Monitoring for Toxin Producing and Nuisance Microalgae in Northern Ireland Coastal Waters

Reporting Period 1st January 2023 - 31st December 2023

Final Report – Version 1

Pages 35

Quality statement: This report is a compilation of the information included on the reports provided daily/ weekly to FSANI and showing the results of the phytoplankton analyses undertaken on samples submitted by third parties. All results were quality checked and approved prior to release to FSANI and the results compiled in this report have been further checked against a copy of the original reports held on a central database. Information relating to the origin of the samples (place, date and time of collection) is as provided by sampling staff and has not undergone verification checks by AFBI.

Contents

Shellfish production waters: reporting period: 1st January 2023- 31st December 2023.

Summary

During the period of this report a total of 381 water samples were received and reported to the customer, Food Standards Agency Northern Ireland (FSANI). Performance indicators set by the customer were met with 100% of samples reported within the stipulated time frame. All four main target phytoplankton groups were recorded (*Alexandrium* spp., Dinophysiales (genera *Dinophysis* and *Phalacroma*), *Prorocentrum lima* and *Pseudo-nitzschia* spp..The samples collected during 2023 also contained one other target species, namely *Karenia mikimotoi.*

Cells of the genus *Alexandrium*, a potential producer of Paralytic Shellfish Toxins (PST's), were recorded on six occasions during 2023 (1.6% of samples). A maximum cell abundance of 120 cells L^{-1} was recorded on 24th April in a water sample from the Larne Lough site.

No official control shellfish flesh samples tested during the year contained levels above the regulatory value of 800µg STX/ Kg.

Monitored target species, responsible for the production of lipophilic toxins, includes some members of the taxonomic order Dinophysiales as well as *Prorocentrum lima*. Target species belonging to the Order Dinophysiales were recorded in six of the seven monitored areas, the exception being Lough Foyle. Overall, they were present in 17.6% of the samples analysed in 2023. This ranged from their absence in Lough Foyle samples to 38.5% of Belfast Lough samples. The trigger level of ≥ 100 cells L^{-1} was breached on 19 occasions. A maximum cell abundance of 1000 cells L^{-1} was recorded on 3rd July in a water sample taken from site B12 AFFNI 54 in Belfast Lough. *Prorocentrum lima* was recorded in two samples tested in 2023. Samples tested from Strangford Lough (S7-AFFNI 76) on 24th July and Carlingford Lough (C11-AFFNI 84) on 8th August both contained cells at 20 cells L^{-1}.

No official control samples tested during 2023 contained lipophilic toxins above the set regulatory limit. More details can be found in the AFBI Biotoxin Report for 2023.

The cosmopolitan diatom genus *Pseudo-nitzschia* contains species which have the potential to produce domoic acid. Cells of the genus were present in all 7 monitored areas and in 42.0% of all samples tested. Their presence ranged from 27.8% of Carlingford Lough water samples to 56.7% of samples tested from Belfast Lough (Table 4). A maximum abundance of 95,600 L^{-1} was recorded on 30th May in a sample taken from the B3-AFFNI 50 site in Belfast Lough.

No official control samples from the Biotoxin Monitoring Programme contained domoic acid above the regulatory level of 20 µg/g.

Only one other target species was identified in water samples taken as part of the Official Control Programme during 2023. The ichthyotoxic dinoflagellate, *Karenia mikimotoi* was recorded on four occasions with a maximum abundance of 140 cells L^{-1} recorded in a water sample from the S2-AFFNI 42 site in Strangford Lough on 25th July.

Introduction

Fisheries and Aquatic Ecosystems Branch of the Agri-Food and Biosciences Institute (AFBI) deliver the Official Control Phytoplankton Monitoring Programme for Northern Ireland on behalf of the competent authority, the Food Standards Agency (FSANI). A monitoring programme has been in place since mid-1993. This report presents the phytoplankton programme results for the period 1st January 2023– 31st December 2023.

A total of 381 water samples were received and reported in 2023. Samples were examined by light microscopy and results reported within 3 working days of sample receipt.

Water samples were obtained from all the classified shellfish production areas in Northern Ireland which included five sea loughs as well as Dundrum Bay and Killough Harbour (Table 1 and Figure 1). Samples were screened for the presence of the toxin producing and nuisance microalgae listed in Table 2.

Sampling

FSANI are responsible for the logistics of the water sampling programme including delivery to the laboratory by designated sampling officers. Sampling officers were asked to take water samples as close to high tide as possible and to deliver these to AFBI for analysis as soon as possible, following the sampling and transport protocol issued by FSANI. Sampling was generally carried out on a fortnightly basis.

Laboratory procedures

Once received in the laboratory each preserved sample was given a unique identifying code and sample details entered into the laboratory log book. A 50 ml subsample was then taken from each water sample and left to settle overnight in a sedimentation (Utermöhl) chamber (limit of detection of 20 cells L^{-1}). Samples were examined the following day using an inverted microscope. Each sample was screened for the target phytoplankton listed in Table 2 and the results reported to FSANI the same day. These procedures are based on those of the UK National Reference Laboratory (UKNRL). AFBI have maintained ISO17025 accreditation for the test method since 2012.

Results

The occurrence (as a percentage) and maximum abundance (in cells per litre) for the four most important taxon groups are reported by individual shellfish site (Table 3) and coastal area (Table 4). Positive results for *Alexandrium* spp., Dinophysiales *Prorocentrum lima* and *Pseudo-nitzschia* spp. are reported in tabular form in Appendix 1.

Table 1. Shellfish production areas monitored for the presence of toxin producing and nuisance microalgae in water in 2023.

Coastal area	Site identification reference (SIR)
Lough Foyle	PA3-Wild fishery
Lough Foyle	PA4-Wild fishery
Larne Lough	L3-AFFNI 88
Belfast Lough	B1-AFFNI 55
Belfast Lough	B3-AFFNI 50
Belfast Lough	B12-AFFNI 54
Belfast Lough	B20-AFFNI 53
Strangford Lough	S2-AFFNI 42
Strangford Lough	S7-AFFNI 76
Killough	K1-AFFNI 18
Dundrum Bay	DB1-AFFNI 95A
Carlingford Lough	C1-AFFNI 27
Carlingford Lough	C11-AFFNI 84
Carlingford Lough	C15-AFFNI 89
Carlingford Lough	NW-Wild fishery

Figure 1 – Current sampling sites

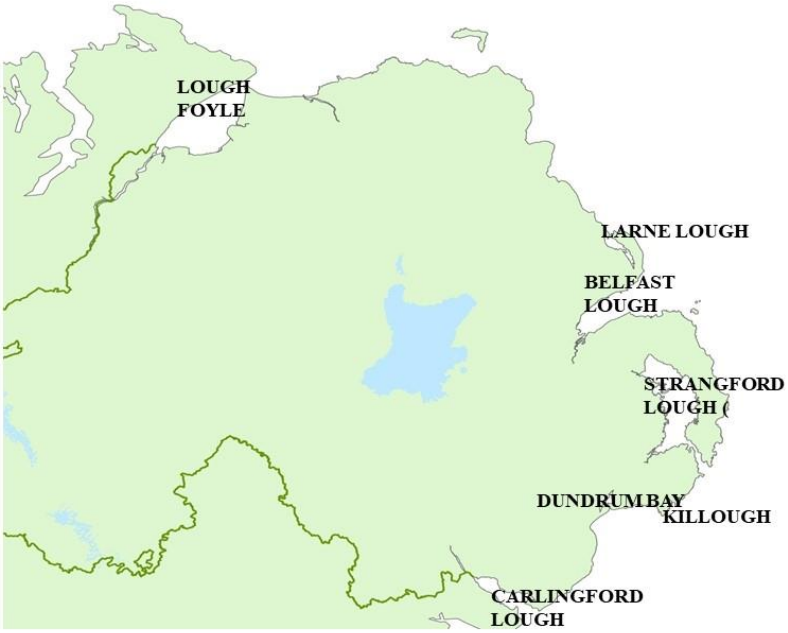


Table 2 – Monitored phytoplankton species.

Species	Toxin	Threshold value
Alexandrium spp.	Paralytic Shellfish Toxin (PST)	40 cells L^{-1}
Dinophysis acuminata	Diarrhetic Shellfish Toxin (DST)	100 cells L^{-1}
Dinophysis acuta	DST	100 cells L^{-1}
Dinophysis norvegica	DST	100 cells L^{-1}
Phalacroma rotundatum (previously known as *Dinophysis rotundata*)	DST	100 cells L^{-1}
Dinophysis spp.	DST	100 cells L^{-1}
Prorocentrum lima	DST	100 cells L^{-1}
Lingulodinium polyedra	Yessotoxin (YTX)	None
Protoceratium reticulatum	YTX	None
Pseudo-nitzschia spp.	Amnesic Shellfish Toxin (AST)	150,000 cells L^{-1}
Prorocentrum cordatum	Hepatotoxins	None
Karenia mikimotoi	Toxic to fish (TTF)	None
Noctiluca scintillans	TTF	None
Phaeocystis spp.	Not known	None

Results by species

Alexandrium spp.

Cells of the potential paralytic shellfish toxin producer *Alexandrium* spp. were recorded in six samples during 2023 (1.6% of samples, Figure 2A). This sample was taken from a site in Larne Lough and recorded an abundance of 120 cells L^{-1} (Table 5). Alexandrium spp. is generally detected in low levels in Northern Ireland waters (Figure 4A).

No Paralytic Shellfish Toxins (PST's) above the regulatory level were detected in shellfish tested as part of the Official Control Monitoring Programme during 2023.

Dinophysiales (*Dinophysis* species and *Phalacroma rotundatum*)

Cells of the target Dinophysiales (Table 2) were present in 6 of the 7 coastal areas monitored, the exception being Lough Foyle (Figure 2B). In 2023 they were recorded in 17.6% of all samples tested. This is an increase in that recorded in 2022 (8.6%), 2021(11.6%) and 2020 (8.3%) but still less than that recorded in 2019 (21.7%). Their maximum cell abundance in 2023 was 1000 cells L^{-1} in a water sample taken from Belfast Lough (B12-AFFNI 54) on 3rd July (Figure 3B and Table 7). As in previous years *Dinophysis acuminata* was the dominant *Dinophysis* species recorded in Northern Ireland waters.

No lipophilic toxins above the regulatory limit were recorded in shellfish tested as part of the Official Control Programme. More detailed information can be found in the AFBI Biotoxin report.

Prorocentrum lima

The DST producer and benthic dinoflagellate *Prorocentrum lima* has a historically low occurrence in samples submitted for testing (Figure 4C). In 2023 it was recorded in two samples, S7-AFFNI 76 (24th July) and C11-AFFNI 84 (8th August). Both were recorded at the limit of detection for the test of 20 cells L^{-1}.

Pseudo-nitzschia spp.

The pennate cosmopolitan diatom genus *Pseudo-nitzschia*, is frequently recorded in Northern Ireland coastal waters (Figure 4D). In 2023 it was detected in 42% of all water samples tested. No samples breached the trigger value of 150,000 cells L^{-1}. A maximum cell abundance of 95,600 cells L^{-1} was recorded in a sample from Belfast Lough on 30th May 2023 (Table 8).

No shellfish samples, tested as part of the 2023 Official Control Programme, contained domoic acid above the EU regulatory limit.

Other species

Only one other target species was identified in water samples taken as part of the Official Control Programme during 2023. The ichthyotoxic dinoflagellate, *Karenia mikimotoi* was recorded on four occasions with a maximum abundance of 140 cells L^{-1} recorded on 25th July in a sample from the S2-AFFNI 42 site in Strangford Lough.

Table 3. The total number of samples collected, their occurrence (presence of cells in sample as a percentage of the total number of samples analysed) and maximum abundance (cells L-1) from each site in 2023.

Sampling site	No. of samples received	No. of samples rejected	*Alexandrium* spp. occurrence	*Alexandrium* spp.* max abundance	*Dinophysis* spp.* occurrence	*Dinophysis* spp. max abundance	*P.lima* occurrence	*P.lima* max abundance	*Pseudo-nitzschia* spp. occurrence	*Pseudo-nitzschia* spp. max abundance
Lough Foyle										
PA3-Wild fishery	18	0	0	0	0	0	0	0	38.9	480
PA4-Wild fishery	18	0	0	0	0	0	0	0	22.2	2500
Larne Lough										
L3-AFFNI 88	25	0	4.0	120	8.0	40	0	0	36.0	1960
Belfast Lough										
B1-AFFNI 55	26	0	3.8	60	30.8	260	0	0	50	18460
B3-AFFNI 50	26	0	7.7	60	42.3	680	0	0	57.7	95600
B12-AFFNI 54	26	0	0	0	46.2	1000	0	0	57.7	8220
B20-AFFNI 53	26	0	3.8	40	34.6	260	0	0	61.5	10460
Strangford Lough										
S2-AFFNI 42	27	0	0	0	18.6	120	0	0	40.7	3980
S7-AFFNI 76	27	0	0	0	11.1	40	3.7	20	48.1	17260
Killough										

Sampling site	No. of samples received	No. of samples rejected	*Alexandrium* spp. occurrence	*Alexandrium* spp.* max abundance	*Dinophysis* spp.* occurrence	*Dinophysis* spp. max abundance	*P.lima* occurrence	*P.lima* max abundance	*Pseudo-nitzschia* spp. occurrence	*Pseudo-nitzschia* spp. max abundance
K1-AFFNI 18	27	0	0	0	25.9	200	0	0	55.6	20000
Dundrum Bay										
DB1-AFFNI 21A	27	0	0	0	7.4	20	0	0	44.4	43600
Carlingford Lough										
C1-AFFNI 27	27	0	0	0	0	0	0	0	22.2	720
C11-AFFNI 84	27	0	3.7	20	18.5	80	3.7	20	37.0	15500
C15-AFFNI 89	27	0	0	0	11.1	20	0	0	29.6	8440
NW-Wild fishery	27	0	0	0	0	0	0	0	22.2	1700

381 samples received

0 samples rejected

381 samples reported

*Includes *Phalacroma rotundatum*

Table 4. The total number of samples collected, their occurrence (presence of cells in sample as a percentage of the total number of samples analysed) and maximum abundance (cells L-1) from each lough in 2023.

Sampling site	No of samples received	No. of samples rejected	Alexandrium spp. occurrence	Alexandrium spp. max abundance	Dinophysis spp.* occurrence	Dinophysis spp.* max abundance	P.lima occurrence	P.lima max abundance	Pseudo-nitzschia spp. occurrence	Pseudo-nitzschia spp. max abundance
Lough Foyle	36	0	0	0	0	0	0	0	30.6	2500
Larne Lough	25	0	4.0	120	8.0	40	0	0	36.0	1960
Belfast Lough	104	0	3.9	60	38.5	1000	0	0	56.7	95,600
Strangford Lough	54	0	0	0	14.8	120	1.9	20	44.4	17,260
Killough	27	0	0	0	25.9	200	0	0	55.6	20,000
Dundrum Bay	27	0	0	0	7.4	20	0	0	44.4	43,600
Carlingford Lough	108	0	0.9	20	7.4	80	0.9	20	27.8	15,500

381 samples received

0 samples rejected

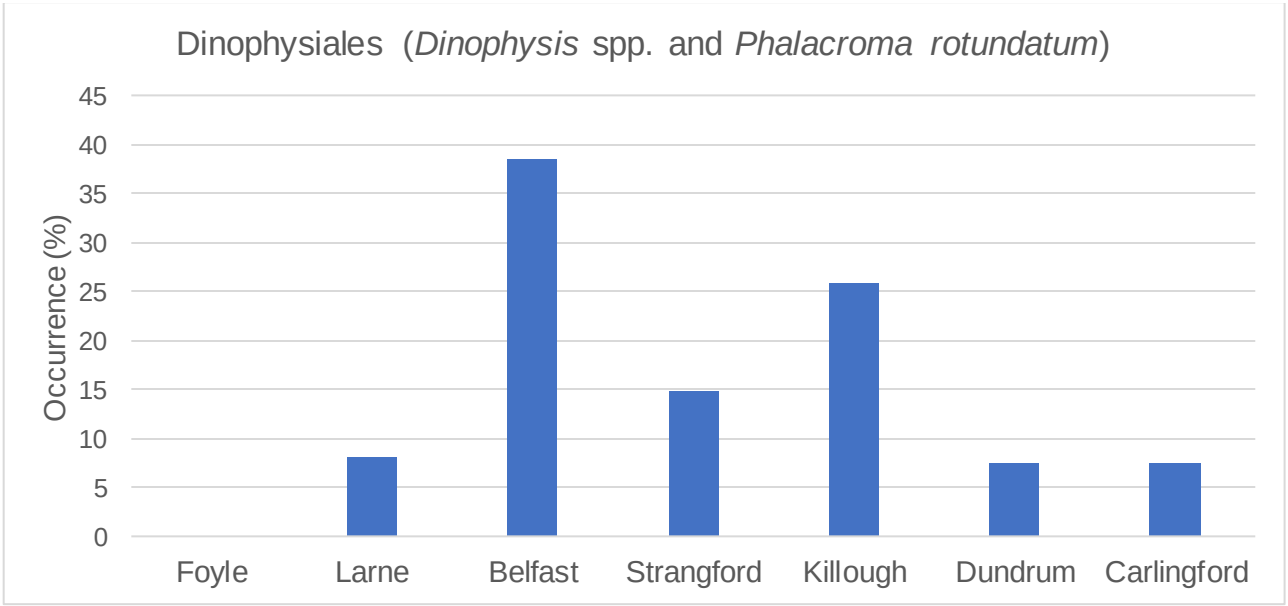
381 samples reported

*Includes *Phalacroma rotundatum*

Figure 2. Occurrence (%) of the four major target organisms in 2023 (presence of cells in water samples as a percentage of the total number of samples reported for each area).

A

B



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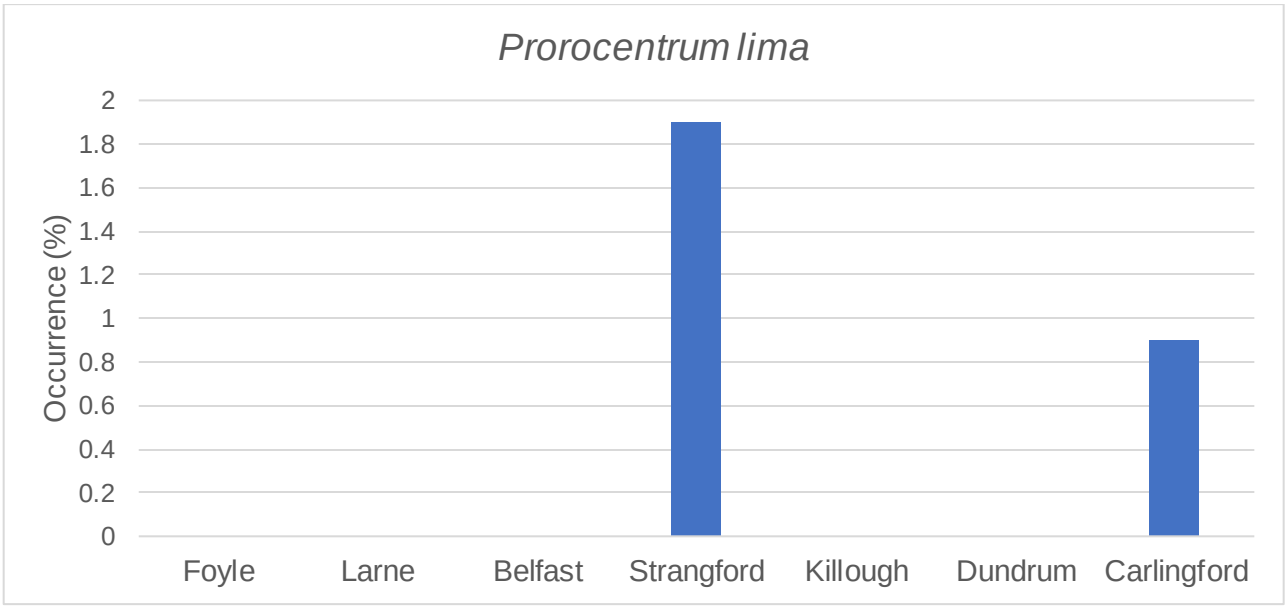

Prorocentrum lima
Occurrence (%)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Foyle
Larne
Belfast
Strangford
Killough
Dundrum
Carlingford

D

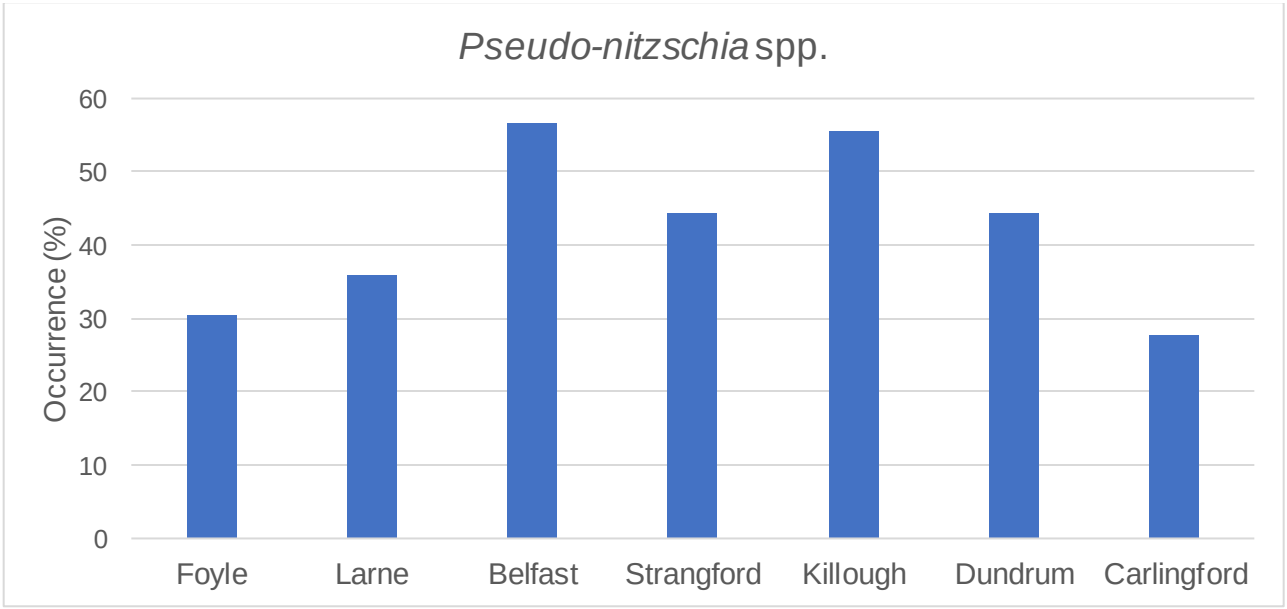
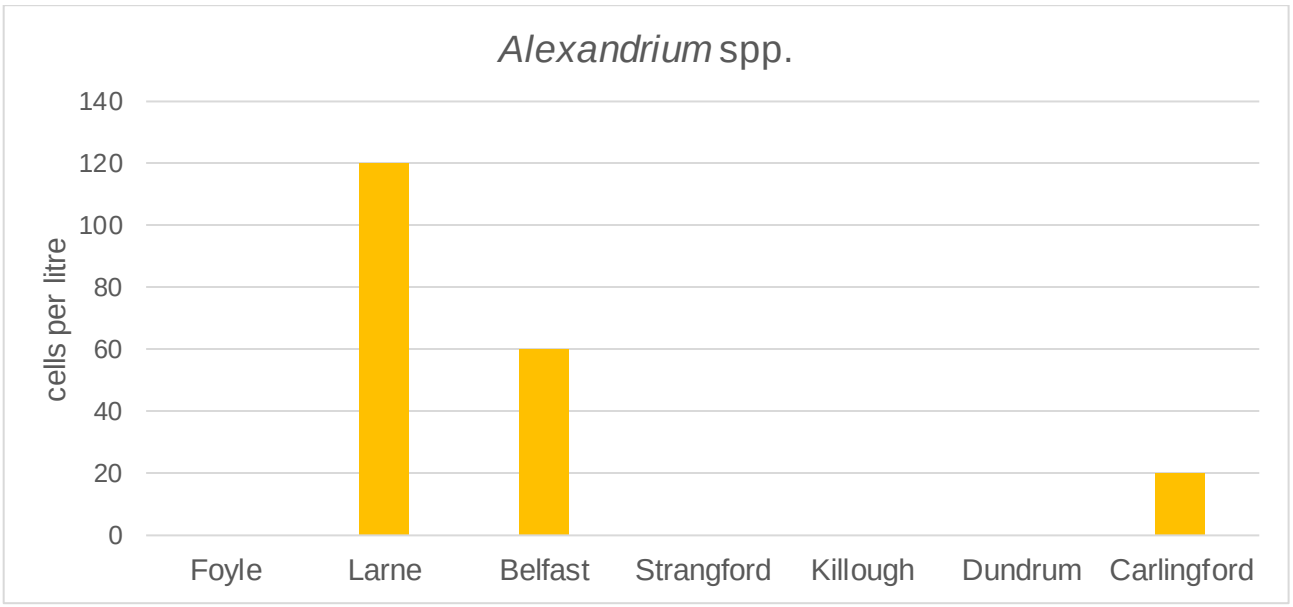

Pseudo-nitzschia spp.
Occurrence (%)
60
50
40
30
20
10
0
Foyle
Larne
Belfast
Strangford
Killough
Dundrum
Carlingford

Figure 3. Maximum abundance (cells per litre) of the four major target groups in 2023 in water samples taken from each area.

A



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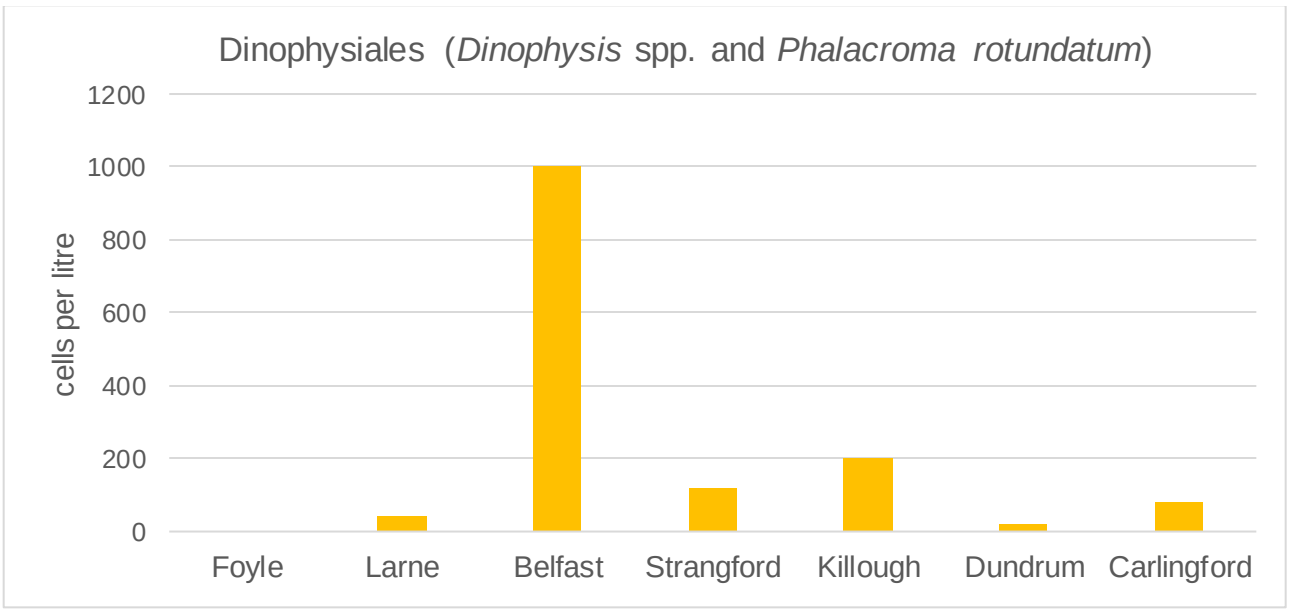

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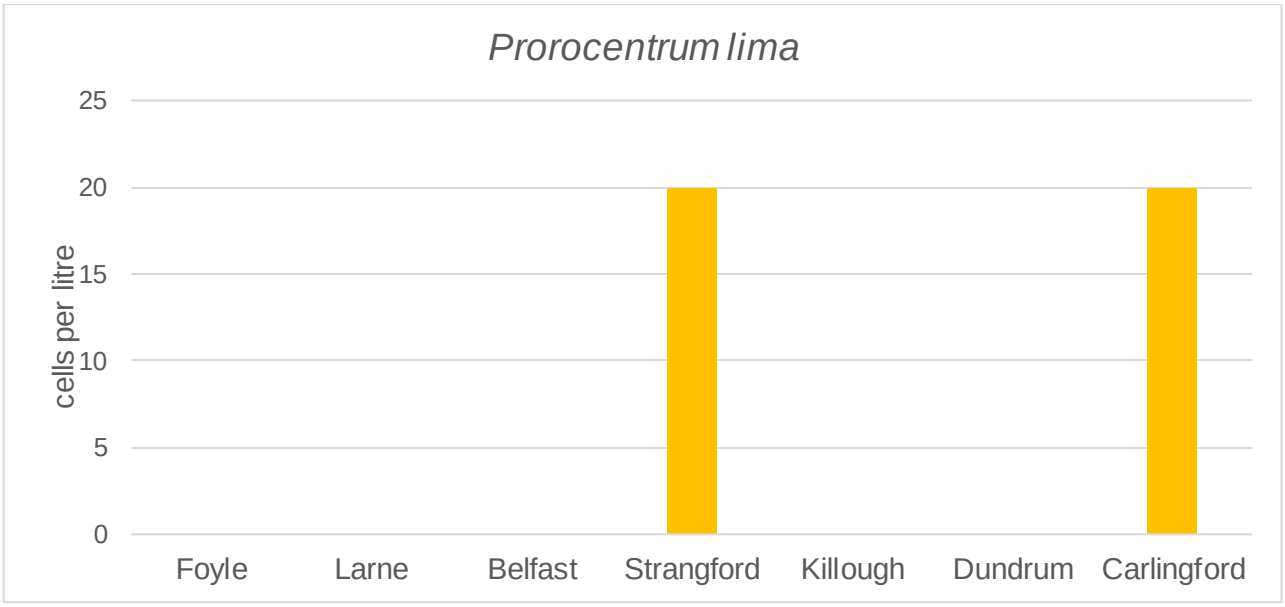

Prorocentrum lima
cells per litre
25
20
15
10
5
0
Foyle
Larne
Belfast
Strangford
Killough
Dundrum
Carlingford

D

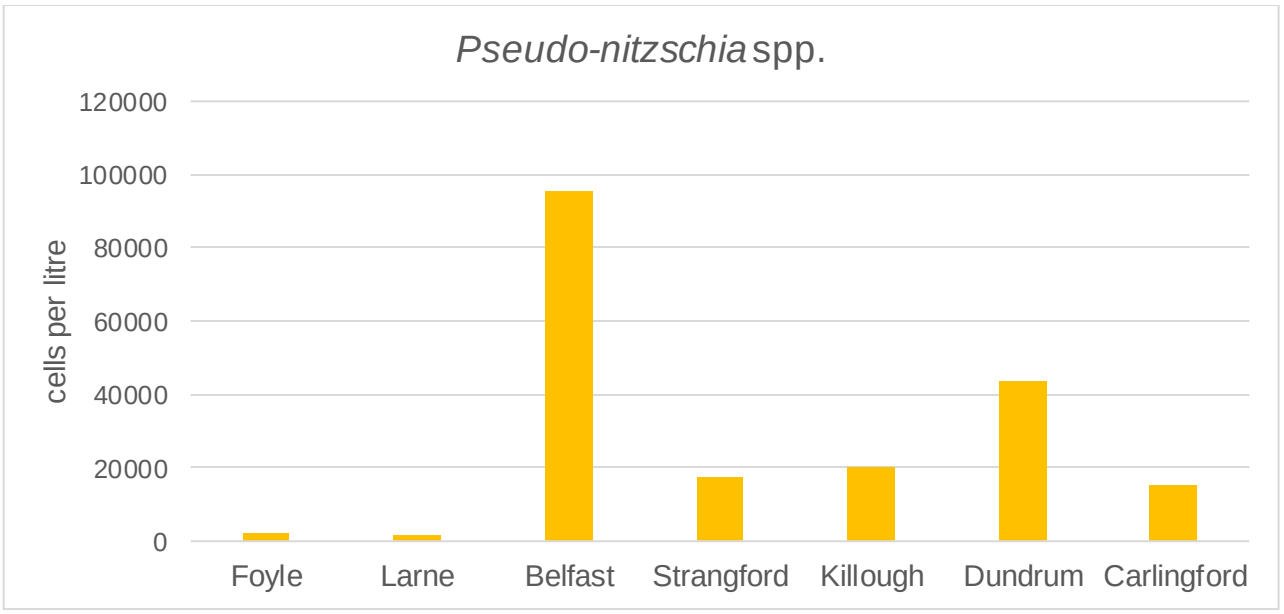
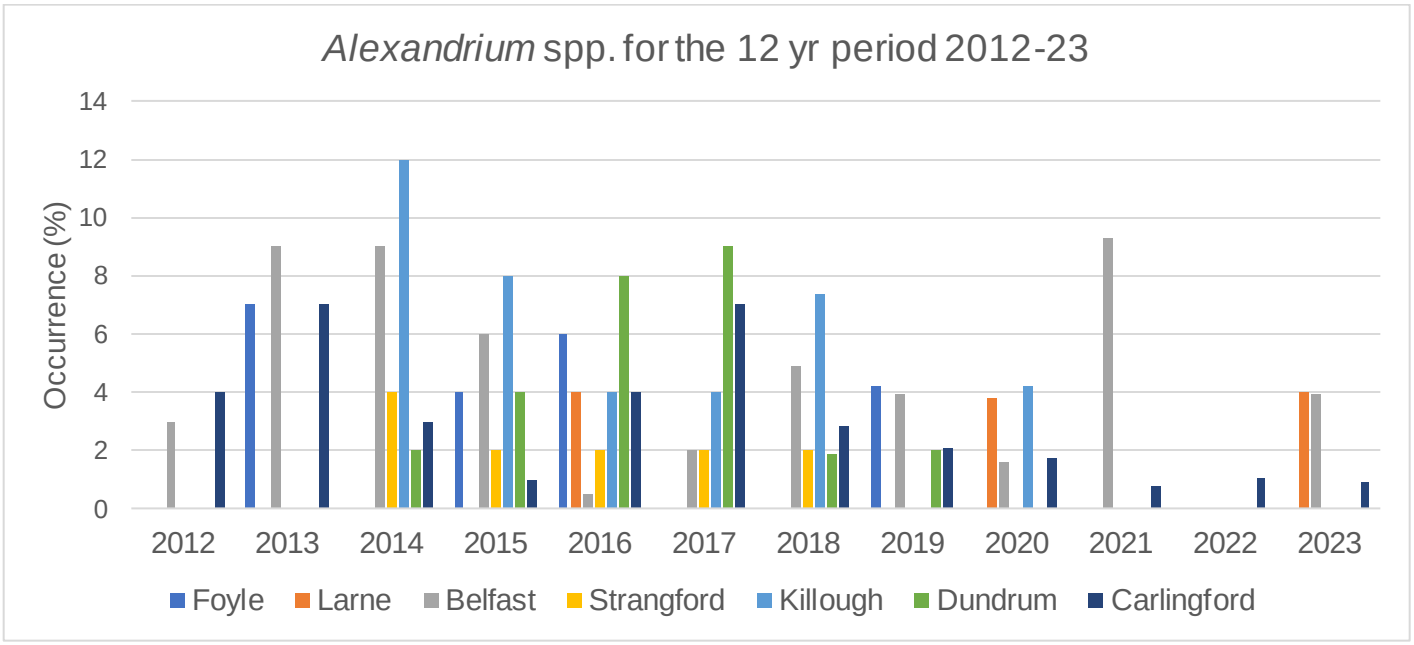

Pseudo-nitzschia spp.
cells per litre
120000
100000
80000
60000
40000
20000
0
Foyle
Larne
Belfast
Strangford
Killough
Dundrum
Carlingford

Figure 4. Occurrence of the four major target organisms for period 2012-2023 (presence of cells in water samples as a % of the total number of samples reported for each sampling area in each year).

A



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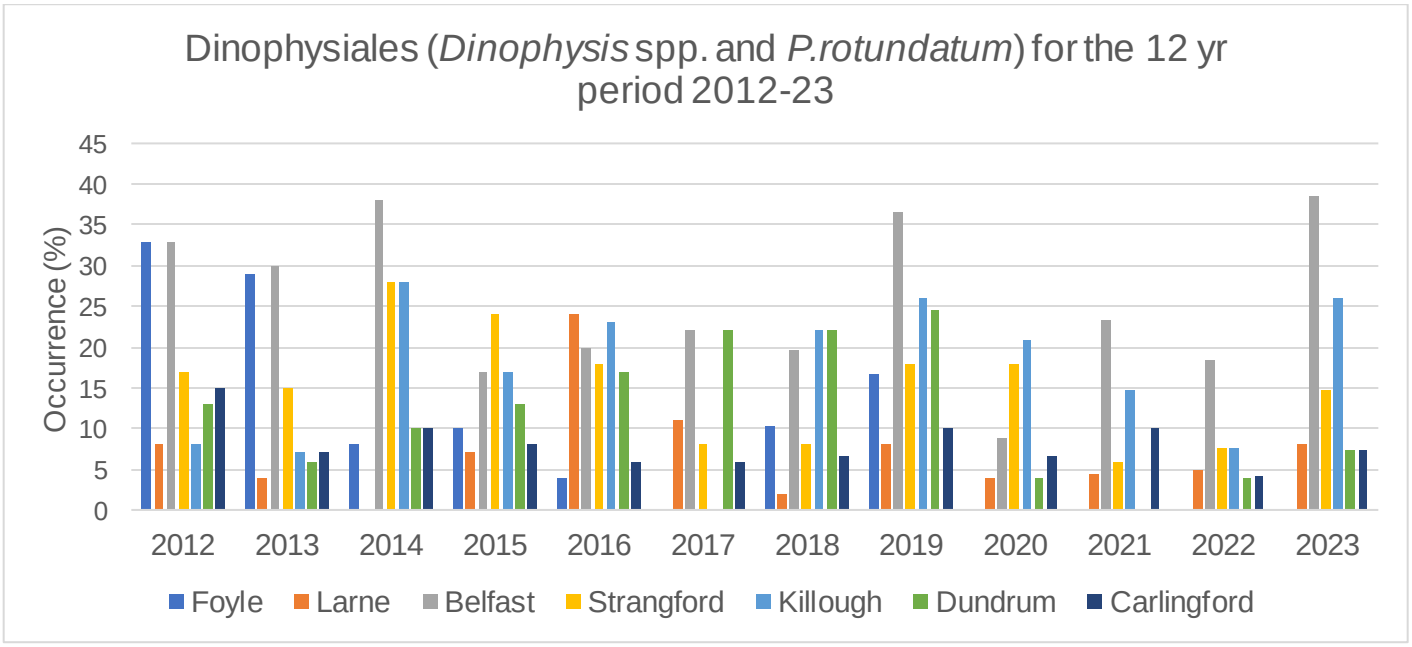

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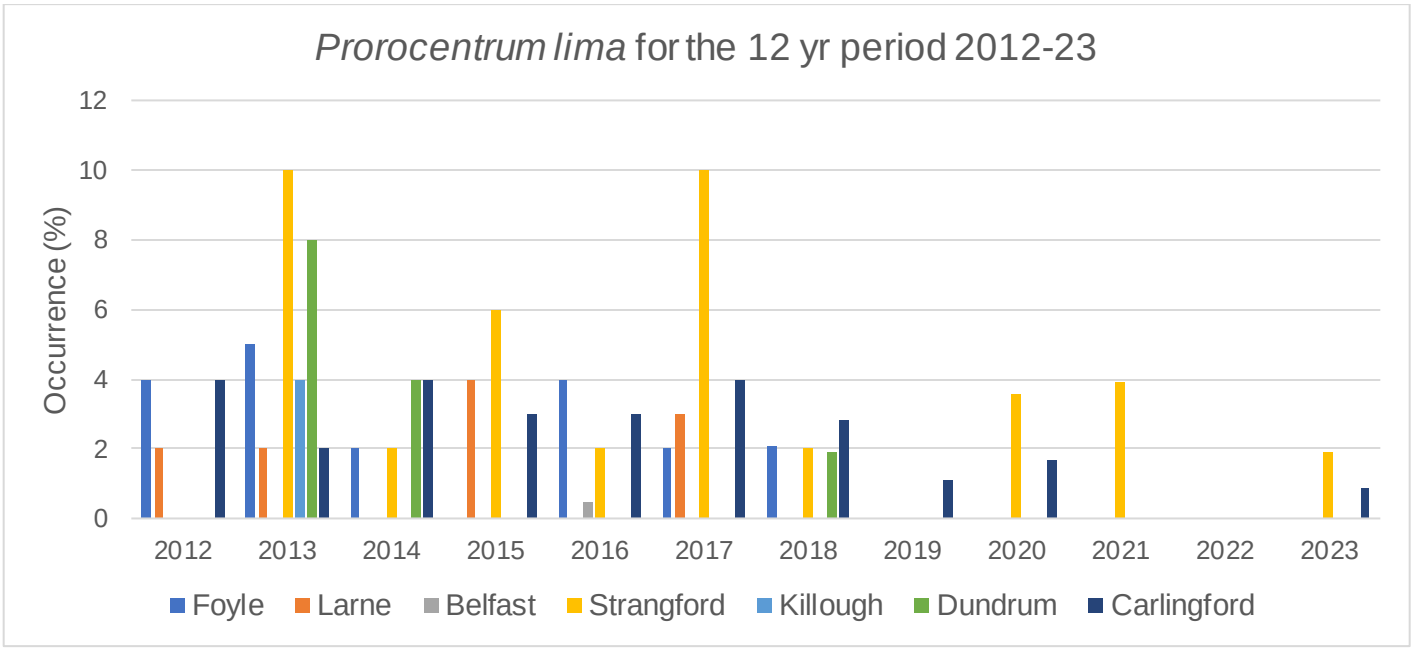
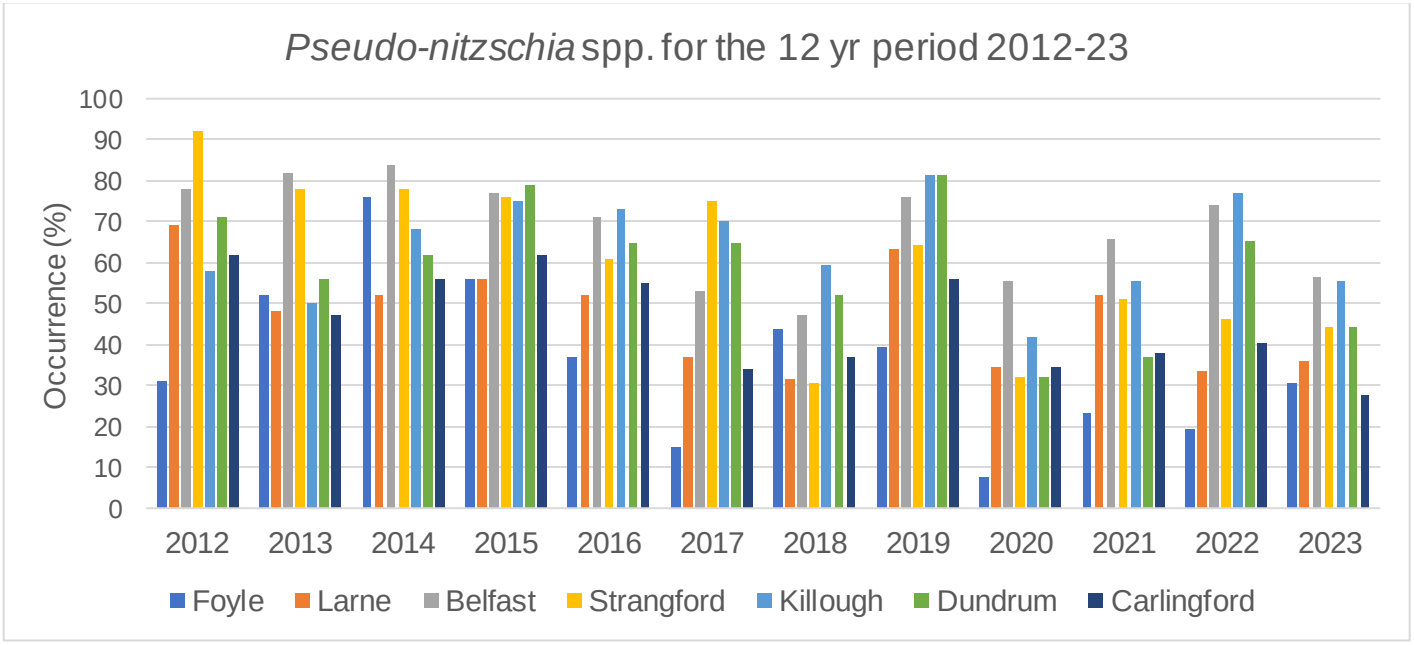

Prorocentrum lima for the 12 yr period 2012-23
Occurrence (%)
0
2
4
6
8
10
12
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Foyle
Larne
Belfast
Strangford
Killough
Dundrum
Carlingford

D


Pseudo-nitzschia spp. for the 12 yr period 2012-23
Occurrence (%)
0
10
20
30
40
50
60
70
80
90
100
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Foyle
Larne
Belfast
Strangford
Killough
Dundrum
Carlingford

Results by area

Lough Foyle

Pseudo-nitzschia spp. was the only target species recorded from Lough Foyle in 2023.

A total of 36 samples were received and analysed from the two monitoring sites in Lough Foyle (Table 3). As in the previous year, *Pseudo-nitzschia* was the only target species detected in samples received from the lough in 2023. It was present in 30.6% of samples reaching a maximum abundance of 2500 cells L^{-1} on 24th April (PA4 Wild fishery).

Larne Lough

The following target species were recorded in water samples from Larne Lough in 2023; Alexandrium spp., *Dinophysis acuminata* and *Pseudo-nitzschia* spp.

A total of 25 samples were received from the one site (L3-AFFNI 88) monitored in Larne Lough (Table 3). Alexandrium spp. was detected in one sample, recording an abundance of 120 cells L^{-1} on 24th April. Cells of the *Dinophysis* genus were counted in 8% of samples from the lough. A maximum cell count of 40 cells L^{-1} was recorded in the water sample taken on 29th May (Table 7). *Pseudo-nitzschia* spp. was recorded in 36% of samples with a maximum abundance of 1960 cells L^{-1} counted in the sample taken on 17th July (Table 8).

Belfast Lough

Target species recorded in water samples from Belfast Lough during the reporting period were as follows; *Alexandrium* spp*., D.acuminata*, *Dinophysis norvegica, Dinophysis* spp. and *Pseudo-nitzschia* spp..

A total of 104 samples were submitted for analysis in 2023. The PST producer, *Alexandrium* spp. was detected in four samples tested in 2023. Cell values were low with a maximum abundance of 60 cells L^{-1} recorded on three occasions: 25th April, 17th July and 8th August (Table 5). Cells from the taxonomic order Dinophysiales have been recorded regularly over the past years in samples from Belfast Lough (Figure 4B). In 2023 they were present in 38.5% of samples which is over twice that recorded in the previous year (18.3%). The dominant species present in samples was *Dinophysis acuminata* which is in keeping with that found in other local production areas. The maximum cell abundance recorded was 1000 cells L^{-1} in a sample taken from B12-AFFNI 54 on 3rd July (Table 7).

Cells of the genus *Pseudo-nitzschia* were found in 56.7% of samples (Table 4 and Figure 2D) reaching a peak abundance of 95,600 cells L^{-1} in a sample from B3-AFFNI 50 on 30th May.

Strangford Lough

Target species recorded from Strangford Lough during 2023 included; *D.acuminata*, *D.acuta*, *Prorocentrum lima, Pseudo-nitzschia* spp. and *Karenia mikimotoi*.

Two sites were monitored in the lough during 2023, S2-AFFNI 42 and S7-AFFNI 76. As in the previous year, cells of *Alexandrium* spp. were not detected in the lough. Dinophysiales were present in 14.8% of samples which was twice that recorded in 2022 (7.7%). However, cell abundance was low reaching a maximum of 120 cells L^{-1} in a sample from S2-AFFNI 42 on the 23rd May (Table 7). *Prorocentrum lima* was detected on one occasion with a cell count of 20 cells L^{-1} recorded on 24th July from the S7-AFFNI 76 site. Cells of *Pseudo-nitschia* were present in just under half (44.4%) of samples, a figure very similar to that recorded in 2022 (46.2%). Cell abundance reached a maximum of 17,260 cells L^{-1} in a sample from S7-AFFNI 76 on 5th June (Table 8).

Killough

The following target species were recorded from Killough waters during 2023; *Dinophysis acuminata, Dinophysis acuta, Karenia mikimotoi* and *Pseudo-nitzschia* spp..

Cells of the Dinophysiales order were recorded in 25.9% of samples a large increase from that recorded in 2022 (7.7%). A maximum cell abundance of 200 cells L^{-1} was recorded on two occasions, 5th June and 26th June (Table 6). *Pseudo-nitzschia* spp. was recorded in 55.6% of samples with a maximum cell abundance of 20,000 cells L^{-1} recorded on the 10th July (Table 8).

Dundrum Bay

Only two target species were recorded at this site in 2023, these were *Dinophysis acuminata* and *Pseudo-nitzschia* spp..

Dinophysis acuminata was recorded on two occasions during the year both were at 20 cells L^{-1} (26th June and 31st July). *Pseudo-nitzschia* spp. was present in 44.4% of Dundrum samples (Table 4) recording a maximum cell abundance of 43,600 cells L^{-1} on 10th July. (Table 8).

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Carlingford Lough

Target species recorded from Carlingford Lough during 2023 were; *Alexandrium* spp., *D.acuminata*, *D.acuta*, *Dinophysis norvegica*, *Prorocentrum lima*, *Pseudo-nitzschia* spp. and *Karenia mikimotoi*.

Alexandrium spp. was detected in one sample from the lough in 2023, as was the case in 2022. This was in a water sample from C11 AFFNI 84 on 8th August when a count of 20 cells L^{-1} was recorded (Table 5).

Members of the Dinophysiales order were present in 7.4% of samples (Table 4) with a maximum

abundance of 80 cells L^{-1} recorded in a water sample from the C11-AFFNI 84 site on 4th July (Table 7).

Pseudo-nitzschia spp. was recorded in 27.8 % of samples which is a reduction in the 40.2% recorded in 2022. A maximum cell abundance of 15,500 cells L^{-1} was recorded on 24th July in a sample from C11 AFFNI 84 (Table 8). *Karenia mikimotoi* was detected in one Carlingford water sample. This was on 8th August when 20 cells L^{-1} were counted in a sample from C11-AFFNI 84.

Appendix 1

Table 5 - Positive occurrences of *Alexandrium* spp. (cells L^{-1}) in 2023

System id	Region	Site ID ref	Report no.	Collection date	*Alexandrium* spp.
phy2300111	Belfast	B3-AFFNI50	phy23-17b	25/04/2023	60
phy2300114	Larne	L3-AFFNI88	phy23-17b	24/04/2023	120
phy2300216	Belfast	B1-AFFNI55	phy23-29a	17/07/2023	60
phy2300244	Belfast	B20-AFFNI53	phy23-32a	08/08/2023	40
phy2300246	Belfast	B3-AFFNI50	phy23-32a	08/08/2023	60
phy2300249	Carlingford	C11-AFFNI84	phy23-32b	08/08/2023	20

Table 6 - Positive occurrences of *Prorocentrum lima* (cells L^{-1}) in 2023

System id	Region	Site ID ref	Report no.	Collection date	*Prorocentrum lima*
phy2300238	Strangford	S7-AFFNI76	phy23-30c	24/07/2023	20
phy2300249	Carlingford	C11-AFFNI84	phy23-32b	08/08/2023	20

Table 7- Positive occurrences of monitored Dinophysiales (cells L^{-1}) in 2023

Abbreviations in table

- Da – *Dinophysis acuminata*
- Dacuta – *Dinophysis acuta*
- Dn – *Dinophysis norvegica*
- Pr – *Phalacroma rotundatum*
- Din. – *Dinophysis* spp. not identified to species level

System id	Region	Site ID ref	Report no.	Collection date	*Da*	*Dacuta*	*Dn*	*Pr*	*Din*	Total *Dinophysis* spp.
phy2300113	Belfast	B20-AFFNI53	phy23-17b	25/04/2023	0	0	20	0	0	20
phy2300121	Belfast	B1-AFFNI55	phy23-19a	09/05/2023	20	0	0	0	0	20
phy2300123	Belfast	B12-AFFNI54	phy23-19a	09/05/2023	20	0	0	0	0	20
phy2300130	Killough	K1-AFFNI18	phy23-20a	15/05/2023	20	0	0	0	0	20
phy2300133	Carlingford	C11-AFFNI84	phy23-21a	22/05/2023	0	0	20	0	0	20
phy2300136	Strangford	S2-AFFNI42	phy23-21a	23/05/2023	120	0	0	0	0	120
phy2300140	Larne	L3-AFFNI88	phy23-22a	29/05/2023	40	0	0	0	0	40
phy2300141	Belfast	B1-AFFNI55	phy23-22a	30/05/2023	20	0	0	0	0	20
phy2300142	Belfast	B3-AFFNI50	phy23-22a	30/05/2023	160	0	0	0	0	160
phy2300143	Belfast	B12-AFFNI54	phy23-22a	30/05/2023	20	0	0	0	0	20
phy2300144	Belfast	B20-AFFNI53	phy23-22a	30/05/2023	20	0	0	0	0	20
phy2300145	Killough	K1-AFFNI18	phy23-23a	05/06/2023	200	0	0	0	0	200
phy2300148	Strangford	S7-AFFNI76	phy23-23a	05/06/2023	20	0	0	0	0	20
phy2300152	Belfast	B3-AFFNI50	phy23-24a	12/06/2023	60	0	0	0	0	60

System id	Region	Site ID ref	Report no.	Collection date	*Da*	*Dacuta*	*Dn*	*Pr*	*Din*	Total *Dinophysis* spp.
phy2300153	Belfast	B12-AFFNI 54	phy23-24a	12/06/2023	20	0	0	0	0	20
phy2300154	Belfast	B20-AFFNI 53	phy23-24a	12/06/2023	60	0	0	0	0	60
phy2300156	Carlingford	C11-AFFNI 84	phy23-24b	12/06/2023	20	0	0	0	0	20
phy2300160	Belfast	B1-AFFNI 55	phy23-25a	19/06/2023	20	0	0	0	0	20
phy2300161	Belfast	B3-AFFNI 50	phy23-25a	19/06/2023	100	0	0	0	0	100
phy2300162	Belfast	B12-AFFNI 54	phy23-25a	19/06/2023	80	0	0	0	0	80
phy2300163	Belfast	B20-AFFNI 53	phy23-25a	19/06/2023	80	0	20	0	0	100
phy2300164	Killough	K1-AFFNI 18	phy23-25a	19/06/2023	40	0	0	0	0	40
phy2300175	Belfast	B1-AFFNI 55	phy23-26a	26/06/2023	140	0	40	0	0	180
phy2300176	Belfast	B3-AFFNI 50	phy23-26a	26/06/2023	160	0	20	0	0	180
phy2300177	Belfast	B12-AFFNI 54	phy23-26a	26/06/2023	660	0	120	0	0	780
phy2300178	Belfast	B20-AFFNI 53	phy23-26a	26/06/2023	100	0	20	0	0	120
phy2300179	Killough	K1-AFFNI 18	phy23-26a	26/06/2023	200	0	0	0	0	200
phy2300180	Dundrum	DB1-AFFNI 95A	phy23-26a	26/06/2023	20	0	0	0	0	20
phy2300181	Strangford	S2-AFFNI 42	phy23-26b	27/06/2023	20	0	0	0	0	20
phy2300182	Strangford	S7-AFFNI 76	phy23-26b	27/06/2023	20	0	0	0	0	20
phy2300183	Larne	L3-AFFNI 88	phy23-26b	26/06/2023	20	0	0	0	0	20
phy2300191	Belfast	B3-AFFNI 50	phy23-27a	03/07/2023	680	0	0	0	0	680
phy2300192	Belfast	B12-AFFNI 54	phy23-27a	03/07/2023	1000	0	0	0	0	1000

System id	Region	Site ID ref	Report no.	Collection date	*Da*	*Dacuta*	*Dn*	*Pr*	*Din*	Total *Dinophysis* spp.
phy2300193	Belfast	B20-AFFNI53	phy23-27a	03/07/2023	60	0	0	0	0	60
phy2300194	Strangford	S2-AFFNI42	phy23-27b	03/07/2023	20	0	0	0	0	20
phy2300198	Carlingford	C11-AFFNI84	phy23-27c	04/07/2023	80	0	0	0	0	80
phy2300201	Killough	K1-AFFNI18	phy23-28a	10/07/2023	20	0	0	0	0	20
phy2300204	Belfast	B1-AFFNI55	phy23-28a	09/07/2023	40	0	0	0	0	40
phy2300205	Belfast	B3-AFFNI50	phy23-28a	09/07/2023	60	0	0	0	20	80
phy2300206	Belfast	B12-AFFNI54	phy23-28a	09/07/2023	320	0	0	0	0	320
phy2300207	Belfast	B20-AFFNI53	phy23-28a	09/07/2023	240	0	0	0	0	240
phy2300210	Carlingford	C11-AFFNI84	phy23-28b	10/07/2023	40	0	0	0	0	40
phy2300211	Carlingford	C15-AFFNI89	phy23-28b	10/07/2023	20	0	0	0	0	20
phy2300216	Belfast	B1-AFFNI55	phy23-29a	17/07/2023	40	0	0	0	0	40
phy2300217	Belfast	B3-AFFNI50	phy23-29a	17/07/2023	20	0	0	0	0	20
phy2300218	Belfast	B12-AFFNI54	phy23-29a	17/07/2023	120	0	0	0	0	120
phy2300219	Belfast	B20-AFFNI53	phy23-29a	17/07/2023	80	0	0	0	0	80
phy2300227	Belfast	B1-AFFNI55	phy23-30a	24/07/2023	20	0	0	0	0	20
phy2300228	Belfast	B3-AFFNI50	phy23-30a	24/07/2023	80	0	0	0	0	80
phy2300229	Belfast	B12-AFFNI54	phy23-30a	24/07/2023	80	0	0	0	0	80
phy2300231	Killough	K1-AFFNI18	phy23-30b	24/07/2023	60	20	0	0	0	80
phy2300235	Carlingford	C15-AFFNI89	phy23-30b	24/07/2023	20	0	0	0	0	20

System id	Region	Site ID ref	Report no.	Collection date	*Da*	*Dacuta*	*Dn*	*Pr*	*Din*	Total *Dinophysis* spp.
phy2300237	Strangford	S2-AFFNI42	phy23-30c	25/07/2023	20	0	0	0	0	20
phy2300241	Dundrum	DB1-AFFNI95A	phy23-31a	31/07/2023	20	0	0	0	0	20
phy2300244	Belfast	B20-AFFNI53	phy23-32a	08/08/2023	260	0	0	0	0	260
phy2300245	Belfast	B12-AFFNI54	phy23-32a	08/08/2023	340	0	0	0	0	340
phy2300246	Belfast	B3-AFFNI50	phy23-32a	08/08/2023	140	0	0	0	0	140
phy2300247	Belfast	B1-AFFNI55	phy23-32a	08/08/2023	260	0	0	0	0	260
phy2300249	Carlingford	C11-AFFNI84	phy23-32b	08/08/2023	20	40	0	0	0	60
phy2300250	Carlingford	C15-AFFNI89	phy23-32b	08/08/2023	0	20	0	0	0	20
phy2300256	Belfast	B3-AFFNI50	phy23-34a	21/08/2023	20	0	0	0	0	20
phy2300257	Belfast	B12-AFFNI54	phy23-34a	21/08/2023	40	0	0	0	0	40
phy2300263	Strangford	S2-AFFNI42	phy23-34b	22/08/2023	0	20	0	0	0	20
phy2300264	Strangford	S7-AFFNI76	phy23-34b	21/08/2023	40	0	0	0	0	40
phy2300275	Killough	K1-AFFNI18	phy23-37a	11/09/2023	20	20	0	0	0	40
phy2300287	Belfast	B12-AFFNI54	phy23-39a	25/09/2023	20	0	0	0	0	20
phy2300299	Belfast	B3-AFFNI50	phy23-41a	09/10/2023	20	0	0	0	0	20

Table 8 - Positive occurrences of *Pseudo-nitzschia* spp. (cells L^{-1}) in 2023

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300041	Foyle	PA3-wild fishery	phy23-07b	13/02/2023	160
phy2300047	Strangford	S2-AFFNI42	phy23-08b	21/02/2023	20
phy2300052	Belfast	B20-AFFNI53	phy23-09a	27/02/2023	40
phy2300053	Foyle	PA3-wild fishery	phy23-09b	27/02/2023	160
phy2300055	Carlingford	C1-AFFNI27	phy23-09c	28/02/2023	140
phy2300058	Carlingford	NW-wild fishery	phy23-09c	28/02/2023	40
phy2300064	Foyle	PA3-wild fishery	phy23-11a	13/03/2023	100
phy2300078	Larne	L3-AFFNI88	phy23-12b	20/03/2023	320
phy2300084	Foyle	PA4-wild fishery	phy23-13a	27/03/2023	80
phy2300089	Foyle	PA3-wild fishery	phy23-14b	04/04/2023	120
phy2300090	Foyle	PA4-wild fishery	phy23-14b	04/04/2023	40
phy2300095	Belfast	B1-AFFNI55	phy23-15a	11/04/2023	160
phy2300101	Dundrum	DB1-AFFNI95A	phy23-16a	17/04/2023	80
phy2300109	Foyle	PA4-wild fishery	phy23-17a	24/04/2023	2500
phy2300111	Belfast	B3-AFFNI50	phy23-17b	25/04/2023	160
phy2300112	Belfast	B12-AFFNI54	phy23-17b	25/04/2023	200
phy2300118	Carlingford	C11-AFFNI84	phy23-19a	08/05/2023	80

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300121	Belfast	B1-AFFNI55	phy23-19a	09/05/2023	540
phy2300122	Belfast	B3-AFFNI50	phy23-19a	09/05/2023	460
phy2300123	Belfast	B12-AFFNI54	phy23-19a	09/05/2023	800
phy2300124	Belfast	B20-AFFNI53	phy23-19a	09/05/2023	1060
phy2300126	Strangford	S7-AFFNI76	phy23-19b	09/05/2023	120
phy2300128	Foyle	PA3-wild fishery	phy23-19c	09/05/2023	480
phy2300129	Foyle	PA4-wild fishery	phy23-19c	09/05/2023	160
phy2300130	Killough	K1-AFFNI18	phy23-20a	15/05/2023	300
phy2300136	Strangford	S2-AFFNI42	phy23-21a	23/05/2023	3980
phy2300140	Larne	L3-AFFNI88	phy23-22a	29/05/2023	40
phy2300141	Belfast	B1-AFFNI55	phy23-22a	30/05/2023	18460
phy2300142	Belfast	B3-AFFNI50	phy23-22a	30/05/2023	95600
phy2300143	Belfast	B12-AFFNI54	phy23-22a	30/05/2023	7860
phy2300144	Belfast	B20-AFFNI53	phy23-22a	30/05/2023	60
phy2300145	Killough	K1-AFFNI18	phy23-23a	05/06/2023	4280
phy2300146	Dundrum	DB1-AFFNI95A	phy23-23a	05/06/2023	2200
phy2300147	Strangford	S2-AFFNI42	phy23-23a	05/06/2023	940

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300148	Strangford	S7-AFFNI76	phy23-23a	05/06/2023	17260
phy2300151	Belfast	B1-AFFNI55	phy23-24a	12/06/2023	540
phy2300152	Belfast	B3-AFFNI50	phy23-24a	12/06/2023	1200
phy2300153	Belfast	B12-AFFNI54	phy23-24a	12/06/2023	560
phy2300154	Belfast	B20-AFFNI53	phy23-24a	12/06/2023	760
phy2300155	Carlingford	C1-AFFNI27	phy23-24b	12/06/2023	40
phy2300156	Carlingford	C11-AFFNI84	phy23-24b	12/06/2023	120
phy2300157	Carlingford	C15-AFFNI89	phy23-24b	12/06/2023	720
phy2300159	Larne	L3-AFFNI88	phy23-24b	12/06/2023	420
phy2300160	Belfast	B1-AFFNI55	phy23-25a	19/06/2023	660
phy2300161	Belfast	B3-AFFNI50	phy23-25a	19/06/2023	520
phy2300162	Belfast	B12-AFFNI54	phy23-25a	19/06/2023	720
phy2300163	Belfast	B20-AFFNI53	phy23-25a	19/06/2023	1060
phy2300164	Killough	K1-AFFNI18	phy23-25a	19/06/2023	2000
phy2300166	Strangford	S2-AFFNI42	phy23-25a	19/06/2023	440
phy2300167	Strangford	S7-AFFNI76	phy23-25a	19/06/2023	1620
phy2300169	Carlingford	C11-AFFNI84	phy23-25b	19/06/2023	120

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300170	Carlingford	C15-AFFNI89	phy23-25b	19/06/2023	80
phy2300171	Carlingford	NW-wild fishery	phy23-25b	19/06/2023	80
phy2300174	Larne	L3-AFFNI88	phy23-25b	20/06/2023	680
phy2300175	Belfast	B1-AFFNI55	phy23-26a	26/06/2023	1320
phy2300176	Belfast	B3-AFFNI50	phy23-26a	26/06/2023	1440
phy2300177	Belfast	B12-AFFNI54	phy23-26a	26/06/2023	1760
phy2300178	Belfast	B20-AFFNI53	phy23-26a	26/06/2023	1480
phy2300179	Killough	K1-AFFNI18	phy23-26a	26/06/2023	2640
phy2300180	Dundrum	DB1-AFFNI95A	phy23-26a	26/06/2023	1180
phy2300181	Strangford	S2-AFFNI42	phy23-26b	27/06/2023	120
phy2300182	Strangford	S7-AFFNI76	phy23-26b	27/06/2023	1540
phy2300183	Larne	L3-AFFNI88	phy23-26b	26/06/2023	680
phy2300185	Carlingford	C11-AFFNI84	phy23-26b	26/06/2023	100
phy2300186	Carlingford	C15-AFFNI89	phy23-26b	26/06/2023	80
phy2300188	Killough	K1-AFFNI18	phy23-27a	03/07/2023	760
phy2300189	Dundrum	DB1-AFFNI95A	phy23-27a	03/07/2023	8640
phy2300191	Belfast	B3-AFFNI50	phy23-27a	03/07/2023	960

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300192	Belfast	B12-AFFNI54	phy23-27a	03/07/2023	1320
phy2300193	Belfast	B20-AFFNI53	phy23-27a	03/07/2023	860
phy2300194	Strangford	S2-AFFNI42	phy23-27b	03/07/2023	420
phy2300195	Strangford	S7-AFFNI76	phy23-27b	03/07/2023	1780
phy2300196	Larne	L3-AFFNI88	phy23-27c	04/07/2023	320
phy2300198	Carlingford	C11-AFFNI84	phy23-27c	04/07/2023	1040
phy2300201	Killough	K1-AFFNI18	phy23-28a	10/07/2023	20000
phy2300202	Dundrum	DB1-AFFNI95A	phy23-28a	10/07/2023	43600
phy2300203	Larne	L3-AFFNI88	phy23-28a	07/07/2023	920
phy2300204	Belfast	B1-AFFNI55	phy23-28a	09/07/2023	300
phy2300205	Belfast	B3-AFFNI50	phy23-28a	09/07/2023	200
phy2300209	Carlingford	C1-AFFNI27	phy23-28b	10/07/2023	400
phy2300210	Carlingford	C11-AFFNI84	phy23-28b	10/07/2023	5900
phy2300211	Carlingford	C15-AFFNI89	phy23-28b	10/07/2023	8440
phy2300212	Carlingford	NW-wild fishery	phy23-28b	10/07/2023	1700
phy2300213	Strangford	S7-AFFNI76	phy23-28b	11/07/2023	1900
phy2300214	Killough	K1-AFFNI18	phy23-29a	17/07/2023	3900

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300215	Dundrum	DB1-AFFNI95A	phy23-29a	17/07/2023	14640
phy2300216	Belfast	B1-AFFNI55	phy23-29a	17/07/2023	740
phy2300217	Belfast	B3-AFFNI50	phy23-29a	17/07/2023	260
phy2300218	Belfast	B12-AFFNI54	phy23-29a	17/07/2023	300
phy2300219	Belfast	B20-AFFNI53	phy23-29a	17/07/2023	940
phy2300220	Strangford	S2-AFFNI42	phy23-29b	17/07/2023	280
phy2300221	Strangford	S7-AFFNI76	phy23-29b	17/07/2023	1620
phy2300222	Larne	L3-AFFNI88	phy23-29b	17/07/2023	1960
phy2300223	Carlingford	C1-AFFNI27	phy23-29c	19/07/2023	720
phy2300224	Carlingford	C11-AFFNI84	phy23-29c	19/07/2023	2880
phy2300225	Carlingford	C15-AFFNI89	phy23-29c	19/07/2023	520
phy2300226	Carlingford	NW-wild fishery	phy23-29c	19/07/2023	120
phy2300227	Belfast	B1-AFFNI55	phy23-30a	24/07/2023	360
phy2300228	Belfast	B3-AFFNI50	phy23-30a	24/07/2023	40
phy2300229	Belfast	B12-AFFNI54	phy23-30a	24/07/2023	40
phy2300230	Belfast	B20-AFFNI53	phy23-30a	24/07/2023	1500
phy2300231	Killough	K1-AFFNI18	phy23-30b	24/07/2023	7540

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300232	Dundrum	DB1-AFFNI95A	phy23-30b	24/07/2023	8380
phy2300233	Carlingford	C1-AFFNI27	phy23-30b	24/07/2023	400
phy2300234	Carlingford	C11-AFFNI84	phy23-30b	24/07/2023	15500
phy2300235	Carlingford	C15-AFFNI89	phy23-30b	24/07/2023	7520
phy2300236	Carlingford	NW-wild fishery	phy23-30b	24/07/2023	200
phy2300237	Strangford	S2-AFFNI42	phy23-30c	25/07/2023	400
phy2300238	Strangford	S7-AFFNI76	phy23-30c	24/07/2023	6800
phy2300240	Killough	K1-AFFNI18	phy23-31a	31/07/2023	1120
phy2300241	Dundrum	DB1-AFFNI95A	phy23-31a	31/07/2023	12320
phy2300242	Strangford	S2-AFFNI42	phy23-31b	01/08/2023	220
phy2300243	Strangford	S7-AFFNI76	phy23-31b	01/08/2023	4820
phy2300244	Belfast	B20-AFFNI53	phy23-32a	08/08/2023	2400
phy2300245	Belfast	B12-AFFNI54	phy23-32a	08/08/2023	600
phy2300246	Belfast	B3-AFFNI50	phy23-32a	08/08/2023	80
phy2300247	Belfast	B1-AFFNI55	phy23-32a	08/08/2023	80
phy2300248	Carlingford	C1-AFFNI27	phy23-32b	08/08/2023	160
phy2300249	Carlingford	C11-AFFNI84	phy23-32b	08/08/2023	3680

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300252	Larne	L3-AFFNI88	phy23-32b	08/08/2023	300
phy2300253	Killough	K1-AFFNI18	phy23-33a	14/08/2023	160
phy2300254	Dundrum	DB1-AFFNI95A	phy23-33a	14/08/2023	7980
phy2300255	Belfast	B1-AFFNI55	phy23-34a	21/08/2023	160
phy2300256	Belfast	B3-AFFNI50	phy23-34a	21/08/2023	360
phy2300257	Belfast	B12-AFFNI54	phy23-34a	21/08/2023	280
phy2300258	Belfast	B20-AFFNI53	phy23-34a	21/08/2023	1540
phy2300263	Strangford	S2-AFFNI42	phy23-34b	22/08/2023	2500
phy2300264	Strangford	S7-AFFNI76	phy23-34b	21/08/2023	1240
phy2300266	Killough	K1-AFFNI18	phy23-35a	30/08/2023	560
phy2300267	Dundrum	DB1-AFFNI95A	phy23-35a	30/08/2023	12660
phy2300268	Belfast	B1-AFFNI55	phy23-36a	04/09/2023	11400
phy2300269	Belfast	B3-AFFNI50	phy23-36a	04/09/2023	17500
phy2300270	Belfast	B12-AFFNI54	phy23-36a	04/09/2023	8220
phy2300271	Belfast	B20-AFFNI53	phy23-36a	04/09/2023	10460
phy2300273	Strangford	S2-AFFNI42	phy23-36b	04/09/2023	480
phy2300274	Strangford	S7-AFFNI76	phy23-36b	04/09/2023	760

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300275	Killough	K1-AFFNI18	phy23-37a	11/09/2023	920
phy2300276	Dundrum	DB1-AFFNI95A	phy23-37a	11/09/2023	760
phy2300278	Carlingford	C11-AFFNI84	phy23-37b	12/09/2023	580
phy2300279	Carlingford	C15-AFFNI89	phy23-37b	12/09/2023	160
phy2300282	Strangford	S7-AFFNI76	phy23-38a	18/09/2023	40
phy2300283	Killough	K1-AFFNI18	phy23-39a	25/09/2023	40
phy2300285	Belfast	B1-AFFNI55	phy23-39a	25/09/2023	40
phy2300286	Belfast	B3-AFFNI50	phy23-39a	25/09/2023	200
phy2300287	Belfast	B12-AFFNI54	phy23-39a	25/09/2023	80
phy2300288	Belfast	B20-AFFNI53	phy23-39a	25/09/2023	80
phy2300296	Killough	K1-AFFNI18	phy23-41a	09/10/2023	80
phy2300299	Belfast	B3-AFFNI50	phy23-41a	09/10/2023	120
phy2300301	Belfast	B20-AFFNI53	phy23-41a	09/10/2023	200
phy2300307	Carlingford	C15-AFFNI89	phy23-41c	10/10/2023	120
phy2300308	Carlingford	NW-wild fishery	phy23-41c	10/10/2023	80
phy2300310	Strangford	S7-AFFNI76	phy23-42a	16/10/2023	200
phy2300313	Belfast	B12-AFFNI54	phy23-43a	22/10/2023	80

System id	Region	Site ID ref	Report no.	Collection date	*Pseudo-nitzschia* spp.
phy2300314	Belfast	B20-AFFNI53	phy23-43a	22/10/2023	160
phy2300322	Killough	K1-AFFNI18	phy23-43c	25/10/2023	40
phy2300346	Dundrum	DB1-AFFNI95A	phy23-48a	27/11/2023	160
phy2300356	Belfast	B12-AFFNI54	phy23-49a	03/12/2023	80
phy2300357	Belfast	B20-AFFNI53	phy23-49a	03/12/2023	160
phy2300367	Foyle	PA3-wild fishery	phy23-50b	11/12/2023	80
phy2300369	Foyle	PA3-wild fishery	phy23-51a	18/12/2023	40