

*Foras na Mara*  
*Marine Institute*

**A Review of Benthic Monitoring at Irish  
Finfish Aquaculture Sites During 2020**

**Marine Institute**

**Report Submitted to**

**Aquaculture and Foreshore Management Division,  
Department of Agriculture, Food and the Marine**

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## 1. Glossary

**ARPD – Apparent Redox Potential Discontinuity**  
**AZE – Allowable Zone of Effect**  
**BIM – Bord Iascaigh Mhara**  
**LOI – Loss On Ignition**  
**MI – Marine Institute**  
**OM – Organic Matter**  
**REDOX – REDuction OXYgenation in marine sediments**  
**DAFM- Department of Agriculture, Food and Marine**

## 2. Overview of the Benthic Monitoring Programme

In May 2000, following consultation with the industry and a number of statutory bodies (including the MI and BIM), the first version of a series of protocols detailing monitoring requirements at marine finfish farm sites was published by the Department of Communications Marine and Natural Resources. In August 2001, a revised Benthic Protocol was produced following consultation with industry and regulators. In 2008, the benthic protocol 'Monitoring Protocol No.1 for Offshore Finfish Farms-Benthic Monitoring, 2008' was reviewed and further revised which consisted of the inclusion of OM and REDOX (ARPD) as additional parameters to be measured. Also, AZE were established wherein varying levels of acceptable impact (thresholds) were defined. The Benthic Protocol is available on the DAFM website.<sup>1</sup>

Since 2008, it has been established<sup>2</sup> that all sites where marine finfish aquaculture was licenced would be subject to the Benthic Protocol, including those sites where benthic monitoring was not explicitly stated as a Condition in the licence. It is, therefore, the understanding of the Marine Institute that benthic monitoring is now a requirement for all marine finfish aquaculture sites in Ireland.

An annual report is prepared by the Marine Institute and submitted to DAFM and includes a review of the marine fish farm benthic survey reports received by the Benthos Ecology Group of the Marine Institute for surveys conducted during the previous year and a comment on their compliance with the standards identified in the protocol. This report deals with marine surveys conducted during 2020. Comments on compliance with reporting requirements are also included.

Since the 2014 reporting cycle, there have been changes to the manner in which sites are assessed and reported on based on the audits provided by the consultants. The level of reporting compliance continues to be provided in this report as before. In relation to environmental compliance a site would be deemed acceptable or unacceptable based on the information provided in the audits. As of the 2015 report, the classification is as follows:

- 1) **Acceptable**- conditions within the environmental standards stated in the Benthic Protocol.
- 2) **Not acceptable**- conditions not within the environmental standards stated in the Benthic Protocol.
- 3) **Indeterminate**- Essential information e.g. Residual Current direction, maximum biomass and current speed missing which prohibits judgement regarding the environmental condition at the site.

This change, the introduction of the 'indeterminate' classification, is a result of reports being submitted with important technical information missing (e.g., residual current direction, stocking data, visual description, etc.).

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<sup>1</sup> <https://assets.gov.ie/99270/feed7128-f7b3-4632-b192-0848a646159e.pdf>

<sup>2</sup> Communication between MI and DAFF on Feb 12, 2009.

### 3. Level of Reporting Compliance

Notwithstanding that all marine fish farm sites are subject to the Benthic Protocol, a pragmatic approach is applied in relation to determining sites that might be subject to monitoring in any one year, i.e., sites where no fish were held during the calendar year were not subject to the requirements of the Benthic Protocol for that year. In order to verify the number of sites that might be subject to the Benthic Protocol in 2020, the Marine Institute relied on a number of information sources:

- 1) Communication from operators responding to reminders from DAFM.
- 2) Direct communication by Marine Institute with operators allied with a review of other monitoring programmes (e.g. residues and sea lice programs).
- 3) Review of fish movements authorised under Council Directive 2006/88/EC.

On the basis of the information supplied, the MI determined that monitoring surveys were required at a total of 29 sites during 2020. A list of sites which were required to have surveys carried out and the level of compliance is provided in Table 1 below. Reports of surveys were not provided for the following sites:

- 1) T09/132A, Ballinakill Harbour, Co. Galway.
- 2) T09/127, Clifden Bay, Co. Galway.
- 3) T10/051, Bellacragher Bay, Co. Mayo.

*Table 1: List of marine finfish farms subject to benthic protocols at year-end 2020 and number of reports submitted*

Location	Company (Licensee)	No. of sites eligible for survey during 2020	No. reports Submitted for 2020
<b>Donegal</b>			
Lough Swilly – T12/085	MOWI	1	1
Mulroy Bay – T12/077A, T12/077C/ T12/077D, T12/077E, T12/077F, T12/77/7	MOWI	6	6
Inver Bay – T12/276	Ocean Farm	1	1
Inver Bay – T12/063, T12/096B	MOWI	2	2
McSwynes Bay- T12/266	Ocean Farm	1	1
<b>Mayo</b>			
Clew Bay- T10/054B, T10/058A, T10/058B, T10/067A	MOWI	4	4
Bellacragher Bay-T10/051	Curraun Fisheries Ltd	1	0
<b>Galway</b>			
Ballinakill Harbour – T09/132A	Bifand Ltd.	1	0
Clifden Bay- T09/127	Ardbear Seafarms Ltd.	1	0
Killary Harbour – T09/143	Curraun Fisheries Ltd.	1	1
Betraghboy Bay-T09/155, T09/107	MOWI	2	2
Betraghboy Bay- T09/093A	Marine Institute	1	1
Kilkieran Bay – T09/114A, T09/136A	Bradán Beo Teoranta	2	2
<b>Kerry/Cork</b>			
Bantry Bay – T05/444D, T05/444E	MOWI	2	2
Bantry Bay- T05/122	Murphy's Irish Sea Food	1	1
Kenmare Bay – T05/233, T06/202	MOWI	2	2
<b>TOTAL</b>		<b>29</b>	<b>26</b>

Nationally, the level of reporting compliance with the Benthic Protocol during 2020 was 26 sites out of 29 eligible sites i.e. representing 89.6% reporting compliance (**Table 2**). This is a decrease on reporting compliance in 2019 (96.4%).

#### 4. Compliance with Environmental Guidelines

Of the 26 sites which provided survey reports in 2020, 22 survey reports (84.6%) demonstrated conditions that were within environmental standards and thus deemed acceptable as per the Benthic Protocol and 4 sites were deemed unacceptable due to conditions not meeting the environmental standards as stated in the Benthic Protocol. (**Table 2** and **Section 6**)

Table 2: Summary of compliance with reporting requirements and environmental standards 2001 – 2020.

<i>Year</i>	<i>Number of sites eligible for survey</i>	<i>Reporting Compliance</i>	<i>Surveyed Sites Compliant with Environmental Standards</i>
<b>2001</b>	<b>27</b>	<b>65% (17/27)</b>	<b>94%</b>
<b>2002</b>	<b>55</b>	<b>62% (34/55)</b>	<b>94%</b>
<b>2003</b>	<b>54</b>	<b>54% (29/54)</b>	<b>100%</b>
<b>2004</b>	<b>50</b>	<b>50% (25/50)</b>	<b>100%</b>
<b>2005</b>	<b>48</b>	<b>60% (29/48)</b>	<b>100%</b>
<b>2006</b>	<b>36</b>	<b>80.5% (29/36)</b>	<b>100%</b>
<b>2007</b>	<b>34</b>	<b>91% (31/34)</b>	<b>100%</b>
<b>2008</b>	<b>35</b>	<b>43% (15/35)</b>	<b>100%</b>
<b>2009</b>	<b>34</b>	<b>44% (15/34)</b>	<b>100%</b>
<b>2010</b>	<b>28</b>	<b>68% (19/28)</b>	<b>89%</b>
<b>2011</b>	<b>28</b>	<b>53.5% (15/28)</b>	<b>80%</b>
<b>2012</b>	<b>29</b>	<b>65.5% (19/29)</b>	<b>79%</b>
<b>2013</b>	<b>30</b>	<b>60% (18/30)</b>	<b>88%</b>
<b>2014</b>	<b>27</b>	<b>81% (22/27)</b>	<b>54%</b>
<b>2015</b>	<b>26</b>	<b>69.23% (18/26)</b>	<b>100%</b>
<b>2016</b>	<b>24</b>	<b>37.5% (9/24)</b>	<b>88%</b>
<b>2017</b>	<b>28</b>	<b>70.4% (19/27)</b>	<b>74%</b>
<b>2018</b>	<b>23</b>	<b>92% (23/25)</b>	<b>91%</b>
<b>2019</b>	<b>28</b>	<b>96.4% (27/28)</b>	<b>78%</b>
<b>2020</b>	<b>29</b>	<b>89.6% (26/29)</b>	<b>84.6% (22/26)</b>

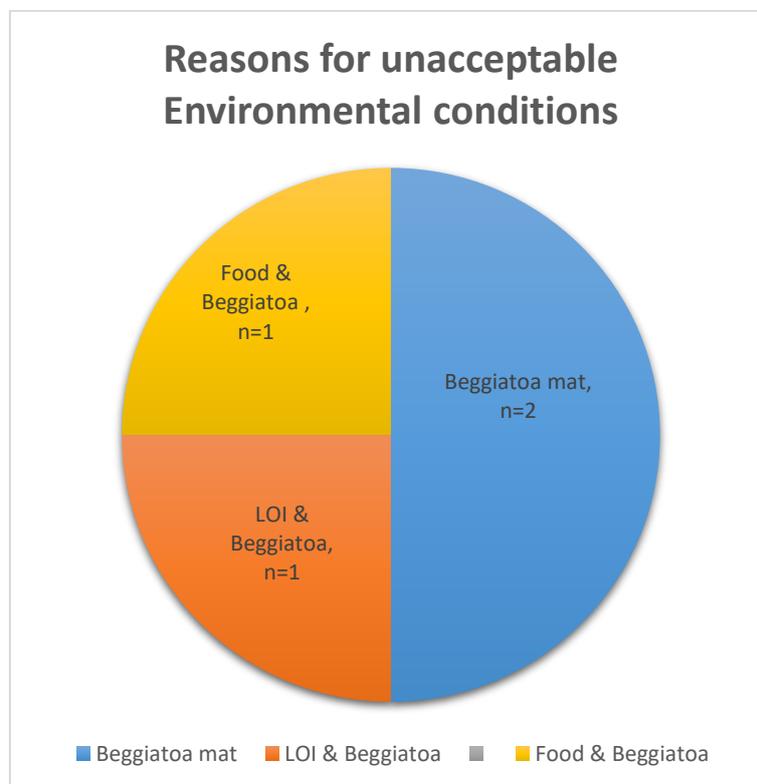
Section 6 presents the review for individual sites submitted during 2020.

In 2020 the reasons for unacceptable environmental conditions were divided into three categories:

- 1) Bacterial mats, e.g., *Beggiatoa* - *Beggiatoa* mat >50% within the AZE or *Beggiatoa* patches present outside AZE.
- 2) *LOI & Beggiatoa* - Percentage Loss on Ignition >100% above the control value within the AZE or control + 25% outside the AZE and *Beggiatoa* mat >50% within the AZE or *Beggiatoa* patches present outside AZE.
- 3) Food & *Beggiatoa*- Excessive waste feed within AZE and *Beggiatoa* mat >50% within the AZE or *Beggiatoa* patches present outside AZE.

Error! Reference source not found. summarises the findings in relation to sites that were non-compliant with environmental standards.

Figure 1: Reasons for unacceptable environmental conditions 2020



It should be noted that in some instances, the LOI did exceed the threshold values either within or outside the AZE. However, these sites were considered of acceptable environmental standards on the basis that, 1) the exceedance was 1% or less, and 2) all other parameters were deemed acceptable. In such instances a weight of evidence approach is applied to the assessment. It is expected that the utilisation of additional control locations would provide greater certainty as it relates to LOI readings.

## 5. Overview and Recommendations for 2020 Audits

The number of sites for which surveys have been completed in 2020 (26/29) is less than that received in 2019 (27/28).

General survey recommendations:

- 1) The MI consider that the use of one reference station per site as recommended in the Benthic Protocol does not enable a robust assessment of ecological effects at finfish farm sites. This deficiency was highlighted by the MI in 2016, when a revised version of the protocol was submitted for review to DAFM. In this revised document it is suggested that a minimum of three reference stations should be used. This would allow for accurate representation of natural variability in unaffected (reference) areas of the site and provide for meaningful comparison of potentially affected areas with reference conditions. The status of this revision is currently uncertain.
- 2) The values of parameters (maximum biomass on site and mean current speed) used to determine the level of survey conducted should be clearly presented and defined. In a number of reports the biomass at time of survey was presented, it is unclear if this is also the maximum biomass licensed for the site.
- 3) The rationale for the selection of location and direction of the survey transect should be clearly communicated in the survey report. It has been noted in some of the survey reports; the direction of the residual current is not reported. This raises questions regarding the suitability of some transects. When transects are chosen to run against the residual current this minimises the potential detection of any likely impact. As clearly identified in the protocols, it is important that transects are located at the areas likely to receive most impact from the cage group. Any deviation from this should be clearly communicated in the report and justified. Direction of residual current should be clearly noted. The residual current is the direction of predicted spatial spread of organic waste over a full production cycle at a fish farm site.
- 4) At the sites considered non-compliant with environmental standards (i.e., not-acceptable) it is recommended that particular attention be paid to stocking densities and feeding regimes in order to minimise the impact observed, subsequent surveys of the site will determine if the management actions have been successful.

## 6. Individual Farm Site Reports and Feedback

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	Murphy's Irish Seafood		
DAFM site code	T05/122		
Species	Salmon		
Date of survey	24 <sup>th</sup> April 2020		
Stocking details	No fish present at time of survey		
Mean bottom current speed	Not reported		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	North to southwest		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	No obvious signs of impact from fish farm.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station range from 6.3cm to 9cm depth. All other stations ranged from 2.9cm to 8.5cm.		
Average %LOI within AZE	3.35	Threshold value within AZE	3.10
Average %LOI outside AZE	2.26	Threshold value outside AZE	1.93
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2013		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T05/233		
Species	Salmon		
Date of survey	25 <sup>th</sup> June2020		
Stocking details	196.2 T on site at time of survey		
Mean bottom current speed	20cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	East to West		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Waste feed under and close to cage within allowable levels.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	ARDP depth at reference station ranged from 4.5cm to 8.2cm. ARDP depth range from 1.1cm to 7.2cm at all other stations.		
Average %LOI within AZE	5.04	Threshold value within AZE	8.26
Average %LOI outside AZE	3.84	Threshold value outside AZE	5.16
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Unacceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T05/444D		
Species	Salmon		
Date of survey	24 <sup>th</sup> April 2020		
Stocking details	1,939.1 T of fish at time of survey. Stocked October 2018.		
Mean bottom current speed	5.9cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	2		
Direction of residual current flow	East to West		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Some waste feed and patches of bacterial mat under the cage. Large number of mobile epifauna.		
Faunal analysis (Level 2 only)	Results of cluster found 3 distinct groupings group a: Under the cage; group b:Edge T1 and T2 group c: all other stations.	Impact from the farm seems to be contained to directly under and to the edge of the cage.	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 1.3cm to 10.9cm. All other stations ranged between 0.0cm and 16.8cm.		
Average %LOI within AZE	5.51	Threshold value within AZE	12.54
Average %LOI outside AZE	4.97	Threshold value outside AZE	7.83
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T05/444E		
Species	Salmon		
Date of survey	23 <sup>rd</sup> April 2020		
Stocking details	752.4 T at times of Survey.		
Mean bottom current speed	5.9 cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	2		
Direction of residual current flow	East-West		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Overall healthy appearance.		
Faunal analysis (Level 2 only)	Two grouping. Group A includes all stations from under the cage to the 20m station on both transects. Group B includes the 50m station on both transects, 100m station and the reference station. This indicates the impact of the farm is limited to 20m from the cage.		
Redox Potential (Relate to control and sediment type)	Variable due to bioturbating species.		
Average %LOI within AZE	5.75	Threshold value within AZE	9.66
Average %LOI outside AZE	4.66	Threshold value outside AZE	6.03
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T06/202		
Species	Salmon		
Date of survey	26 <sup>th</sup> March 2020		
Stocking details	1081.4 T on site at time of survey.		
Mean bottom current speed	30cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	North to South		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Waste feed under and close to cage within allowable levels.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	ARDP depths at the reference station ranged from 4.1cm to 6.7cm. ARDP depth ranged from 0.0cm to 11.1cm at all other stations.		
Average %LOI within AZE	3.60	Threshold value within AZE	5.18
Average %LOI outside AZE	2.61	Threshold value outside AZE	3.23
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	Marine Institute		
<b>DAFM site code</b>	T09/093A		
<b>Species</b>	Salmon		
<b>Date of survey</b>	13 <sup>th</sup> September 2020		
<b>Stocking details</b>	3 T of fish at the site at time of survey.		
<b>Mean bottom current speed</b>	Not reported		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Not reported		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Photographs of very poor quality.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station 3cm. All other stations between 1cm and 2cm depth.		
<b>Average %LOI within AZE</b>	4.19	<b>Threshold value within AZE</b>	4.86
<b>Average %LOI outside AZE</b>	3.87	<b>Threshold value outside AZE</b>	3.03
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Unacceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	MOWI Ireland		
<b>DAFM site code</b>	T09/107		
<b>Species</b>	Salmon		
<b>Date of survey</b>	12 August 2020		
<b>Stocking details</b>	641 T of fish present at time of survey. Stocked October 2019.		
<b>Mean bottom current speed</b>	Not reported		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	East to West		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Some signs of impact from the fish farm such as waste feed, faeces and bacterial mat. All impacts were close to the cage and within the allowable levels of effect.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station range from 0.5 to 6cm depth. All other stations ranged from 0.1cm to 13.5cm.		
<b>Average %LOI within AZE</b>	7.53	<b>Threshold value within AZE</b>	17.52
<b>Average %LOI outside AZE</b>	7.65	<b>Threshold value outside AZE</b>	10.95
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	Bradán Beo Teoranta		
<b>DAFM site code</b>	T09/114A		
<b>Species</b>	Salmon		
<b>Date of survey</b>	21 <sup>st</sup> July 2020		
<b>Stocking details</b>	798 T on site at time of survey		
<b>Mean bottom current speed</b>	0.3ms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Not reported		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Overall healthy appearance.		
<b>Faunal analysis (Level 2 only)</b>	N/A		N/A
<b>Redox Potential (Relate to control and sediment type)</b>	ARDP depths were variable with opportunistic polychaetes seen close to the cage. ARDP depths at the reference station ranged between 2.1cm and 6.7cm. Depths ranged from 0.1cm to 15.3cm at all other stations.		
<b>Average %LOI within AZE</b>	5.33	<b>Threshold value within AZE</b>	5.46
<b>Average %LOI outside AZE</b>	4.70	<b>Threshold value outside AZE</b>	3.41
<b>Overall Assessment of Conditions</b>	Acceptable.		
<b>Previous Assessment</b>	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	Bradán Beo Teoranta		
<b>DAFM site code</b>	T09/136A		
<b>Species</b>	Salmon		
<b>Date of survey</b>	21 <sup>st</sup> July 2020		
<b>Stocking details</b>	All fish harvested by 27 <sup>th</sup> May 2020. Total harvest biomass of just under 1,700 T.		
<b>Mean bottom current speed</b>	20cms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Not reported		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Overall healthy appearance, no sign of excess feed or bacterial mats.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Mean ARPD depth at reference station was 4.5cm compared to an average mean ARPD depth of 3.11cm within the AZE and 2.7cm outside the AZE.		
<b>Average %LOI within AZE</b>	9.06	<b>Threshold value within AZE</b>	14.66
<b>Average %LOI outside AZE</b>	8.20	<b>Threshold value outside AZE</b>	9.16
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	Curraun fisheries Ltd.		
<b>DAFM site code</b>	T09/143		
<b>Species</b>	Salmon		
<b>Date of survey</b>	16 <sup>th</sup> July 2020		
<b>Stocking details</b>	Approximately 370 T of fish present at time of survey.		
<b>Mean bottom current speed</b>	Not reported		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Northwest to southeast		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Some waste feed and dark patches of sediment under the cage.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station range from 0.1 to 7.9cm depth. All other stations ranged from 3.4 to 13.9cm.		
<b>Average %LOI within AZE</b>	11.84	<b>Threshold value within AZE</b>	23.20
<b>Average %LOI outside AZE</b>	10.98	<b>Threshold value outside AZE</b>	14.50
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T09/155		
Species	Salmon		
Date of survey	12 <sup>th</sup> August 2020		
Stocking details	No fish at time of survey		
Mean bottom current speed	23cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	North to south		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Overall healthy appearance.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 1.8cm to 4.2cm. All other stations ranged from 0.5cm to 11.6cm depth.		
Average %LOI within AZE	3.29	Threshold value within AZE	7.02
Average %LOI outside AZE	2.99	Threshold value outside AZE	4.38
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Unacceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	MOWI Ireland		
<b>DAFM site code</b>	T10/054B		
<b>Species</b>	Salmon		
<b>Date of survey</b>	8 <sup>th</sup> May 2021		
<b>Stocking details</b>	Fallow since May 2018		
<b>Mean bottom current speed</b>	0.10-0.12 cms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Northeast to Southwest		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Healthy appearance. No signs of aquaculture practices.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station ranged from 0.5cm to 11.3cm. Stations on T1 and T2 ranged between 0.0cm and 12.7cm.		
<b>Average %LOI within AZE</b>	6.11	<b>Threshold value within AZE</b>	16.10
<b>Average %LOI outside AZE</b>	5.86	<b>Threshold value outside AZE</b>	10.06
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2018		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T10/58A		
Species	Salmon		
Date of survey	21 September 2020		
Stocking details	Stocked March 2020. 719.2 T on site at time of survey.		
Mean bottom current speed	Peak mid-water current 30cms <sup>-1</sup> . Mean mid –water current 12.4cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	East to West		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Overall healthy appearance.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged for 2.5cm to 3.2cm. All stations on T1 and T2 ranged from 0.1cm to 6.4cm.		
Average %LOI within AZE	2.26	Threshold value within AZE	4.04
Average %LOI outside AZE	2.34	Threshold value outside AZE	2.52
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T10/058B		
Species	Salmon		
Date of survey	21 <sup>st</sup> September 2020		
Stocking details	Stocked March 2020. 322.1 T on site at time of survey.		
Mean bottom current speed	Peak mid-water current 21cm s <sup>-1</sup> , mean mid-water current 7.8cm s <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	East to West		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Small patches of bacterial mat seen under the cage, otherwise healthy appearance.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 3.4cm to 5.1cm. Stations on T1 and T2 ranged between 0.0cm and 7.2cm.		
Average %LOI within AZE	2.42	Threshold value within AZE	4.00
Average %LOI outside AZE	2.21	Threshold value outside AZE	2.5
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	MOWI Ireland		
<b>DAFM site code</b>	T10/067A		
<b>Species</b>	Salmon		
<b>Date of survey</b>	8 <sup>th</sup> May 2021		
<b>Stocking details</b>	Fallow since May 2018		
<b>Mean bottom current speed</b>	0.10-0.12 cms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	East to West		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Healthy appearance.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station ranged from 0.5cm to 8.2cm. Stations on T1 and T2 ranged between 0.0cm and 10.8cm.		
<b>Average %LOI within AZE</b>	8.06	<b>Threshold value within AZE</b>	19.44
<b>Average %LOI outside AZE</b>	10.16	<b>Threshold value outside AZE</b>	12.15
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2018		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	MOWI Ireland		
<b>DAFM site code</b>	T12/063A/B		
<b>Species</b>	Salmon		
<b>Date of survey</b>	5 <sup>th</sup> October 2020		
<b>Stocking details</b>	477.8 T of fish on site at time of survey. Stocked October 2019.		
<b>Mean bottom current speed</b>	5.3cms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	East to west		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Patches of dark sediment, waste feed and faeces under and at the edge of the cage, close to exceeding the allowable level of effect.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station ranged from 0.1cm to 9.4cm depth. All other stations ranged from 0.0cm to 9.2cm.		
<b>Average %LOI within AZE</b>	9.85	<b>Threshold value within AZE</b>	14.66
<b>Average %LOI outside AZE</b>	7.33	<b>Threshold value outside AZE</b>	9.16
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T12/085		
Species	Salmon		
Date of survey	15 <sup>th</sup> May 2020		
Stocking details	970.6 T of fish at time of survey. Stocked December 2019.		
Mean bottom current speed	23 cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	North to South		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Overall healthy appearance similar to that of the reference station.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 3.7cm to 7.8cm. All other stations ranged between 3.1cm and 9.2cm.		
Average %LOI within AZE	4.46	Threshold value within AZE	3.55
Average %LOI outside AZE	3.03	Threshold value outside AZE	2.23
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	MOWI Ireland		
<b>DAFM site code</b>	T12/077A		
<b>Species</b>	Salmon		
<b>Date of survey</b>	9 <sup>th</sup> July 2020		
<b>Stocking details</b>	Holding site for brood stock prior to transfer to hatchery. 78 T of fish on site at time of survey.		
<b>Mean bottom current speed</b>	Not reported		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Northeast- southwest		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	Yes	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Extensive cover of bacterial mat under and close to the cage. Waste feed also visible.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	ARDP depth ranged from 0.5 to 16.3cm at the reference. ARDP depths ranged from 0 to 14.7cm at all other stations.		
<b>Average %LOI within AZE</b>	18.30	<b>Threshold value within AZE</b>	39.4
<b>Average %LOI outside AZE</b>	19.06	<b>Threshold value outside AZE</b>	24.62
<b>Overall Assessment of Conditions</b>	Unacceptable – Bacterial mat cover was greater than 50% under the cage on both transects.		
<b>Previous Assessment</b>	Unacceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T12/077C		
Species	Salmon		
Date of survey	14 <sup>th</sup> May 2020		
Stocking details	764.9T at time of survey. Stocked April 2019.		
Mean bottom current speed	15cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	Northeast to southwest		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Small patches of bacterial mat and waste feed in the vicinity of the cage. Large numbers of brittle stars throughout the site.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 2.8 to 7.9cm depth. All other stations ranged from 0.1 to 12.5cm.		
Average %LOI within AZE	3.05	Threshold value within AZE	8.16
Average %LOI outside AZE	2.84	Threshold value outside AZE	5.10
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T12/077D		
Species	Salmon		
Date of survey	9 <sup>th</sup> July 2020		
Stocking details	Stocked January 2019 with 16.2 T before onward transfer. (Holding site for brood stock). No fish at time of survey.		
Mean bottom current speed	Mean surface current speed 2.6ms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	North to South		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Overall healthy appearance. No sign of waste feed or faeces.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	ARDP depth at the reference station ranged from 1 to 9.4cm. All other stations ranged between 0.1 and 15.7cm.		
Average %LOI within AZE	10.36	Threshold value within AZE	13.00
Average %LOI outside AZE	9.16	Threshold value outside AZE	8.12
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T12/77E		
Species	Salmon		
Date of survey	10 <sup>th</sup> June 2020		
Stocking details	No fish on site at time of survey. Fallow since April 2019.		
Mean bottom current speed	Mean mid-water current 2.6cms <sup>-1</sup> Max mid-water current 12.5cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	Not reported		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Patches of dark sediment under the cage.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 10.1cm to 11.8cm depth. All other stations ranged from 0.1cm to 15.3cm.		
Average %LOI within AZE	4.09	Threshold value within AZE	6.20
Average %LOI outside AZE	3.05	Threshold value outside AZE	3.87
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T12/77F		
Species	Salmon		
Date of survey	14 <sup>th</sup> May 2020		
Stocking details	251.5 T at time of survey. Stocked March 2020.		
Mean bottom current speed	Mean mid-water current 3.6cms <sup>-1</sup> Max mid-water current 15.2cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	Not reported		
Accumulated feed within AZE?	Yes	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	Yes	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Bacterial mat and large amounts of waste feed seen under the cage. 10m and beyond didn't show impacts of the fish farm.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 0.5cm to 16.6cm depth. All other stations ranged from 0.0cm to 15.6cm.		
Average %LOI within AZE	19.27	Threshold value within AZE	37.1
Average %LOI outside AZE	18.16	Threshold value outside AZE	23.18
Overall Assessment of Conditions	Unacceptable- Conditions under the cage were above the allowable level of effect.		
Previous Assessment	Acceptable 2019		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	MOWI Ireland		
<b>DAFM site code</b>	T12/77/7		
<b>Species</b>	Salmon		
<b>Date of survey</b>	10 <sup>th</sup> June 2020		
<b>Stocking details</b>	266 T at time of survey. Stocked January 2020.		
<b>Mean bottom current speed</b>	42cms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Northwest to southeast		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	No	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Living and dead Maerl at most stations. Large amount of waste feed under T2 seems to be aggregating around a discarded weight.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	Reference station ranged from 1.9cm to 6.8cm depth. All other stations ranged from 0.1cm to 6.2cm.		
<b>Average %LOI within AZE</b>	2.44	<b>Threshold value within AZE</b>	6.58
<b>Average %LOI outside AZE</b>	2.48	<b>Threshold value outside AZE</b>	4.11
<b>Overall Assessment of Conditions</b>	Acceptable		
<b>Previous Assessment</b>	Acceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	MOWI Ireland		
DAFM site code	T12/096B		
Species	Salmon		
Date of survey	5 <sup>th</sup> October 2020		
Stocking details	No fish on site at time of survey.		
Mean bottom current speed	5.3cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	East to west		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	No	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Patches of dark sediment and bacterial mat under the cage.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	Reference station ranged from 0.5cm to 17.6cm depth. All other stations ranged from 0.0cm to 15.9cm.		
Average %LOI within AZE	12.00	Threshold value within AZE	23.30
Average %LOI outside AZE	12.06	Threshold value outside AZE	14.56
Overall Assessment of Conditions	Acceptable		
Previous Assessment	Unacceptable 2014		

<b>Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring</b>			
<b>Individual Site Review</b>			
<b>Licensed Operator</b>	Ocean Farm Ltd.		
<b>DAFM site code</b>	T12/266		
<b>Species</b>	Salmon		
<b>Date of survey</b>	14 <sup>th</sup> August 2020		
<b>Stocking details</b>	Fallow since July 31 <sup>st</sup> . 363.5 T harvested.		
<b>Mean bottom current speed</b>	10cms <sup>-1</sup>		
<b>Maximum licensed Biomass</b>	Not reported		
<b>Level of Benthic Monitoring</b>	1		
<b>Direction of residual current flow</b>	Southwest-Northeast		
<b>Accumulated feed within AZE?</b>	No	<b>Feed pellets beyond the AZE?</b>	No
<b>Bacterial mat &gt;50% within AZE?</b>	Yes	<b>Bacterial mat outside of AZE?</b>	No
<b>Visual Assessment- Overview</b>	Cover of bacterial mat under the cage and at the edge.		
<b>Faunal analysis (Level 2 only)</b>	N/A	N/A	
<b>Redox Potential (Relate to control and sediment type)</b>	ARDP depths at the reference station ranged from 0.5cm to 5.6cm. All other stations ranged 0cm and 5.5cm.		
<b>Average %LOI within AZE</b>	12.88	<b>Threshold value within AZE</b>	5.48
<b>Average %LOI outside AZE</b>	5.26	<b>Threshold value outside AZE</b>	3.42
<b>Overall Assessment of Conditions</b>	Unacceptable- LOI and bacterial mat exceed allowable thresholds.		
<b>Previous Assessment</b>	Unacceptable 2019		

Monitoring Protocol No. 1 for Offshore Finfish Farms - Benthic Monitoring			
Individual Site Review			
Licensed Operator	Ocean Farm Ltd.		
DAFM site code	T12/276		
Species	Salmon		
Date of survey	14 <sup>th</sup> August 2020		
Stocking details	1080 T on site at time of survey. Stocked October 2019.		
Mean bottom current speed	10cms <sup>-1</sup>		
Maximum licensed Biomass	Not reported		
Level of Benthic Monitoring	1		
Direction of residual current flow	Southwest-Northeast		
Accumulated feed within AZE?	No	Feed pellets beyond the AZE?	No
Bacterial mat >50% within AZE?	Yes	Bacterial mat outside of AZE?	No
Visual Assessment- Overview	Cover of bacterial mat out to 20m station. Dark reduced sediment with waste feed.		
Faunal analysis (Level 2 only)	N/A	N/A	
Redox Potential (Relate to control and sediment type)	ARDP depth ranged from 6.5cm to 18.8cm at the reference station. All other stations ranged from 0cm to 18.2 cm.		
Average %LOI within AZE	7.41	Threshold value within AZE	19.72
Average %LOI outside AZE	8.88	Threshold value outside AZE	12.32
Overall Assessment of Conditions	Unacceptable- Bacterial mat exceeds allowable threshold.		
Previous Assessment	Acceptable 2019		