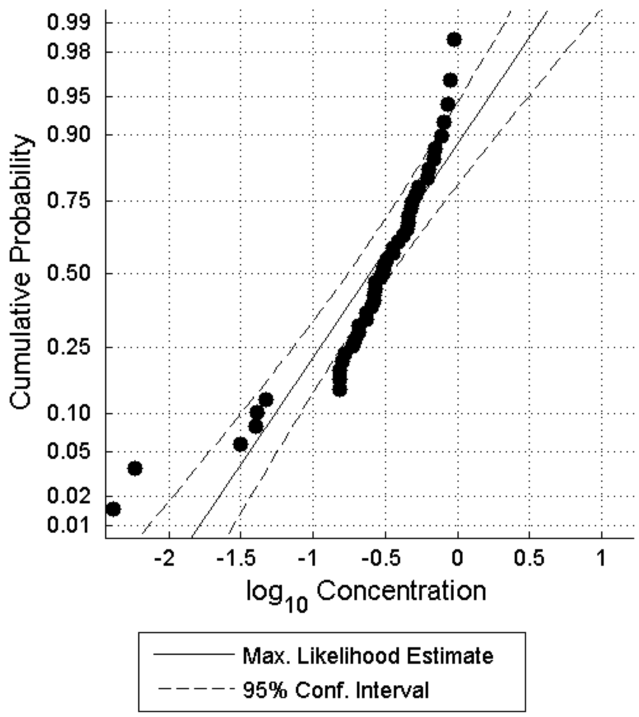


Figure 4. PECs for 46 freshwater marina scenarios and log normal distribution. Shown are the results for the average dissolved concentration inside the marina for the rapidly degrading substance.

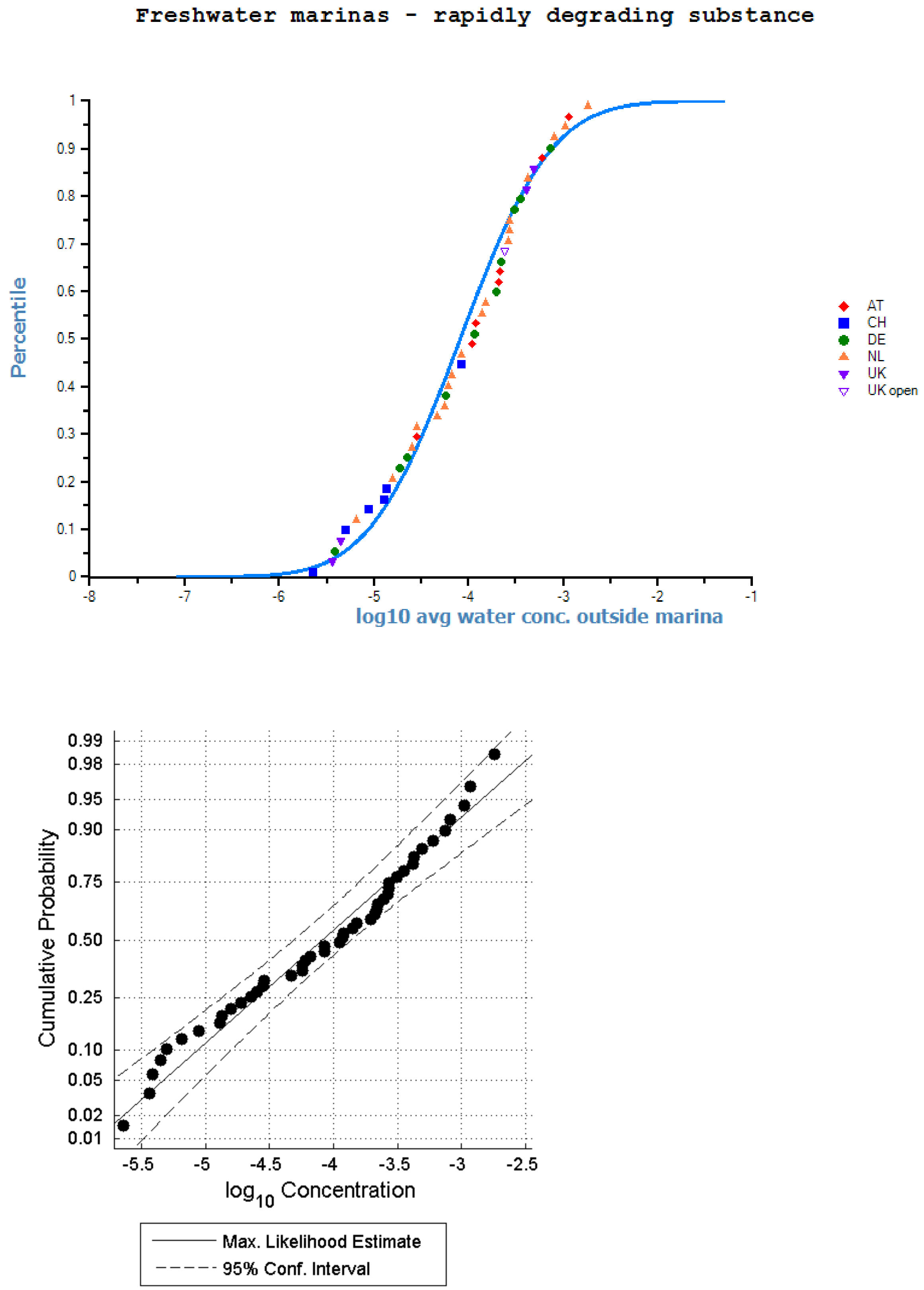


Figure 5. PECs for 46 freshwater marina scenarios and log normal distribution. Shown are the results for the average dissolved concentration outside the marina for the rapidly degrading substance.

3.2 Goodness of fit

Visual inspection of the four distributions (Figure 2-Figure 5) shows that a log normal distribution fits the distributions of PEC outside the marina better than the distribution of PECs inside the marinas. This is confirmed by goodness of fit testing for a log normal distribution of the PEC data, which resulted in a rejection of normality at all levels of significance in all three normality tests for the log normal distribution of PECs inside the marinas for both compounds, i.e. Figure 2 and Figure 4. Both distributions of PECs outside the marina passed all three normality tests at all levels of significance, illustrated by Figure 3 and Figure 5. We have looked qualitatively for an explanation of the shape of the PEC distributions inside the marina, e.g. for the persistent compound, a bimodal seems apparent. However, we could not find an explanation (such as a combination of one or more marina parameters) explaining the shape. See also section 4.2. Due to this result, we propose that percentiles from these distributions should be drawn from the raw PEC data using standard percentile functions from Excel rather than calculating percentiles assuming a normal distribution. In cases where the data are log normally distributed (e.g. Figure 5, Webfram plot) the calculation of percentiles from the fitted log normal distribution will usually result in acceptable estimates. However, this is not the case when (log) normality is rejected. In order to have a common approach we choose to use the (Excel) standard rank percentile functions in all cases. It is noted that the calculation of percentiles is subject of an WG e-consultation.

3.3 General observations

The ratio of concentrations inside the marina versus those in the surrounding area calculated for the 50th percentile are 20,794 for the persistent and 2,605 for the rapidly degrading compound, clearly indicating accumulation within the marina. The minimum and maximum of the inside/outside ratio are 17 and 936,000 for the persistent compound, whereas these are 17 and 109,000 for the rapidly degrading substance. The relatively high ratios are likely to be a consequence of the absence of tidal exchange in the environment of the modelled marinas. Exchange can only be caused by flow of the adjacent water and wind driven exchange. A relatively open geometry (wide harbour mouth) will also result in higher exchange volumes.

The distribution of PECs inside the marina for the persistent compound is broad, PECs span more than five orders of magnitude. The PEC distribution for the rapidly degrading compound inside the marinas spans a factor of 228, much narrower than that for the persistent compound. Concentrations outside the marina span a factor of roughly 150 for the persistent compound and a factor of 800 for the rapidly degrading substance.

3.4 Open type geometry marina and flushed marina

The single open type marina that was included in the analysis (Marina 51 (UK3)) results in the lowest PEC value inside the marina for both the persistent and the rapidly degrading compound (Figure 2 and Figure 4, respectively). For the rapidly degrading substance, one enclosed marina (DE marina nr. 24 (DE19-1) has nearly the same PEC value inside the marina. With respect to concentrations in the surrounding area for the persistent compound, the open marina again has the lowest PEC (Figure 3) also accompanied by DE marina nr. 24. This is not the case for PECs in the surrounding area for the rapidly degrading compound, where the open marina has a PEC around the 69th percentile (Figure 5). The low PEC values 'inside' for an open type marina are not surprising, as exchange by both flow of adjacent water as well as wind driven exchange in this type of marinas is maximal. This is also illustrated by the ratio between the concentration inside and outside the marina which is the lowest for the open marina for both substances: a factor of 17. All other marinas have higher inside/outside ratios, ranging from 173 to 900,000 for the persistent compound and from 117 to 100,000 for the rapidly degrading compound.

The PEC in the flushed marina (marina 13-CH6) represents the 29th and 33rd percentile of the distribution of PECs inside the marina for the persistent and rapidly degrading substance, respectively. This was the 22nd and 44th percentile for the distribution of PECs outside the marina. We conclude that based on this single exercise, the single flushed marina cannot be stated to results in strongly deviating PECs.

3.5 PECs in sediment

With respect to PECs in sediment, the same conclusions apply as pointed out by the UK CA for the saltwater marina analysis: "It should be noted that all of the above results and subsequent analyses are based on surface water concentrations only. No detailed analysis of sediment concentrations has been undertaken here. However since the PECsediment concentrations based on suspended matter are derived assuming instantaneous partitioning from the water phase concentrations, the $PEC_{sediment}$ values are perfectly correlated with the PEC_{water} values. Therefore the UK CA considers that any conclusions based on the surface water values can be directly read across to the sediment values." This is illustrated by Figure 5 in the document on saltwater pleasure craft marina scenario development (WGI2017_ENV_7_2b(i)_Analysis of marina scenarios.doc).

4. Discussion

4.1 Water characteristics

The 'ideal', realistic dataset would contain a specific value for each parameter for each marina. However, most of these parameters fluctuate during the year and over the years, so each value would need to be an average based on a longer term monitoring series. As it is extremely unlikely that such long-term monitoring series are available for the specific locations (i.e. within each marina), these data need to be approximated by values measured in water bodies considered representative for the selected marinas. Without a well-based data set on these parameters both over time and across the EU waters covered, an in depth analysis of these data is not possible. This was also not foreseen within the time frame of this project. For the current project, we consider that the data provided by the MS experts adequately represent average values for the six parameters (SPM, POC, DOC, chlorophyll, salinity, pH) for each marina. In addition, the effect of variation of each of the six parameters on PECs inside and outside the marinas may be relatively minor in comparison to parameters such as tide, flow rate and geometry.

4.2 Correlation between PECs and marina parameters

4.2.1 Correlation coefficients

The four series of computed PEC values (see Table 3) for the two dummy substances were investigated for correlation with marina characteristics. We used GraphPad Prism software [11] for these analyses. The marina parameters selected for analysis were: flow rate (values as submitted by experts), SPM, DOC, chlorophyll, salinity, pH, marina volume and mouth width. Marina volume was calculated as x2*y1*depth using the specific values per marina provided by the MS experts.

To decide between calculating correlation on a parametric or nonparametric basis, we first determined for all data sets whether they followed a Gaussian distribution, by using the D'Agostino & Pearson, Shapiro-Wilk and Kolmogorov-Smirnov tests built in in GraphPad software. None of the data sets passed any of the three normality tests, except for DOC, which passed only the D'Agostino & Pearson test and did not pass the other two tests. Gaussian distribution was not expected for these water characteristics parameters beforehand, since the data sets were often composed of the same average value for a series of marinas (section 2.2.2). Based on this outcome (non normal distribution) we calculated the nonparametric Spearman correlation coefficient (r) between each PEC and parameter combination, results are shown in Table 4.

Table 4. Spearman correlation coefficients (r) and P values for the four series of PEC values and selected marina characteristics, asterisk indicates a significant result.

		flow rate	**SPM**	**DOC**	**chlorophyll**	**salinity**	**pH**	**volume**	**mouth width**
PEC inside persistent	r	-0.696	0.0781	0.128	0.208	0.124	0.122	-0.117	-0.188
	P	<0.0001*	0.606	0.396	0.166	0.413	0.420	0.438	0.210
	n	46	46	46	46	46	46	46	46
PEC outside persistent	r	-0.0301	0.263	0.230	0.186	-0.357	0.0444	0.0587	0.0570
	P	0.842	0.0773	0.125	0.216	0.0148*	0.770	0.699	0.707
	n	46	46	46	46	46	46	46	46
PEC inside rapidly	r	-0.410	0.306	0.172	0.0211	0.216	0.0586	-0.349	-0.281
	P	0.0046*	0.0386*	0.253	0.889	0.150	0.699	0.0175*	0.0584
	n	46	46	46	46	46	46	46	46
PEC outside rapidly	r	0.199	0.154	0.105	0.141	-0.0744	-0.167	-0.154	-0.0329
	P	0.185	0.307	0.487	0.352	0.623	0.267	0.306	0.828
	n	46	46	46	46	46	46	46	46

The results show that few of the marina parameters correlate strongly with the PECs calculated. In general, correlation coefficients are low and do not approach 1 or -1, except for the value of -0.696 for flow rate and PECs inside the marina for the persistent compound. Correlation between flow rate and PEC inside the marina for the rapidly degrading substance is substantially lower (-0.410), although significant.

Five combinations show a significant correlation. The P value represents the probability that random sampling would lead to the correlation coefficient observed. This probability is low with a significant result (hence, with low P, the result is unlikely due to random sampling), but this does not necessarily mean that the data are highly correlated. The combinations showing a significant correlation are: flow rate with PEC_{inside} for both compounds, SPM with PEC_{inside} (rapidly degrading compound), salinity with $PEC_{outside}$ (persistent compound) and marina volume with PEC_{inside} (rapidly degrading compound). Plots of the five parameter sets showing a significant result are presented in Appendix C. These plots illustrate that the degree of correlation is still quite low and that there is no direct obvious relationship between PECs and the parameters, hence the order of PECs cannot be not explained from the correlation observed.

4.2.2 Flow rate ranking

Flow rate of the adjacent water is intuitively thought to be one of the more influential parameters with respect to PECs inside as well as outside the marina. A higher flow rate could mean that the marina is more easily flushed leading to a larger exchange volume than when a comparable marina would have low or zero flow in the adjacent water. At the same time, higher dilution rates are expected for the surrounding environment at higher flow rates. This expectation is indeed reflected in the correlation coefficient for the PECs inside the marina for the persistent compound (r=-0.696), but less so for the rapidly degrading compound (r=-0.410). No obvious correlation is found between flow rate and the PECs in the adjacent water for both compounds, r=-0.0301 and 0.199 for the persistent and rapidly degrading substance, respectively.

To make another, more qualitative comparison, we ordered the marinas + code from low to high flow rate and then matched the marina code with the place (rank nr.) in the PEC distribution. Results are shown in Table 5.

Various inferences can be drawn from this table, e.g. that some of the marinas with the highest flow rates do indeed end up in the lower range of PEC distributions inside the marina, for both substances. But for the rapidly degrading substance some of the marinas with higher flow rates also end up higher in the distribution, at rank 14, 36, 10, 21, 25, 24.

There are 13 marinas with a flow rate of zero (the AT and CH marinas), these are in the upper rows of Table 5. These marinas could thus be expected to represent the 13 highest PEC values, i.e. have the PEC rank numbers 38 – 50. The ranking of these 13 marinas shows that for the PEC inside the marina, only 6 of the 13 marinas with zero flow rate score within the 13 highest PECs. This number is equal for both compounds. For the PECs outside the marina, 4 (persistent compound) and 2 (rapidly degrading compound) of the marinas with zero flow rate score within the 13 highest PECs (for both compounds). It can be concluded from both analyses (correlation and ranking) that flow rate is an important parameter, but it does not solely determine the distribution. A zero (or low) flow rate of the adjacent water does not necessarily mean that the PEC inside or outside the marina will be among the highest values and vice versa: a high flow rate does not always cause the lowest PEC.

Table 5. Marinas ordered according to increasing flow rate, with their corresponding rank nr in each of the four distributions of PECs in water inside or outside of the marina. Lowest rank = lowest PEC, highest rank = highest PEC.

Marina code	Flow rate (ordered low to high) (m/s)	PECwater inside persistent rank	PECwater outside persistent rank	PECwater inside rapidly rank	PECwater outside rapidly rank
Freshwater marina 1 (AT1)	0.00E+00	39	34	38	25
Freshwater marina 2 (AT2)	0.00E+00	40	44	41	29
Freshwater marina 3 (AT3)	0.00E+00	20	45	46	45
Freshwater marina 4 (AT4)	0.00E+00	41	46	44	41
Freshwater marina 5 (AT5)	0.00E+00	22	17	40	23
Freshwater marina 6 (AT6)	0.00E+00	38	20	32	14
Freshwater marina 7 (AT7)	0.00E+00	29	38	37	30
Freshwater marina 9 (CH2)	0.00E+00	26	5	7	1
Freshwater marina 10 (CH3)	0.00E+00	32	12	22	7
Freshwater marina 12 (CH5)	0.00E+00	24	6	11	5
Freshwater marina 13 (CH6)	0.00E+00	14	11	16	21
Freshwater marina 18 (CH11)	0.00E+00	46	3	45	9
Freshwater marina 19 (CH12)	0.00E+00	43	25	33	8
Freshwater marina 40 (NL26)	4.39E-04	31	27	17	10
Freshwater marina 41 (NL30)	8.73E-04	45	23	39	13
Freshwater marina 50 (UK2)	1.00E-03	35	13	19	2
Freshwater marina 51 (UK3)	1.00E-03	1	1	1	32
Freshwater marina 53 (UK5)	1.00E-03	42	4	35	4
Freshwater marina 48 (NL48)	1.42E-03	27	24	18	16
Freshwater marina 32 (NL4)	2.05E-03	44	26	43	17
Freshwater marina 42 (NL34)	2.07E-03	30	43	20	19
Freshwater marina 47 (NL46)	2.82E-03	25	14	8	6
Freshwater marina 31 (NL3)	2.83E-03	34	18	28	15
Freshwater marina 35 (NL7)	2.87E-03	19	16	31	22
Freshwater marina 45 (NL44)	5.65E-03	36	36	26	20
Freshwater marina 34 (NL6)	6.88E-03	28	41	27	26
Freshwater marina 37 (NL14)	7.39E-03	33	37	34	27
Freshwater marina 30 (NL1)	9.77E-03	37	42	42	33
Freshwater marina 36 (NL8)	1.59E-02	23	39	30	35
Freshwater marina 49 (UK1)	4.90E-02	4	10	15	40
Freshwater marina 22 (DE43-1)	5.00E-02	21	33	9	18
Freshwater marina 23 (DE49-1)	5.00E-02	15	22	6	11
Freshwater marina 28 (DE50-1)	5.00E-02	17	29	29	36
Freshwater marina 39 (NL21)	7.71E-02	16	35	23	39
Freshwater marina 20 (DE21-1)	1.00E-01	18	31	12	24
Freshwater marina 27 (DE46-1)	1.00E-01	12	9	5	12
Freshwater marina 43 (NL40)	2.19E-01	9	32	13	43
Freshwater marina 26 (DE33-1)	2.40E-01	11	30	24	42
Freshwater marina 44 (NL42)	2.84E-01	8	40	25	46
Freshwater marina 46 (NL45)	2.91E-01	7	28	21	44
Freshwater marina 29 (DE38-1)	3.30E-01	3	8	10	37
Freshwater marina 52 (UK4)	4.72E-01	13	21	36	38
Freshwater marina 21 (DE22-1)	6.80E-01	10	15	14	28
Freshwater marina 24 (DE19-1)	7.00E-01	6	2	2	3
Freshwater marina 38 (NL17)	7.70E-01	2	7	3	34
Freshwater marina 25 (DE45-1)	1.07E+00	5	19	4	31

4.3 Applicability of regulatory scenarios - single marinas

The two known regulatory scenarios, the appended OECD Swiss scenario and the NL scenario generally represent a low percentile of the distribution of PECs inside the 46 EU marinas. The OECD Swiss scenario represented the 25th and 12th percentile of PECs inside the marina for the persistent and rapidly degrading compound, respectively. This was the 13th (persistent) and 31st (rapidly degrading) percentile of PECs outside the marina.

The NL scenario represented the 14th and the 24th percentile of the distribution of PECs inside the marinas for the persistent and rapidly degrading compound, respectively. It represented the 59th (persistent) and the 92nd (rapidly degrading) percentile of PECs outside the marina.

If the 90th percentile of the PEC distribution of the 46 EU marinas is seen as a reasonable worst-case estimate, it can be concluded that both regulatory scenarios do not represent this reasonable worst-case scenario for the estimation of the concentration inside the marina for the two compounds investigated. This is also true for the concentration outside the marina, except for the rapidly degrading substance, for which the NL marina was close to the 90th percentile.

Table 3 also shows that there is not a single marina that consistently ends up closest to the 90th percentile in the four combinations investigated, although marina nr. 4 (AT4) is closest to the 90th percentile in two cases.

These observations are comparable to what was observed for the saltwater marinas [2]. It emphasises that the variation in both marina and substance characteristics lead to a specific distribution for each combination. It seems not possible to define one marina scenario that will consistently represent a realistic worst-case exposure concentration for all situations.

5. Way forward

As stated before by the UK CA, the current approach 'captures at least some of the variability associated with exposure concentrations and the degree of protection can at least be inferred from the chosen percentile'. Based on the results presented at WG III ENV 2017, the WG ENV concluded that substance specific Excel calculation tools for freshwater marinas should be further developed based on the collected marina characteristics and scenarios.

This entails the same procedure as has recently been performed for the saltwater pleasure craft scenarios. The final Excel tools will contain a distribution of PECs for the 46 freshwater marinas based on a given substance using a default leaching rate and application factor. Agreed percentile calculations for PEC as well as the agreed PNEC will also be included in the sheet. This will be based on the conclusions of the e-consultation initiated by UK on the use of percentiles. At WG III ENV the WG further concluded that calculation sheets are needed for the same eight active substances (plus 1 metabolite) as in the saltwater marina project. With these calculator sheets, end users can calculate a product specific PEC and risk quotient, by entering product specific data on leaching rate from a measured study or from a CEPE or ISO mass balance calculation method.

The MAMPEC scenarios currently used for this WG work include only losses from the 'in service' life stage. Further to discussions held at the AHEE meeting, a question at WG ENV I 2017 was raised on this topic:
Q5: Do MS agree that the Excel tool should focus only on losses during service life and that the amended phrasing from the BPC-17 meeting can be included in the product manual to mitigate losses during application, maintenance or repair activities?
The WG concluded: 'The WG agreed that the Excel tool should focus only on losses during service life and agreed to include the amended phrasing from the BPC meeting in the product manual (mitigation losses).'

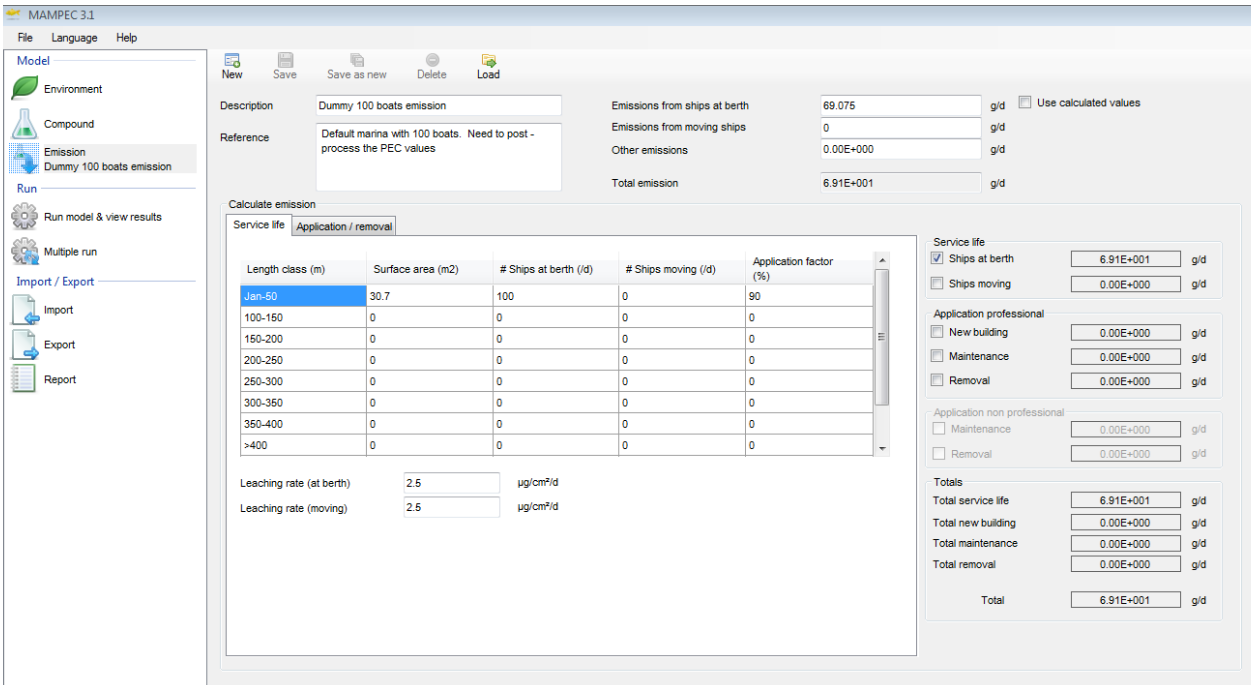
The results presented here suggest that the approach based on the 90th percentile value is likely to result in PEC estimates that are more conservative than the two regulatory scenarios used for comparison in this study. It should however be added, that up to date, there has not been an agreed or EU harmonised scenario for freshwater marinas. NL proposes that before any tools are agreed for use, the approach outlined in this document (highly comparable to the approach for saltwater marinas) and the selection of appropriate percentiles to use in regulatory decision-making should be agreed with Risk Managers.

6. References

1. ECHA (BPC AHEE). 2016. PT21 Product authorisation manual (environmental risk assessment). Draft for discussion. European Chemicals Agency. Helsinki, Finland: Report nr. AHEE-1-AP6-1 (AHEE-1-AP6-1_PT21 product authorisation manual_C.doc). 17 p.
2. ECHA (BPC AHEE). 2016. Analysis of regional pleasure craft marina scenarios and proposals for a PEC calculation tool. European Chemicals Agency. Helsinki, Finland: Report nr. WGI2017_ENV_7_2b(i)_Analysis of marina scenarios.doc. 30 p.
3. ECHA (BPC AHEE). 2017. Towards harmonised PT21 freshwater scenario(s). Proposed working plan & time schedule. ECHA. Helsinki, Finland: Report nr. WGII2017_ENV_7-5_PT21_harmonised freshwater scenarios_C. 10 p.
4. ECHA (BPC AHEE). 2017. Analysis of EU freshwater marina scenarios and proposals for a PEC calculation tool. European Chemicals Agency. Helsinki, Finland: Report nr. WGIII2017_ENV_8-6b_Analysis of fw marina scenarios_C. 35 p.
5. Van Hattum B, Van Gils J, Markus A, Elzinga H, Jansen M, Baart A. 2016. MAMPEC 3.1 Handbook. Technical documentation (October 2016). Deltares. Delft, The Netherlands: 85 p.
6. Van Hattum B, Van Gils J, Markus A, Elzinga H, Jansen M, Baart A. 2016. User manual – quick guide MAMPEC 3.1, MAMPEC-BW 3.1. Deltares. Delft, The Netherlands: 53 p.
7. OECD. 2005. OECD series on Emission Scenario Documents. Number 13. Emission Scenario Document on Antifouling Products. Organisation for Economic Co-operation and Development. Paris, France: Series on Emission Scenario Documents Report nr. ENV/JM/MONO(2005)8. 166 p.
8. Van der Meulen MD, Nolte AJ, Van Hattum AGM. 2012. Definition of a Dutch inland marina scenario in MAMPEC. International Paint Nederland B.V., Deltares, VU University Amsterdam. Report nr. 12085885-000-ZKS-0002. 34 p.
9. Deltares. 2016. MAMPEC. Marine antifoulant model to predict environmental concentrations (computer program). Version 3.1. Delft, The Netherlands: Deltares. https://www.deltares.nl/en/software.mampec/.
10. Daehne D, Fürle C, Thomsen A, Watermann B, Feibicke M. 2017. Antifouling biocides in German marinas: Exposure assessment and calculation of national consumption and emission. Integrated and Environmental Assessment and Management in press (Early view). http://onlinelibrary.wiley.com/doi/10.1002/ieam.1896/full.
11. Graphpad Software Inc. 2017. GraphPad Prism, (computer program). Version 7.03. Prism 7 for Windows.
12. Watermann B, Daehne D, Fürle C, Thomsen A. 2015. Sicherung der Verlässlichkeit der Antifouling- Expositionsschätzung im Rahmen des EU-Biozid- Zulassungsverfahrens auf Basis der aktuellen Situation in deutschen Binnengewässern für die Verwendungsphase im Bereich Sportboothäfen. Umweltbundesamt. Dessau-Roßlau, Germany: Report nr. Texte 68/2015, FKZ3711 67 432. 135 p.
13. ANWB. 2013. Wateralmanak. Deel 2. Vaargegegevens Nederland-België. Den Haag, The Netherlands: ANWB Media. ISBN 978-90-18-03592-1. 928 p.
14. Prinsen GF, Becker BPJ. 2011. Application of SOBEK hydraulic surface water models in the netherlands hydrological modelling instrument. Irrigation and Drainage 60 (Suppl. 1): 35-41.
15. Prinsen GF, Sperna Weiland F, Ruijgh E. 2015. The Delta Model for Fresh Water Policy Analysis in the Netherlands. Water Resources Management 29: 645-661.

o0o

Appendix A



MAMPEC Emission scenario used for the reported modelling work.

Appendix B

Dataset used for analysis

The data set with freshwater marina data received from the participating MS CAs is presented below as a link. Amendments to the data set shown in the previous version of this document () are described in sections 2.1.1 and 2.5.

https://echa.europa.eu/documents/10162/23464933/WGIV2017_ENV_8-8_Analysis_of_marina_scenarios_INFO.xlsx

All data were entered in MAMPEC (v 3.1). Export files in .csv (link) and .db format of all MAMPEC marina 'Environments' are provided below.

EUMSMarinas_all_v2.db

https://echa.europa.eu/documents/10162/23464933/WGIV2017_ENV_8-8_Analysis_of_marina_scenarios_INFO.xlsm

Selection procedure of Austrian freshwater marinas

The AT CA provided a document explaining the selection and parametrisation of the submitted freshwater marina data. The document is presented below as a link.

https://echa.europa.eu/documents/10162/23464933/PT21_Harmonised_freshwater_scenarios%E2%80%93sources_of+input_data_Austria.doc

Selection procedure of German freshwater marinas

The data are mainly taken from a final report of a research project funded by UBA between 2011-2014, published in Watermann et al. 2015 [12] (soon be available in English). In this project, an inventory of German pleasure boats marinas was made by digital analysis via Google Maps - including freshwater, brackish and marine water marinas. Out of the whole data set (which revealed a total number of 3091 pleasure boat marinas in Germany) 50 marinas were picked out for a detailed analysis of structural marina parameters (number of berth, length width, etc.), water characteristics (Temperature, DOC, TOC, SPM, pH, etc.) and concentration of selected antifouling substances. These 50 marinas are not a representative set of marinas per se, although the selections tried to consider an appropriate range of marina characteristics (number of berths, marina volume, open and closed marinas), marinas in areas with higher and lower hydrodynamic activity (lake, river, canal) and marinas located in fresh, brackish and marine water (similar ratio between the three categories as for whole Germany). The detailed marina set included 34 freshwater marinas and will also be the main basis of a German freshwater scenario currently under development.

As a first step, these marinas were ranked according to their antifouling concentrations measured in 2013 and is the basis for the submitted selection. However, several marinas out of these 34 have not been considered due to the following reasons: The final selection includes only marinas with a (more or less) closed structure, fitting into the standard marina layout of MAMPEC. Moreover, all marinas which were influenced by tidal water exchange (mainly marinas in the estuarine area of the North Sea) were also not considered. Finally, some marinas were deselected because they have some special structural characteristics – e.g. a pier in the middle of the harbour – which would alter the hydrodynamics in the marina and which could not be simulated by the standard marina layout in MAMPEC. Therefore, the selection of 10 marinas represents a subset of the 34 pleasure boat freshwater marinas, which fit in the structural marina setup of MAMPEC. These marinas are not the “top 10 marinas” of the concentration-based ranking (neither do we currently know, how they would be ranked in a modelling-based ranking with MAMPEC – this in under development) and therefore represent not worst-case selection. However, one could also not consider the selection as a representative selection as well, as described previously.

Some parameters have been additionally gathered during the preparation of the current selection (e.g. the flow velocity of the adjacent water body) or have been processed (e.g. averaging) or estimated. Corresponding explanations and sources of each parameters are given in the table.

See section 2.1.1 for an adaption in POC content that was applied to marinas nr. DE21-1, DE46-1 and DE38-1. These value were originally 0 mg/L, which resulted in zero outcomes for $PEC_{sediment}$ in MAMPEC runs. DE provided the following information:

'We have come to the conclusion that each of the three zero values for POC should be replaced with an value 0.1 mg/L, representing the half of the lowest value for POC which was observed. This adaption would ensure that $PEC_{sediment}$ values may be derived for these marinas while ensuring that as much site specific information as possible could be retained in order to take the difference between each site into account. The retention of the site specific environmental characteristics is also the reason why we decided not to define a mean value for any of the water characteristics where we have measured values for.'

Selection procedure of Dutch freshwater marinas

A dataset of 50 Dutch freshwater marinas without tidal influence was collected by Deltares (Van der Meulen et al. [8]). The authors provided us kindly with an Excel version of this dataset, which was used as the basis for our work, we further refer to this collection as 'Deltares data set'.

Van der Meulen et al. did not collect the marina data with the aim to model each marina individually, as done in the present study. Two key marina parameters were not or partly available in their dataset: marina depth (absent for 20 marinas) and the flow rate of the water adjacent to the marina (absent for all marinas). The missing marina depths were appended by searching in either the Wateralmanak [13] or marina's websites. Depths for two marinas remained unknown (nr. 9 and 41). It is nearly impossible to derive flow rates in the waters adjacent to the marinas from measured data, because flow rates are hardly ever measured at the correct locations or even close by. The only workaround that was available to us to fill that data gap was to model flow rates. Modelling of flow rates was performed by Deltares colleagues by making use of the Dutch nationwide Sobek model (LSM 1.2). This model is a 1D schematised hydrodynamic surface water model of the main waterways in the Netherlands. It has a typical spatial resolution of 500 m and consists of about 21,000 calculation points, the computational time step is 10 min and it allows for computation of a whole year at national scale. The model calculated discharges, water levels and depths. See Prinsen and Becker [14] and Prinsen et al. [15] for more detailed information.

Flow rates were modelled for three years that have been selected as average (1967), dry (1989) and extremely dry (1976) with respect to river water discharge. For each of these years and for each location a daily flow rate was modelled, resulting in 365 or 366 flow rates per location per year. From the average discharge (1967) data set, we calculated the yearly arithmetic mean value per location and used these values as input for MAMPEC modelling.

Flow rates in adjacent waters

Each adjacent water location was assigned a code indicating the reliability of the modelled value. Code A (30 marinas) means that the adjacent water body is present in the model environment of the LSM model and a reliable modelling is therefore possible. Code B (5 marinas) means that the adjacent water present in the LSM model environment and a reliable modelling is possible, but the water body has a large surface area. This results in low flow rates, on which the influence of e.g. wind may be larger. Code C (7 marinas) means that a direct coupling with a modelling point within LSM was not possible and a flow rate was modelled for the closest nearby water. These flow rates are assigned a lower reliability. It should however be noted that if the modelled flow rate at this nearby location is low and there is no presence of water bodies that may strongly influence the flow rate, the modelled value is likely to be acceptable.

Code D (8 marinas) means that a flow rate could not be modelled.

Check on geometry of marinas

In order to evaluate whether the type and shape of each marina matched to the basic geometric design of the marina 'Environment' in MAMPEC, we checked the geometrical appearance of the 50 marinas in the Deltares data set using Google Maps. We checked the geometrical measurements (length, width, mouth width, width of adjacent water) using the Google Maps measuring tool. Our preference was to keep the Deltares data set as unaltered as possible. We have only altered the values provided by Deltares if our measurements differed appreciably from those contained in the data set. E.g.: in some instances length (x2) and width (y1) of the marina had to be switched; or a mouth width, or length value etc., was considerably different upon checking. In those cases, we have overwritten the Deltares value with our Google Maps measurement. For marinas that were not rectangular in shape, measurements of length of width were done at three locations and the arithmetic mean of these three values taken.

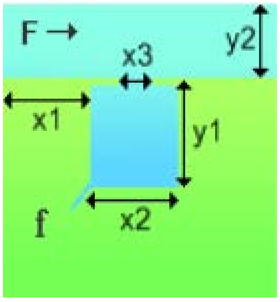
Another alteration to the Deltares data set was that the geometry of some marinas corresponded to the 'Open harbour' Environment rather than to the 'classic' enclosed marina. We identified several open type marinas, however we excluded these from the final selection for the EU dataset.

Width of adjacent water (y2)

In contrast to saltwater marinas that often border large water bodies, freshwater marinas may also be situated along smaller water bodies (e.g. canals, rivers). The general MAMPEC setting for saltwater marinas is that the width of the adjacent water is set equal to the marina width: y2=y1. The MAMPEC manual (v. 3.1, p. 16) advises to set the lower limit for y2 at 10 m and, for the marina scenario, y2 should be set to y1 or 50% of y1. However, for many marinas, the real value of y2 was regularly smaller than the marina width y1 or even smaller than 0.5*y1. In order not to compromise these situations, we used the realistic value for y2 even if it was <0.5*y1. The lower limit of 10 m was maintained.

Correspondence of marinas to MAMPEC modelling Environment

Of the 50 marinas in the Deltares data set, several had geographical or geometric characteristics that did not match well with the marina lay out ('Environment') as available in MAMPEC:



In the Deltares data set, and in the Netherlands in general, a variety of marina types is encountered. A first distinction is between open marinas and enclosed marinas. Although the open marinas can potentially be modelled in MAMPEC with the Environment 'Open harbour', we have chosen not to include open marinas for this project. Enclosed marinas of various types are encountered e.g.: marinas having two 'mouths', marinas bordered at three sides (x3 as wide as x2), marinas bordered at two sides, marinas consisting of multiple parallel rectangular marinas, marinas with a very extended 'mouth' or area without berths, etc. For this project, we selected marinas with a lay out that can reasonably be approached with the rectangular MAMPEC marina lay out. It is noted however, that not all selected marinas had a rectangular shape. In case of marinas with an asymmetrical shape or skewed sides, length and width measurements were checked using Google Maps and, if necessary the length or width was calculated as the average of three measurements, equally distributed over the specific marina side.

We coded marinas based on lay out characteristics enabling filtering out those marinas that cannot be modelled using the above MAMPEC geometry.

Code 1: enclosed marina, 1 mouth, shape rectangular or can reasonably be approximated by rectangular (25 marinas).

Code 2: enclosed marina, ≥1 mouth, shape rectangular or can reasonably be approximated by rectangular (2 marinas).

Code 4: enclosed marina, but geometry not standard (3 marinas).

Code 20: open marina (4 marinas).

Code 100: complex geometry, MAMPEC modelling not possible (8 marinas).

Neighbouring marinas

Each marina received a code indicating whether it has 'neighbouring' marinas at close (CN) distance, connected to the same adjacent water or whether it is 'isolated' (NN). In the Netherlands, several areas exist that are very densely populated with marinas, all connected to the same adjacent water. Neighbour marinas can be either directly adjacent (sometimes even series of adjacent marinas) or on the opposite side of the same water. To formalise the distinction between CN (close neighbours) and NN (no neighbours), we assigned a marina with code NN if no other marinas were present within a 1 km radius centred at the marina. If marina(s) were present within the 1 km radius, but these were ≤5 times (visual estimate) the size of the modelled marina, the NN code was maintained. We identified 27 CN and 15 NN marinas of the 42 for which flow rates were available.

We assigned these codes to flag that PEC estimates outside the CN marinas are likely to be underestimates of the true PECs as emission of multiple marinas to the same water is not taken into account. However, in the present project the primary aim was not to cover for this situation. The goal of this project was to compile a set of representative freshwater marinas in EU member states.

The final selection of Dutch marinas were those flow rate codes A or B and geometry code 1. Two marinas with flow rate code C are also included as the modelled location was close to the adjacent water and the modelled flow rate was relatively low: the maxima of mean yearly flow rates were 0.03 and 0.01 m/s, respectively. The types of adjacent water are of various kinds and include both large and small lakes, rivers, river side arms and canals.

Selection procedure of Swiss freshwater marinas

The CH CA provided a document explaining the selection and parametrisation of the submitted freshwater marina data. The document is presented below as a link.

https://echa.europa.eu/documents/10162/23464933/Swiss_freshwater_marina_dataset_Data_collection_and_processing.doc

Selection procedure of United Kingdom freshwater marinas

The UK CA provided a document explaining the selection and parametrisation of the submitted freshwater marina data. The document is presented below as a link.

https://echa.europa.eu/documents/10162/23464933/Harmonisation_of_PT21_freshwater_scenario%28s%29_UK_CA_Input.docx

Appendix C

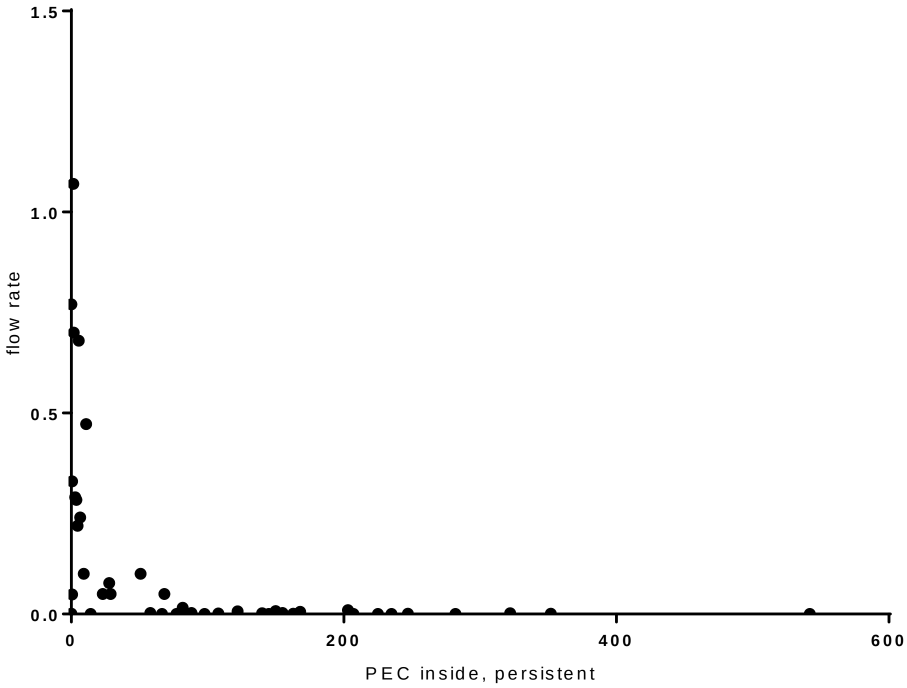


Figure 6. Correlation between the PEC inside the marina (persistent compound) and flow rate for the 50 EU marinas. Spearman r = -0.696, P <0.0001, n=46.

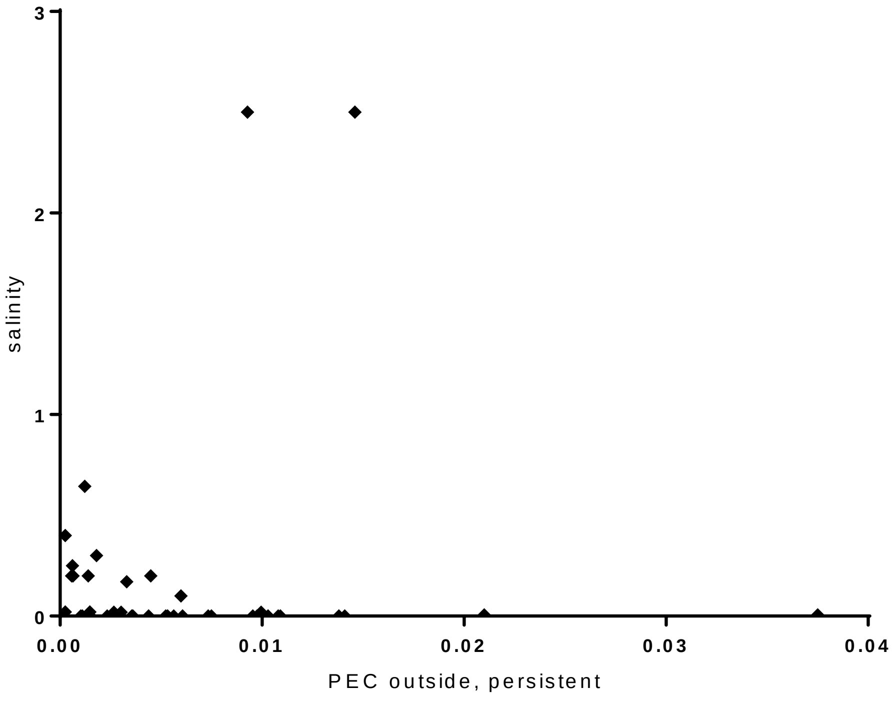


Figure 7. Correlation between the PEC outside the marina (persistent compound) and salinity for the 46 EU marinas. Spearman r = -0.357, P = 0.0148, n=46.

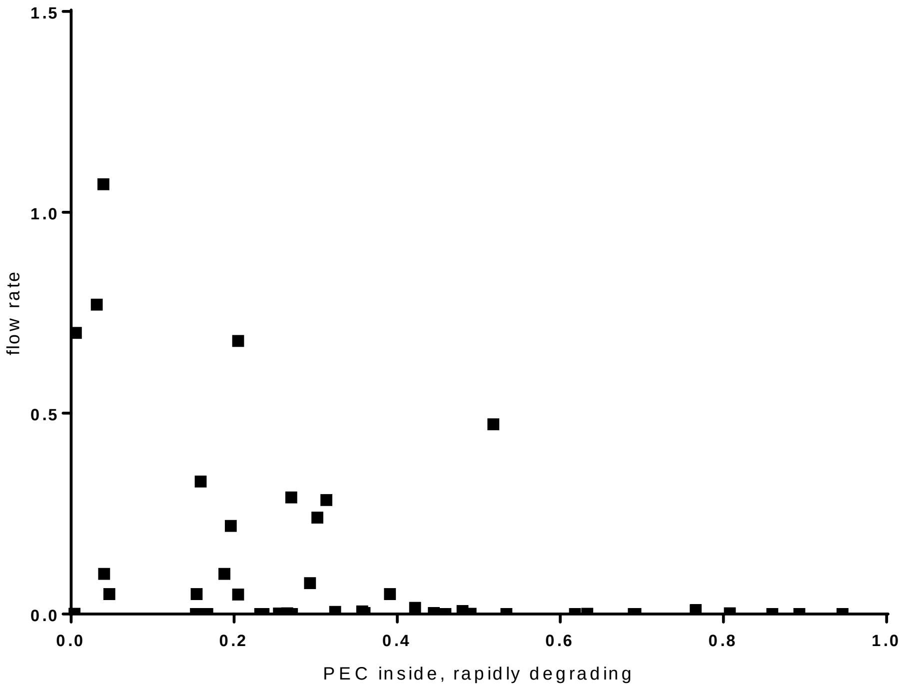


Figure 8. Correlation between the PEC inside the marina (rapidly degrading compound) and flow rate for the 46 EU marinas. Spearman r = -0.410, P = 0.0046, n = 46.

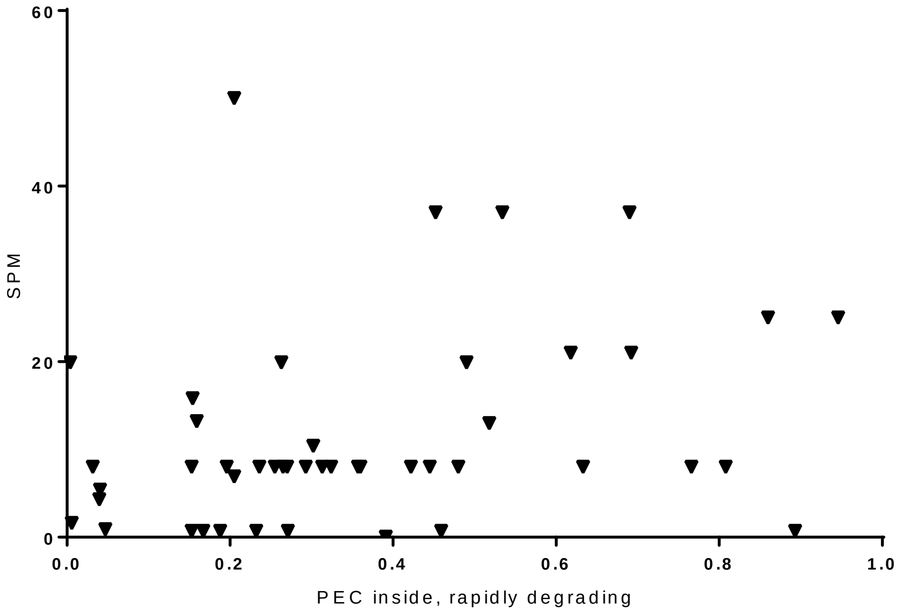


Figure 9. Correlation between the PEC inside the marina (rapidly degrading compound) and suspended matter concentration for the 46 EU marinas. Spearman r = 0.306, P = 0.0386, n = 46.

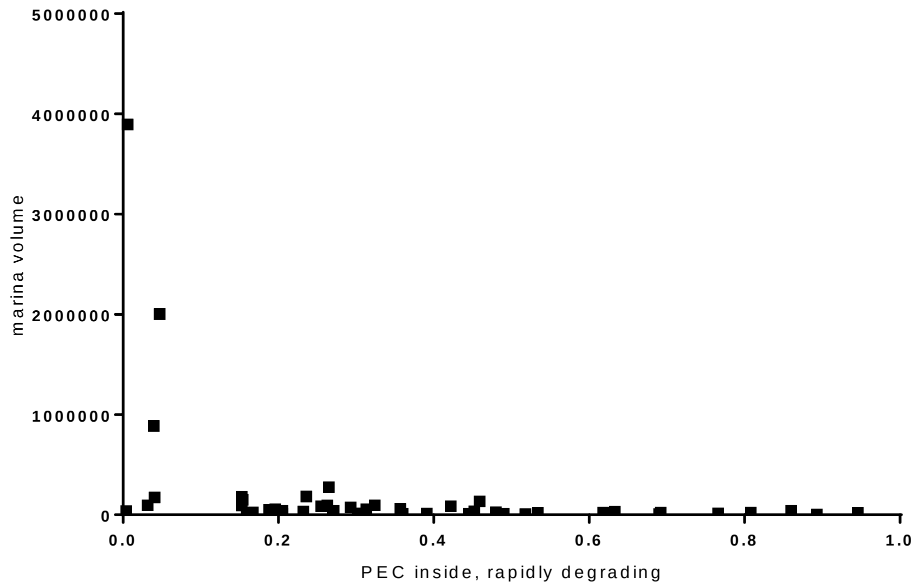


Figure 10. Correlation between the PEC inside the marina (rapidly degrading compound) and marina volume for the 46 EU marinas. Spearman r = -0.349, P = 0.0175, n = 46.