

Spring Mussel Larvae Monitoring Program- 2016

Contents

Background	2
Sampling location.....	2
Methodology.....	4
Husbandry Maturity Monitoring.....	5
Results.....	7
➤ <i>Details per location</i>	9
Wexford Bar	9
Rusk Channel.....	11
Wicklow.....	13
Castlemaine Harbour	15
2015/ 2016 comparison.....	17
Conclusion.....	21
Appendix:	22

Spring Mussel Larvae Monitoring Program- 2016

Background

Following last year's encouraging results, it was decided to continue the larvae monitoring program for the next three years (2016 to 2018 included), in order to gather as much data variation as possible. The main objective of this program is to establish the amount and the timing of mussel larvae within the vicinity of seed mussel fishing area.

2015 data showed that, in the southeast, larvae are probably mainly produced by mussel stock from Wexford (Large amount of fertilised eggs were observed in a sample on week 18 during last year program). In addition, it was possible to observe a pattern in larvae age through the weeks (growing larvae) as well as possible signs of larvae settlement (steep drop in 3 to 4 week old larvae from one week to the following).

To improve data collection for 2016, it was decided to add husbandry meat yield monitoring, temperature and salinity collection at depth and include an extra station in Castlemaine Harbour (including husbandry monitoring as well). And following last year recommendations, containers were changed to soft plastic to avoid breaks.

Wind directions and strength as well as air and water temperature from the buoy M5, situated on the southeast coast, were also looked at.

Sampling location

Sampling locations in the Irish Sea remains similar to last year's. The additional sampling station in Castlemaine Harbour was located slightly west of Cromane Point, in the channel (see maps).

Sampling Locations Coordinates (WGS 84)

Location	Latitude	Longitude
Wexford Bar	52° 19.741' N	006° 18.351' W
Rusk Channel	52° 28.689' N	006° 12.067' W
South Wicklow	52° 56.799' N	005° 59.171' W
Cromane Point	52° 08.582' N	009° 54.351' W

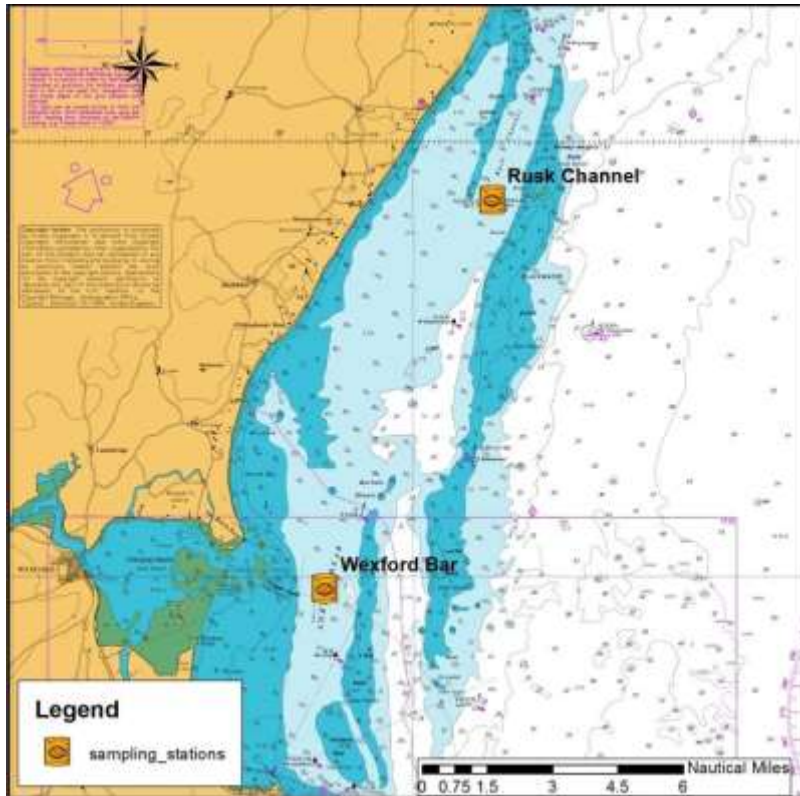


Fig. 1: Sampling Stations Location on the Wexford Coast

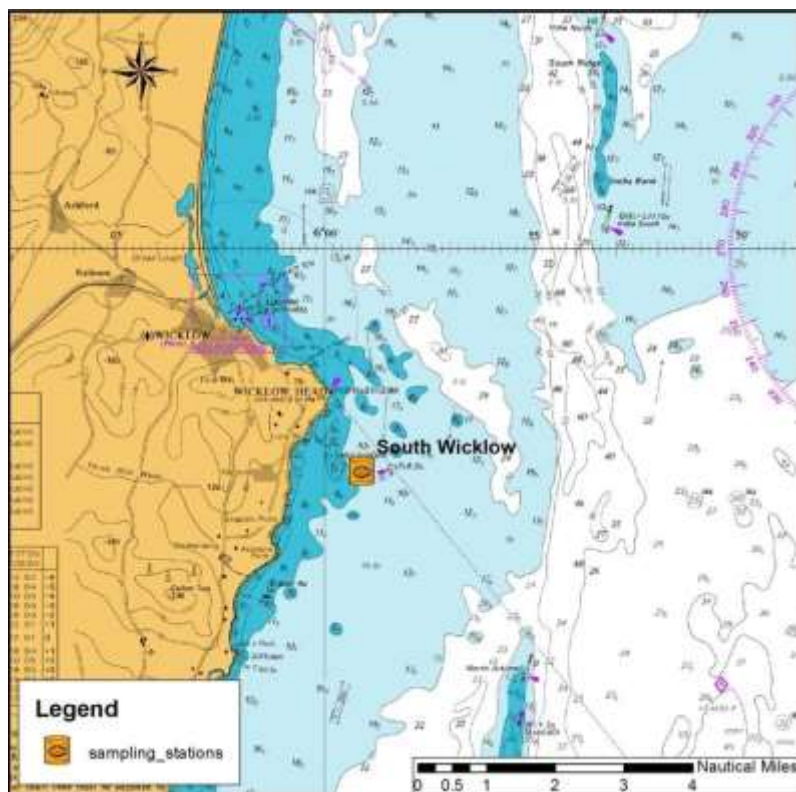


Fig. 2: Sampling Station Location on the Wicklow Coast

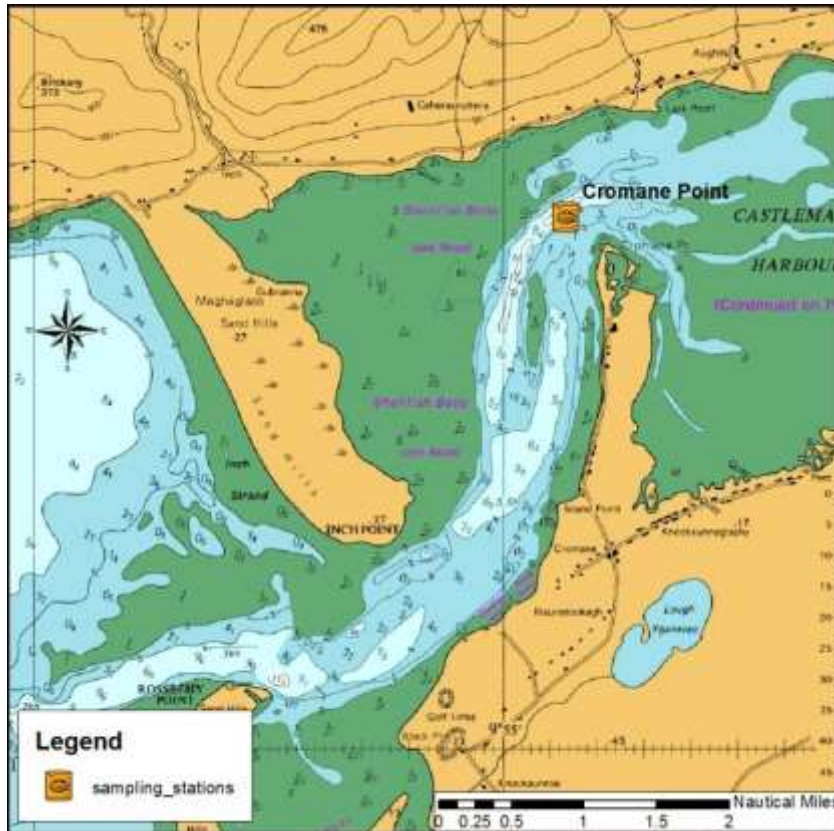


Fig. 3: Sampling Station Location in Castlemaine Harbour

Methodology

Weekly samples were taken from April 11th to July 30th, 2016 (calendar week 13 to week 30) at each location. A Wexford fisherman undertook the sampling for the Wexford Bar and the Rusk Channel while the Wicklow samples were collected by the operator of a local angling charter. A local mussel farmer collected the samples in Castlemaine Harbour.

The samples were collected using a 100µm mesh plankton net weighted at the bottom to allow a vertical haul through the entire water column. The net was deployed within 2 to 3 meters of the seabed and hauled at a slow pace to the surface.

Once on deck, the contents of the net were washed gently into a labelled jar and fixed with Lugol's iodine and sea water. At each location various parameters were recorded:

- Date and time of sampling
- Depth (sounder reading)
- Weather conditions (wind) and sea state
- Water temperature
- Current speed and direction

The samples were then posted and processed a few days after. All the data was recorded on a spreadsheet for analysis (see appendix). The analysis consisted of the identification of mussel larvae within the samples as well establishing an age classification throughout the mussel larvae using the development of the larvae internal organs.

In 2016, the trigger for larvae sampling depended on the husbandry meat yield.

Husbandry Maturity Monitoring

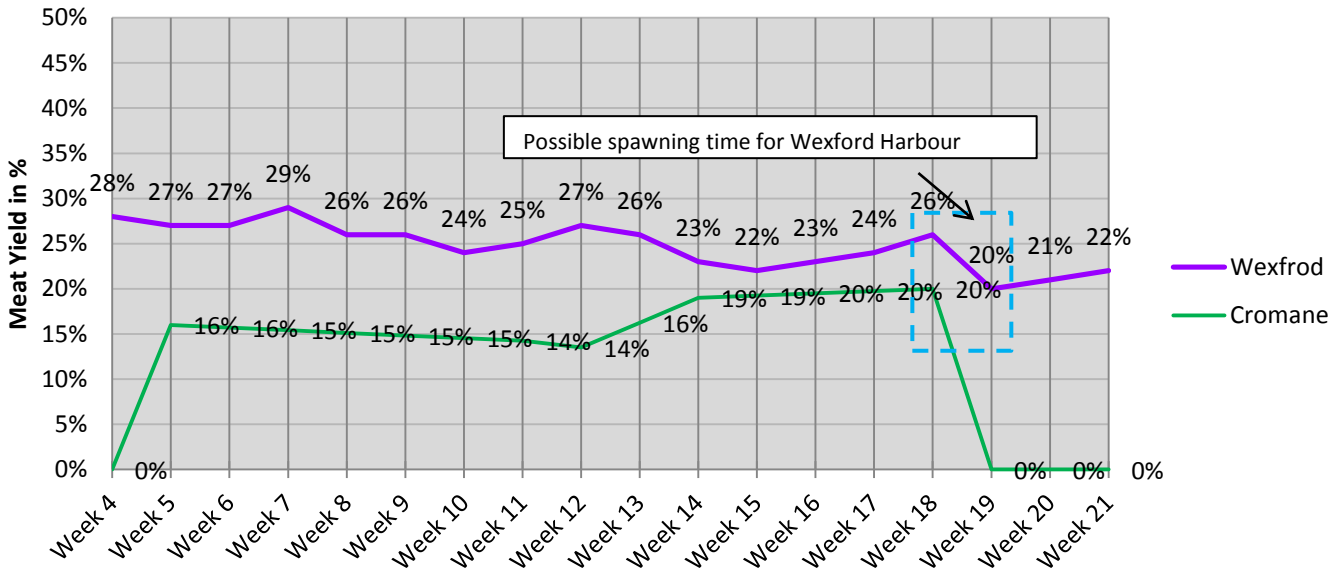
In addition to the larvae sampling, it was decided, in 2016, to monitor the husbandry maturity using meat yield. Ideally, 2 samples were supposed to be collected on bottom mussel farming licences with the help of the local industry in Wexford and Castlemaine. Sampling started on February 5th (week 4) to May 25th (week 21). The samples were collected by the local bottom mussel growers, but due to lack of availability or weather conditions, some samples were missed.

Table 1: Mussel Meat Yield Variation in Wexford Harbour and Castlemaine Harbour from February 5th to May 25th

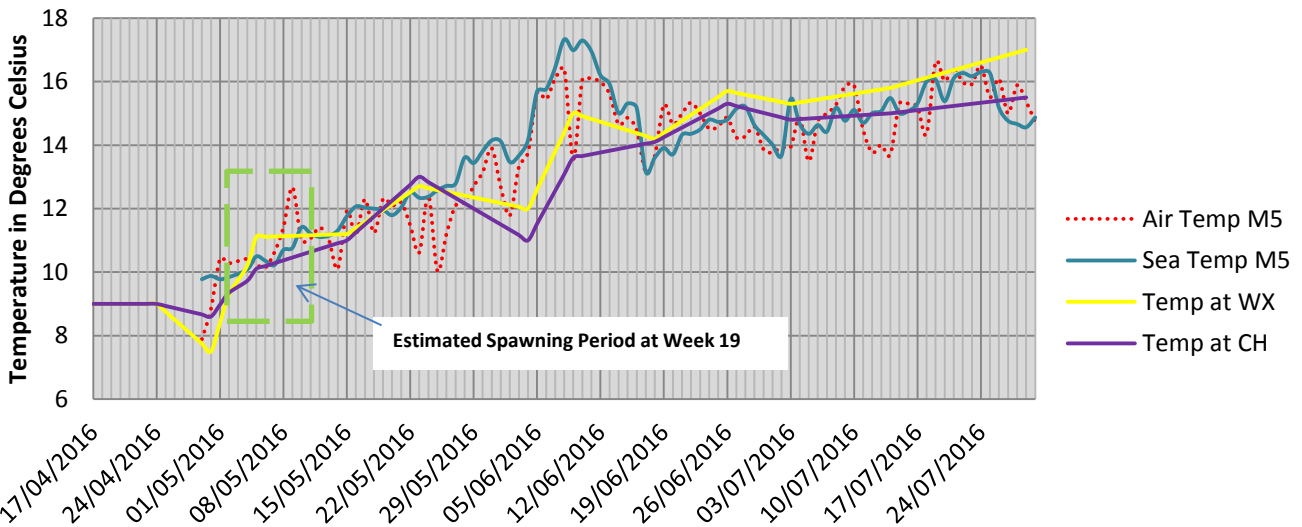
Period	Wexford 1 (mid)	Cromane 1	Wexford 2 (mid)	Date
Week 4	28%	no data		Wx1(5/02/16)
Week 5	27%	16%	21%	Cr1(8/02/2016), Wx2 (11/02/16)
Week 6	27%	16%		Wx1 (12/02/16)
Week 7	29%	15%		Wx1 (19/02/16)
Week 8	26%	15%		Wx1(26/02/2016)
Week 9	26%	15%		Wx1 (4/03/2016)
Week 10	24%	15%		Wx1 (11/03/16)
Week 11	25%	14%		Cr1(15/03/16)
Week 12	27%	14%		Wx1 (22/03/2016), Cr1 (21/03/2016)
Week 13	26%	16%		Wx1 (31/03/2016)
Week 14	23%	19%		Cr1(04/04/16) Wx1(7/04/16)
Week 15	22%	19%		Wx1 (14/04/2016)
Week 16	23%	20%		WX 1 (21/04/2016)
Week 17	24%	20%		Wx1 (28/04/2016)
Week 18	26%	20%		Wx1 (5/05/2016), CR (3/05/2016)
Week 19	20%	no data		Wx1(12/05/2016)
Week 20	21%	no data		Wx1 (19/05/2016)
Week 21	22%	no data		Wx1 25/05/2016)

 No sample, projected values for graph purpose

Mussel Meat Yield For Wexford and Cromane - 2016



Temperature Comparison for Wexford during Sampling Period



Nevertheless, we could observe a 6% drop in Wexford 1 sample between Week 18 and Week 19, and following larvae sample results this would indicate a spawning period (see page 9). In addition, sea temperature showed nearly 4 degrees increase (for Wexford Bar) prior to the possible spawning week. Temperature variation is a known factor that can influence mussel or bivalve spawning. There was less steep temperature variation in Rusk Channel due to its more oceanic situation.

Results

A total of 50 samples were collected. Only 3 samples at the Wexford Bar and 2 in The Rusk were missed due to bad weather conditions, 100% of the samples were collected in Castlemaine, but only 5 samples on 16 were collected in Wicklow.

With the change of container type in 2016, no sample was lost due to damage container.

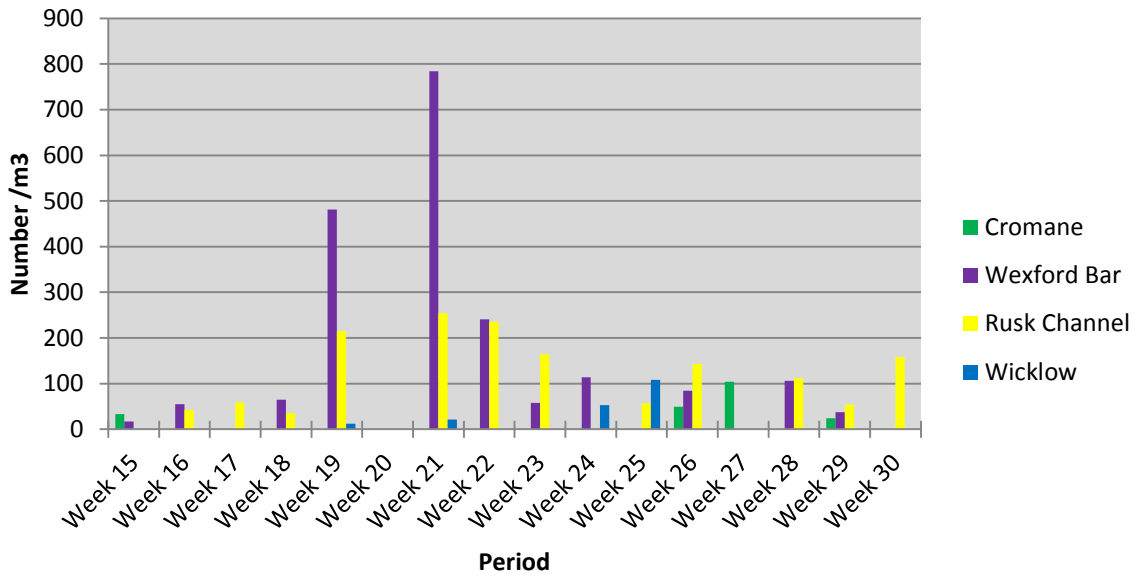
In addition to larvae sampling, operators were provided with an Oxyguard Temperature and Salinity probe with 6 m cable to measure data at sampling depth.

Table 2: Global Larvae Population per Samples and Location in Number/ m³

Period	Wexford Bar	Rusk Channel	Wicklow	Cromane
Week 15	17	0	NS	33
Week 16	55	42	0	0
Week 17	0	59	NS	0
Week 18	65	35	NS	0
Week 19	481	215	12	0
Week 20	NS	NS	NS	0
Week 21	784	254	21	0
Week 22	241	235	0	0
Week 23	58	164	NS	0
Week 24	114	0	53	0
Week 25	NS	57	108	0
Week 26	84	143	NS	49
Week 27	NS	NS	NS	104
Week 28	106	112	NS	0
Week 29	37	54	NS	24
Week 30	0	158	NS	0
NS - No sample	3	2	10	0

As last year, five classes were defined in the larvae population: less than 1 week old, D-Larvae 1-2 weeks old, D-larvae 2-3 weeks old, D-larvae 3-4 old and finally D-Larvae over 4 weeks old.

Global Mussel Larvae Population per Location



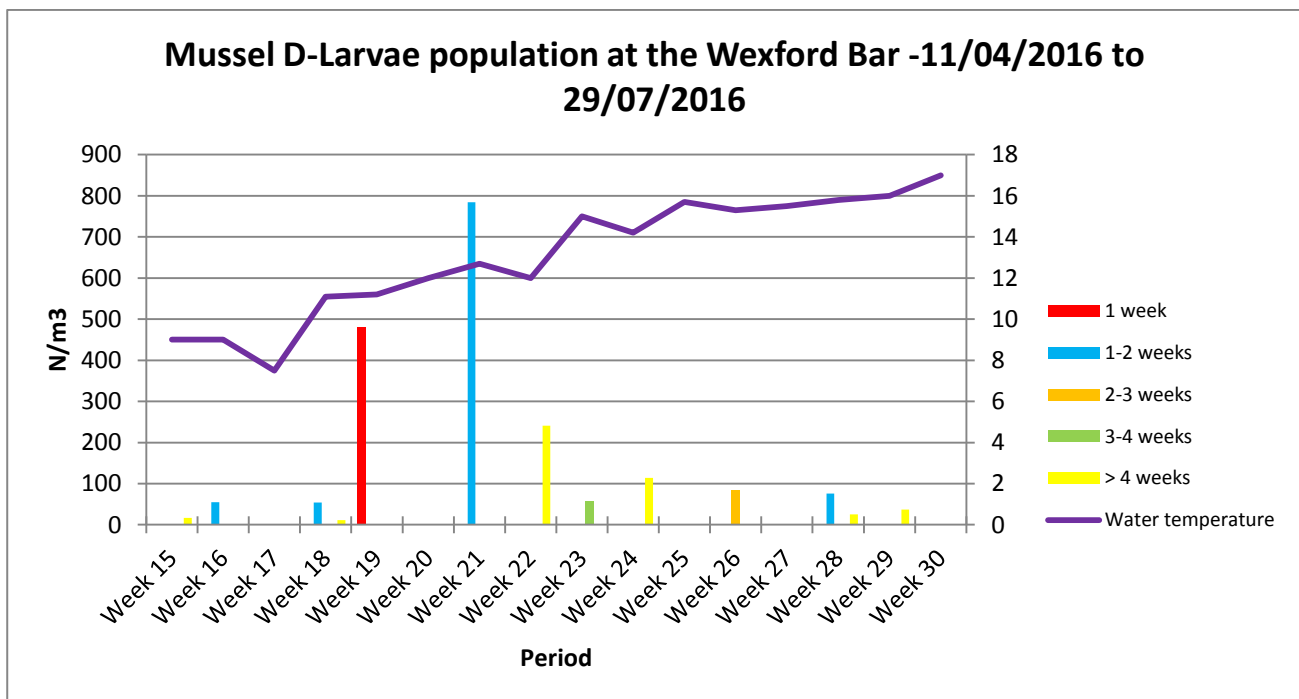
➤Details per location

Wexford Bar

Table 3: D-Larvae Population at the Wexford Bar (Number/ m³)

Period	1 week	1-2 weeks	2-3 weeks	3-4 weeks	> 4 weeks	Water temperature	Total larvae/ week	
Week 15	481				17	9	17	
Week 16		55				9	55	
Week 17						7.5	*0	
Week 18		54				11.1	65	
Week 19		11.2				481		
Week 20		12				NS		
Week 21		784				12.7	784	
Week 22						241	12	241
Week 23					58		15	58
Week 24						114	14.2	114
Week 25							15.7	NS
Week 26				84			15.3	84
Week 27							15.5	NS
Week 28			76			25	15.8	76
Week 29						37	16	37
Week 30							17	*0

* No larvae in the sample / NS-No sample



The larvae population at the Wexford Bar was very low for the first 4 weeks, which indicate that, although some spawning had taken, the bulk of the mussel hadn't. The first spike occurred within a week of the estimated major spawning (between Week 18 and Week 19 according to meat yield analysis); where over 450 larvae per m³ were observed (around 1 week old larvae).

This episode was followed on week 21 by a major spike in the population (over 750 larvae per m³) of 1 to 2 weeks old larvae.

Although we can observe a possible settlement between week 22 and week 24 (more than 50% drop in the 3 to 4 weeks old larvae); it seems that the bulk of the larvae travelled further (no large population of the older class).



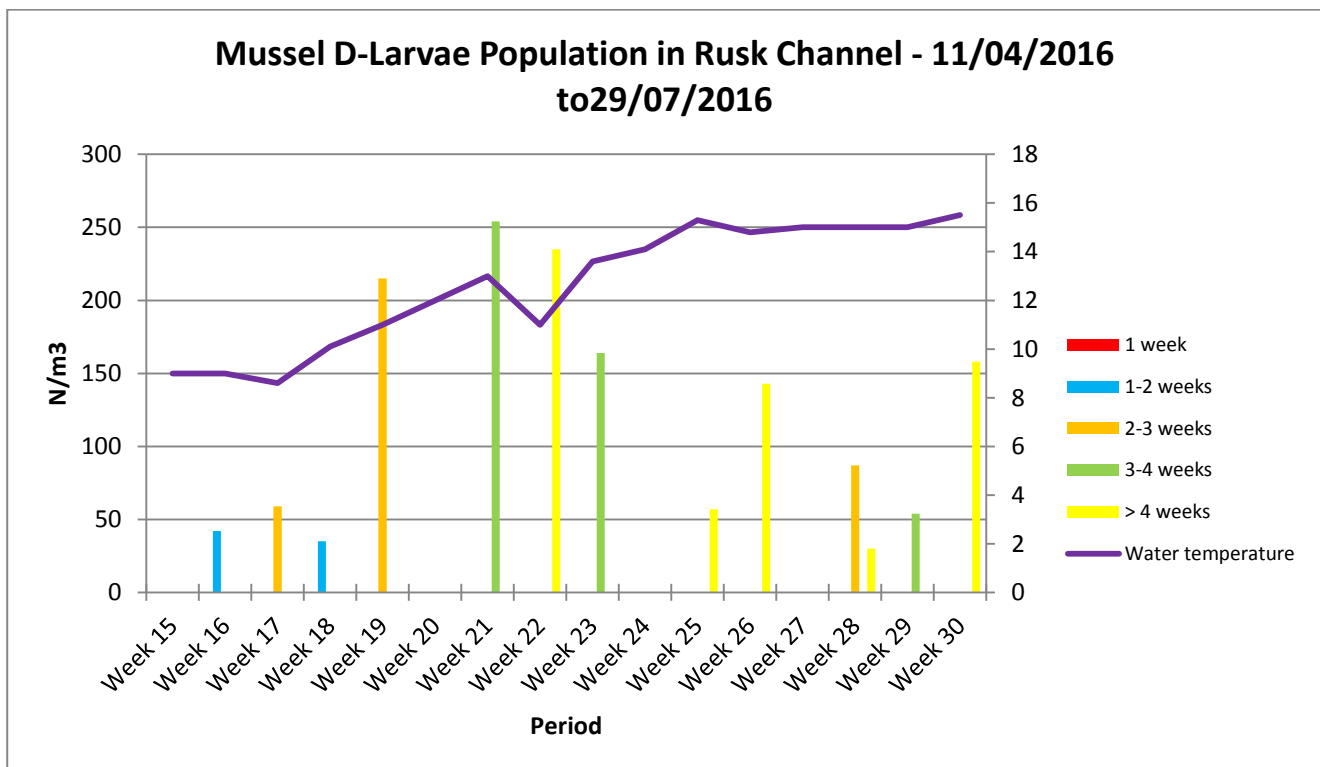
Fig.4: Seed Mussel from The Bar Buoy Bed – August 2016

Rusk Channel

Table 4: D-Larvae Population in the Rusk Channel (Number/ m³)

Period	1 week	1-2 weeks	2-3 weeks	3-4 weeks	> 4 weeks	Water temperature	Total larvae/ week
Week 15						9	*0
Week 16		42				9	42
Week 17			59			8.6	59
Week 18		35				10.1	35
Week 19			215			11	215
Week 20						12	NS
Week 21				254		13	254
Week 22					235	11	235
Week 23				164		13.6	164
Week 24						14.1	*0
Week 25					57	15.3	57
Week 26					143	14.8	143
Week 27						15	NS
Week 28			87		30	15	87
Week 29				54		15	54
Week 30					158	15.5	158

* No larvae in the sample / NS-No sample



As for the Wexford Bar station, only small amount of larvae were observed until Week 19 when over 200 larvae per m³ were found. The larvae were aged of 2 to 3 weeks old, which means that they were coming from an earlier spawning than the one observed on the husbandry monitoring.

According to the graph, we can assume that those larvae stayed within the Rusk channel until they settled: we can see that the number of larvae is similar during Week 19, 21 and 22 although the age category is changing. A similar phenomenon seemed to have happened between Week 23 and 25 as well as through the last three weeks but to a lesser extent.

Those various settlements were confirmed by the samples taken during the seed mussel survey which took place in August 2016.



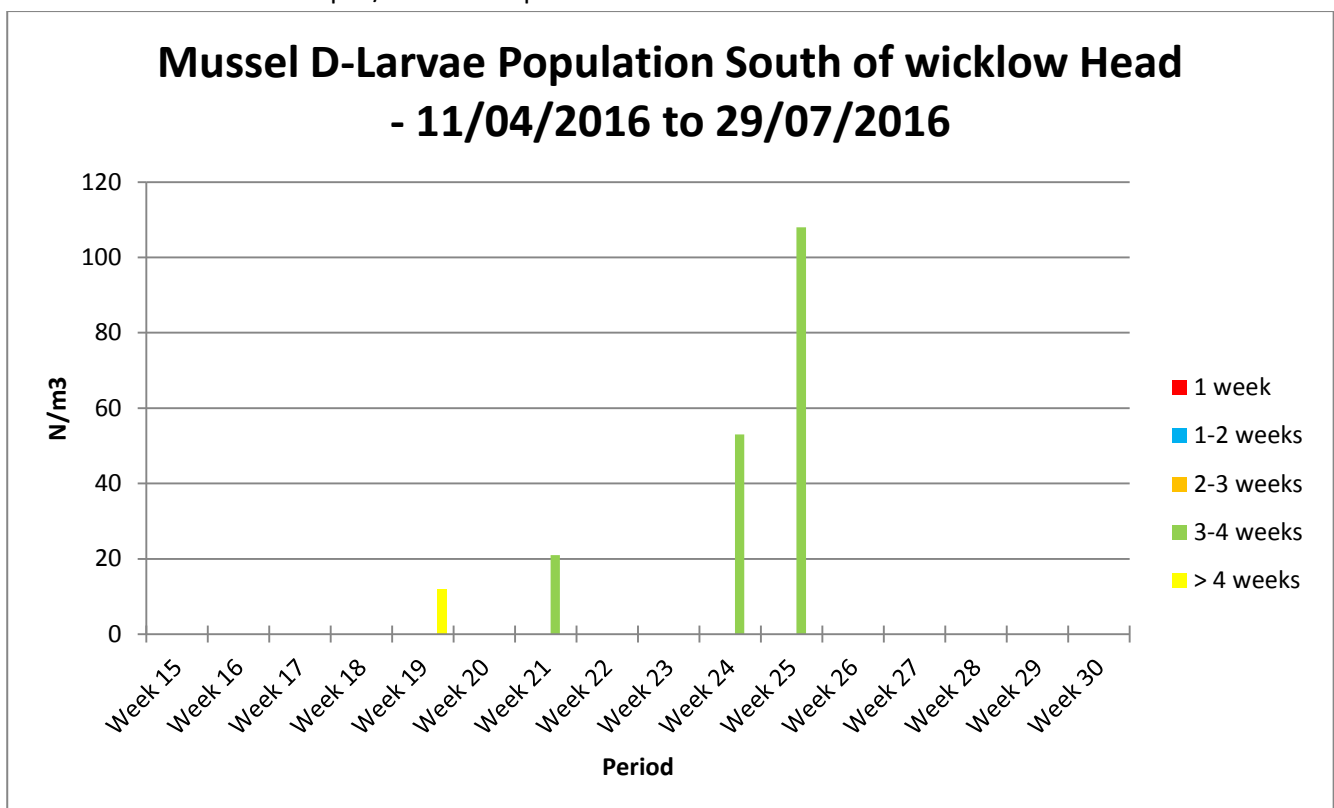
Fig.5: Underwater Footage of the Seed Mussel in the Rusk Channel

Wicklow

Table 6: D-Larvae Population South of Wicklow Head (Number/ m³)

Period	1 week	1-2 weeks	2-3 weeks	3-4 weeks	> 4 weeks	Water temperature	Total larvae/ week
Week 15							NS
Week 16							NS
Week 17							NS
Week 18							NS
Week 19					12	10	12
Week 20							NS
Week 21				21		12.2	21
Week 22							*0
Week 23							NS
Week 24				53			53
Week 25				108			108
Week 26							NS
Week 27							NS
Week 28							NS
Week 29							NS
Week 30							NS

* No larvae in the sample / NS-No sample

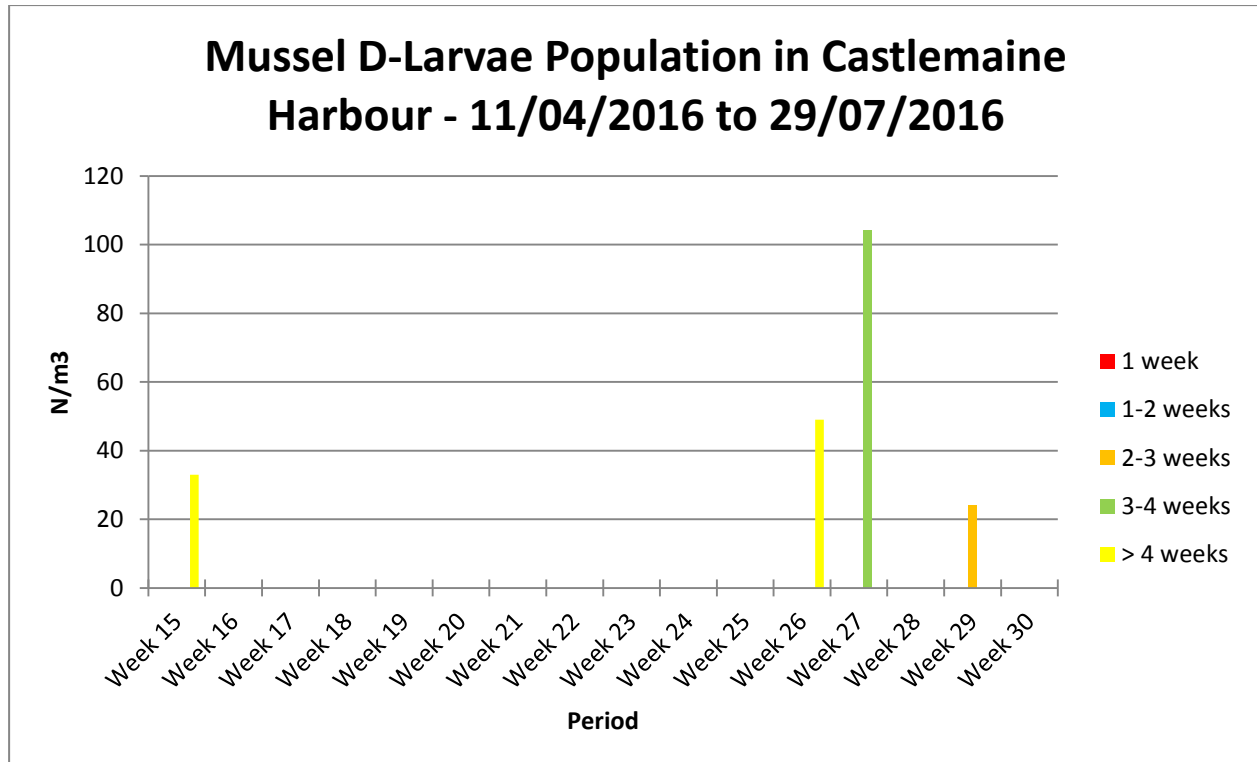


Due to the lack of sampling in Wicklow in 2016, it is difficult to make any observations. Although larvae were found on Week 25 in reasonable quantity (over 100 larvae per m³), the lack of followed up sample and the lack of seed mussel bed observation around Wicklow for 2016 make it difficult to form any opinion. Very small quantity of new seed was found mixed up with overwinter half-grown mussel.

Castlemaine Harbour

Table 7: D-Larvae Population in Castlemaine Harbour (Number/ m³)

Period	1 week	1-2 weeks	2-3 weeks	3-4 weeks	> 4 weeks	Total larvae/ week
Week 15					33	33
Week 16						0
Week 17						0
Week 18						0
Week 19						0
Week 20						0
Week 21						0
Week 22						0
Week 23						0
Week 24						0
Week 25						0
Week 26					49	49
Week 27				104		104
Week 28						0
Week 29			24			24
Week 30						0



This was the first year that the larvae monitoring program was extended to Castlemaine Harbour. Although, meat yield in mussel were monitored, it seems that the spawning took place before and after it was ever identified in the samples.

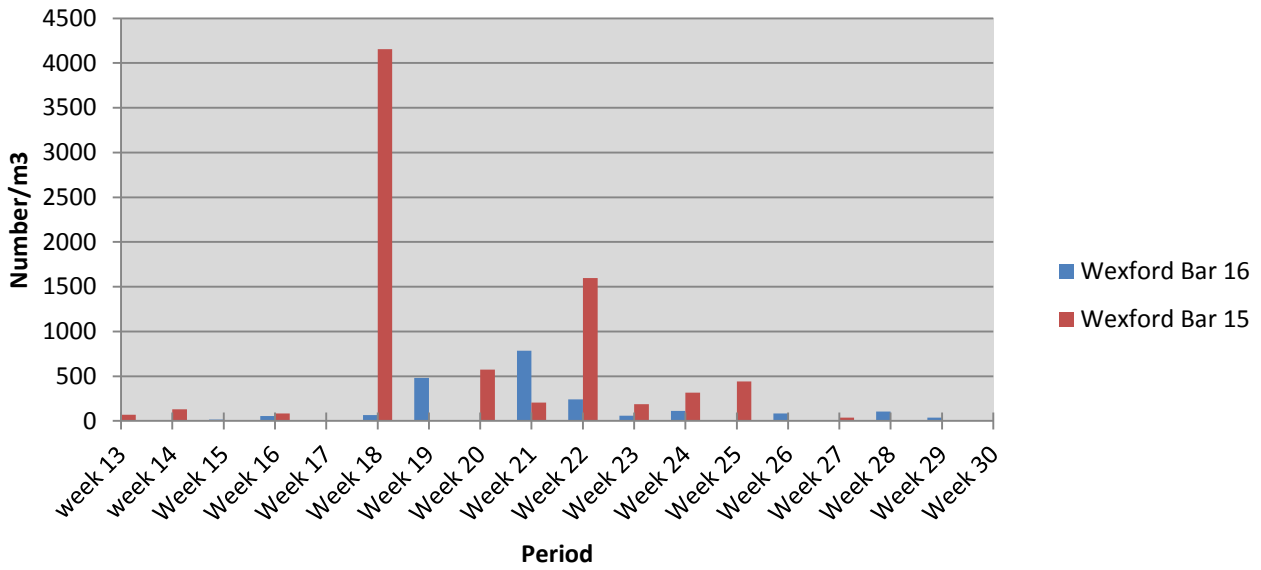
During most of the sampling, no larvae were found, which correspond as well to what has been observed during the seed mussel survey when no settlement were found. Very young spat was observed on seaweed and bryozoans but only in very small quantities compared to previous years.

2015/ 2016 comparison

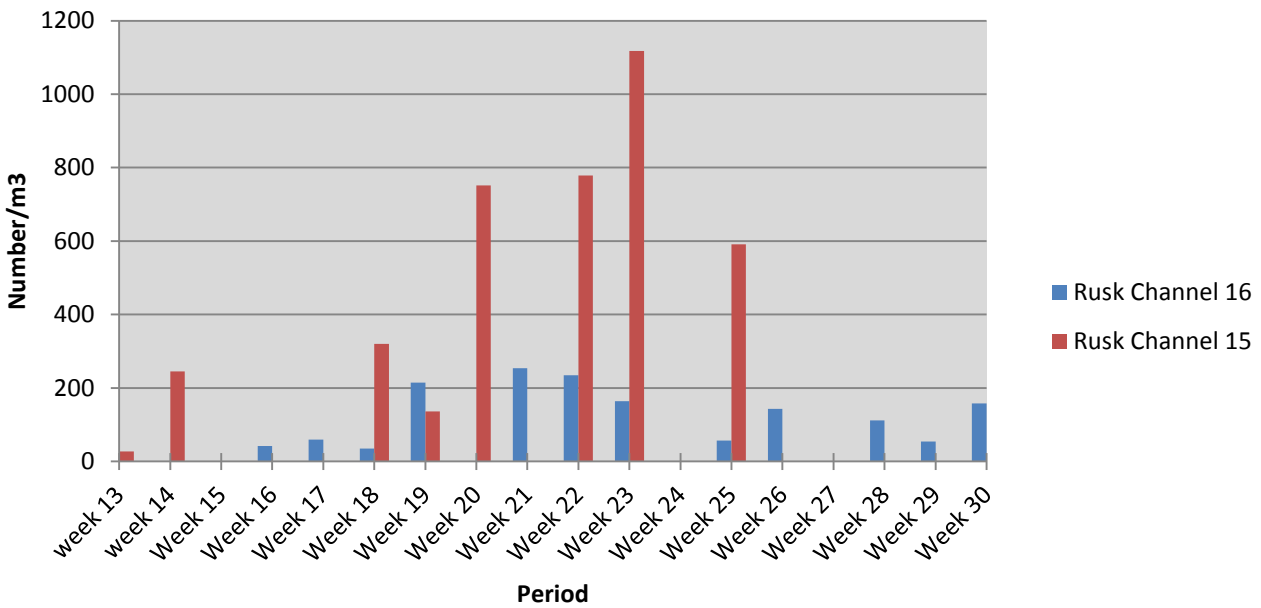
Table 8: D-Larvae Population in the Various Sampling Station in 2015 and 2016 (Number/ m³)

Period	Wexford Bar 16	Rusk Channel 16	Wicklow 16	Wexford Bar 15	Rusk Channel 15	Wicklow 15
week 13				68	27	0
week 14				132	245	NS
Week 15	17	0	NS	NS	NS	340
Week 16	55	42	0	83	0	NS
Week 17	0	59	NS	NS	NS	NS
Week 18	65	35	NS	4156	320	277
Week 19	481	215	12	0	136	0
Week 20	NS	NS	NS	574	752	59
Week 21	784	254	21	204	NS	33
Week 22	241	235	0	1596	779	56
Week 23	58	164	NS	186	1118	0
Week 24	114	0	53	317	NS	NS
Week 25	NS	57	108	442	591	NS
Week 26	84	143	NS	NS	NS	47
Week 27	NS	NS	NS	37	NS	52
Week 28	106	112	NS			
Week 29	37	54	NS			
Week 30	0	158	NS			
NS - No sample	3	2	10	3	6	5

Wexford Bar 16 vs Wexford Bar 15



Rusk Channel 16 vs Rusk Channel 15



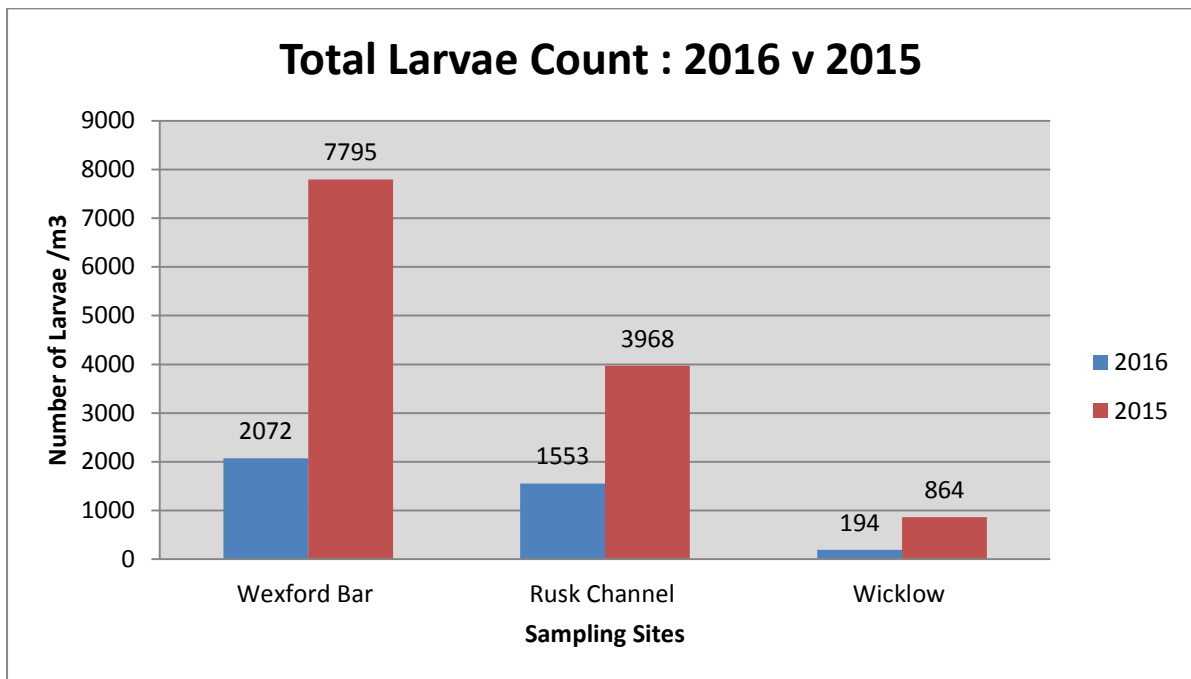
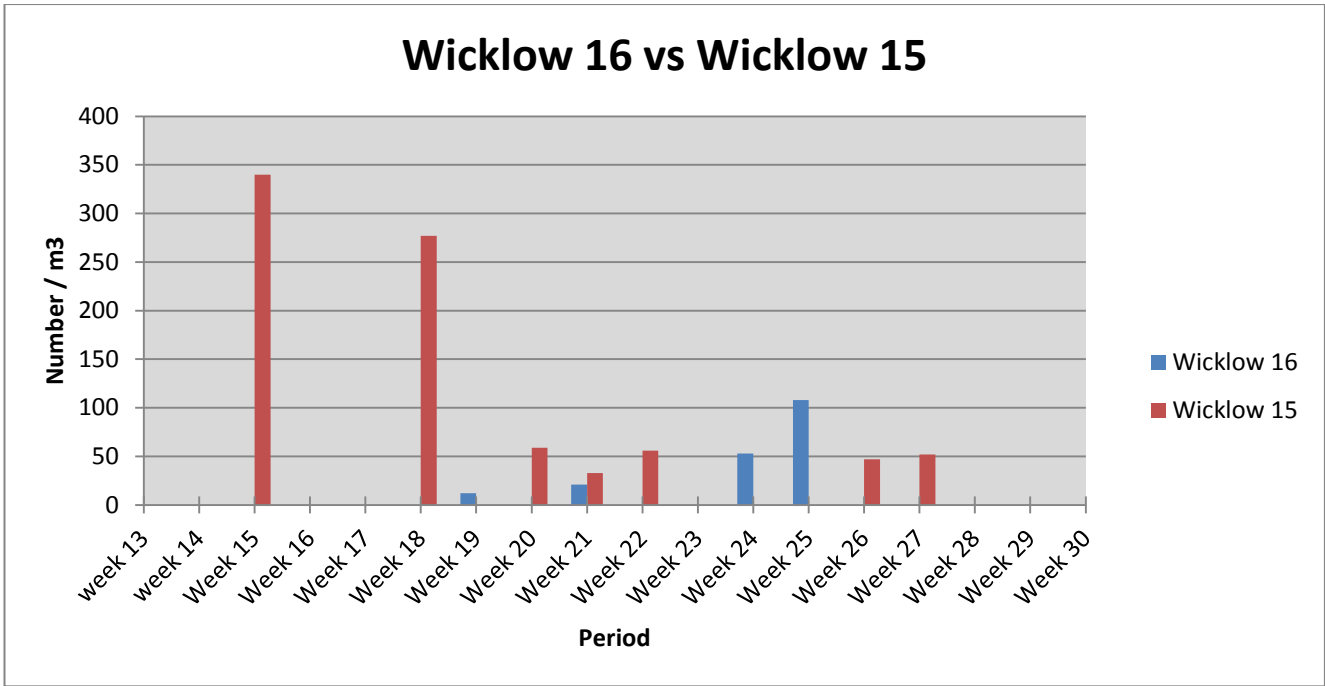
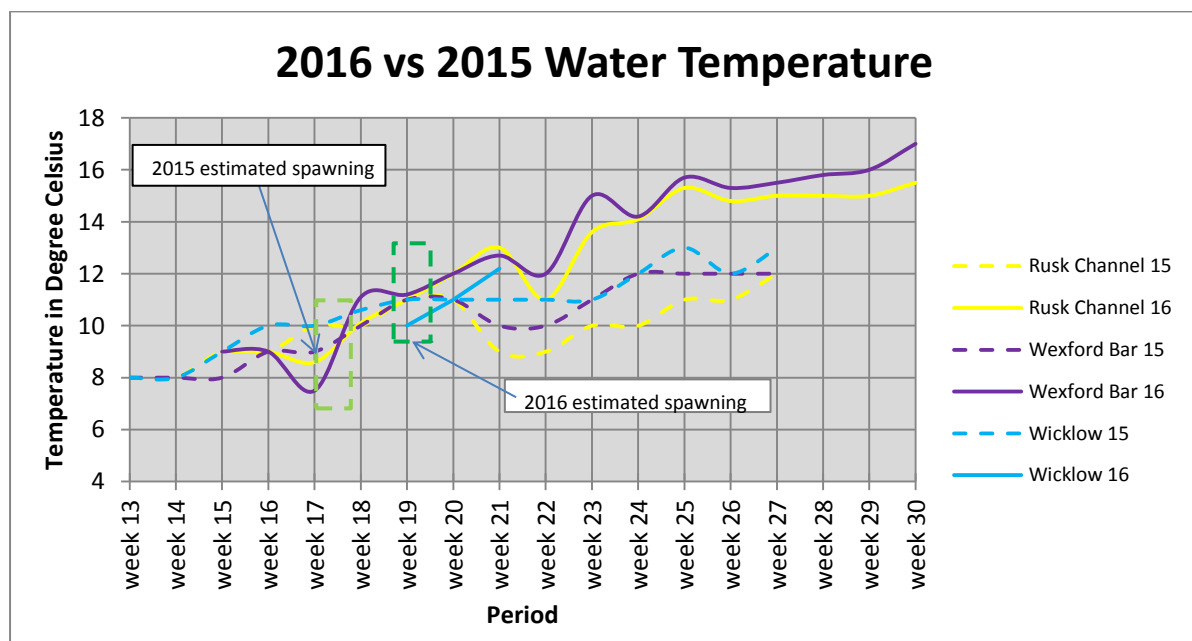


Table 9: Total Larvae Population per Sites in 2015 and 2016 (Number/ m³)

Year	Wexford Bar	Rusk Channel	Wicklow
2016	2072	1553	194
2015	7795	3968	864
<i>Difference</i>	<i>5723</i>	<i>2415</i>	<i>670</i>
<i>Percent drop</i>	<i>73%</i>	<i>61%</i>	<i>77%</i>

When comparing the amount of larvae between 2015 and 2016 for each station, we can see that there was a lot less larvae in the water column in 2016 than in 2015. In all cases, various factors affect those results:

- There were only few samples taken in Wicklow in 2016 in comparison with 2015 (from 10 in 2015 to 6 in 2016).
- The blastula bloom at the Wexford Bar in 2015 (week 18) wasn't observed in 2016.
- The amount of larvae was less in the Rusk in 2016, translating in less mussel beds found (4 beds found in 2015, only 2 in 2016). This probably due to current and weather dispersing larvae toward the south (a dense settlement was found in the South Shear next to Rosslare).



In the above graph, we can observe as well that the estimated main spawning time in Wexford Harbour was nearly two weeks later in 2016:

- The blastula spike in 2015 on week 18 which means probable spawning between week 16 and week 17.
- The brood stock meat yield drop between week 18 and week 19 in 2016, which means viable eggs, would have appeared on week 20.

At the temperature level, we observed that until Week 19, the water temperature is at a similar level in 2015 and 2016. In 2015, the water temperature in the sampling period didn't go above 12 degrees Celsius; as per 2016, we can observe a steep increase of 3 degrees (12 to 15°C) over 3 weeks (from Week 20 to Week 23). The difference between 2015 and 2016 went as far as an extra 4°C during Week 25. Higher water temperature during larvae development can increase growth¹ and therefore with larger larvae settling on the seabed, there chance of survival could be increased.

¹ Hayhurst, Susan, "The Effects of Temperature on the Survival, Growth and Development of Larvae of Two Blue Mussel Species (*Mytilus edulis* and *Mytilus trossulus*)" (2001). *Electronic Theses and Dissertations*. Paper 145.

Conclusion

By including brood stock and water temperature monitoring, we were able to correlate the spawning time and the observation of the larvae on the various sites. As per 2015, it is possible to establish some kind of pattern in the larvae dispersal and although the Rusk Channel is a very dynamic location with strong current, larvae seemed to stay within the location, which was confirmed by the formation of a large seed mussel bed in the channel.

The seed settlement in Rosslare could be resulting of change of wind direction and strong ebb tidal current (south to southwest direction in this part of the Irish Sea) at the time the larvae came out of Wexford Harbour. Indeed, larvae were observed last year on a sample taken in the South Shear (Rosslare).

The settlement at the Bar Buoy probably resulted from a neap tide at the time of the larvae release.

A solution has to be found for Wicklow to avoid a repetition of this year as well as for Castlemaine. Brood stock monitoring should probably start earlier for Castlemaine and probably extent longer too due to the likeliness of this year's phenomenon.

Although the amount of larvae this year is nearly 70% lower than 2015, it seems that the quantity of seed and its quality is higher than 2015 (from seed mussel surveys), this could be due to higher water temperature. This will be confirmed or dismissed following the 2016 seed mussel final tonnage.

Two of the improvement required from last year's report (change of container and salinity and temperature probe) were put in place and made a considerable difference. No sampling station could have been established in Rosslare unfortunately, due to logistics with the local operator.

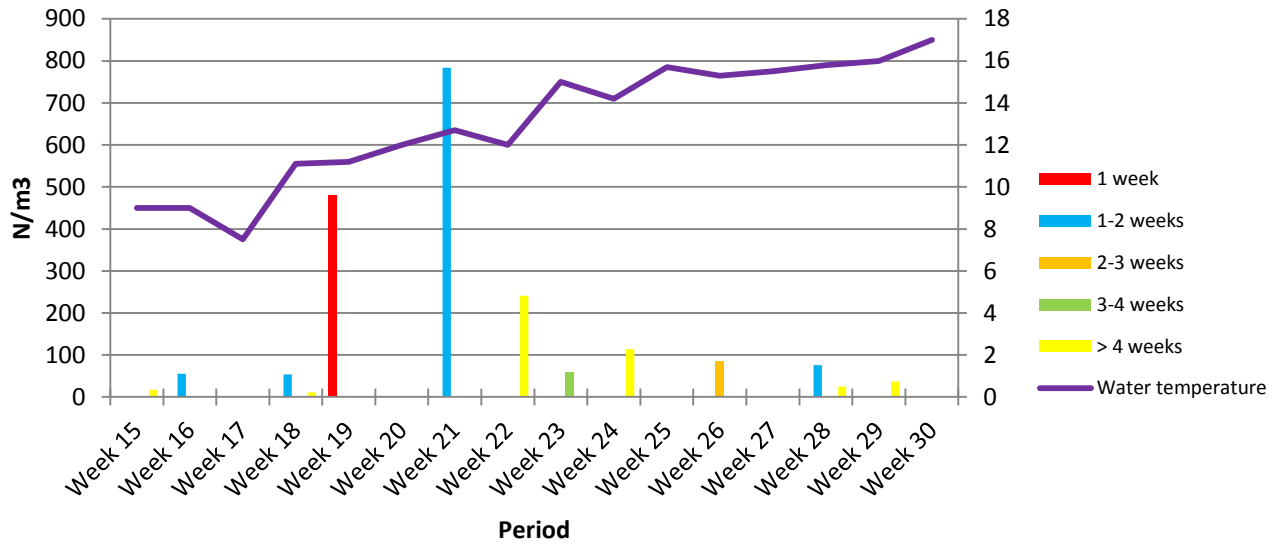
Improvements for 2017:

- Resolve the problem in Wicklow and Castlemaine
- Introduce a new station in Malahide following the discovery of a large intertidal brood stock in the estuary.
- Possible deployments of GPS buoys with drogues during spawning time, to be able to track the larvae on the coast.

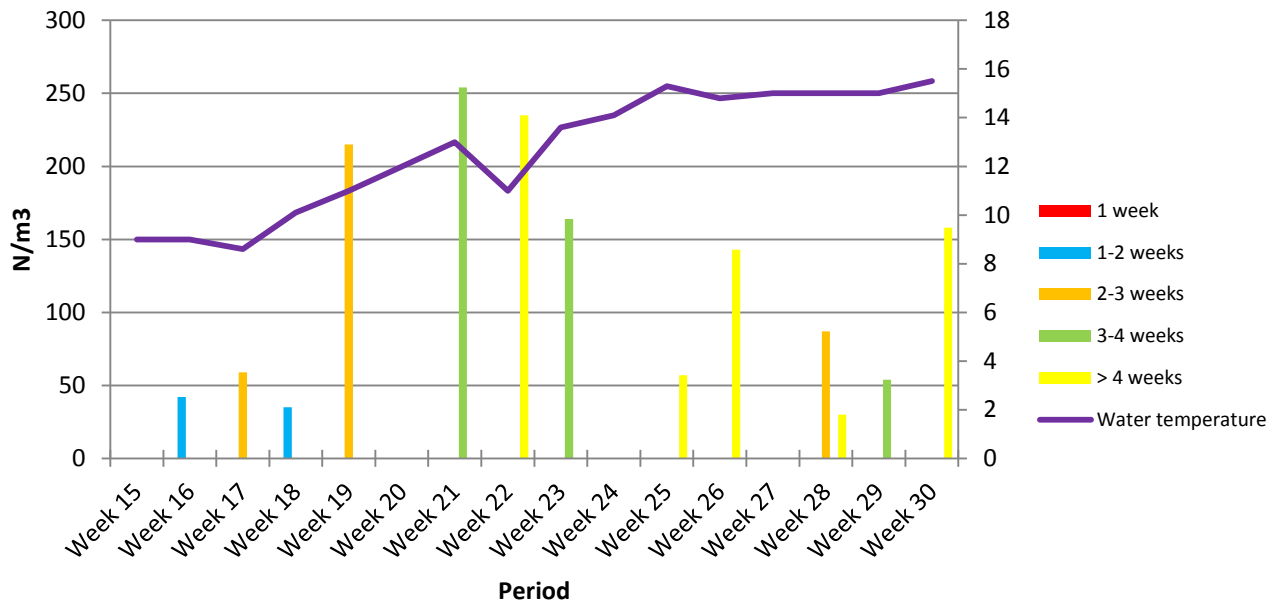
Appendix:

- Graphs
- Data collection Sheet
- Weather graphs

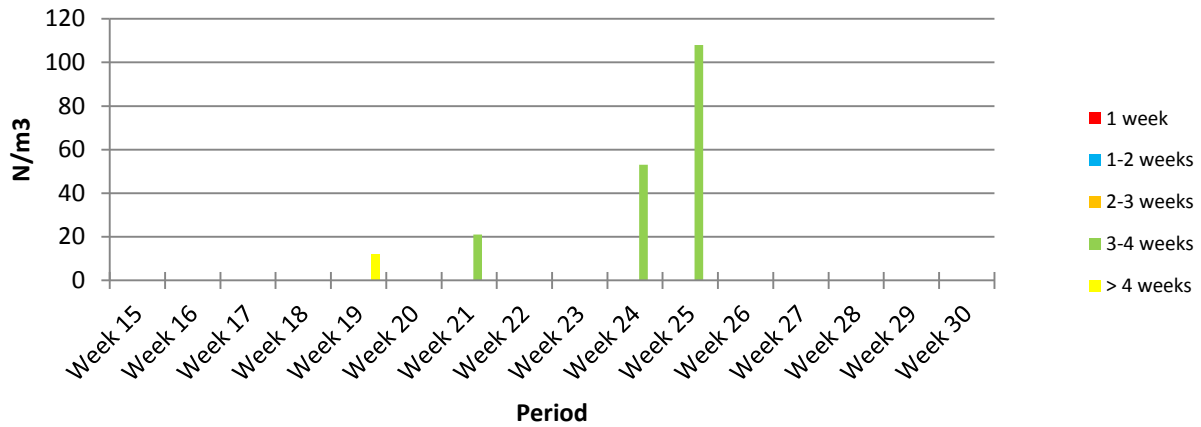
Mussel D-Larvae population at the Wexford Bar -11/04/2016 to 29/07/2016



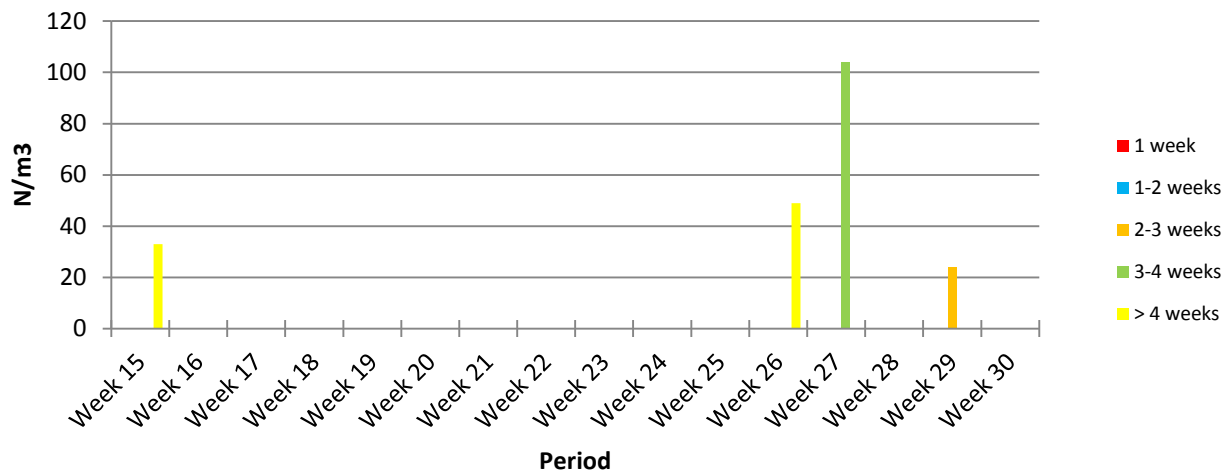
Mussel D-Larvae Population in Rusk Channel - 11/04/2016 to 29/07/2016



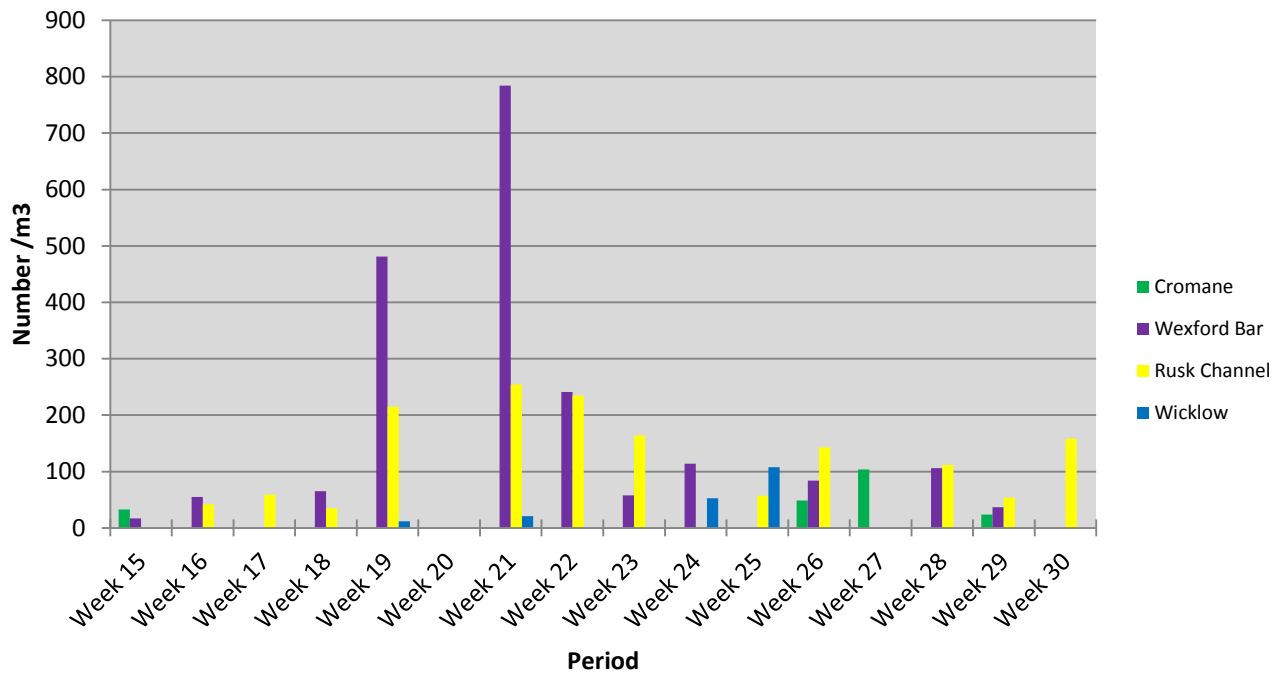
Mussel D-Larvae Population South of wicklow Head - 11/04/2016 to 29/07/2016



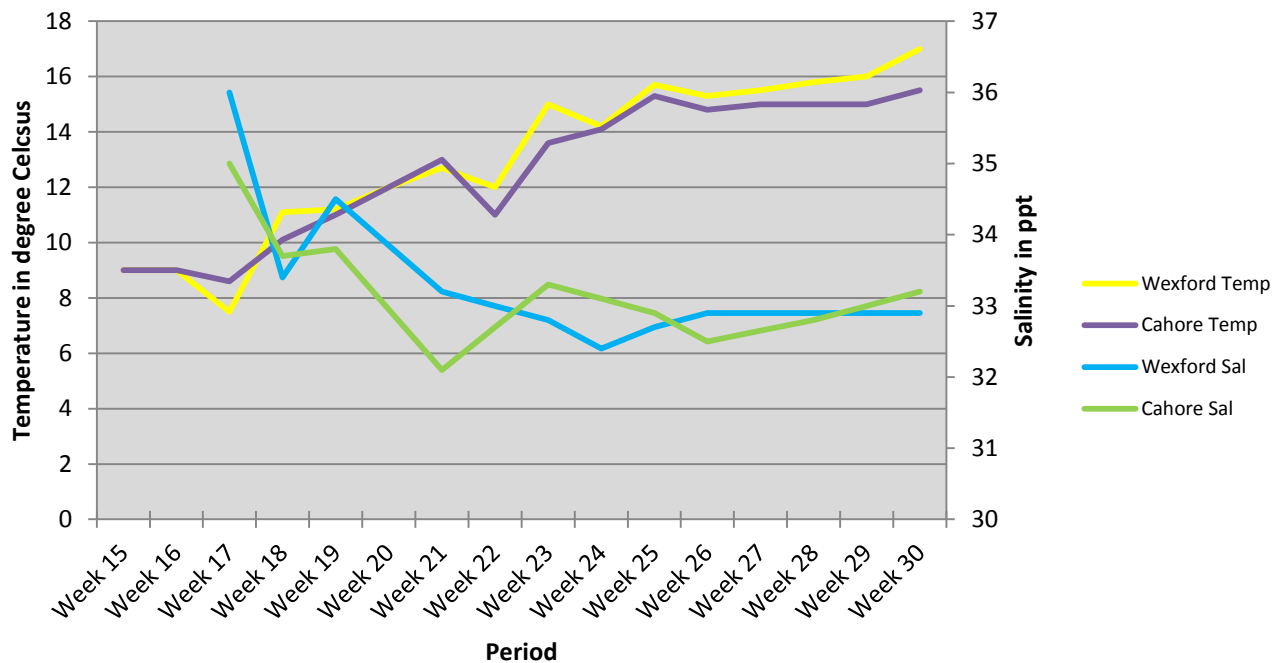
Mussel D-Larvae Population in Castlemaine Harbour - 11/04/2016 to 29/07/2016

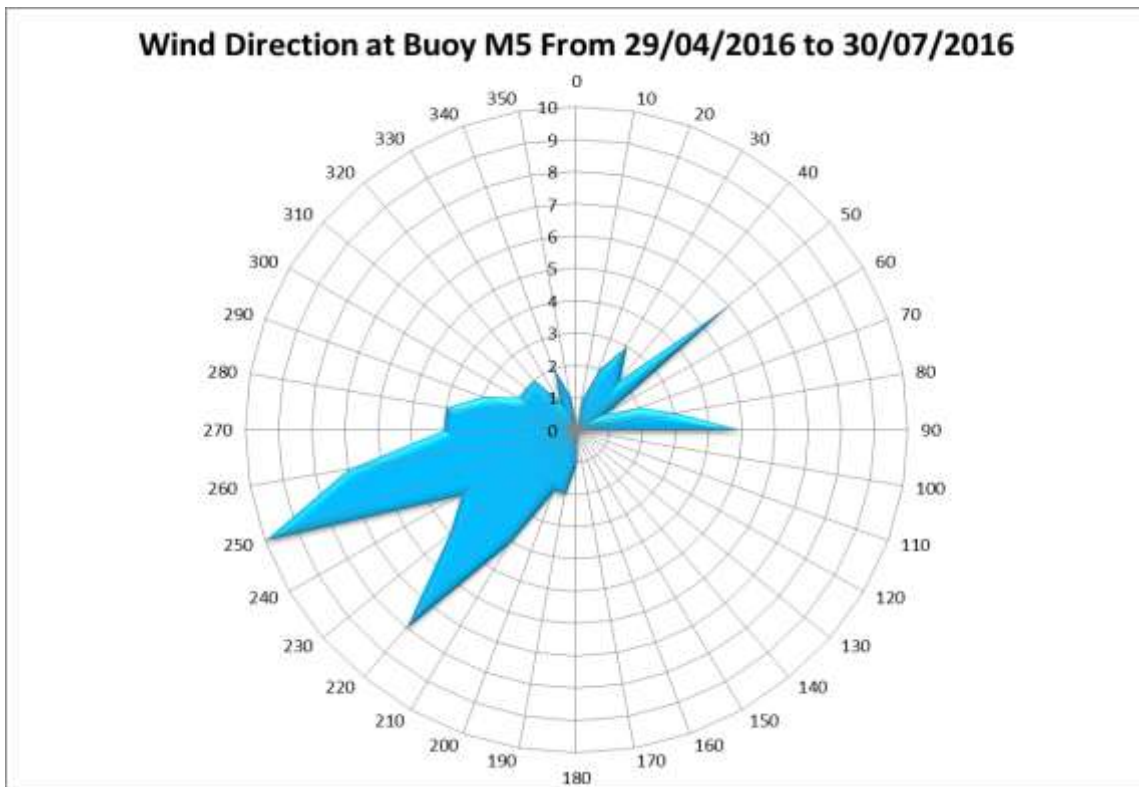
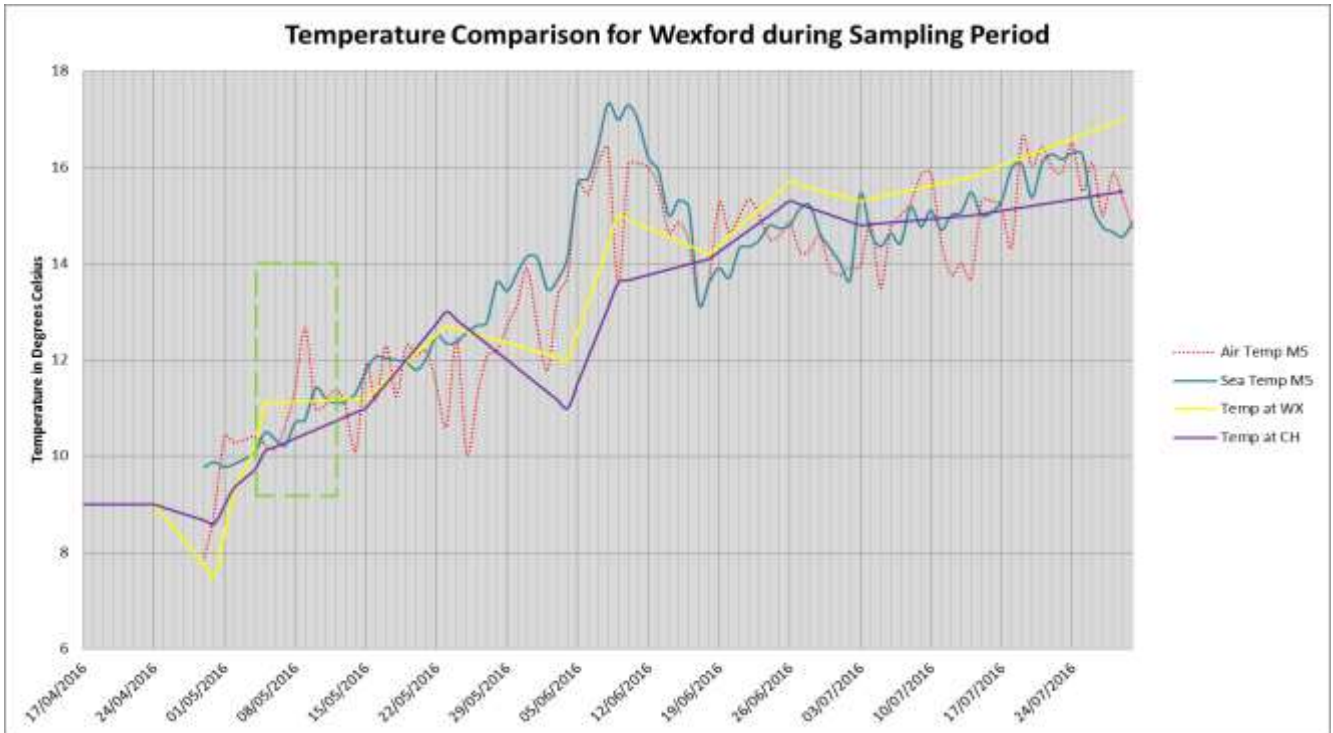


Global Mussel Larvae Population per Location



Sea temperature and salinity for the Wexford Bar and Rusk Channel stations - 2016





Sectors	Number of days	Percentage
N to E	25	27%
E to S	4	4%
S to W	46	50%
W to N	17	18%

