Shellfish Action Plan

Carlingford Lough

December 2019

Department of
Agriculture, Environment
and Rural Affairs
www.daera-ni.gov.uk

INVESTORS
IN PEOPLE

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1.0 Introduction

Pollution Reduction Programmes (now Shellfish Action Plans) were established under Article 5 of the Shellfish Waters Directive (2006/113/EC) which stated that all Member States should establish programmes in order to reduce pollution in designated shellfish waters.

Shellfish Action Plans will next be reviewed on a priority basis starting in 2021 which is in line with the third River Basin Cycle under the Water Framework Directive.

The Shellfish Waters Directive was subsumed into the Water Framework Directive (2000/60/EC) in December 2013. Since then all shellfish waters are protected under the Water Framework Directive (WFD) and are hereafter referred to as Shellfish Water Protected Areas. Shellfish Water Protected Areas are afforded the same level of protection under WFD as they were under the Shellfish Waters Directive. The Department will continue to work to deliver effective management of Shellfish Water Protected Areas through the UK's post Brexit Marine Strategy.

Carlingford Lough was designated under the Shellfish Waters Directive in 2009. The Food Standards Agency in Northern Ireland (FSA in NI) commissioned a Sanitary Survey in 2011.

There are currently three shellfish production areas within Carlingford Lough Shellfish Water Protected Area. These production areas contain nine shellfish farms licensed by the Department of Agriculture and Rural Affairs (DAERA) Marine and Fisheries Division and monitored by the FSA in NI. Blue mussels (*Mytilus edulis*) and Pacific oysters are both harvested within the protected area. There is also a wild shellfish harvesting area at Narrow Water, for mussels, but this is outside of the Shellfish Water Protected Area.

2.0 Description of catchment

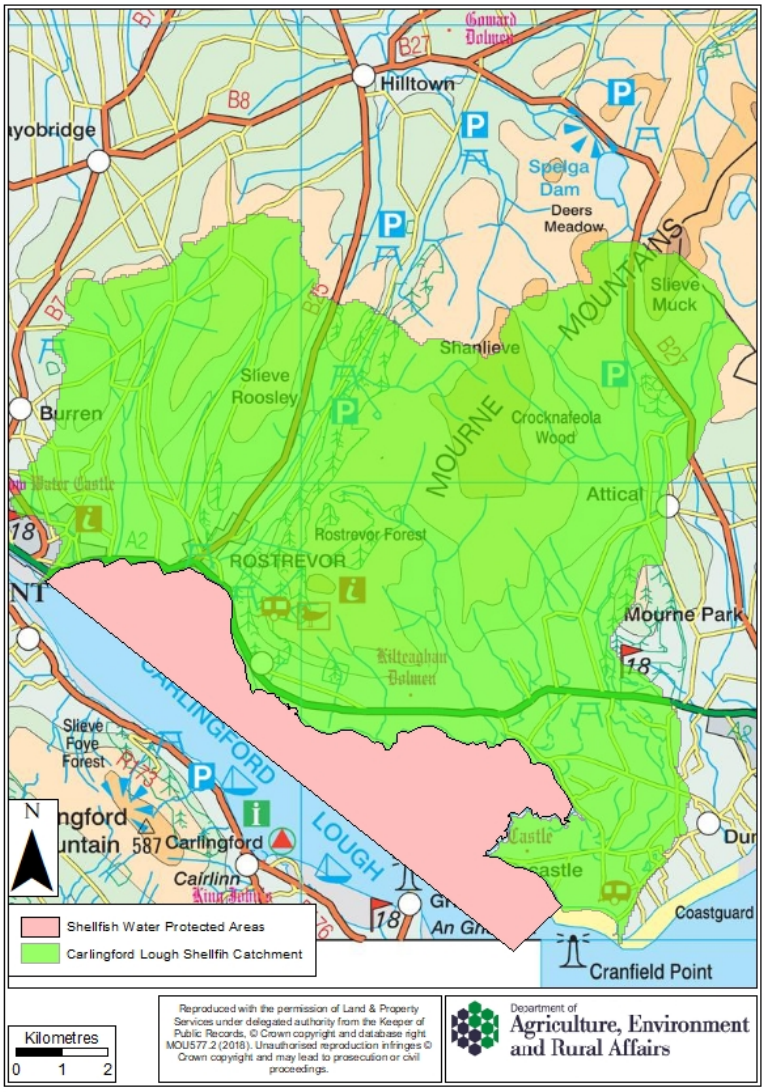
Carlingford Lough lies within the Neagh Bann River Basin District. The catchment area also drains into Dundalk Bay and covers an area approximately 823km2. The largest river is the Newry River which rises around Rathfriland and flows through Newry City to Carlingford Lough. There are also a number of rivers that discharge directly into Carlingford Lough or coastal waters such as the White Water River, Kilbroney River

and Cassey Water. The main towns are Newry and Warrenpoint with several smaller towns throughout the area including Rathfriland, Rostrevor and Crossmaglen. The main pollution sources in Carlingford Lough come from continuous and intermittent discharges mainly concentrated in the north-western region of the Lough where the Newry River enters. The Newry and Warrenpoint Wastewater Treatment Works (WWTWs) have the highest discharges flowing into the river and subsequently into the lough. There are also untreated discharges entering the lough from Greenore and Omeath in the Republic of Ireland and various other non-point sources associated with agricultural land use, tourism and wildfowl.

The 2011 Sanitary Survey[1] reported that within the catchment area, land use is dominated by pastures 63%, followed by natural grassland 9% and moors and heathland 6%. In total, agricultural activities comprise 70% of the land use in the area. Carlingford Lough was designated under the Shellfish Waters Directive in 2009 when the existing designations of Ballyedmond and Cassey Water were realigned to include all licensed shellfish beds. In Carlingford Lough there are fourteen shellfish production areas licensed by DAERA within the Shellfish Water Protected Area and one wild shellfish harvesting area at Narrow Water, which is outside the Shellfish Water Protected Area.

[1] https://www.food.gov.uk/sites/default/files/media/document/carlingfordlough.pdf

Figure 1. River Catchment Areas Draining into Carlingford Lough



3.0 Objectives for Shellfish Water Protected Areas

Under WFD all Shellfish Water Protected Areas (SWPAs) must be managed to ensure that they meet their ecological and chemical objectives under WFD **AND** meet at least Class B status under the EU Hygiene Regulations. SWPAs must also make progress towards the WFD microbiological guideline standard of ≥75% of samples contain ≤230 *E.coli* in the shellfish flesh and intervalvular liquid[2]. The Food Standards Agency in NI is responsible for the implementation of Classification and monitoring programmes for shellfish for the protection of public health.

3.1 Water Framework Directive status and shellfish classification

Comprehensive monitoring programmes are in place to assess the status of Shellfish Water Protected Areas under the WFD and classification under the EU Hygiene Regulations. A suite of determinands is assessed to determine ecological status and the overall objective under WFD. Table 1 shows the future WFD ecological objective for Carlingford Lough water body.

Table 1. WFD Ecological Status and Objectives for Carlingford Lough

2021 Objective	2027 Objective
Moderate Ecological Status & Class B under EU Hygiene Regulations	Good Ecological Status & Class B under EU Hygiene Regulations

[2] http://www.legislation.gov.uk/nisr/2015/351/contents/made

Table 2 shows the Classification status at Carlingford Lough under WFD (colour) and the licensed shellfish beds under the EU Hygiene Regulations (text).

Table 2. Classification status of shellfish production areas in Carlingford Lough

	2018	2017	2016	2015	2014	2013
Ballyedmond (AFFNI 73 – C7)	B	A Provisional	A Provisional	A Provisional	A Provisional	A Provisional
Carriganean (AFFNI 39 – C9)	B	A Provisional	A Provisional	A Provisional	A Provisional	A Provisional
Fair Green (AFFNI 84 – C11)	B	B	B	B	B	B
Flynn (AFFNI 94 – C3)	B	B	B	B	B	B
Killowen (AFFNI 68 – C4)	B	B	B	B	B	B
Rostrevor (AFFNI 27 – C1)	B	B	B	B	B	B
Cloughmore (AFFNI 74 – C2)	B	B	B	B	n/a	n/a
O Hare (AFFNI 89 – C15)	B	A Provisional	A Provisional	A Provisional	n/a	n/a
Mill Bay (AFFNI 92 – C17)	B	A Provisional	A Provisional	A Provisional	n/a	n/a
Narrow Water Wild Fishery	B/C **	B/C **	B/C **	B Provisional	B	B

** Seasonal Classification

Class B (01 July – 31 October)

Class C (01 November – 30 June)

A provisional classification is given when a new bed is classified based on a limited number of samples or when a bed is borderline compliant with criteria of a classification.

Key to WFD Status

	High		
	Good		Good Ecological Potential
	Moderate		Moderate Ecological Potential
	Poor		Poor Ecological Potential
	Bad		Bad Ecological Potential

4.0 Monitoring programmes for Shellfish Water Protected Areas and shellfish flesh

4.1 Monitoring of *E. coli* in shellfish flesh

FSA in NI conducts monthly analysis of *E. coli* in shellfish flesh as part of its Official Control monitoring. This analysis is used to classify the quality of shellfish production areas. The classification determines the level of post-harvest treatment required before placing shellfish product from that area on the market. The FSA in NI's Official Control monitoring programme is solely for the purpose of classification of shellfish production areas. It is not intended as an indication of the end product standard of shellfish. Responsibility for ensuring the safety of shellfish which are placed on the market for human consumption rests solely with the food business operator (FBO)[3].

[3] https://www.food.gov.uk/business-guidance/biotoxin-and-phytoplankton-monitoring

Table 3. Shellfish classification and post-harvest treatment

Classification of harvesting areas		
Category	**E.coli per 100g flesh and intravalvular liquid**	**Post-harvest treatment required**
A	≤230	May go directly for human consumption if end product standard met.
B	90% results <4600 Remaining 10% results <46000 100% results <46000	Must be subject to purification or cooked by an approved method.
C	<46,000	Must be subject to relaying for a period of at least 2 months or cooked by an approved method.
	>46,000 E.coli/100g of flesh	Prohibited. Harvesting not permitted.

4.2 Producer responsibility

Shellfish producers and harvesters have obligations under the EU Hygiene Regulations to ensure the quality of the product which they place on the market for human consumption. Producers should have an understanding and awareness of the environment in which product is being produced. Producers should use where possible, their own testing regimes to inform business management decisions. It is acknowledged that in order to make sounds decisions, producers need access to appropriate and timely information relating to the quality of the shellfish water and anything which has the potential to impact upon it.

4.3 Guideline microbiological standard (DAERA)

The shellfish flesh monitoring programme is operated by FSA in NI. The analyses in shellfish flesh are carried out by Northern Ireland Public Health Laboratories and results are reported back to both DAERA and FSA in NI.

In addition to being used for the Official Control monitoring for the microbiological shellfish classification carried out by the FSA in NI, this information is also used by DAERA to determine the status of Shellfish Water Protected Areas against a guideline microbiological standard for shellfish flesh which is set in the Water Framework Directive (Priority Substances and Classification) (Amendment) Regulations (Northern Ireland) 2015. This guideline standard requires that 75% of samples contain ≤ 230 *E. coli* per 100ml of shellfish flesh and intervalvular liquid.

Table 4 shows the status of Carlingford Lough against the WFD Guideline standard.

Shellfish Water Protected Area	*2018*	*2017*	*2016*	*2015*	*2014*	*2013*
Carlingford Lough						
Total Number of Samples	*36*	*39*	*39*	*51*	*39*	*49*
% Samples Meeting Guideline	*81*	*82*	*67*	*59*	*77*	*80*

	Met Guideline
	Did Not Meet Guideline

4.4 Monitoring of contaminants in shellfish flesh

Annual analysis of a suite of contaminants in shellfish flesh is carried out in all seven of the sea loughs/areas in Northern Ireland in which shellfish are cultivated and harvested. This is a joint programme of monitoring currently in place with FSA in NI and DAERA to meet both organisations' requirements under EU legislative requirements and OSPAR (Oslo/Paris convention *(for the Protection of the Marine Environment of the North-East Atlantic*)) and to enable DAERA to determine compliance with a range of environmental obligations relating to Shellfish Water Protected Areas.

The suite of contaminants tested for includes trace metals, lipids, dioxins, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). See Annex B.

4.5 Investigative monitoring (DAERA)

Where Shellfish Water Protected Areas are at risk of failing to meet objectives, specific investigative monitoring is undertaken of the protected areas, rivers and any other potential sources of pollution identified.

In addition to the measures set out in this Shellfish Action Plan, DAERA will investigate any pollution incident and/or deterioration in water quality. Formal arrangements are in place between DAERA, NI Water and the FSA in NI to investigate and respond to incidents relating to water quality at Shellfish Water Protected Areas. This includes responding to requests for investigation of FSA in NI microbiological official control sample results which are outwith the classification of the shellfish production area and any pollution incident in the proximity of a Shellfish Water Protected Area.

It is an offence under the terms of the Water (Northern Ireland) Order 1999 to cause pollution to a waterway. Pollution incidents will be investigated in accordance with the DAERA Enforcement and Prosecution Policy, which can be found at; https://www.daera-ni.gov.uk/sites/default/files/publications/daera/emfg-enforcement-policy.pdf

Figure 2. Licensed shellfish production areas inCarlingford Lough, showing sampling points for microbiological analysis, the Shellfish Water Protected Area and potential point pollution sources.

Key – Carlingford Lough

1: The Docks Warrenpoint Wastewater Pumping Station

2: Warrenpoint Golf Club Wastewater Pumping Station

3: Spring Meadows Wastewater Pumping Station

4: Warrenpoint Main Wastewater Pumping Station

5: Springfield Road Ringmackilroy Wastewater Pumping Station

6: Seafields Wastewater Pumping Station

7: Dobbins Point Wastewater Pumping Station

8: Drumsesk Road Wastewater Pumping Station 1

9: Horners Lane Combined Sewer Overflow

10: Shore Road Rostrevor 2 Wastewater Pumping Station

11: Cherry Hill South Combined Sewer Overflow

12: Pinewood Wastewater Pumping Station

13: Killowen Wastewater Pumping Station

14: Cranfield Wastewater Treatment Works

15: Greencastle Pier Road Wastewater Pumping Station (1)

16: Greencastle Pier Road Wastewater Pumping Station (2)

17: Cranfield 1 Crossroads Wastewater Pumping Station

18: Cranfield 2 Chestnutts Wastewater Pumping Station

19: Cranfield 3 Grange Chapel Wastewater Pumping Station

20: Warrenpoint Wastewater Treatment Works

5.0 Programme of Measures to Protect Shellfish Water Protected Areas

A Neagh Bann River Basin Management Plan was published in December 2009, identifying where the water environment needed to be protected or improved, the timeframe to make these improvements and how this could be achieved through a Programme of Measures.

Since this first Plan was published in 2009, the Department has been working with others to make improvements detailed within the Plan. Progress has been made and there are signs of improvement throughout the Neagh Bann River Basin District water environment. NIEA has updated the Programme of Measures taking into consideration existing measures and identifying new measures which are required to meet the objectives for 2021 and 2027.

A second Neagh Bann River Basin Management Plan was published in 2015 which builds on the positive work already being carried out. It details changes and new measures for the second river basin planning cycle 2015-2021. The Programme of Measures aims to address the key pressures through concentrated efforts targeted at greatest threats to the water environment. From assessments conducted, two significant sources of pressure have been identified that are preventing water bodies from achieving good status in the Neagh Bann River Basin District. These are diffuse pressures and point source pressures from both agricultural, urban wastewater and development.

A summary of some of the existing and planned measures is below. More detail can be found at https://www.daera-ni.gov.uk/sites/default/files/publications/doe/water-report-neagh-bann-river-basin-plan-2015.pdf
https://www.daera-ni.gov.uk/sites/default/files/publications/daera/NIEA%20-%20WFD%20Statistics%20Report%202018.pdf

Key Sector – Agriculture – General

Specific actions for Carlingford Lough are highlighted in the report card below.

Pressure Type – Diffuse and Point Source Pollution

Improvements required – Reduction in nutrient inputs and reduction in organic waste, reduction in pollution from sediment, education and awareness.

A **Memorandum of Understanding** has been signed between NIEA and the Ulster Farmers' Union. It is hoped that the MOU will assist in improving environmental outcomes, including improving water quality through addressing diffuse pollution.

One new incentive the Department has introduced is the **Environment Farming Scheme** (EFS) Launched in February 2017, this is a voluntary scheme that will support farmers and land managers to carry out environmentally beneficial farming practices on agricultural land. Agriculture pollution can have potentially damaging effects on rivers and shellfish growing waters. Many of our shellfish waters are in rural catchments and can therefore be susceptible to agricultural pollution. The scheme includes elements to improve and enhance water quality through both individual and group catchment improvement actions. Measures to improve water quality include buffer strips around rivers and riverine fencing.

The **Catchment Care Project,** which will be funded under INTERREG VA, will look at a range of agricultural issues across three catchments which have the potential to cause water pollution. The project will also examine measures to mitigate against water pollution impacts. The catchments are the Arney, Finn and Blackwater.

A **Strategic Agricultural Land Management Strategy** was launched by Minister McIlveen on 21st October 2016. Some of the recommendations within the Strategy are now being progressed by a pilot scheme in the Upper Bann catchment. A report on the effectiveness of the pilot, which will influence future management of agricultural land use incorporating better protection of waterways.

Although both the Catchment Care Project and the Strategic Land Management Strategy pilot are not within shellfish water catchments, the methodology and findings will be transferable to other sites.

Knowledge Advisory Service

A knowledge focussed service, managed by CAFRE which will deliver proactive programmes and drive innovation to improve the economic and environmental performance and resilience of the land based and food processing industries. Early indications are that interactions with the Knowledge Advisory Service and NIEA will

help to provide advice to farmers on the linkages between their agricultural practices and impacts on water quality.

Compliance and Enforcement Visits - DAERA to enforce closed spreading period for slurries and application on land restrictions. Encourage and advise on good land management practices such as; riverbank fencing and riparian buffers.

Key Sector – Sewage and Industry – General.

Specific actions for Carlingford Lough are highlighted in the report card below.

Pressure Type – Diffuse and Point source pollution

Improvements required – Reduction in pollution from sewage, reduction in nutrient and dangerous substances, reduction in pollution from unsewered properties, reduction in pollution from industry.

Actions – Northern Ireland Water Price Control (PC) process ensures investment in infrastructure. DAERA continue work on microbial source tracking to identify sources of bacterial contamination. Reviews of discharge consents on a catchment basis and comply with discharge standards in quality and quantity. Also improvements to existing controls on septic tanks, develop models and catchment based approaches to protect areas.

Key Sector – Urban Catchment

Pressure Type – Diffuse and point source pollution

Improvements required – Control of diffuse and point source pollution, reduction in pollution and flood risk,

Actions – Promote and adopt good practice with respect to storage, use and disposal of hazardous chemicals. Promote wider use of Sustainable Urban Drainage Systems (SuDs) and buffer strips.

The water environment in the Neagh Bann River Basin District is being managed at a local level through Local Management Area action plans, including the Carlingford & Newry Local Management Area action plan. In 2017 and 2018, activities have focussed on targeted catchments to best utilise resources.

Catchment Stakeholder groups provide forums for stakeholders to discuss water management issues in their local area and to work in partnership to address them.

Local Management Area Plan and 2013 update for Carlingford & Newry [4] :

[4] https://www.daera-ni.gov.uk/sites/default/files/publications/doe/water-information-carlingford-and-newry-local-management-area-action-plan-and-update-2013.pdf

6.0 Summary of Outputs (Expanded at Annex A)

Actions in Improving Sewerage Network and Waste Water Treatment Works
Monitoring and Investigations
Actions in Reducing Agricultural Inputs
Overall Management Actions

How much did we do #	How well did we do it %
Actions in improving Sewerage Network and Waste Water Treatment Works	
Sewerage network improvements in Carlingford Lough Area	Installation of Combined Sewer Overflow (CSO) monitors within 2km of identified Bathing Waters and Shellfish Water Protected Areas. NIW is currently carrying out a Drainage Area Study.
Upgrades to Wastewater Treatment Works (WWTW) since 2012	There have been no upgrades of WWTWs in this period.
Monitoring and Investigations	
WFD classification (2015/21)	The 2015 status for Carlingford Lough is Moderate and therefore it is currently meeting its 2021 target.
Food Standards Agency *E. coli* in flesh programme (Annual Classification) 2002 – 2018	Full statistical analysis of the raw data is presented in Annex A There has been shown to be significant deteriorating trends at C11 AFFNI 84 (Fairgreen) Oysters and C9 AFFNI 39 (Carriganean) Oysters in certain months, whilst Narrow Water Fishery has seen a significant overall deterioration in this period
NIEA Pollution Investigations within 1km radius of Carlingford Lough	Since 2012 the overall number of pollution investigations appears to be decreasing, although it remains low.

Actions in Reducing Agricultural Inputs	
Inspection and enforcement of the NAP Regulations carried out by NIEA	Around 300 farm businesses annually assessed for compliance with the Nitrates Directive. Levels of non-compliance decreased in 2014-16, but increased in 2017 and 2018.
Overall Management Actions	
Statistical calculations using Seasonal Kendall test (SK test) were investigated for all data available from FSA E-coli monitoring programme.	This process is quality assured to the ISO9001:2008 standard.

Is anyone better off as a result #/%

It is not possible to measure temporal trends using shellfish flesh classifications alone. Full statistical analysis of raw data is required (See Annex A).

Significant increasing trends in E. coli at Narrow Water Wild Mussel Fishery, C11 AFFNI 84 (Fairgreen) Oysters and C9 AFFNI 39 (Carriganean) Oysters.

Overall a highly significant increasing monotonic trend in E. coli was observed at Narrow Water Wild Mussel Fishery (this is outside the Shellfish Water Protected Area). When assessing trend by month, this observation could not be attributed to increases for particular months.

Although overall they did not exhibit significant increasing monotonic trends, C11 AFFNI 84 Oysters showed a significant monthly increasing monotonic trend in E. coli in April and June and C9 AFFNI 39 showed a significant monthly increasing monotonic trend in April.

Pollution investigations are carried out by Water Management Unit. Since 2012 there has been **an overall decreasing trend in the number of reported pollution incidents**, there was only one confirmed high severity incidents within the time period.

Overall status for Carlingford Lough is Moderate (the 2021 classification objective is Moderate).

Pollution investigations are carried out by Water Management Unit. Since 2012 the **overall number of pollution investigations appears to be decreasing**. 2014 was the only year to have seen a medium and high severity incident.

Inspection and enforcement of the NAP Regulations is carried out by NIEA. Around 300 farm businesses are now selected for scheduled inspection each year and all are assessed for compliance with the Nitrates Directive. **The levels of non-compliance were found to be reducing from 2014 to 2016. However in 2017 and 2018 the levels of non-compliance increased.** NIEA have increased the number of identified risk farms to visit in 2019 and will increase the number of inspections in selected priority water bodies this year.

Conclusions – Carlingford Lough continues to perform well. WFD status is moderate, with a 2021 objective of moderate. Pollution incidents are reducing and the Shellfish Water Protected Area met WFD Shellfish Guideline standards. DAERA will continue to monitor the area to ensure no significant deterioration of the lough occurs.

Any incident should be reported to the NIEA Water Pollution Hotline on
0800 80 70 60

7.0 Further Information:

Further Information is available at: www.daera-ni.gov.uk

Or by Emailing:

MarineDivision.InfoRequests@daera-ni.gov.uk

Annex A

Action/Output	Group	Completed, Ongoing or Planned
Upgrades to Sewerage Network		
Combined Sewer Overflow (CSO) monitor installation due to be completed by mid-2019. Pilot project completed 2018, to be rolled out to CSOs within 2km of identified bathing waters and Shellfish Water Protected Areas.	NI Water	Ongoing
Northern Ireland Water is currently carrying out a Drainage Area Study.	NI Water	Ongoing
Upgrades to Dundrum Wastewater Treatment Works		
There have been no upgrades in this period, however Newry WWTW and Warrenpoint WWTW will need to be upgraded as they require Total Nitrogen and Phosphorus removal by 2022.	NI Water	Ongoing
Monitoring and Investigations		
The 2015 status for Carlingford Lough is Moderate and therefore it is currently meeting its 2021 target. Elements that are causing the Moderate classification are angiosperms, benthic invertebrates, DIN, hydromorphology and specific pollutants.	DAERA	Ongoing
E. coli in shellfish flesh monthly Official Control monitoring and classification programme - Increased knowledge and better understanding of what's happening in all Catchments It is not possible to measure temporal trends using FSA in NI shellfish flesh classifications alone. Full statistical analysis of raw data is required. **Statistical calculations using Seasonal Mann-Kendall test (SM-K test).** Using SM-K tests, it was found; (Period 2002-2018) • Overall a highly significant increasing monotonic trend in E. coli was observed at Narrow Water Wild Mussel Fishery. • Whilst Narrow Water Wild Mussel Fishery, exhibited an overall significant increasing monotonic trend, this observation could not be attributed to increases for particular months. • Although overall it did not exhibit a significant increasing monotonic trend overall, C11 AFFNI 84 Oysters showed a significant monthly increasing monotonic trend in E. coli in April and June.	FSA in NI DAERA	Ongoing Ongoing

- Although overall it did not exhibit a significant increasing monotonic trend overall, C9 AFFNI 39 Oysters showed a significant monthly increasing monotonic trend in E coli in April

SM-K is a nonparametric test that analyses data for monotonic trends in seasonal data. It is the most popular trend test in environmental studies. “Monotonic” means a consistent upwards or downwards trend. “Seasonal” means that data is collected for periods where trends can are upwards or downwards. While it can refer to Spring, Summer etc., “seasonal” can also refer to other time periods, such as months. This will allow analysis of monthly trends over all the years’ data alongside an overall annual trend.

Pollution Investigations in 1km radius of Carlingford Lough Breakdown by category

Pollution investigations continue to be carried out by Water Management Unit when possible pollution has been reported through the Emergency Pollution Hotline or identified by WMU staff. Since 2012 the overall number of pollution investigations, although remaining low appears to be decreasing. 2014 was the only year to have seen a medium and high severity incident.

	High	Medium	Low	Total Incidents
2012	0	0	4	**4**
2013	0	0	3	**3**
2014	1	1	1	**3**
2015	0	0	2	**2**
2016	0	0	1	**1**
2017	0	0	1	**1**
2018(to date)	0	0	1	**1**

DAERA – Water Management Unit

Ongoing

Actions In Reducing Agricultural Inputs		
Inspection and enforcement of the NAP Regulations is carried out by NIEA. Around 300 farm businesses are now selected for scheduled inspection each year and all are assessed for compliance with the Nitrates Directive. **The levels of non-compliance were found to be reducing from 2014 to 2016. However in 2017 the levels of non-compliance increased and the same increased level of non-compliance was found in 2018.** The main non-compliances found over the period were nitrate pollution and defective effluent storage, with N loading in 2017 and spreading issues last year due to the exceptionally wet winter in 2017-2018.	Water Management Unit	Ongoing

Annex B

Contaminants in shellfish flesh monitored by DAERA and FSA in NI

Metals	Polycyclic aromatic Hydrocarbons
Arsenic	Naphthalene
Silver	Phenanthrene
Cadmium	Anthracene
Chromium	Fluoranthene
Copper	Pyrene
Iron	Benzo (a) Anthracene
Mercury	Chrysene
Nickel	5 Methyl Chrysene
Lead	Benzo (b) Fluoranthene
Zinc	Benzo (k) Fluoranthene
Selenium	Benzo (j) Fluoranthene
	Benzo (c) Fluorene
	Benzo (a) Pyrene
	Indeno (123,cd) Pyrene
	Dibenzo (a,h) Anthracene
	Benzo (ghi) Perylene
	Dibenzo (a,l) Pyrene
	Dibenzo (a,e) Pyrene
	Dibenzo (a,i) Pyrene
	Dibenzo (a,h) Pyrene
	Cylcopenta (c,d) Pyrene

Polychlorinated Biphenyls
PCB 28
PCB 52
PCB 101
PCB 118
PCB 138
PCB 153
PCB 180

Dibenzo-p-dioxins (PCDDs)
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDD

1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD

Department of Agriculture, Environment and
Rural Affairs
Marine and Fisheries Division
17 Antrim Road
Tonagh
Lisburn
BT28 3AL

Water Pollution Hotline: 0800 807060
Email: Marine.InfoRequests@daera-ni.gov.uk

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Department of
Agriculture, Environment
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