WGI2017 ENV 7-2b(i) Analysis of regional pleasure craft marina scenarios and proposals for a PEC calculation tool	
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1. Summary

At WGIV2016 the results of interim analysis of regional pleasure craft marina scenarios for the Atlantic and Mediterranean regions were discussed. The analysis has now been extended to include the Baltic Transition[1] and Baltic Sea regions. The modelling has also been repeated using the final release version of MAMPEC v3.1 for all regions.

Detailed results are presented in Section 3. The key conclusion made by the UK based on this dataset is that in our opinion it is going to be very difficult to identify appropriately conservative individual pleasure craft marina scenarios to use as the basis of future first tier exposure assessments for each region. This is discussed briefly in Section 4. Rather than try to identify single representative scenarios, the UK now proposes to develop an Excel calculation tool that would allow results for all marinas in all regions to be automatically generated for each product. These proposals are outlined in Section 5. A prototype Excel tool based on dicopper oxide (see WGI2017_ENV_7_2b(iii)_PT21_prototype Excel calculator_Copper(draft)) and associated introductory instructions (see doc WGI2017_ENV_7_2b(ii)_PT21 Calculation Tool Instructions) have also been prepared.

The UK welcomes MS comments on the results in this paper and the proposals to develop an Excel calculation tool.

Reference

Regional marina scenario: Defining typical regional please craft marinas in the EU for use in environmental risk assessment of antifouling products (University of Newcastle, Shan-I et al., 2013)

2. Methods

Modelling was performed using the final release version of MAMPEC v3.1. The MAMPEC model was parameterised for all Atlantic Region (n = 47), Mediterranean Region (n = 46), Baltic Transition (n = 17) and Baltic Sea (n= 38) marinas listed in the Newcastle University report (Shan-I et al., 2013). A selection of key parameters is listed in Tables 3 to 6 for each region (see Appendix 5 of the original Newcastle University report for full details). Modelling was performed for two contrasting, dummy substances – one rapidly degrading and one persistent substance, using example data sets already parameterised into the MAMPEC model[2]. A dummy leaching rate of 2.5 µg/cm^2/day was used for each substance. All marinas were assumed to contain the maximum number of vessels as listed in the Newcastle University report. This was based on the maximum number of vessels which can be moored in each marina, based on information provided on official marina websites, berth booking websites or in the absence of these two data sources, by counting the number of berths present on images displayed on Google

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[1] The UK would like to acknowledge the contribution of Birgitte Skou Cordua (DK) who kindly prepared results for the Baltic Transition zone.

[2] For the rapidly degrading substance, the example substance '*Dichlofluanid (example)*' was selected. For the persistent substance, the example substance '*Irgarol (example)*' was selected from the MAMPEC v3.1 database. These do not necessarily represent EU agreed endpoints for the named substances, but were simply intended to represent contrasting substances for the purposes of this analysis.

Earth. An Application Factor of 0.9 was used and a default surface area of 30.7 m^2 for boats in the 1-50 m class was assumed. The simple assumption of a default surface area of 30.7m^2 is likely to be conservative, particularly for those marinas that house a high proportion of smaller boats with smaller surface areas.

In the absence of detailed site specific information a number of default values were used. Of these, the flow rate ('F' in Figure 1 below) was set to a default of 1 m/s in the Atlantic, Mediterranean and Baltic Transition regions (this value being consistent with that used in the existing OECD marina scenario). Similarly the tide maximum density difference was set to a default of 0.1 kg/m^3 in these three regions (again consistent with the value used in the OECD marina). For the Baltic Sea region default parameters were amended in response to comments received from SE and FI after the intitial discussion at WGIV2016. In line with existing Baltic Sea pleasure craft marina scenarios in use in both SE and FI the following parameter values were proposed by each MS (Table 1).

Figure 1: Basic dimensions of marinas and surrounding areas according to MAMPEC v3.1

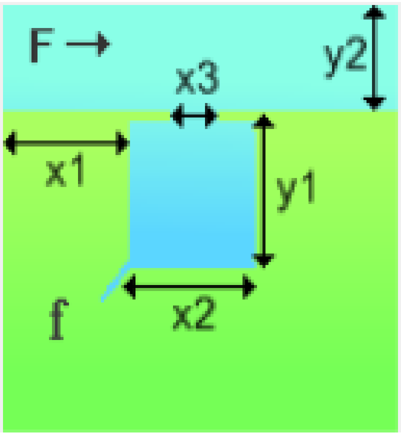


Table 1: Parameter values proposed by SE and FI for use in Baltic Sea region

Parameter	Proposals from SE	Proposals from FI
Maximum density difference (kg/m^3)	0	0
Flow (m/s)	0.048	0.01
Non tidal exchange (m)	0.042	0.11
Wind (m/s)	4	3.6
Fraction of time wind perpendicular	0.15	0.1

To implement these proposed amended parameters in the current modelling, the UK used the SE values for all Baltic Sea region scenarios located in SE, DK and PL as well as to amend the proposed Regional Baltic Sea marina scenario. The FI values were used for all scenarios in FI, EE, LT and LV in this region.

Modelling was also performed for the same two substances with the existing OECD marina scenario and the proposed regional marinas which were based on parameter sets proposed by Shan-I et al, (2013) for the Atlantic, Mediterranean, Baltic Transition and Baltic Sea Regional Marinas. Note that the regional marinas proposed by Shan-I et al. (2013) were derived from the average parameter values of the individual marinas within each region – see table 2 below for full details. PEC surface water values based on average total steady state concentrations inside the marinas and in the surrounding environment were recorded and further analysed. The dimensions of the surrounding environment were defined following the same methodology as the existing OECD scenarios, based on the individual marina dimensions. This is illustrated with the graphic in Figure 1 above and since the values for x1 and 2 and y1 and 2 were always identical, the surrounding area was effectively double the size of each marina in every case.

Cumulative probability distributions were constructed from the MAMPEC results. PECsw values based on individual average total steady state concentrations inside marinas and in the surroundings area were used. The webfram model (https://webfram.com) was used to fit log normal distributions to the MAMPEC modelled exposure distributions and perform various statistical tests on the fitted distributions. The generic webfram model was selected because it allows the user to produce a number of different outputs including exposure distributions and user selected percentiles and confidence intervals for individual concentrations. Note that as part of the original development of webfram the log normal fitting module was compared with outputs from alternative tools such as ETX version 2.0 (RIVM, NL) and found to give identical results. Here the model was used to determine the following parameters:

- The 90th percentile concentration from the individual exposure distributions
- The percentile of the distribution represented by the average PEC calculated using the existing OECD marina scenario
- The percentile of the distribution represented by the average PEC calculated using the parameter set for the respective regional marina scenario proposed by Shan-I et al, (2013; see also Table 2)

Table 2: Average parameter values for the OECD and regional marina scenarios used to define the four separate regional marina sceanrios (taken from Table 16 of Shan-I et al. (2013)

Regional Mean Value/ Parameters All values ± Standard Deviation except OECD Marina	Unit	OECD Marina*	All Marinas	Atlantic	Baltic Sea Area	Mediterranean	Baltic Sea	Baltic Transition
Marina Length	m	141.5	398±217	436±241	294±171	483±196	275±164	339±183
Marina Width	m	141.5	207±121	215±145	162±101	254±98	148±97	192±105
Marina Depth	m	4	5±3.0	5±3.7	4±1.9	6±2.8	4±2.2	4±1.3
Entrance Width	m	100	79±75	68±53	79±101	91±56	79±77	80±143
Tidal Difference	m	1.5	1.2±1.4	3±0.9	0.2±0.18	0.4±0.25	0.12±0.05	0.4±0.25
Maximum Vessel Occupancy	--	276	392±396	403±356	259±294	540±486	165±151	469±414
Maximum vessel length	m	50	35±24	32±22	28±22	47±24	27±21	32±26
Salinity	PSU	34	25±13	31±5.7	9.4±6.7	38±0.9	6±2.1	17±8.3
Average water temp	^{o}C	20	14±4.5	13±3.7	11±1.5	19±2.5	11±1.5	12±1.3
pH		8	8±0.5	8±0.5	8±0.4	8±0.3	8±0.4	8±0.3
DOC$	mg/l	2	--	3.2±1.9	5.2±1.1	1.5±1.2	5.4±1.1	5.4±1.1
Marina Surface Area	m^2	20022	82,386.00	93,740.00	47,628.00	122,682.00	40,700.	65,088
Surface Area per boat	m^2	73	210	233	184	227	247	139
Marina volume	m^3	80089	411,930	468,700	190,512	736,092	162,800	260,352
Volume per boat	m^3	290	1,050	1,163	735	1,363	987	555

* number of vessels moored amended to 276 as per TM meeting guidance

$ Average values taken from references and not from canonical analysis due to lack of marina specific data

Table 3: Key parameters of marinas in the Atlantic Region

Scenario	Length (m)	Width (m)	Depth (m)	Volume (m^3)	No. of boats[a]	Volume per boat (m^3 per boat)	Exchange volume (% of total marina volume per tide)[b]
OECD Marina	141.5	141.5	4.0	80089	276	290	307.39
Regional Atlantic Marina	436.0	215.0	5.0	468700	403	1163	70.91
Atlantic Marina 1(ES1)	645.0	300.0	8.0	1548000	1000	1548	31.25
Atlantic Marina 2(ES2)	525.0	327.0	7.0	1201725	500	2403	38.02
Atlantic Marina 3(ES3)	288.0	215.0	15.0	928800	180	5160	92.22
Atlantic Marina 4(PT1)	449.0	251.3	7.0	789644	650	1215	51.12
Atlantic Marina 5(PT10)	1036.1	809.3	3.5	2934640	240	12228	83.00
Atlantic Marina 6(PT3)	663.6	236.0	4.0	626484	620	1010	67.88
Atlantic Marina 7(PT4)	520.0	480.0	4.0	998400	1000	998	75.23
Atlantic Marina 8(PT5)	977.2	185.9	3.0	544908	462	1179	93.81
Atlantic Marina 9(PT7)	366.3	181.3	6.9	458168	250	1833	68.37
Atlantic Marina 10(PT8)	365.0	111.5	15.0	610648	150	4071	117.99
Atlantic Marina 11(PT9)	433.9	102.6	3.0	133490	163	819	97.29
Atlantic Marina 12(GB1)	249.0	237.0	10.7	629645	250	2519	109.49
Atlantic Marina 13(GB2)	340.2	189.6	4.0	257968	250	1032	96.89
Atlantic Marina 14(GB3)	337.3	138.3	4.0	186619	120	1555	158.42
Atlantic Marina 15(EI1)	650.4	263.5	10.5	1799522	800	2249	72.57
Atlantic Marina 16(EI2)	330.0	270.0	5.0	445500	350	1273	95.73
Atlantic Marina 17(EI4)	337.3	165.1	2.4	133651	370	361	154.52
Atlantic Marina 18(EI5)	217.7	73.0	2.4	38148	100	381	142.35
Atlantic Marina 19(GB10)	189.5	164.2	7.0	217830	160	1361	84.90
Atlantic Marina 20(BE1)	87.6	85.8	2.5	18784	100	188	216.69
Atlantic Marina 21(BE2)	676.6	108.9	13.5	994188	180	5523	156.19
Atlantic Marina 22(BE3)	429.6	112.0	4.0	192393	225	855	95.24
Atlantic Marina 23(BE4)	441.0	188.5	2.0	166255	200	831	207.54
Atlantic Marina 24(BE5)	522.4	260.4	2.0	272097	1000	272	198.06
Atlantic Marina 25(BE6)	279.8	98.6	2.5	68944	300	230	159.50
Atlantic Marina 26(BE7)	399.2	134.7	3.0	161308	350	461	132.20
Atlantic Marina 27(BE8)	419.6	241.2	2.5	252999	900	281	151.82
Atlantic Marina 28(DE5)	219.4	80.9	2.2	39062	53	737	264.55
Atlantic Marina 29(DE8)	353.6	142.0	3.2	159118	148	1075	123.39
Atlantic Marina 30(GB4)	447.5	448.6	3.0	602272	315	1912	123.55
Atlantic Marina 31(GB5)	247.2	159.9	4.0	158142	300	527	113.37
Atlantic Marina 32(GB6)	151.2	90.0	2.5	34013	100	340	81.34
Atlantic Marina 33(GB7)	274.9	139.9	3.0	115363	114	1012	147.17
Atlantic Marina 34(GB8)	497.1	241.1	3.5	419444	100	4194	78.98
Atlantic Marina 35(GB9)	209.6	127.3	2.4	64049	250	256	142.91
Atlantic Marina 36(NL10)	969.4	198.3	2.8	538293	400	1346	103.83
Atlantic Marina 37(NL4)	371.6	127.0	3.5	165129	170	971	125.61
Atlantic Marina 38(NL5)	318.7	97.9	2.5	77988	250	312	92.39
Atlantic Marina 39(NL8)	195.2	54.6	9.0	95984	100	960	167.28
Atlantic Marina 40(DE4)	591.9	450.9	3.7	984788	1950	505	105.80

Scenario	Length (m)	Width (m)	Depth (m)	Volume (m^3)	No. of boats[a]	Volume per boat (m^3 per boat)	Exchange volume (% of total marina volume per tide)[b]
Atlantic Marina 41(NL3)	422.1	144.9	8.0	489265	435	1125	34.16
Atlantic Marina 42(NL6)	401.3	152.0	3.0	182951	850	215	90.37
Atlantic Marina 43(NL1)	574.7	449.9	2.8	723872	670	1080	71.63
Atlantic Marina 44(NL9)	245.8	212.4	2.5	130510	450	290	116.83
Atlantic Marina 45(NO1)	180.0	153.7	12.0	332001	300	1107	214.62
Atlantic Marina 46(NO2)	1250.4	550.2	9.0	6191083	800	7739	29.33
Atlantic Marina 47(NO6)	378.5	174.7	10.5	694243	300	2314	80.59

a: note that for the individual marinas (1-47) the no. of boats was based on berth numbers and assuming 100% occupancy. The OECD marina was based on maximum theoretical occupancy assuming 1.38 boats per $100m^2$ surface area. The value for the regional marina from Shan-I et al. (2013) represents the average number of berths from all 47 marinas. The same approach was applied to all other regions.

b: this value is calculated by the MAMPEC model as part of each scenario simulation and is influenced by marina dimensions, including entrance width, tidal height, flow rate and salinity differences.

Table 4: Key parameters of marinas in the Mediterranean Region

Scenario	Length (m)	Width (m)	Depth (m)	Volume (m^3)	No. of boats	Volume per boat (m^3 per boat)	Exchange volume (% of total marina volume per tide)
OECD Marina	141.5	141.5	4.0	80089	276	290	307.39
Regional Mediterranean Marina	483.0	254.0	6.0	736092	540	1363	51.74
Mediterranean Marina 1(CY1)	418.9	301.2	5.0	630888	350	1803	62.61
Mediterranean Marina 2(CY2)	206.3	198.7	5.0	204950	237	865	106.01
Mediterranean Marina 3(CY3)	285.0	316.5	5.0	451055	50	9021	114.77
Mediterranean Marina 4(CY5)	509.5	227.4	4.0	463353	25	18534	94.13
Mediterranean Marina 5(ES10)	775.3	218.9	8.0	1357502	176	7713	52.16
Mediterranean Marina 6(ES4)	510.0	309.0	4.5	709155	440	1612	32.03
Mediterranean Marina 7(ES5)	560.0	240.0	4.5	604800	450	1344	49.09
Mediterranean Marina 8(ES6)	290.0	137.0	6.5	258245	227	1138	73.76
Mediterranean Marina 9(ES7)	593.0	422.0	3.0	750738	1100	682	18.85
Mediterranean Marina 10(ES8)	487.0	309.0	3.0	451449	375	1204	30.27
Mediterranean Marina 11(ES9)	538.4	258.5	5.0	696003	1300	535	34.86
Mediterranean Marina 12(FR1)	866.0	307.0	6.8	1807862	2588	699	20.40
Mediterranean Marina 13(FR10)	352.0	182.0	4.0	256256	511	501	33.60
Mediterranean Marina 14(FR2)	300.0	133.0	6.0	239400	285	840	88.58
Mediterranean Marina 15(FR3)	492.0	259.0	7.0	891996	960	929	51.39
Mediterranean Marina 16(FR4)	375.0	338.0	5.0	633750	650	975	54.38
Mediterranean Marina 17(FR5)	326.0	142.0	4.0	185168	520	356	37.27
Mediterranean Marina 18(FR6)	410.0	225.0	4.5	415125	743	559	45.81
Mediterranean Marina 19(FR7)	285.0	146.0	12.0	499320	253	1974	146.51
Mediterranean Marina 20(FR8)	533.0	170.0	5.0	453050	800	566	39.55
Mediterranean Marina 21(FR9)	792.0	514.0	6.0	2442528	1556	1570	14.05
Mediterranean Marina 22(GR10)	263.0	126.0	6.0	198828	250	795	84.07
Mediterranean Marina 23(GR2)	626.0	452.0	5.0	1414760	900	1572	18.04
Mediterranean Marina 24(GR3)	639.0	463.0	9.0	2662713	247	10780	26.32
Mediterranean Marina 25(GR5)	198.0	185.0	8.0	293040	113	2593	112.20
Mediterranean Marina 26(GR6)	451.0	389.0	4.3	754388	680	1109	21.36

Scenario	Length (m)	Width (m)	Depth (m)	Volume (m^3)	No. of boats	Volume per boat (m^3 per boat)	Exchange volume (% of total marina volume per tide)
Mediterranean Marina 27(GR7)	293.0	165.0	3.7	178877	280	639	53.69
Mediterranean Marina 28(GR8)	309.0	125.0	8.0	309000	225	1373	65.06
Mediterranean Marina 29(GR9)	530.0	350.0	5.5	1020250	315	3239	27.48
Mediterranean Marina 30(IT1)	622.0	259.0	8.0	1288784	974	1323	124.15
Mediterranean Marina 31(IT10)	401.2	284.4	4.5	513443	800	642	32.59
Mediterranean Marina 32(IT2)	373.0	274.0	10.0	1022020	300	3407	125.98
Mediterranean Marina 33(IT3)	271.0	252.0	5.0	341460	460	742	40.56
Mediterranean Marina 34(IT4)	855.0	233.0	5.0	996075	1560	639	19.31
Mediterranean Marina 35(IT5)	382.0	222.0	8.0	678432	548	1238	47.99
Mediterranean Marina 36(IT6)	255.0	177.0	10.0	451350	150	3009	226.76
Mediterranean Marina 37(IT7)	454.0	395.0	10.0	1793300	100	17933	54.32
Mediterranean Marina 38(IT8)	654.0	220.0	10.0	1438800	300	4796	63.24
Mediterranean Marina 39(IT9)	398.3	306.9	4.5	550199	400	1375	48.46
Mediterranean Marina 40(MT1)	859.0	198.8	18.0	3073655	193	15926	155.40
Mediterranean Marina 41(MT3)	727.0	261.9	5.0	951887	150	6346	79.18
Mediterranean Marina 42(MT4)	883.2	129.2	10.0	1140767	700	1630	118.27
Mediterranean Marina 43(MT5)	503.9	270.6	5.0	681798	208	3278	40.56
Mediterranean Marina 44(SI1)	696.6	319.8	3.5	779598	650	1199	37.49
Mediterranean Marina 45(SI2)	503.2	185.4	4.5	419869	640	656	27.39
Mediterranean Marina 46(SI3)	149.4	85.6	3.5	44743	85	526	250.43

Table 5: Key parameters of marinas in the Baltic Transition Region

Scenario	Length (m)	Width (m)	Depth (m)	Volume (m3)	No. of boats	Volume per boat (m3 per boat)	Exchange volume (% of total marina volume per tide)
OECD Marina	141.5	141.5	4.0	80089	276	290	307.39
Regional Marina Baltic Transition	339	192	4	260352	469	555	76.3
Baltic Transition Marina 1(DE10)	137.50	100.00	3.00	41250	115	359	83.8
Baltic Transition Marina 2(DE2)	530.71	433.36	3.69	848657	1400	606	26.0
Baltic Transition Marina 3(DE3)	338.70	293.31	5.00	496720	400	1242	28.9
Baltic Transition Marina 4(DK4)	80.47	62.99	5.00	25344	50	507	418
Baltic Transition Marina 5(DK5)	415.54	291.07	3.50	423329	760	557	12.0
Baltic Transition Marina 6(DK9)	278.49	180.48	2.75	138220	250	553	43.7
Baltic Transition Marina 7(DK1)	178.00	100.00	3.00	53400	350	153	49.3
Baltic Transition Marina 8(DK10)	150.00	125.00	7.00	131250	183	717	59.0
Baltic Transition Marina 9(DK11)	262.00	112.00	1.80	52819	400	132	56.3
Baltic Transition Marina 10(DK2)	223.10	107.72	2.00	48065	175	275	62.2
Baltic Transition Marina 11(SE15)	700.00	200.00	3.00	420000	1288	326	249
Baltic Transition Marina 12(DE11)	200.00	187.50	3.00	112500	366	307	30.4
Baltic Transition Marina 13(DE6)	368.63	246.48	3.69	335273	450	745	25.2
Baltic Transition Marina 14(DE7)	534.48	201.43	3.69	397266	285	1394	33.0
Baltic Transition Marina 15(DE9)	560.68	52.77	3.00	88761	150	592	39.2

Scenario	Length (m)	Width (m)	Depth (m)	Volume (m3)	No. of boats	Volume per boat (m3 per boat)	Exchange volume (% of total marina volume per tide)
Baltic Transition Marina 16(DK3)	228.63	225.17	3.00	154442	260	594	252
Baltic Transition Marina 17(SE3)	570.65	347.81	5.00	992389	1088	912	25.9

Table 6: Key parameters of marinas in the Baltic Sea Region

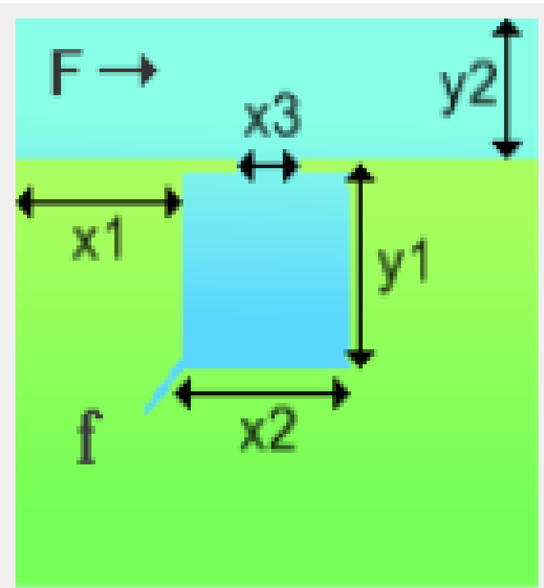
Scenario	Length (m)	Width (m)	Depth (m)	Volume (m^3)	No. of boats	Volume per boat (m^3 per boat)	Exchange volume (% of total marina volume per tide)
OECD Marina	141.5	141.5	4.0	80089	276	290	307.39
Regional Baltic Sea Marina	275	148	4.0	162800	165	987	10.50
Baltic Sea Marina 01(SE11)	283	155	4	175460	400	439	18.09
Baltic Sea Marina 02(DK8)	256.41	100	3.4	87179	45	1937	10.34
Baltic Sea Marina 03(DK12)	56	87	1.25	6090	85	72	20.37
Baltic Sea Marina 04(DK13)	70	51	2.25	8032.5	150	53.5	10.69
Baltic Sea Marina 05(DK14)	192	127	2	48768	101	483	82.15
Baltic Sea Marina 06(DK15)	121	65	1.2	9438	115	82.0	25.27
Baltic Sea Marina 07(DK16)	71	55	3.5	13668	45	304	12.72
Baltic Sea Marina 08(FI8)	116.33	34.32	3.58	14293	29	493	35.55
Baltic Sea Marina 09(FI9)	121.54	34.5	3.58	15011	45	334	18.22
Baltic Sea Marina 10(LT1)	228.41	50.42	5	57582	100	576	4.21
Baltic Sea Marina 11(LV2)	320.87	205.96	5	330432	500	661	2.38
Baltic Sea Marina 12(PL7)	466.01	378.15	5	881108	420	2098	2.08
Baltic Sea Marina 13(PL2)	482.41	265.6	5	640640	60	10677	3.17
Baltic Sea Marina 14(PL3)	423.22	271.02	5	573505	60	9558	3.57
Baltic Sea Marina 15(PL5)	175.4	82.37	13	187820	33	5691	14.50
Baltic Sea Marina 16(EE10)	886.48	390.35	2.8	968905	310	3125	2.30
Baltic Sea Marina 17(EE2)	252	201	4.2	212738	10	21274	6.77
Baltic Sea Marina 18(EE5)	174.73	69.99	2.2	26905	10	2690	8.10
Baltic Sea Marina 19(FI1)	216.25	105.31	2.5	56933	55	1035	4.57
Baltic Sea Marina 20(FI10)	420	140	2.2	129360	226	572	15.40
Baltic Sea Marina 21(FI6)	328.08	309.15	3	304278	190	1601	3.18
Baltic Sea Marina 22(FI7)	263.03	117.88	3.58	111001	190	584	2.89
Baltic Sea Marina 23(EE1)	200	150	2	60000	70	857	4.23
Baltic Sea Marina 24(EE3)	368.68	100	3.5	129038	20	6452	11.12
Baltic Sea Marina 25(EE4)	459	143.83	2.5	165045	132	1250	4.56
Baltic Sea Marina 26(EE7)	411.29	163.46	2.3	154628	18	8590	4.45
Baltic Sea Marina 27(EE8)	121.07	59.89	5	36254	90	403	8.71
Baltic Sea Marina 28(EE9)	529.22	147.84	3	234720	70	3353	2.59
Baltic Sea Marina 29(SE10)	339	82	6	166788	270	618	5.60
Baltic Sea Marina 30(SE12)	220	166	3	109560	342	320	18.21
Baltic Sea Marina 31(SE13)	152	191	4	116128	150	774	22.63
Baltic Sea Marina 32(SE14)	193	108	10	208440	200	1042	15.31

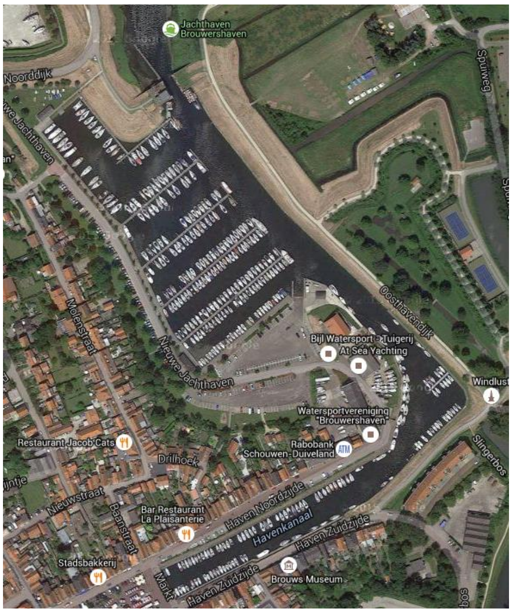
Scenario	Length (m)	Width (m)	Depth (m)	Volume (m^3)	No. of boats	Volume per boat (m^3 per boat)	Exchange volume (% of total marina volume per tide)
Baltic Sea Marina 33(SE9)	350	400	3	420000	376	1117	6.14
Baltic Sea Marina 34(FI2)	356.86	180.08	5	321317	500	643	3.12
Baltic Sea Marina 35(FI3)	334.85	98.11	5	164261	200	821	4.14
Baltic Sea Marina 36(FI4)	94.33	80.3	3.58	27117	32	847	7.14
Baltic Sea Marina 37(FI5)	131.99	82.03	3.58	38761	120	323	3.46
Baltic Sea Marina 38(SE7)	252.3	186.68	5	235497	500	471	14.80

The exchange volume is an important parameter that influences mixing and dilution rates and can be used to distinguish between different marinas. Although the information in the tables above clearly indicates quite large ranges across each region (e.g. Atlantic Region ranged from 29.33 to 264%; Baltic Sea ranged from 2.08 to 82.15%) when looking at the median values it can be seen that there is reasonable separation between the 4 regions. The median values in the Atlantic, Mediterranean, Baltic Transition and Baltic Sea were 103.8, 50.2, 43.7 and 7.0%. This provides some evidence that the way the MAMPEC model has been parameterised is able to distinguish between the different regions in this regard.

2.1. Limitations of the work

The option to simulate marinas within MAMPEC is limited to marinas with a simple quadrilateral geometry. In reality many of the marinas had much more complex geometries. Therefore the UK CA considers that the results for individual marinas across the four regions should be considered as being generally indicative of the likely range of concentrations, rather than being accurate predictions for any individual marina. As an example the simple geometry of the MAMPEC marina and the more complex geometry of Marina 41 (NL3) at Brouwershaven are shown below. The NL3 marina was simulated assuming a length of 422m, width of 145m and entrance width of 12.26 m. Maximum vessel occupancy was set at 435 boats. It is clear from the figures below that MAMPEC is not capabale of fully depicting the complex geometry of real world marinas.





In the absence of site specific information a number of default values were used for all modelled marinas. This is discussed in more detail in Section 2 above in relation to the flow rate and maximum tide density difference. Across the four regions, some marinas were noted to lie at the mouth of a river, where flow rates (and possibly salinity differences) may be expected to be higher than the defaults due to increased freshwater inputs. Salinity differences are also likely to be much more variable than is reflected by the single defaults per region. The UK CA accepted the use of standard defaults for the Atlantic, Mediterranean and Baltic Transition regions, and the use of amended defaults for the Baltic Sea Region in the absence of more detailed site specific information for each marina. 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. However a limited consideration of results against available monitoring data has been provided in Section 3.1.

It should also be noted that the marinas selected within the Newcastle University report were chosen to be representative of the type of inlet marina represented by the existing OECD marina. So all marinas are enclosed to a greater or lesser extent with a clear entrance. This reduces exchange with the wider environment and is likely to mean that this set of marinas represents a conservative population – at least with regards to concentrations inside the marinas. More open or 'pontoon' style marinas would be expected to experience much greater exchange with the wider environment and represent less conservative scenarios with respect to concentrations inside the immediate marina area. This point is also important when considering the different percentiles that are calculated from the underlying distributions. For example, when reference is made to a 90^{th} percentile concentration this should only be interpreted as the 90^{th} percentile of concentrations either within or surrounding the marina types included in the different data set, rather than being representative of the percentile distribution in all marinas or even all of the wider environment

Noting these limitations, results and further analysis are presented in the tables and figures in Section 3.

3. Results

Results for each region are presented in Tables 7 to 10. An example of the cumulative probability distribution (for concentrations of the persistent substance inside the Atlantic marina) is presented in Figure 2. Similar figures were obtained for each model run for each region and have not been included here for simplicity. However details extracted from the distributions (such as 90^{th} percentile concentrations etc) are tabulated below for each region and substance combination.

Table 7: Results of MAMPEC 3.1 modelling for the Atlantic Region (all exposure values represent the average total steady state concentration)

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
	Persistent compound		Rapidly degrading compound	
OECD Marina	2.41E-01	1.98E-3	1.15E-01	1.08E-03
Regional Marina Atlantic	4.31E-01	1.45E-03	4.01E-02	2.59E-04
Atlantic Marina 1(ES1)	8.58E-01	1.57E-03	1.75E-02	1.03E-04
Atlantic Marina 2(ES2)	3.39E-01	8.75E-04	1.28E-02	8.60E-05
Atlantic Marina 3(ES3)	6.30E-02	2.29E-04	6.37E-03	4.27E-05
Atlantic Marina 4(PT1)	5.32E-01	1.40E-03	2.91E-02	1.77E-04
Atlantic Marina 5(PT10)	2.11E-02	3.50E-04	3.34E-03	7.44E-05
Atlantic Marina 6(PT3)	7.94E-01	2.42E-03	3.35E-02	2.58E-04
Atlantic Marina 7(PT4)	3.05E-01	2.14E-03	3.19E-02	3.80E-04
Atlantic Marina 8(PT5)	8.73E-01	2.92E-03	2.92E-02	2.65E-04
Atlantic Marina 9(PT7)	3.08E-01	7.63E-04	2.02E-02	1.11E-04
Atlantic Marina 10(PT8)	9.00E-02	2.84E-04	8.67E-03	5.25E-05
Atlantic Marina 11(PT9)	1.08E+00	1.53E-03	5.85E-02	2.02E-04
Atlantic Marina 12(GB1)	1.10E-01	4.23E-04	1.76E-02	1.07E-04
Atlantic Marina 13(GB2)	3.28E-01	1.35E-03	4.33E-02	3.03E-04
Atlantic Marina 14(GB3)	2.74E-02	7.75E-04	1.50E-02	4.54E-04
Atlantic Marina 15(EI1)	2.70E-01	1.19E-03	2.54E-02	2.14E-04
Atlantic Marina 16(EI2)	1.75E-01	1.06E-03	3.82E-02	3.27E-04
Atlantic Marina 17(EI4)	6.92E-01	3.41E-03	1.40E-01	1.01E-03
Atlantic Marina 18(EI5)	1.14E+00	1.66E-03	1.44E-01	3.75E-04
Atlantic Marina 19(GB10)	2.14E-01	5.60E-04	3.34E-02	1.41E-04
Atlantic Marina 20(BE1)	6.02E-01	1.77E-03	1.42E-01	5.91E-04
Atlantic Marina 21(BE2)	5.90E-02	3.51E-04	6.64E-03	6.91E-05
Atlantic Marina 22(BE3)	1.02E+00	1.56E-03	6.32E-02	2.25E-04
Atlantic Marina 23(BE4)	2.90E-01	1.91E-03	3.80E-02	4.12E-04
Atlantic Marina 24(BE5)	7.58E-01	7.15E-03	1.61E-01	2.11E-03
Atlantic Marina 25(BE6)	1.42E+00	4.11E-03	2.07E-01	1.00E-03
Atlantic Marina 26(BE7)	1.03E+00	2.90E-03	1.10E-01	5.74E-04
Atlantic Marina 27(BE8)	7.56E-01	5.74E-03	1.57E-01	1.68E-03
Atlantic Marina 28(DE5)	1.46E-01	9.17E-04	5.25E-02	4.07E-04
Atlantic Marina 29(DE8)	3.20E-01	1.19E-03	4.60E-02	2.84E-04
Atlantic Marina 30(GB4)	1.08E-01	9.67E-04	2.20E-02	2.75E-04
Atlantic Marina 31(GB5)	4.29E-01	1.79E-03	8.22E-02	5.13E-04
Atlantic Marina 32(GB6)	1.21E+00	1.54E-03	1.41E-01	3.29E-04
Atlantic Marina 33(GB7)	1.94E-01	9.95E-04	4.37E-02	3.17E-04
Atlantic Marina 34(GB8)	7.28E-02	3.26E-04	9.10E-03	6.99E-05
Atlantic Marina 35(GB9)	8.30E-01	3.20E-03	1.85E-01	1.02E-03
Atlantic Marina 36(NL10)	7.00E-01	2.74E-03	3.76E-02	3.44E-04
Atlantic Marina 37(NL4)	4.00E-01	1.39E-03	4.76E-02	2.96E-04
Atlantic Marina 38(NL5)	2.38E+00	3.43E-03	1.76E-01	5.53E-04
Atlantic Marina 39(NL8)	3.06E-01	5.07E-04	4.81E-02	1.31E-04

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
Atlantic Marina 40(DE4)	4.74E-01	4.78E-03	5.13E-02	8.31E-04
Atlantic Marina 41(NL3)	1.64E+00	1.23E-03	4.87E-02	1.13E-04
Atlantic Marina 42(NL6)	2.77E+00	7.14E-03	2.29E-01	1.21E-03
Atlantic Marina 43(NL1)	2.92E-01	2.26E-03	4.80E-02	5.56E-04
Atlantic Marina 44(NL9)	6.26E-01	3.47E-03	1.35E-01	1.06E-03
Atlantic Marina 45(NO1)	7.80E-02	6.57E-04	3.33E-02	3.27E-04
Atlantic Marina 46(NO2)	2.63E-01	7.06E-04	8.72E-03	6.42E-05
Atlantic Marina 47(NO6)	2.27E-01	5.91E-04	2.53E-02	1.21E-04
Summary	**Persistent compound**		**Rapidly degrading compound**	
Maximum concentration, µg/l	2.77E+00 (Marina 42)	7.15E-03 (Marina 24)	2.29E-01 (Marina 42)	2.11E-03 (Marina 24)
Minimum concentration, µg/l	2.11E-02 (Marina 5)	2.29E-04 (Marina 3)	3.34E-03 (Marina 5)	4.27E-05 (Marina 3)
Ratio between max. and min. concentration	131	31	67	49
Median estimate of 90th percentile conc., µg/l (95% confidence intervals)	1.50E+00 (1.01E+00–2.48E+00)	4.13E-03 (3.06E-03–6.09E-3)	1.55E-01 (1.08E-01 – 2.48E-01)	9.57E-04 (6.86E-4–14.7E-4)
Marina closest to 90th percentile (conc. µg/l)	Marina 25 (1.42E+00)	Marina 25 (4.11E-03)	Marina 18 (1.44E-01)	Marina 40 (8.31E-04)
Percentile represented by the Regional Atlantic Marina scenario	56.6%ile	52.7%ile	48.9%ile	46.8%ile
Number of marinas with PECsw > PECsw Regional Atlantic Marina	21/47	23/47	24/47	28/47
Percentile represented by the OECD marina scenario	36.2%ile	66.6%ile	83.8%ile	92.0%ile
Number of marinas with PECsw > PECsw OECD marina	33/47	15/47	11/47	3/47
Ratio between 90th percentile and PECsw Regional Atlantic Marina scenario conc.	3.5	2.8	3.9	3.7

Table 8: Results of MAMPEC 3.1 modelling for the Mediterranean Region (all exposure values represent the average total steady state concentration)

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
	Persistent compound		Rapidly degrading compound	
OECD Marina	2.41E-01	1.98E-03	1.15E-01	1.08E-03
Regional Med. Marina	6.21E-01	1.45E-03	2.49E-02	1.53E-04
Med. Marina 1(CY1)	2.40E-01	9.35E-04	1.29E-02	1.12E-04
Med. Marina 2(CY2)	3.32E-01	9.65E-04	2.54E-02	1.52E-04
Med. Marina 3(CY3)	3.14E-02	1.29E-04	2.27E-03	1.88E-05
Med. Marina 4(CY5)	1.82E-02	1.02E-04	1.01E-03	1.20E-05
Med. Marina 5(ES10)	1.64E-01	3.91E-04	4.03E-03	2.94E-05
Med. Marina 6(ES4)	5.98E-01	1.25E-03	2.13E-02	1.21E-04
Med. Marina 7(ES5)	7.16E-01	1.66E-03	2.11E-02	1.40E-04
Med. Marina 8(ES6)	5.47E-01	8.81E-04	2.34E-02	9.87E-05
Med. Marina 9(ES7)	2.05E+00	3.43E-03	4.38E-02	2.32E-04
Med. Marina 10(ES8)	1.04E+00	1.46E-03	1.91E-02	8.85E-05
Med. Marina 11(ES9)	2.86E+00	3.52E-03	5.88E-02	2.41E-04
Med. Marina 12(FR1)	5.33E+00	4.17E-03	5.59E-02	1.77E-04
Med. Marina 13(FR10)	2.88E+00	2.56E-03	7.31E-02	2.08E-04
Med. Marina 14(FR2)	5.67E-01	1.38E-03	4.62E-02	2.30E-04
Med. Marina 15(FR3)	9.55E-01	2.16E-03	3.78E-02	2.25E-04
Med. Marina 16(FR4)	6.36E-01	1.55E-03	3.57E-02	2.01E-04
Med. Marina 17(FR5)	4.46E+00	3.16E-03	1.06E-01	2.49E-04
Med. Marina 18(FR6)	1.70E+00	2.70E-03	6.58E-02	2.82E-04
Med. Marina 19(FR7)	8.86E-02	5.39E-04	1.54E-02	1.42E-04
Med. Marina 20(FR8)	3.33E+00	3.02E-03	6.85E-02	2.13E-04
Med. Marina 21(FR9)	1.85E+00	1.90E-03	2.32E-02	8.90E-05
Med. Marina 22(GR10)	6.53E-01	1.15E-03	4.23E-02	1.68E-04
Med. Marina 23(GR2)	1.45E+00	1.55E-03	2.44E-02	9.18E-05
Med. Marina 24(GR3)	1.61E-01	2.11E-04	3.51E-03	1.47E-05
Med. Marina 25(GR5)	9.84E-02	3.10E-04	1.22E-02	6.69E-05
Med. Marina 26(GR6)	1.44E+00	1.57E-03	3.28E-02	1.16E-04
Med. Marina 27(GR7)	1.11E+00	1.68E-03	5.24E-02	2.02E-04
Med. Marina 28(GR8)	6.17E-01	7.47E-04	2.48E-02	8.17E-05
Med. Marina 29(GR9)	3.59E-01	6.21E-04	1.22E-02	5.86E-05
Med. Marina 30(IT1)	1.62E-01	1.90E-03	2.35E-02	4.16E-04
Med. Marina 31(IT10)	1.61E+00	2.56E-03	5.70E-02	2.52E-04
Med. Marina 32(IT2)	5.73E-02	4.47E-04	8.70E-03	1.04E-04
Med. Marina 33(IT3)	1.15E+00	1.46E-03	4.69E-02	1.60E-04
Med. Marina 34(IT4)	6.72E+00	4.23E-03	5.96E-02	1.59E-04
Med. Marina 35(IT5)	7.84E-01	1.16E-03	2.81E-02	1.16E-04
Med. Marina 36(IT6)	2.55E-02	3.41E-04	8.07E-03	1.32E-04
Med. Marina 37(IT7)	3.72E-02	1.02E-04	1.92E-03	1.23E-05

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
Med. Marina 38(IT8)	1.81E-01	5.10E-04	7.08E-03	5.22E-05
Med. Marina 39(IT9)	4.20E-01	1.17E-03	2.47E-02	1.55E-04
Med. Marina 40(MT1)	1.11E-02	2.10E-04	1.69E-03	4.63E-05
Med. Marina 41(MT3)	8.21E-02	4.64E-04	4.91E-03	5.90E-05
Med. Marina 42(MT4)	2.25E-01	1.53E-03	1.85E-02	2.41E-04
Med. Marina 43(MT5)	3.27E-01	6.22E-04	9.88E-03	5.45E-05
Med. Marina 44(SI1)	8.71E-01	2.38E-03	3.16E-02	2.30E-04
Med. Marina 45(SI2)	3.07E+00	2.68E-03	5.99E-02	1.83E-04
Med. Marina 46(SI3)	1.44E-01	9.78E-04	4.81E-02	4.09E-04
Summary	**Persistent compound**		**Rapidly degrading compound**	
Maximum concentration, µg/l	6.72E+00 (Marina 34)	4.23E-03 (Marina 34)	1.06E-01 (Marina 17)	4.16E-04 (Marina 30)
Minimum concentration, µg/l	1.11E-02 (Marina 40)	1.02E-04 (Marina 4)	1.01E-03 (Marina 4)	1.20E-05 (Marina 4)
Ratio between max. and min. concentration	605	41	105	35
Median estimate of 90th percentile conc., µg/l (95% confidence intervals)	3.49 (2.00 – 7.18)	3.65E-03 (2.58E-03-5.70E-03)	8.34E-02 (5.64E-02-13.8E-02)	3.45E-04 (2.54E-04-5.13E-04)
Marina closest to 90th percentile (conc. µg/l)	Marina 20 (FR9) (3.33)	Marina 11 (ES9) (3.52E-03)	Marina 13(FR10) (7.31E-02)	Marina 46 (4.09E-04)
Percentile represented by the Regional Atlantic Marina scenario	57.7%ile	63.3%ile	57.9%ile	63.5%ile
Number of marinas with PECsw > PECsw Regional Med. Marina	22/46	22/46	21/46	21/46
Percentile represented by the OECD marina scenario	34.3%ile	74.5	94.1%ile	99.5%ile
Number of marinas with PECsw > PECsw OECD marina	30/46	12/46	0/46	0/46
Ratio between 90th percentile and PECsw Regional Med. Marina scenario conc.	5.6	2.5	3.3	2.3

Table 9: Results of MAMPEC 3.1 modelling for the Baltic Transition Region (all exposure values represent the average total steady state concentration)[3]

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
	Persistent compound		Rapidly degrading compound	
OECD Marina	2.41E-01	1.97E-03	7.37E-02	7.67E-04
Regional Baltic Transition	4.88E-01	1.36E-03	8.77E-02	4.92E-04
Baltic Marina 1 (DE10)	1.09E+00	1.04E-03	1.08E-01	3.17E-04
Baltic Marina 2 (DE2)	1.65E+00	1.81E-05	4.84E-04	4.69E-04
Baltic Marina 3 (DE3)	8.92E-01	6.83E-05	2.93E-03	1.41E-04
Baltic Marina 4 (DK4)	6.30E-02	2.16E-03	1.58E-01	3.67E-04
Baltic Marina 5 (DK5)	4.58E+00	5.11E-05	2.00E-03	2.44E-04
Baltic Marina 6 (DK9)	1.57E+00	3.08E-04	1.66E-02	2.88E-04
Baltic Marina 7 (DK1)	5.71E+00	3.54E-04	2.72E-02	6.13E-04
Baltic Marina 8 (DK10)	8.73E-01	2.48E-04	2.21E-02	1.47E-04
Baltic Marina 9 (DK11)	6.72E+00	4.75E-04	2.41E-02	1.06E-03
Baltic Marina 10 (DK2)	2.47E+00	9.89E-04	6.40E-02	5.13E-04
Baltic Marina 11 (SE15)	1.51E-01	4.64E-05	4.55E-04	3.97E-03
Baltic Marina 12 (DE11)	3.02E+00	1.94E-04	1.38E-02	3.77E-04
Baltic Marina 13 (DE6)	1.97E+00	1.05E-04	3.93E-03	2.34E-04
Baltic Marina 14 (DE7)	1.40E+00	1.81E-04	5.33E-03	1.38E-04
Baltic Marina 15 (DE9)	7.95E+00	5.45E-04	3.60E-02	5.48E-05
Baltic Marina 16 (DK3)	1.57E-01	2.35E-04	8.08E-03	6.71E-04
Baltic Marina 17 (SE3)	2.08E+00	2.09E-05	5.46E-04	2.27E-04
Summary	**Persistent compound**		**Rapidly degrading compound**	
Maximum concentration, µg/l	7.95 (Marina DE9)	2.16E-03 (Marina DK4)	1.58E-01 (Marina DK4)	3.97E-03 (Marina SE15)
Minimum concentration, µg/l	6.30E-02 (Marina DK4)	1.81E-05 (Marina DE2)	4.55E-04 (Marina SE15)	5.48E-05 (Marina DE9)
Ratio between max. and min. concentration	126	120	348	72
90th percentile conc., µg/l	8.12	1.15E-03	9.75E-02	1.17E-03
Marina closest to 90th percentile (conc. µg/l)	Marina DE9 (7.95)	Marina DE10 (1.04E-03)	Marina DE10 (1.08E-01)	Marina DK11 (1.06E-03)
Percentile represented by the Regional Marina scenario	23.0%ile	91.9%ile	88.9%ile	64.9%ile
Number of marinas with PECsw > Regional Marina	14/17	1/17	2/17	5/17
Percentile represented by the OECD marina scenario	10.6%ile	95.2%ile	87.1%ile	80.0%ile
Number of marinas with PECsw > OECD marina	14/17	1/17	2/17	2/17
Ratio between 90th percentile and Regional Marina scenario conc.	16.6	0.8	1.1	2.4

[3] Results for the Baltic Transition region were kindly prepared by Birgitte Skou Cordua (DK)

Table 10: Results of MAMPEC 3.1 modelling for the Baltic Sea Region (all exposure values represent the average total steady state concentration)

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
	Persistent compound		Rapidly degrading compound	
OECD Marina	2.41E-01	1.98E-03	1.15E-01	1.08E-03
Regional Baltic Sea Marina	2.43E+00	3.53E-03	6.11E-02	2.66E-04
Baltic Sea Marina 01(SE11)	1.95E+00	7.68E-03	1.35E-01	1.08E-03
Baltic Sea Marina 02(DK8)	2.20E+00	9.36E-04	3.33E-02	5.40E-05
Baltic Sea Marina 03(DK12)	3.46E+01	1.05E-02	8.42E-01	8.59E-04
Baltic Sea Marina 04(DK13)	5.63E+01	6.89E-03	1.14E+00	5.09E-04
Baltic Sea Marina 05(DK14)	4.03E-01	1.53E-03	9.12E-02	4.91E-04
Baltic Sea Marina 06(DK15)	1.90E+01	8.50E-03	7.13E-01	9.15E-04
Baltic Sea Marina 07(DK16)	6.98E+00	1.39E-03	1.97E-01	1.26E-04
Baltic Sea Marina 08(FI8)	6.18E-01	3.48E-04	1.13E-01	9.95E-05
Baltic Sea Marina 09(FI9)	7.07E+00	6.98E-04	1.86E-01	6.12E-05
Baltic Sea Marina 10(LT1)	2.77E+01	8.48E-04	1.24E-01	1.98E-05
Baltic Sea Marina 11(LV2)	1.36E+01	7.90E-03	9.15E-02	2.12E-04
Baltic Sea Marina 12(PL7)	4.41E+00	6.51E-03	3.12E-02	1.44E-04
Baltic Sea Marina 13(PL2)	8.22E-01	8.22E-04	6.12E-03	2.27E-05
Baltic Sea Marina 14(PL3)	7.14E-01	9.84E-04	6.96E-03	3.23E-05
Baltic Sea Marina 15(PL5)	3.43E-01	1.88E-04	1.08E-02	1.79E-05
Baltic Sea Marina 16(EE10)	4.53E+00	6.98E-03	2.20E-02	8.80E-05
Baltic Sea Marina 17(EE2)	1.67E-01	2.45E-04	3.08E-03	1.42E-05
Baltic Sea Marina 18(EE5)	2.13E+00	2.98E-04	2.49E-02	1.49E-05
Baltic Sea Marina 19(FI1)	7.65E+00	1.63E-03	5.56E-02	5.43E-05
Baltic Sea Marina 20(FI10)	1.52E+00	4.93E-03	1.04E-01	6.92E-04
Baltic Sea Marina 21(FI6)	4.05E+00	6.33E-03	2.79E-02	1.28E-04
Baltic Sea Marina 22(FI7)	1.81E+01	2.95E-03	7.73E-02	5.95E-05
Baltic Sea Marina 23(EE1)	7.07E+00	3.28E-03	7.84E-02	1.46E-04
Baltic Sea Marina 24(EE3)	2.16E-01	2.50E-04	9.28E-03	2.80E-05
Baltic Sea Marina 25(EE4)	8.36E+00	2.79E-03	5.46E-02	8.07E-05
Baltic Sea Marina 26(EE7)	1.04E+00	4.97E-04	7.90E-03	1.58E-05
Baltic Sea Marina 27(EE8)	7.25E+00	1.41E-03	1.51E-01	1.05E-04
Baltic Sea Marina 28(EE9)	5.29E+00	9.31E-04	2.07E-02	1.67E-05
Baltic Sea Marina 29(SE10)	1.84E+01	2.15E-03	1.11E-01	6.24E-05
Baltic Sea Marina 30(SE12)	3.76E+00	1.14E-02	1.91E-01	1.32E-03
Baltic Sea Marina 31(SE13)	1.97E+00	5.15E-03	8.04E-02	5.19E-04
Baltic Sea Marina 32(SE14)	1.18E+00	1.72E-03	5.88E-02	2.10E-04
Baltic Sea Marina 33(SE9)	3.42E+00	1.19E-02	5.90E-02	5.30E-04
Baltic Sea Marina 34(FI2)	1.25E+01	7.05E-03	1.10E-01	2.50E-04
Baltic Sea Marina 35(FI3)	1.33E+01	1.99E-03	8.66E-02	6.12E-05
Baltic Sea Marina 36(FI4)	4.29E+00	9.66E-04	7.42E-02	6.30E-05
Baltic Sea Marina 37(FI5)	2.71E+01	2.80E-03	2.17E-01	1.06E-04
Baltic Sea Marina 38(SE7)	2.85E+00	9.70E-03	1.18E-01	9.40E-04

Scenario	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)	PECsw inside marina (µg/l)	PECsw surrounding marina (µg/l)
Summary	**Persistent compound**		**Rapidly degrading compound**	
Maximum concentration, µg/l	5.63E+01 (Marina 04)	1.19E-02 (Marina 33)	1.14E+00 (Marina 04)	1.32E-03 (Marina 30)
Minimum concentration, µg/l	1.67E-01 (Marina 17)	1.88E-04 (Marina 15)	3.08E-03 (Marina 17)	1.42E-05 (Marina 17)
Ratio between max. and min. concentration	337	63	370	93
Median estimate of 90th percentile conc., µg/l (95% confidence intervals)	2.48E+01 (1.42E+01-5.22E+01)	1.01E-02 (0.63E-02-1.89E-02)	3.56E-01 (2.13E-01-7.05E-01)	6.72E-04 (3.96E-04-13.5E-04)
Marina closest to 90th percentile (conc. µg/l)	Marina 37 (2.71E+01)	Marina 03 (1.05E-02)	Marina 37 (2.17E-01)	Marina 20 (6.92E-04)
Percentile represented by the Regional Atlantic Marina scenario	37.7%ile	66.4%ile	48.6%ile	72.9%ile
Number of marinas with PECsw > PECsw Regional Atlantic Marina	24/38	14/38	22/38	10/38
Percentile represented by the OECD marina scenario	2.92%ile	48.1%ile	66.9%ile	94.7%ile
Number of marinas with PECsw > PECsw OECD marina	36/38	20/38	11/38	1/38
Ratio between 90th percentile and PECsw Regional Atlantic Marina scenario conc.	10.2	2.9	5.8	2.5

Statistical tests (Anderson Darling, Cramer Von Mises and Kolmogorov Smirnov) were performed as standard as part of the webfram model analysis of the data sets. Results of these statistical tests were variable across the regions.

For the Atlantic region marinas this analysis confirmed the acceptability of the fitted distributions for all combinations (inside and surrounding areas for both substances) for all tests and P-values. An example of the statistical analysis from webfram has been included in Appendix 1.

For the Mediterranean region marinas the statistical analysis from the webfram model could only confirm the acceptability of the fitted distribution for the persistent substance inside the marinas (all three tests and P-values). For the persistent substance outside the marinas the three tests were accepted at a P-value of 0.025 or 0.01 only. For the rapidly degrading substance inside the marina all statistical tests were rejected. For the rapidly degrading substance only the Kolmogorov Smirnov test was accepted at P values of 0.05, 0.025 and 0.01. Examples of the statistical outputs for this region is provided in Appendix 1.

For the Baltic Transition region all statistical tests were accepted except for the persistent substance inside the marina at a P-vaue of 0.1 for all three tests.

For the Baltic Sea region all statistical tests were accepted except for the persistent substance outside the marina and the rapidly degrading substance inside the marina where all three tests were rejected at a P-value of 0.1.

Since the UK is no longer proposing to use these specific set of results in future regulatory decision making the rejection of certain statistical tests is not considered critical. However for any future models that are developed based on thjis methodology it is considered important to test the robustness of the underlying statistical tests. An example of the cumulative probability distribution for the rapidly degrading substance inside the Mediterranean marinas (where all statistical tests were rejected) is shown in Figure 3 below.

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 PECsed concentrations based on suspended matter are derived assuming instantaneous partitioning from the water phase concentrations, the PECsed values are perfectly correlated with the PECsw values. Therefore the UK CA considers that any conclusions based on the surface water values can be directly read across to the sediment values. An illustration of PECsed vs PECsw is shown in Figure 5 based on concentrations inside the Atlantic marinas based on the persistent substance.

Figure 2: Cumulative probability distribution for concentrations inside the 47 Atlantic marinas (persistent compound)

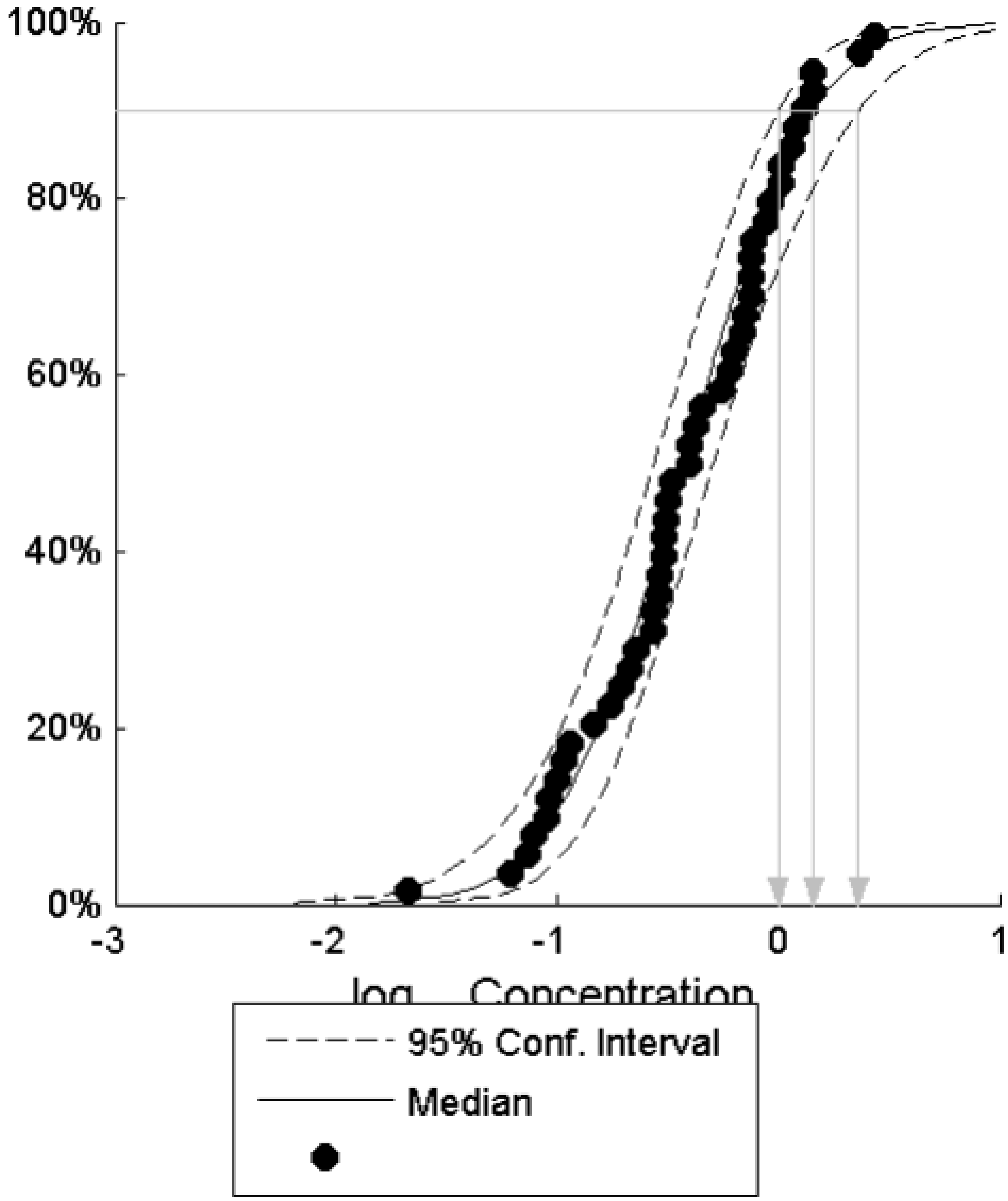
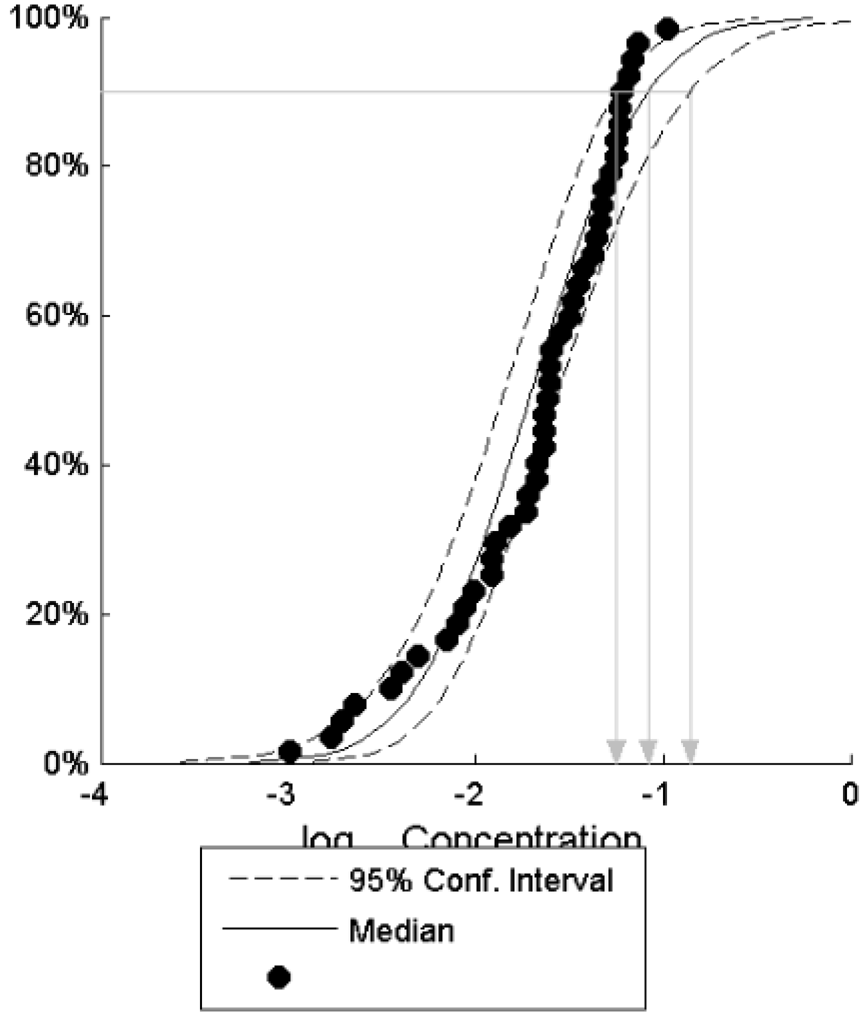


Figure 3: Cumulative probability distribution for concentrations inside the 46 Mediterranean marinas (rapidly degrading compound)



Note that the data underpinning Figure 3 resulted in all three statistical tests being rejected according to the webfram analysis. However based on the median estimate of the distribution, the UK RMS considers this to still represent a conservative estimate of the distribution of the actual data, particularly around the 90th percentile. Note that the actual data points around the 90th percentile are within the lower bounds of the 95% confidence intervals and thus the median estimate is likely to be conservative.

Additional analysis was performed comparing the the different region marina PECsw outputs (Tables 7 to 10) with different combinations of key marina input parameters (Table 3 to 6). This was intended to identify correlations and determine the most sensitive marina parameters.

Not surprisingly a relationship was identified between the PECsw value and the marina volume per boat. The highest PECsw values were identified in marinas with the smallest volume to boat ratio (indicative of the most densely occupied marinas). For example maximum concentrations of both substances inside the Atalantic Region marinas were found in Marina 42 – this marina had the lowest volume to boat ratio of all marinas tested in this region(215 m^3 per boat). This was the strongest relationship identified in the limited analysis performed here. An example for the rapidly degrading substance inside the Atlantic marinas is presented in Figure 4 below.

Figure 4: Relationship between PECsw (µg/l, inside Atlantic Region marinas for the degrading substance) and marina volume per boat (m^3/boat)

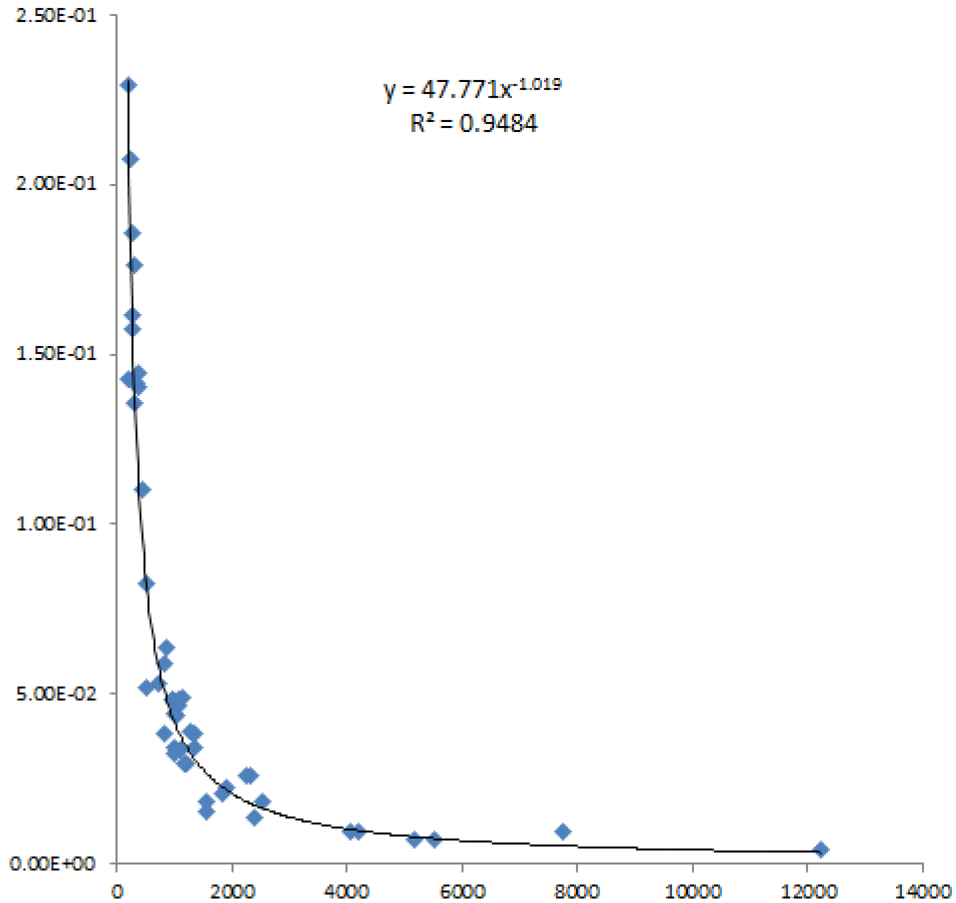
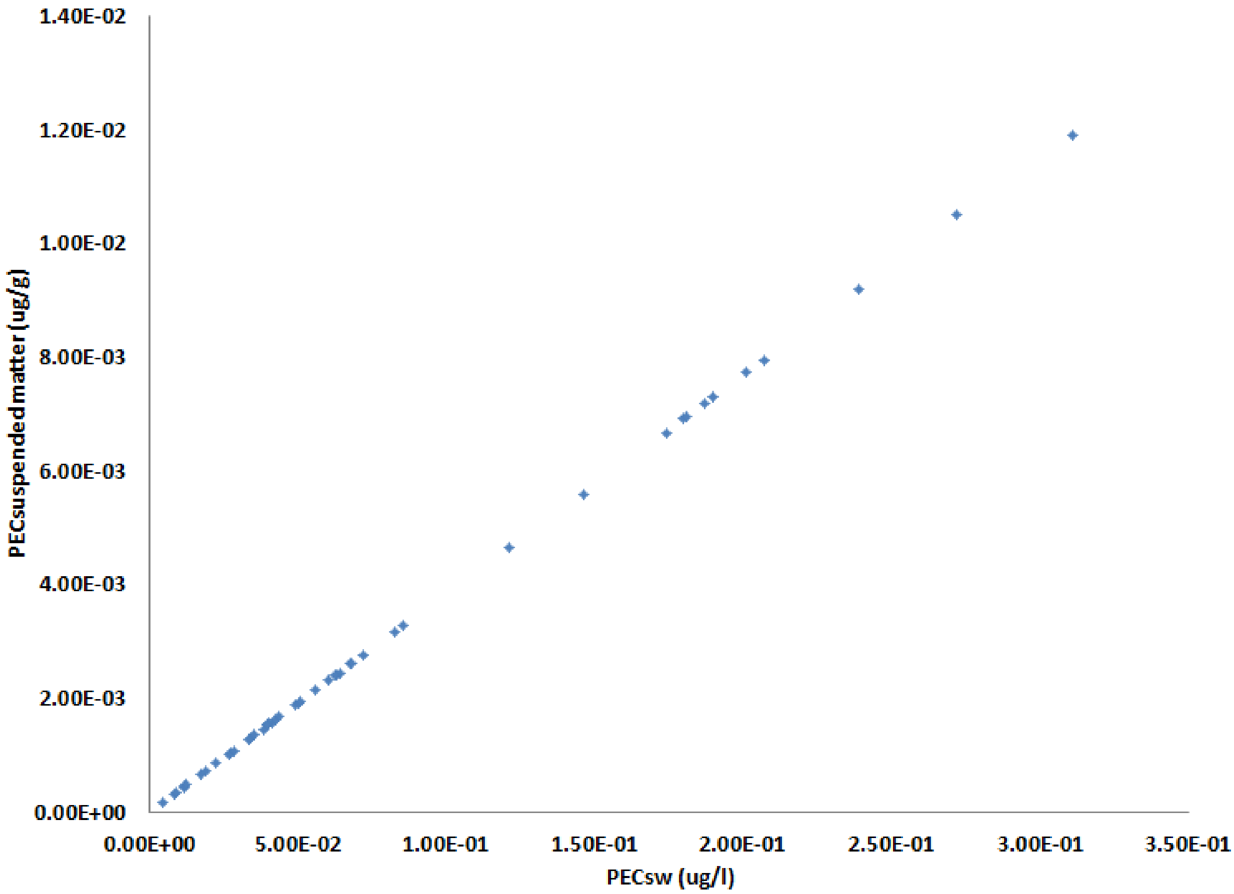


Figure 5: Relationship between PECsw and PECsuspended matter (persistent substance inside the Atlantic marinas)



3.1 Comparison against existing regulatory models and monitoring data

In order to test and partially validate the results in Section 3 above the UK has compared the results here with those derived from other existing regulatory models used for PT21 products. In addition a brief comparison against existing monitoring data has been provided.

For comparison with the Atlantic Region, the UK has used the existing UK regulatory model REMA. The REMA model is parameterised with four UK specific estuarine scenarios each containing up to 3 different pleasure craft marinas. For the comparison the UK simply ran a standard tier 1 REMA simulation using the same two substance properties and emission rates as used above.

For the persistent substance, the REMA model returned PECsw values inside marinas ranging from 0.41 up to 1.83µg/l. The compares reasonably well with the range of values generated for the Atlantic region, where concentrations ranged from 0.0211 up to 2.77µg/l. If a decision is made to accept the use of the 90th percentile concentration in future regulatory assessments, then the 90th percentile from the Atlantic region i.e. 1.50µg/l, is broadly comparable to the peak concentration from the REMA model (1.83µg/l).

For the rapidly degrading substance substance, the REMA model returned PECsw values inside marinas ranging from 3.79E-02 up to 0.169µg/l. The also compares reasonably well with the range of values generated for the Atlantic region, where concentrations ranged from 3.34E-03 up to 0.229µg/l. Again if a decision is made to accept the use of the 90th percentile concentration in future regulatory assessments, then the 90th percentile from the Atlantic region i.e. 0.155µg/l, is broadly comparable to the peak concentration from the REMA model (0.169µg/l).

For comparison with the Baltic Sea Region, the UK has used the existing SE KEMI Bullando (east coast) marina and the FI Uittamo (SYKE) marina. Both these marinas were simulated within the latest version of MAMPEC v3.1. For the comparison the UK simply ran standard simulations using the same sets of substance properties and leaching rates as used above. No other amendments to existing scenarios was made.

For the persistent substance, the SE KEMI (Bullando) marina returned a PECsw value inside the marina of 8.19µg/l. For the FI SYKE marina a PECsw value inside the marina of 0.98µg/l was calculated. In comparison the values generated for the Baltic Sea region ranged from 0.167 up to 56.3µg/l. If a decision is made to accept the use of the 90th percentile concentration in future regulatory assessments, then the 90th percentile from the Baltic Sea region i.e. 24.8µg/l, is significantly higher than predicted by the two existing scenarios. In comparison with the values generated for the Baltic Transition region, these ranged from 0.0630 up to 7.95µg/l. If a decision is made to accept the use of the 90th percentile concentration in future regulatory assessments, then the 90th percentile from the Baltic Transition region i.e. 8.12µg/l, is in very good agreement with the concentration from the more conservative SE KEMI scenario (i.e. 8.19µg/l).

It should be noted that the Bullando marina is actually included in the regional marina database, where it is reported as Marina 33 (SE9). However in the table above the SE9 marina is only assumed to contain 376 boats with a total surface area of 11,543m^2 (based on the values from the Newcastle University report and the default surface area assumption of 30.7m^2 per boat) compared to the 1400 boats (with surface area of 27,650m^2) used in the SE National Bullando marina scenario. Since the SE National Bullando marina has a total treated surface area nearly 2.4 times higher than in the regional Marina 33 (SE9) this explains why the SE National Bullando marina gave PECsw values nearly 2.4 times higher than Marina 33 (SE9) (i.e. 8.19 vs 3.42 µg/l). The existing FI National scenario is also included within the regional database, where it is Marina 20 (FI10). In the case of the FI scenario, the regional marina modelling actually represents a slightly more conservative assessment than is used currently in FI national assessment (this is due to the simplistic assumption in the regional scenario modelling where all boats are assumed to have a surface area of 30.7m^2, which results in a higher leaching area than in the more details FI scenario where a range of pleasure craft sizes is simulated). The differences identified in the scenarios above could be corrected in updated analysis, or in any future tools that are developed to harmonise outputs with existing MS scenarios.

For the rapidly degrading substance, the SE KEMI (Bullando) marina returned a PECsw value inside the marina of 0.141µg/l. For the FI SYKE marina a PECsw value inside the marina of 6.71E-02µg/l was calculated. In comparison the values generated for the Baltic Sea region ranged from 3.08E-03 up to 1.14µg/l. If a decision is made to accept the use of the 90th percentile concentration in future regulatory assessments, then the 90th percentile from the Baltic Sea region i.e. 0.356µg/l, would represent a conservative estimate compared to both existing Baltic Region national marina scenarios. In comparison with the values generated for the Baltic Transition region, these ranged from 4.55E-4 up to 0.158µg/l. If a decision is made to accept the use of the 90th percentile concentration in future regulatory assessments, then the 90th percentile from the Baltic Transition region i.e. 9.75E-02µg/l, is close to the average of the SE KEMI and FI SYKE scenarios (i.e. 0.104µg/l).

Since these simulations have only used dummy substances the UK proposes that as part of any future development work (i.e. to develop substance specific Excel calculation tools as outlined in Section 5) the results from the calculation tools could be benchmarked more fully against a range of existing regulatory scenarios.

In order to compare the outputs of the regional marina scenarios with monitoring data the UK has simply used the summary results from ACE (Assessment of Antifouling Agents in Coastal Environments report MAS3-CT98-0178) (Readman, J.W. et al 2002). A summary table taken directly from the report has been provided in Appendix 2. Note this is not intended to represent a detailed comparison against monitoring data. However it does at least provide some level of validation of the results reported in Section 3 above.

For comparison against the persistent substance (which used dummy substance properties for Irgarol as reported within the MAMPEC model), the monitoring data for Irgarol 1051 has been used. Monitoring data from the following areas within the Atlantic Region were reported – Netherlands, UK and France (English Channel Marinas and Atlantic Coast marinas). Concentrations ranged from <1E-03 up to 0.621µg/l. This compares to the range of values generated for the Atlantic region, where concentrations ranged from 0.0211 up to 2.77µg/l (90th percentile 1.50µg/l). Monitoring data from the following areas within the Mediterranean Region were reported – France (Mediterranean marinas), Spain and Greece. Concentrations ranged from <1E-03 up to 0.670µg/l. This compares to the range of values generated for the Mediterranean region, where concentrations ranged from 1.11E-02 up to 6.72µg/l (3.49µg/l). Monitoring data from the following areas within the Baltic Regions were reported – Sweden and Denmark. Concentrations ranged from 4E-03 up to 0.364µg/l. This compares to the range of values generated for the combioned Baltic regions, where concentrations ranged from 6.30E-02 up to 56.3µg/l (90th percentiles ranging from 8.12-24.8).

More limited detections of dichlofluanid were available and these were compared to the results for the rapidly degraded substance above (which used dummy substance properties for dichlofluanid as reported within the MAMPEC model). All regions monitored reported minimum concentrations of <1E-03. The peak concentration in the Atlantic region (from UK monitoring) was reported to be 0.390µg/l with a mean of 8E-03µg/l. This compares to the 90th percentile from the Atlantic Region of 0.155µg/l. Peak concentrations in the Mediterranean region (from Spanish and Greek monitoring sites) was reported to range from 0.284 to 0.760µg/l with means ranging from 0.030 to 0.061µg/l. This compares to the 90th percentile from the Mediterranean Region of 0.0834µg/l.

From this very limited assessment it appears that the regional marina modelling approach may provide reasonable estimates of peak monitored concentrations for the persistent substance in the Atlantic and Mediterranean Regions, but provide significant overestimates in the Baltic Sea Region. For the rapidly degraded substance the regional marina modelling approach may underestimate peak concentrations detected in the Atlantic and Meditteranean regions but provide reasonable estimates that broadly reflect the average monitored concentrations. However it should be noted that this represent a very limited analysis and the properties of the dummy substances simulated based on existing MAMPEC compounds do not necessarily reflect final EU agreed regulatory endpoints. It is however probably reasonable to conclude that the approach to modelling multiple regional marina scenarios results in ranges of concentrations that are likely to be more reflective of the range of concentrations encountered from EU monitoring studies. It should be noted that any discrepancies between the modelled and monitored concentrations would be exacerbated if the comparison were only made between the existing OECD marina (or the proposed individual regional pleasure pleasure craft marinas).

4. Discussion

The results in Section 3 provide a reasonably comprehensive dataset for further analysis. In particular they provide information on the sensitivity of the MAMPEC model to different substance, environmental and physical marina parameters. They also allow comparison against existing regulatory scenarios and monitoring data. However for the purposes of developing agreed EU wide regional marina scenarios the UK considers that a couple of findings are particularly critical.

When looking across the 4 regions it is clear that there is no single marina within each region that consistently represents either a worst case (i.e. always the maximum PECsw) or a reasonable worst case (i.e. always closest to the calculated 90th percentile PECsw) for both substances inside and outside of the marinas (see Tables 7 to 10). For example, within the Mediterranean region Marina 34 represented the worst case inside and outside the marinas for the persistent compound. However Marina 17 was worst case inside for the degrading compound and Marina 30 was worst case outside for the degrading compound. Similarly four different marinas (no. 20, 11, 13 and 46) were closest to the 90th percentile for the four simulations. This finding is considered important because it indicates that it may be impossible to identify a single worst case or reasonable worst case marina for each region for consistent use in future product authorisation assessments.

The other key finding is related to the degree of protection[4] afforded by either the existing OECD marina or the proposed regional marinas (based on average properties). For example, the degree of protection afforded by the existing OECD marina varied from 2.92% (persistent substance inside the Baltic Sea marina) up to 99.5% (degrading substance outside the Mediterranean marinas). Although the range represented by the average regional marinas was smaller (and closer to the 50th percentile in most cases) this scenario still ranged from 37.7 to 72.9% (Baltic Sea region). This finding is important because again it suggests it may be impossible to identify a single generic scenario that consistently represents an appropriately conservative scenario for use in future product authorisation procedures. Since the degree of protection is quite variable across the four regions, it also suggest that it may be difficult to identify appropriate correction factors that could be applied to the results of the generic sceanrios in order to provide an appropriate level of protection and/or conservatism. Note the proposal to explore the use of correction factors was based on earlier interim results from only two regions – now that the full data set is available this option seems less suitable.

Although these findings do not help to directly identify suitable scenarios, the extensive work undertaken with the MAMPEC model has shown that it may be possible to develop a simplified MS Excel calculation tool that would allow quite detailed regional marina exposure assessments to be performed. These proposals are outlined in Section 5.

5. Proposals

Rather than try to identify single representative scenarios, the UK proposes to develop an Excel calculation tool that would allow results for all marinas in all regions to be automatically generated. This would be expected to have several advantages. For example, rather than basing risk assessments on single deterministic estimates of exposure for single scenarios where the level of protection is either unknown or is highly variable, the exposure part of the risk assessment can be based on an appropriate percentile from the underlying distribution for each region. This captures at least some of the variability associated with the exposure concentrations and the degree of protection can at least be

[4] Here we define '*degree of potection*' as the percentile of the distribution of all of the individual regional marinas represented by the single OECD or average regional marina (see Tables 7 to 10 for full results).

inferred from the chosen percentile. Retaining information for all marinas should also allow more sophisticated risk assessments, particularly where multiple active substance or SoCs need to be assessed. For example for multiple substance assessments it would be possible to combine exposure levels within the same marinas to provide a more realistic estimate of combined exposure.

To illustrate the proposed calculation tool the UK has prepared a prototype tool for dicopper oxide (see doc WGI2017_ENV_7_2b(iii)_PT21_prototype Excel calculator_Copper(draft)). This tool has been built by running MAMPEC simulations for all 148 regional marinas using the PT21 EU agreed copper endpoints. The preprepared MAMPEC simulations use a dummy leaching rate and Application Factor. The Excel tool then allows the user to simply input their own leaching rate which can be from a measured study or using the ISO mass balance calculation method. If data is available to support a reduction in Application Factor this can also be amended. In the case of copper, since background concentrations often represent a significant contribution to the total environmental loading there is the final option to use region specific background data if this becomes available in the future. Instructions and background to the tool can be found in (see doc WGI2017_ENV_7_2b(ii)_PT21 Calculation Tool Instructions).

It should also be acknowledged that this approach has some disadvantages. Since the Excel tool is built using outputs from MAMPEC, separate substance specific tools would be needed. This will require additional resource and the UK will need assistance if these tools are to be created for all active substances. Separate tools may also potentially need to be created for major substanes of concern and/or ecotoxicologically relevant metabolites. The UK estimates that it takes around 5 days to run the necessary MAMPEC simulations and import data into the Excel format. Since these tools could potentially support all future product authorisations we would suggest that a similar amount of time should be spent on peer reviewing and Quality Control procedures. MS comments on the proposed Excel calculation tool are requested. In addition MS support to develop additional substance specific calculation tools should be noted.

The results presented here suggest that for some regions and substances the approach besed on the 90^{th} percentile value from the regional marina database could result in PECsw estimates that are more conservative than the existing OECD marina scenario. The UK therefore additionally proposes that before any tools are agreed for use they should be subject to a regulatory impact assessment. The selection of appropriate percentiles to use in regulatory decision making may also need to be agreed with Risk Managers.

Finally it should be noted that prototype Excel calculation tool only includes losses during the in-service life stage. No emissions from application, maintenance or repair activities have been included. During the AHEE-1 2016 meeting MS experts discussed the appropriateness of using standard risk mitigation labelling (based on the legal text of the individual active substance approvals) to control emissions during these other life stages. A question was sent to the BPC meeting to consider the specific risk mitigation phrasing. A summary of the conclusions from BPC-17 were presented at WGV-2016 and are summarised below:-

RMM for PT 21 - AHEE-1 (item 6.1) / WG-III-2016 (item 6.7)

a) *BPC was questioned how the conditions in the RMM for PT 21 are linked.*

Conclusions BPC*: It should be 1 and (2 or 3). For further clarification the text of the RMM should be reworded in the future as follows: „…that application, maintenance and repair activities shall (1) be conducted within a contained area to prevent losses and minimize emissions to the environment, meaning (2) on an impermeable hard standing with bunding or (3) on soil covered with an impermeable material. Any losses or waste containing [the substance] shall be collected for reuse or disposal"*

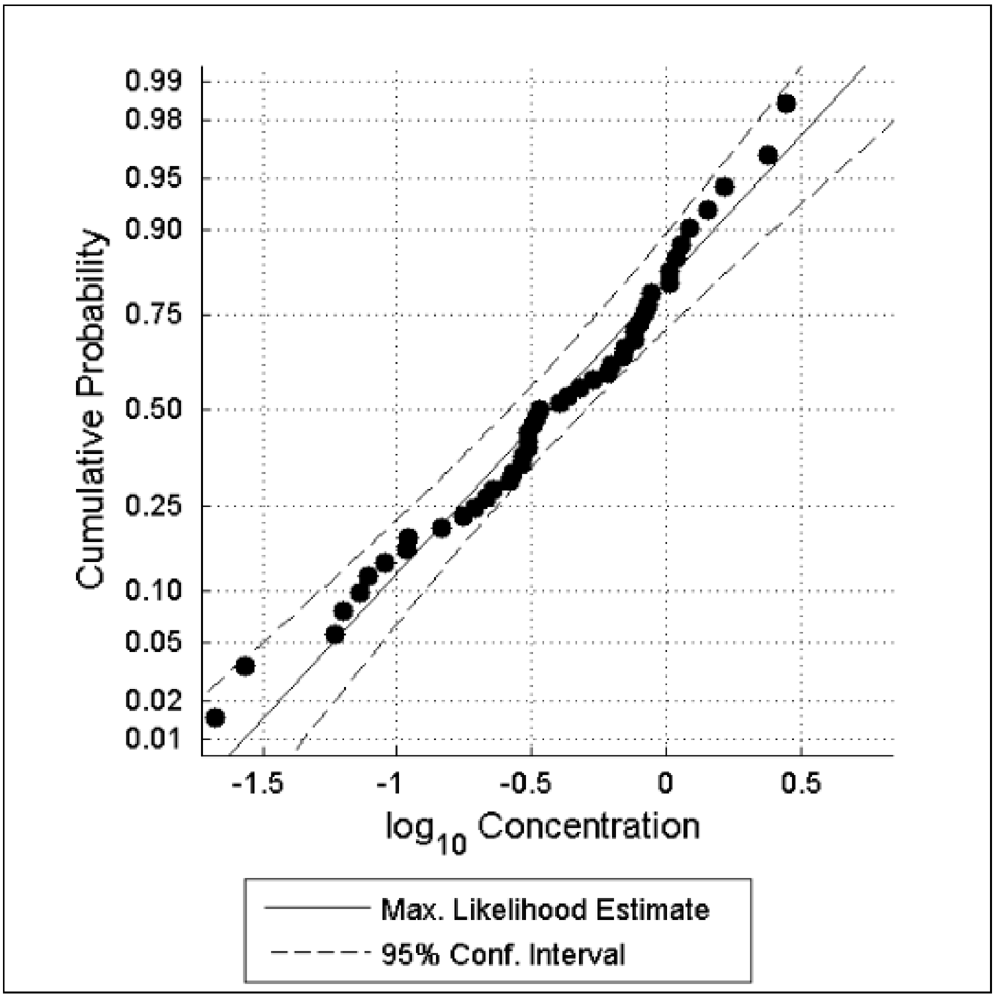
b) *The meaning of contained area was further discussed, specifically if it includes wind protection.*

__Conclusions BPC__: It needs to be further specified between the boat type and the application method: For pleasure crafts in case the antifouling is applied by brushing, wind protection is not relevant. For commercial ships in case the antifouling is applied by spraying, it may be relevant. This should be reflected in the PT 21 product manual currently under preparation by UK. It was further noted that wind protection should not be as such part of the standard RMM, but if needed during product authorisation (to be followed up by CG), it could be added as second provision. If identified as being relevant during product authorisation, also the release pathway via air should be covered by an emission scenario to be developed (AHEE). As overall conclusion, at this point in time the standard condition currently available should not be changed.

The UK understands this conclusion to mean that the BPC was content that emissions from these pathways could be controlled by risk mitigation phrasing, as long as this is amended in line with the BPC-17 conclusions above. The UK intends to update the PT21 product authorisation guide in line with these conclusions and recommendations for specific label phrases. The UK also notes the request to AHEE to further develop release pathways to air following spray applications to commercial shipping. The PT21 guide can be updated to include future scenarios as necessary.

UK CA
15th December. 2016

Appendix 1: Goodness of fit statistical tests from the webfram model for the PECsw values inside the Atlantic marinas and the persistent substance (to show a statistically acceptable distribution)



GoF Results

Kolmogorov Smirnov

P-Values	Critical Values For Test Statistic	Calculated Test Statistic	Accepted or Rejected
0.1	0.819	0.6503	Accepted
0.05	0.895	0.6503	Accepted
0.025	0.995	0.6503	Accepted
0.01	1.035	0.6503	Accepted

Cramer Von Mises

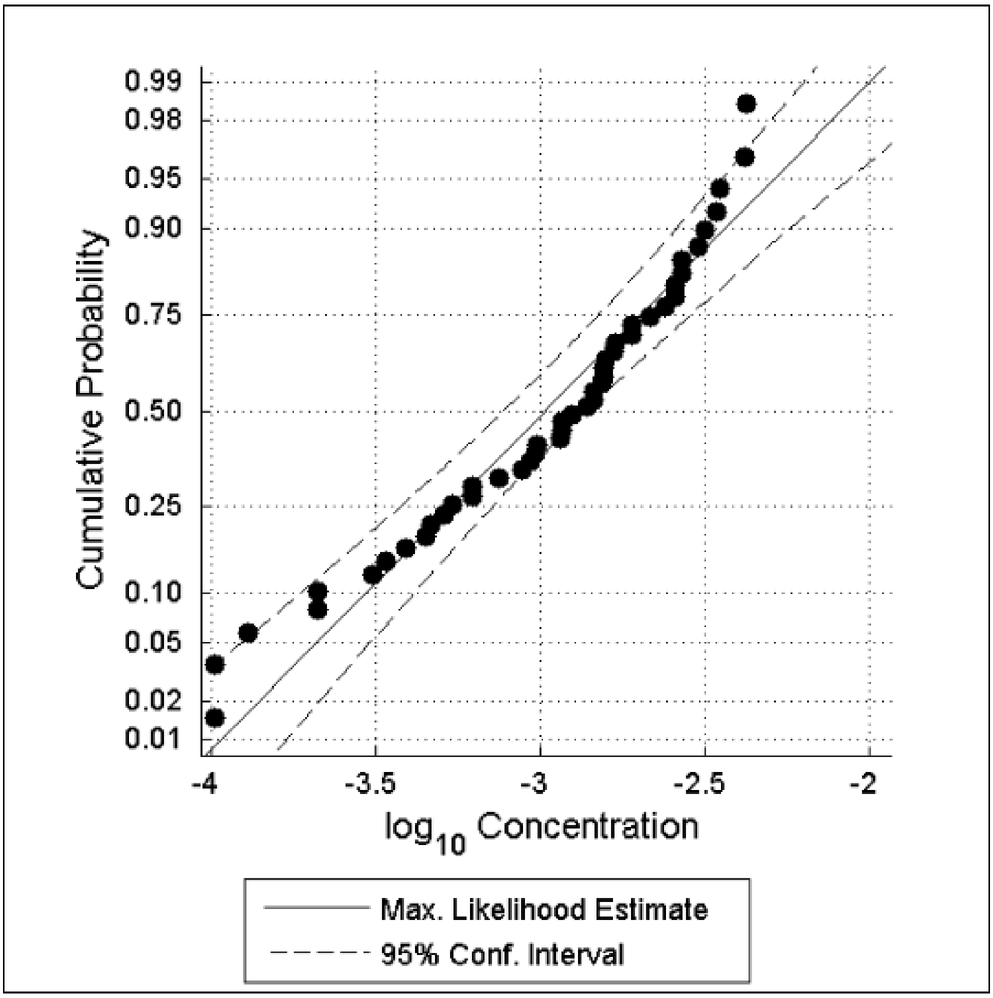
P-Values	Critical Values For Test Statistic	Calculated Test Statistic	Accepted or Rejected
0.1	0.104	0.0751	Accepted
0.05	0.126	0.0751	Accepted
0.025	0.148	0.0751	Accepted
0.01	0.179	0.0751	Accepted

Anderson Darling

P-Values	Critical Values For Test Statistic	Accepted or Rejected
0.1	0.631	Accepted
0.05	0.752	Accepted
0.025	0.873	Accepted
0.01	1.035	Accepted

AD Stat: 0.4738
AD P-Val: 0.7582

Goodness of fit statistical tests from the webfram model for the PECsw values inside the Mediterranean marinas and the persistent substance (to show a distribution that was not fully statistically acceptable at all P-values)



GoF Results

Kolmogorov Smirnov

P-Values	Critical Values For Test Statistic	Calculated Test Statistic	Accepted or Rejected
0.1	0.819	0.8921	Rejected
0.05	0.895	0.8921	Accepted
0.025	0.995	0.8921	Accepted
0.01	1.035	0.8921	Accepted

Cramer Von Mises

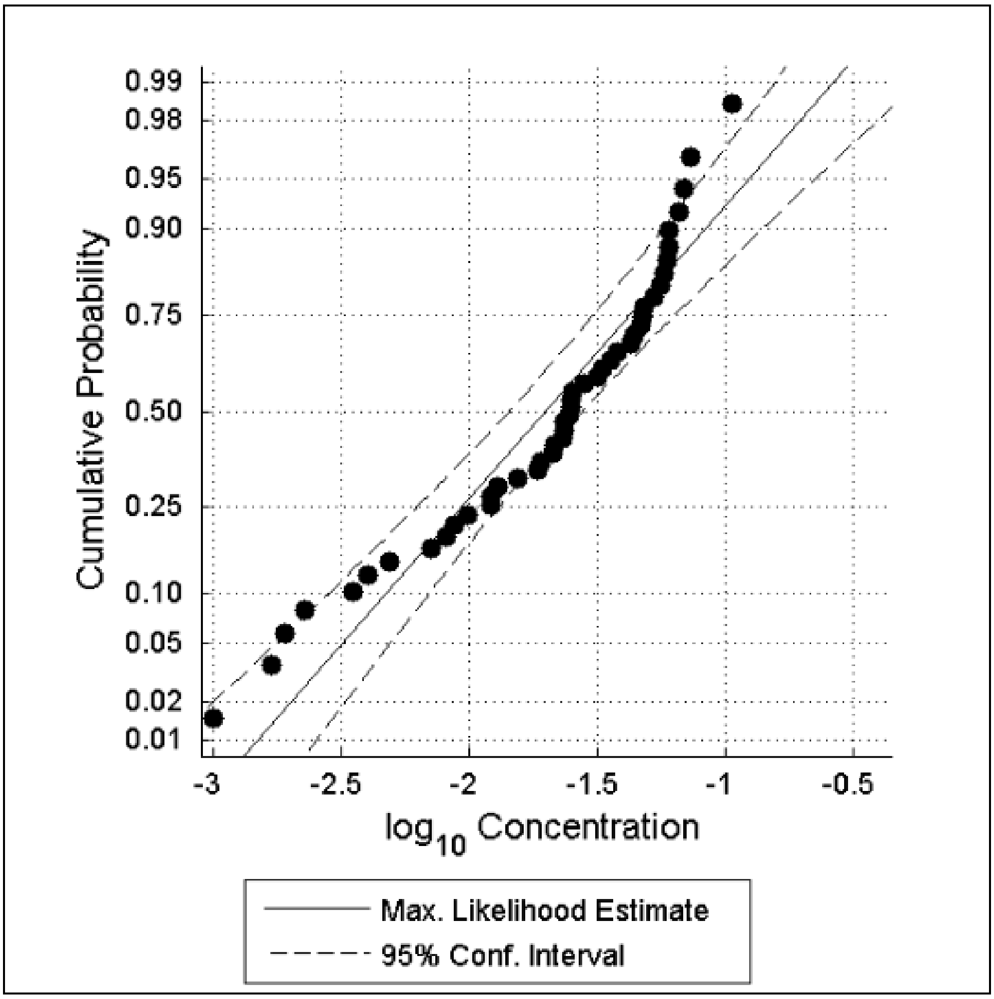
P-Values	Critical Values For Test Statistic	Calculated Test Statistic	Accepted or Rejected
0.1	0.104	0.1378	Rejected
0.05	0.126	0.1378	Rejected
0.025	0.148	0.1378	Accepted
0.01	0.179	0.1378	Accepted

Anderson Darling

P-Values	Critical Values For Test Statistic	Accepted or Rejected
0.1	0.631	Rejected
0.05	0.752	Rejected
0.025	0.873	Accepted
0.01	1.035	Accepted

AD Stat: 0.8669
AD P-Val: 0.9738

Goodness of fit statistical tests from the webfram model for the PECsw values inside the Mediterranean marinas and the rapidly degrading substance (to show a distribution that was not statistically acceptable according to any of the three tests)



GoF Results

Kolmogorov Smirnov

P-Values	Critical Values For Test Statistic	Calculated Test Statistic	Accepted or Rejected
0.1	0.819	1.0467	Rejected
0.05	0.895	1.0467	Rejected
0.025	0.995	1.0467	Rejected
0.01	1.035	1.0467	Rejected

Cramer Von Mises

P-Values	Critical Values For Test Statistic	Calculated Test Statistic	Accepted or Rejected
0.1	0.104	0.2130	Rejected
0.05	0.126	0.2130	Rejected
0.025	0.148	0.2130	Rejected
0.01	0.179	0.2130	Rejected

Anderson Darling

P-Values	Critical Values For Test Statistic	Accepted or Rejected
0.1	0.631	Rejected
0.05	0.752	Rejected
0.025	0.873	Rejected
0.01	1.035	Rejected

AD Stat: 1.3239
AD P-Val: 0.9980

Appendix 2: Monitoring data from European Coastal waters

Note the table below is a direct copy of Table 5 from the ACE (Assessment of Antifouling Agents in Coastal Environments report (MAS3-CT98-0178) (Readman, J.W. et al 2002).

Concentrations (ng/L) of antifouling booster biocides measured in European coastal waters.

Country	Site Description	No. of samples analysed		Irgarol 1051	Diuron	Dichlo-fluanid	Chloro-thalonil	Seanine
Sweden	Marinas	10	range	2 – 364	<1 - 35	<1	<1	<1 - 3
			mean	61	5	<1	<1	<1
			median	16	3	<1	<1	0
	Ports	8	range	<1 – 6	<1 - 3	<1	<1	<1 - 1
			mean	2	1	<1	<1	<1
			median	1	0	<1	<1	<1
	Coastal	19	range	<1 – 36	<1 - 7	<1	<1	<1
			mean		2	<1	<1	<1
			median	0	2	<1	<1	<1
Denmark	Marinas	21	range	4-9	37 - 174	n/a	n/a	n/a
			mean	2	27			
			median	0	0			
	Ports	3	range	<1 – 68	<1 - 628	n/a	n/a	n/a
			mean	23	209			
			median	0	0			
Netherlands	Marinas	26	range	<1 – 87	<1 - 1129	n/a	n/a	n/a
			mean	20	328			
			median	17	233			
	Coastal	12	range	<1 – 39	<1 - 282	n/a	n/a	n/a
			mean	4	51			
			median	0	19			
UK	Marinas	168	range	<1 – 621	<1 - 685	<1 - 390	<1 - 30	<1
			mean	52	62	8	1	<1
			median	19	<1	<1	<1	<1
	Ports	47	range	<1 – 208	<1 - 110	<1 - 26	<1 - 20	<1
			mean	10	27	1	1	<1
			median	4	20	<1	<1	<1
	Estuaries	64	range	<1 – 47	<1 - 438	<1 - 40	<1	<1
			mean	9	43	1	<1	<1
			median	7	20	<1	<1	<1
	Coastal	49	range	<1 – 92	<1 - 465	<1 - 7	<1 - 26	<1
			mean	6	23	1	1	<1
			median	2	7	<1	<1	<1
France	English channel Marinas	3	range	6 – 23	n/a	<1	8 - 11	n/a
			mean	15		<1	9	
			median	17		<1	9	
	Atlantic coast Marinas	14	range	3 – 491	n/a	<1	<1	n/a
			mean	55		<1	<1	
			median	18		<1	<1	
	Atlantic Coastal	19	range	<1 – 21	n/a	<1	<1	n/a
			mean	5		<1	<1	
			median	2		<1	<1	
	Meditteranean Marinas	18	range	11 – 244	n/a	<1	<1 - 27	n/a
			mean	67		<1	9	
			median	33		<1	6	
	Meditteranean Coastal	32	range	<1 – 11	n/a	<1	<1 - 2	n/a
			mean	1		<1	1	
			median	1		<1	<1	
Spain	Marinas	112	range	<1 – 670	<1 - 2190	<1 - 760	<1	<1 - 3700
			mean	80	190	30	<1	110
			median	40	80	<1	<1	<1
	Ports	11	range	30 – 323	<1 - 240	<1	<1	<1
			mean	100	90	<1	<1	<1
			median	80	60	<1	<1	<1
Greece	Marinas	58	range	<1 – 90	n/a	<1 - 284	<1 - 63	<1
			mean	18		61	16	<1
			median	15		38	16	<1
	Ports	27	range	<1 - 24	n/a	<1 - 88	<1 - 35	Detected
			mean	6		25	10	<1
			median	<1		<1	11	<1