Irish Sea Portal Pilot

Bantry/Cromane Case Study

i. Version Control

The following table documents changes made to the document, the current version number, who made the changes and on what date.

Date	Author	Version	Change Description
21/11/17	Matthew Ferguson	1	Document creation – amalgamation of several pre-existing reports

ii. Distribution List

The following table documents who has access to the document as of 21/11/17

Name	Organisation	Position
Terence O'Carroll	Bord Iascaigh Mhara	Aquaculture Technical Manager
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iii. Table of Abbreviations

The following table contains a list of abbreviations specific to the project

Abbreviation	Definition
ISPP	Irish Sea Portal Pilot
BIM	Bord Iascaigh Mhara
BU	Bangor University
MI	Marine Institute
RIB	Rigid Inflatable Boat

iv. Contents

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Chapter 1: Introduction, Planning and Deployment

The bottom grown mussel industry is an important aquaculture sector in both Ireland and Wales, generating a total of some €9 million in Ireland alone in 2017 (Business of Seafood, 2018). The industry follows a broadly similar technique across the regions:

1. Collection of wild seed from areas of natural settlement.
2. Transport and respreading of wild seed onto licensed ongrowing plots in areas like Wexford Harbour, the Menai Straits and Castlemaine Harbour.
3. Harvesting of mature mussel, primarily for export markets.

This business model is crucially dependent on natural spatfall, an inherently unpredictable and spatially variable resource which is a major bottleneck on the industry's development. This case study aims to investigate the use of rope grown seed as an alternative source to ensure stability at the base of the business model.

Case Study Aim

The aim of the case study is to investigate the feasibility of using rope grown seed for bottom culture and explore the performance of different collector rope types.

Planning and Deployment

The site chosen for the deployment of was Bantry Bay, Co. Cork. This site has extensive existing rope grown mussel aquaculture infrastructure and expertise, a preferable location, favourable water conditions and is known for reliable seed settlement. In addition, Bantry is within close proximity to the bottom culture sites in Cromane, Co. Kerry where the seed will be relayed.

Figure 1: Existing mussel lines in Bantry, Co. Cork

The ISPP test site consists of one double longline of 110m length, equally spaced with flotation barrels. This double longline arrangement was then populated with continuous ropes of an approx. total of 1500 m. Three rope constructions were used in the test line: Hairy, looped and hairy looped rope types and were chosen to examine what difference, if any, using different rope types would cause on seed settlement.

Figure 2a-c: a. Satellite imagery of the test location within the region NOT TO SCALE. b. Location of the test line within Bantry (Bottom right of imagery). Boxed areas represent existing mussel lines. c. Deployment of the collector ropes.

The test ropes were deployed on 2rd May 2017 and were initially monitored by the growers at Bantry Harbour Mussels ltd. (BHM Ltd.) from

whom the line had been leased. Several initial water samples were taken and analysed by Tara Chamberlain (MI) for presence of seed and ascidians, an important fouling species in rope based aquaculture.

Chapter 2: Settlement Monitoring and Biometrics

The site was re-visited 3rd July 2017 to examine mussel settlement. Successful settlement was observed on all three rope types. Six samples were taken of 10cm of rope. The seed collected was measured and counted. Average seed size was 5 mm, however the measurement of smaller seed was precluded as very small seed proved difficult to sample given the nature of the collector ropes used. It is also important to note that collector ropes were tied up at the surface at this stage to prevent excessive competition by fouling ascidians.

Table 1: Counts and mean length of mussel seed from 10cm samples off each rope type.

Rope Type	Count 1 (n)	Count 2 (n)	Average length 1 (mm)	Average length 1 (mm)	Average Count (n)	Average length (mm)
Hairy	2	7	3.1	4.3	4.5	3.7
Looped	9	3	4.9	5.4	6	5.15
Hairy/Looped	5	18	4.8	5	11.5	4.9

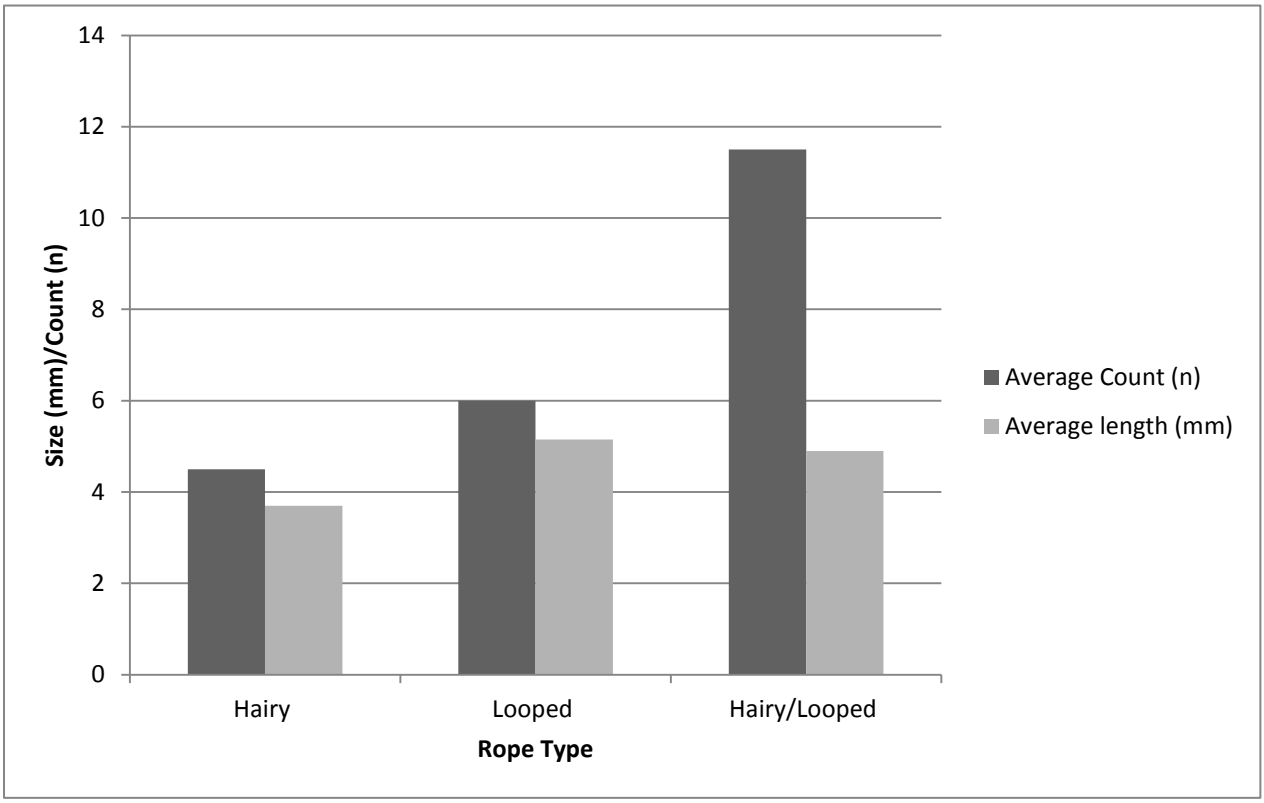


Figure 3: Counts and mean length of mussel seed from 10cm samples off each rope type.

Figure 4a-b: a. Seed sampled from a collector rope. b. Measuring the larger seed using a set of digital callipers.

The site was visited again on 1st August 2017 in conjunction with Paul Shaw and Niall McKeon from Aberystwyth University (Wales). This was to introduce these partners to the case study areas and also to discuss genetic aspects of the project with BIM and industry. This visit had several aims: 1. To observe mussel settlement on the test lines, 2. To visit additional aquaculture sites in Castletownbere, Co. Cork, 3. To visit the chosen ongrowing areas in Castlemaine Harbour, Co. Kerry.

Sampling was undertaken as per the protocol above from the visit in July, with six 10 cm samples collected. Mean shell length had increased from 5 mm to 8.7 mm. Note that collector ropes were still tied up.

Table 2: Counts and mean length of mussel seed from 10cm samples off each rope type.

Site ID	Count (n)	Average Length (mm)	Length SD
Hairy 1	360	7.3	2.9
Hairy 2	377	8.5	3.0
Middle 1	201	11.1	3.7
Middle 2	206	11.2	2.9
West 1	500	7.9	2.4
West 2	330	6.7	3.2

After visiting the ISPP test site in Bantry, BIM and Aberystyth Univeristy staff travelled to the Bantry Bay Marine Research Centre. This was to discuss the ISPP and BLUEFISH projects with Freddie O'Mahony.

Figure 5: Paul Shaw and Niall McKeown in Bantry

Figure 6a-b:a. Staff from BHM Ltd. sampling a mussel line. b. Mussel settlement on a mature mussel line near Castletownbere.

Following these meetings, several aquaculture sites in the Castletownbere area were visited and meetings held with representatives from the rope mussel industry and Marine Harvest Ireland (MHI). Figure 6 shows an example of rope mussel culture, such as that found in the Castletownbere area.

Following on the staff visited MHI Roancarrig organic salmon farm. Wrasse and lumpfish are used to control sea lice on this site. At the time of visit, there were 560,000 fish of circa 1.5 kgs on site. During this stop the partners also met with Tara Chamberlain of the Bantry Marine Research Station.

Figure 7: Salmon cages at Roancarrig, Co. Cork

On August 2nd, the partners travelled to Castlemaine Harbour, Co. Kerry to meet Arthur McCarthy of Mccarthy O'Sullivan Mussel Development Ltd. This was to discuss several aspects of the project such as the transfer of seed from ropes to bottom culture.

Chapter 3: Transport and Respreading

Summary

On 9th October 2017, mussel seed was harvested from the ISPP test line site in Bantry. Total harvest was approx. 11.5 tonnes. The seed was then transported by road to Cromane Point, Co. Kerry. At Cromane the seed was distributed between three growers: Arthur McCarthy, Frank McCarthy and John Foley. The seed was then relayed onto three intertidal plots and one subtidal plot by boat.

Once relayed, an initial post relay survey was carried out at low tide the following day (10th Oct) to assess and record stocking density, confirm the location of the individual plots and stake the extent of the site. The seed was relayed over four sites shown below.

Narrative

Early on the 9th October 2017, BIM staff Benen Dallaghan and Matthew Ferguson met with BHM Ltd. to observe the harvest of mussel seed from *MFV Blue Harvest.* Conditions were overcast, with light drizzle and temperatures of

Figure 8: Taking a GPS track of the ISPP test line: Cutting dropper lines ahead of harvesting

14-15^{0}C. The harvest process is highly mechanised and progresses quickly, with a total of 11.5t of seed collected in a single morning. During the harvest process, BIM staff took several samples to investigate pieces per kilogram metrics and evaluate the condition of the mussel seed. During the steam back to Bantry several samples were taken of each rope type for reference. At the quay, the seed was transferred into a refrigerated lorry for onward transport to Cromane, Co. Kerry to be relayed to bottom culture sites.

Figure 9 a-d: a. Example of clean mussels feeding into a 1t bag b. Removing bycatch from the seed c. The operation underway d. Unloading the seed in Bantry

By 14:30, the seed has arrived in Cromane and is distributed to three growers with a range of test sites:

1. Arthur McCarthy – 2 Sites – 2.5t Intertidal sand – 3t Subtidal sand
2. Stephen Foley – 1 Site – 3t Intertidal fine sand
3. Frank McCarthy – 1 Site – 3t Intertidal mud

N.B. Stress assessment (gaping test) was deemed unnecessary as all samples were found to be fully closed and relay from Bantry to Cromane was complete within 8 hours

Over the course of the afternoon, the seed is transferred to the sites. Seed is relayed by hand from flat bottom oyster boats using shovels. During the course of the spreading, the track of the vessel is monitored using GPS

Figure 10 a-c: a. Transfer of seed onto and oyster boat b-c. Relaying the seed onto intertidal sites at high tide

The following day (10/10/17) the sites were visited at low tide to locate and mark the site extents, sample the seed for stocking density and take photographs of the general area.

Fouling, Non-native and Invasive Assessment

During the harvest process, the seed was examined for fouling, non-native and invasive species.

Overall, the harvest process was highly successful and transfer of non-target organisms was kept to an absolute minimum. *Asterias rubens* was the most common non-target organism removed from the collected seed. Other non-target species collected include mixed fucoids, rhodophytes, *Cancer pagurus, Necora puber, Carcinus maenas, Marthasterias glacialis, Ascidiella aspersa* among other mixed nemerteans, platyhelminthes and annelids. The transfer of subtidal organisms to intertidal culture is a notably good control on fouling and pest species due to very poor survival.

Observations

The opinion of the growers was that hairy rope showed better settlement during the early months of the deployment relative to other types. While this is an interesting qualitative point, previous surveys have not shown any statistical difference between mussels from different rope types and that the depth of the rope at which mussels settle is a greater control factor. Generally, differences became less pronounced with time.

Navigation and vessel handling during the relay is an important consideration to ensure stocking density is kept consistent across sites

Stocking Density and Shell Count Assessment

Stocking density was assessed for each of the three intertidal sites for each grower. Single samples were taken at Arthur McCarthy's and Frank McCarthy's sites and 7 samples were taken at Stephen Foley's site. Samples from Stephen Foley's site were found to vary between 100t/ha and 0 t/ha, reflecting a somewhat patchy distribution along the rippled nature of the seabed.

On average, density for the SF site was 46.0 t/ha and across all sites was found to be 45.1 t/ha. This is well within conventional stocking density for bottom grown mussel aquaculture and should prove appropriate for the test area. A breakdown of the post-relay surveys is contained below in table 3.

Figure 11: John Foley (L) and Matthew Ferguson at the test site: Relayed mussels from an intertidal plot at low tide

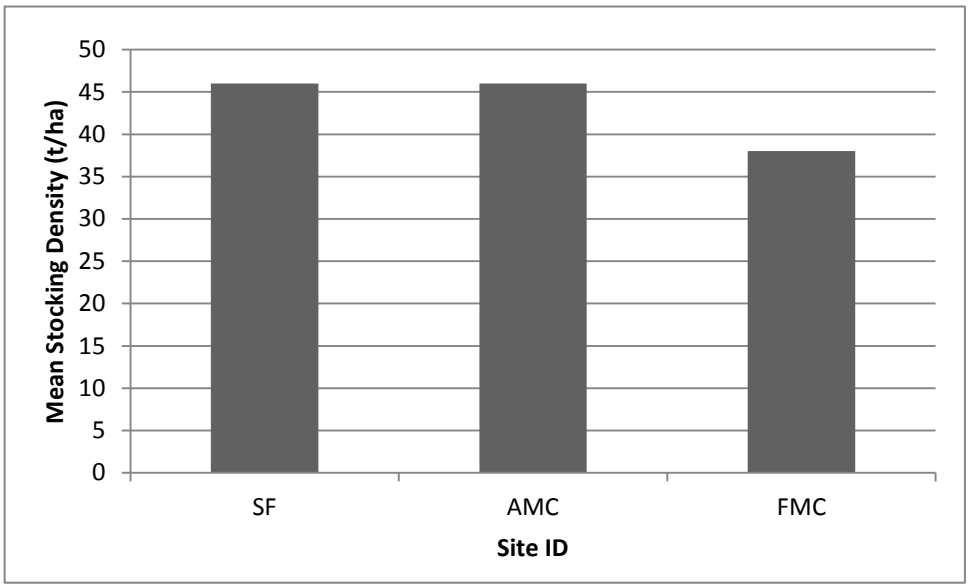


Figure 12: Stocking density (t/ha) for each site. SF = Stephen Foley, AMC = Arthur McCarthy and FMC = Frank McCarthy

Upon relaying the seed and marking the extents of the sites we can calculate a total area for each plot. Using this area and the known mass of seed relayed onto each site allows us to calculate a mean stocking density:

- AMC Subtidal – 0.057 ha - 22.8 t/ha
- AMC Intertidal – 0.062 ha – 48.3 t/ha
- FMC Intertidal – 0.054 ha – 55.6 t/ha
- SF Intertidal – 0.111 ha – 27.0 t/ha

While the stocking density is variable between sites, all sites are within conventionally accepted limits for bottom grown mussel aquaculture.

In addition Shell count was assessed for each rope type during the harvest process. Hairy/looped rope was found to have the highest count per kg (780), followed by hairy rope (638 per kg) and finally looped rope (534 per kg).

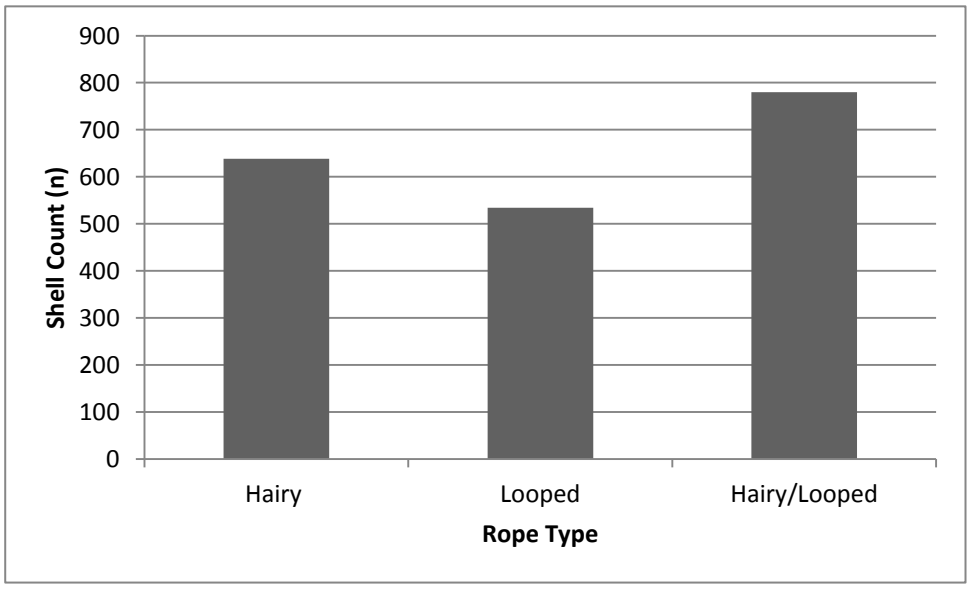


Figure 13: Shell count against rope type

This would suggest the greater surface area afforded by hairy/looped ropes supports a greater density of individuals at a smaller body size while the reverse is true for looped rope with hairy rope as an intermediate. Further investigation may reveal more information on this trend but given the scale of the commercial harvest operation, noticeable differences may prove difficult to detect.

Summary and Further Actions

- Transplant from Bantry to Cromane was successful and ran smoothly
- Seed was relayed onto 4 sites in Cromane, 3 intertidal and 1 subtidal
- An initial survey and site location was carried out and stocking density was calculated for each site
- Monitoring will be put in place to ensure the size, condition and biometrics of the relayed mussels are monitored

Table 3: Stocking density assessment. SF = Stephen Foley, AMC = Arthur McCarthy and FMC = Frank McCarthy.

Site ID	Weight (0.5m2)	Weight (1m2)	Stocking density (t/ha)
SF	1.15	4.6	46
AMC	1.15	4.6	46
FMC	0.95	3.8	38

Table 4: Shell count (kg) against rope type.

Bag no.	Rope type	Shell Count/500g	Shell Count/1kg
1	Hairy	319	638
5	Looped	265	530
6	Looped	269	538
11	Hairy/Looped	390	780

Chapter 4: Intertidal and Subtidal Monitoring

Introduction

The survey was undertaken from 06/11/17 to 08/11/17 to observe and quantify mussel growth on the three intertidal relay sites after one month *in situ*. Additionally, Matthew Ferguson (ISPP Technical Assistant) and Catherine Butler (SW Regional Aquaculture Officer) attended a Cromane Fisherman's co-operative meeting.

. Fieldwork was undertaken on 06/11/17 and 08/11/17 on three plots belonging to Frank McCarthy (FMC), Arthur McCarthy (AMC), Stephen Foley (SF). The three survey plots are shown below (Fig. 14a-c.).

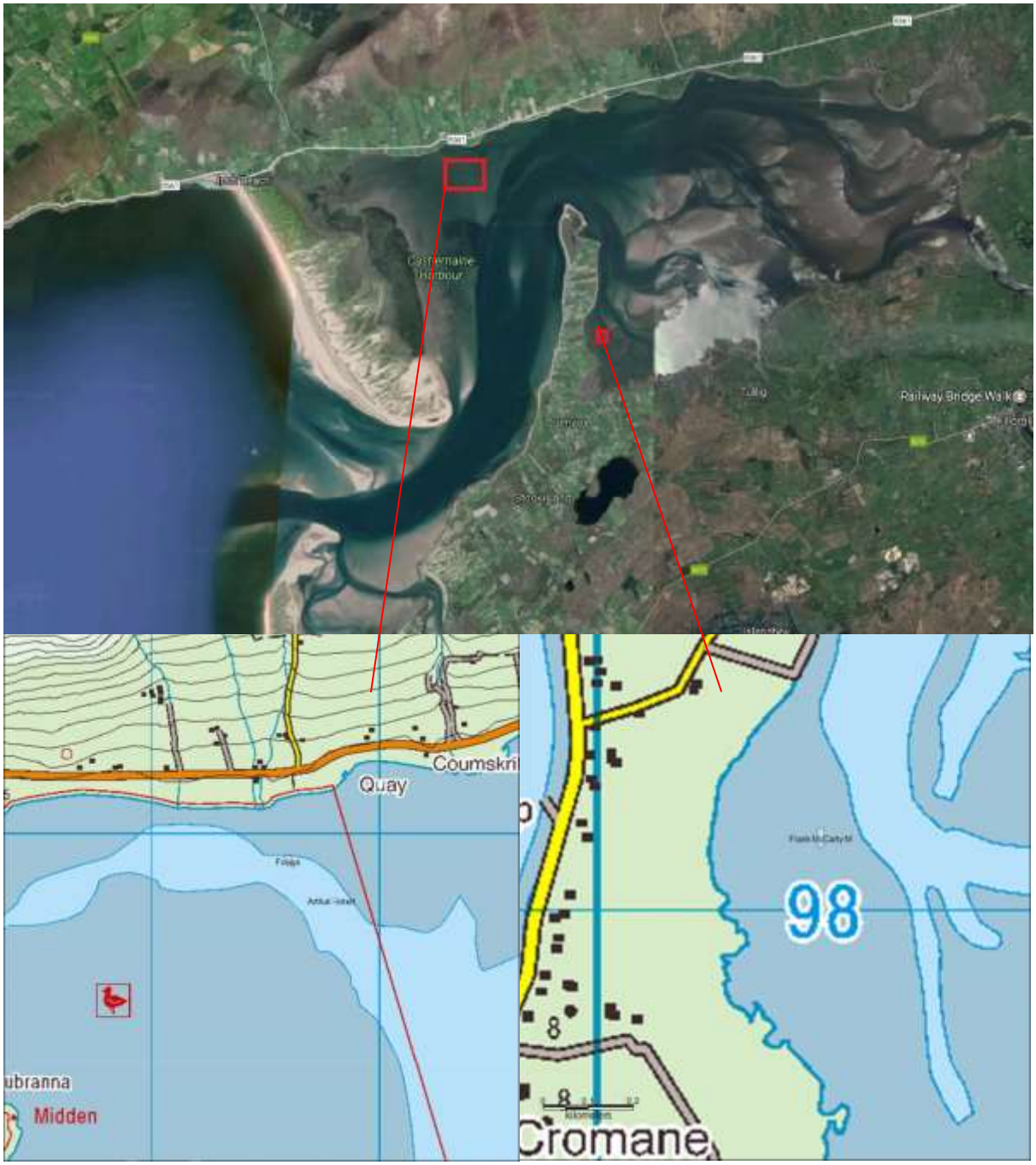


Figure 14a-c. Clockwise from top: General location of the relay sites within Castlemaine harbour (Not to scale: source: Google maps), b. Location of FMC site, c. Location of the AMC and SF sites.

Methods

Surveys were undertaken from shore at low tide on both days. Low tide was at 12:23 and 14:06 respectively. Conditions on the 6/11/17 were good, with dry sunny spells and slight to moderate westerly winds. The plots were located and walked to examine the distribution of seed. After the site was initially examined and photographed, three samples were taken. Given the very patchy nature of

seed distribution in the survey areas and observed movement of seed it was decided to pragmatically sample the seed present to obtain a representative biometric sample rather than restrict the survey to the marked area.

Observations and Results

From initial observation, it appears the sites have performed differently. Most strikingly, the seed from the FMC plot has shown extremely extensive mortality throughout and sampling found 0% survival. The seed located within the AMC plot has nearly entirely migrated 10-15m north of the initial plot. Most promisingly, the seed from the SF plot has largely remained within the confines of the plot but has shown some movement to the east.

Figure 15a-c. Photographs of each site (left to right) a. Frank McCarthy (FMC) b. Arthur McCarthy (AMC) c. Stephen Foley (SF)

Frank McCarthy

This site is located to the east of Cromane on intertidal mudflats. This site showed extremely high mortality and sampling of the site found no live mussels (fig. 3). Mean shell size across all three samples was 29.9mm (SD 3.4, fig. 5) indicating some growth prior to the mass mortality observed. However, this result should be interpreted cautiously as it appears smaller shells are more likely to be spread over a wide area by tidal influence or subsumed within the muds, making the samples collected potentially bias towards larger shell size. In any case, the extensive mortality observed is likely to be caused by extreme weather events (re. Storms Ophelia and Brian) between

Figure 16: Sample photograph from FMC_3. Note the very high abundance of empty shell in good physical condition. Quadart = 0.5m^2

respreading and this survey. It is likely that predation does not play a large role in the observed mortality due to the strongly tidal nature and location of the site. Overall, shell condition was very good and the absence of drill holes or nipped/broken edges support this theory.

Arthur McCarthy

This site is located centrally within the area, located between Inch Beach and the Cromane point. This site showed mass relocation of the mussel seed to 10-15 m outside the initial marked area (fig. 4). This presents a problem to the survey as evaluating the growth of mussels outside the marked area makes it difficult to definitively separate the respreads mussels from wild populations. The sampling was focussed on seed that had clearly been respread. Overall, the seed was found to be in very good condition, clean with good edges. Mean shell length was 28.4 mm (SD 4.1, fig 5.) again indicating some growth. In addition, there appears to be gregarious behaviour between respreads mussels and larger wild individuals adjacent to the plot. Estimates of empty shell and mortality is difficult as it appears that the empty shells are susceptible to movement with the tide and prevailing currents. An example of this was observed clustering of empty shells around the base of tree trunks used as markers near the survey site. I would estimate that 65% of the seed remains alive.

Figure 17: Photograph of the AMC site. The observer is standing at the northeast corner facing the northwest corner, marked by the red bucket. Seed is visible to the left of this line outside the marked extent of the site

Stephen Foley

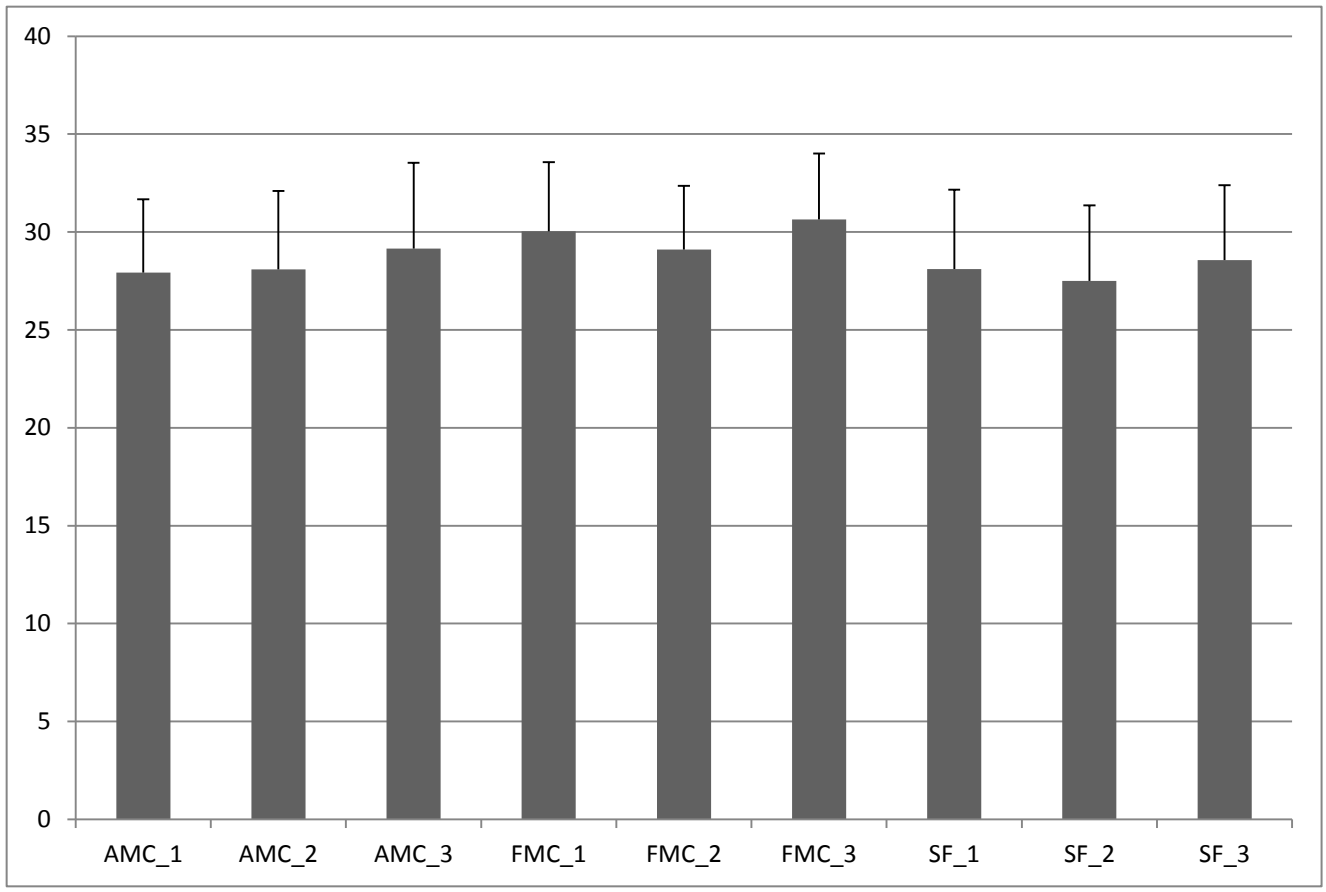
The site closest to the northern shores of the bay shows the most promising results. The vast majority of the seed remained inside the marked site only showing some movement to the east. Again shell condition was found to be very good and mortalities are estimated to be less than 5%. Mean shell length was 28.1 mm (SD 3.9, fig. 5) again indicating growth. Seed in this area again is very patchy.

Figure 18: Photograph of the SF site. The observer is standing at the southwest corner facing the northeast corner. Seed is visible within the extent of the marked site.

Ongoing and Subtidal Monitoring

In December 2017, the subtidal and SF and AMC intertidal sites were revisited to evaluate the progress of the experiment. As with the previous surveys in November, the SF site shows the most promise. The seed is largely within the confines of the site and in good condition. Clumping and matting of the seed is more prevalent and obstructions, such as the marker poles, existing mature mussels and larger poles already in place support larger quantities of mussel than flat seabed. The AMC site shows no seed from the transplant but existing mussel beds to the North of the site show aggregation of transplanted seed. It is the opinion of the grower that larger seed is more profitable for wading birds to feed on, especially in their soft shelled condition. This opinion I supported by the surveyors observations of large bird concentrations on both the SF and AMC sites.

Subtidal monitoring was conducted from a small punt using a hand dredge of approx. 40cm width. The dredge was towed across the short width of the site for approx. 10m. The dredge contents were then examined and in all three tows no live transplanted mussel was found. What transplanted shell was recovered was heavily damaged along the shell margin, which is indicative of damage by crabs, most likely *Carcinus maenas* which were abundant in the dredge samples.



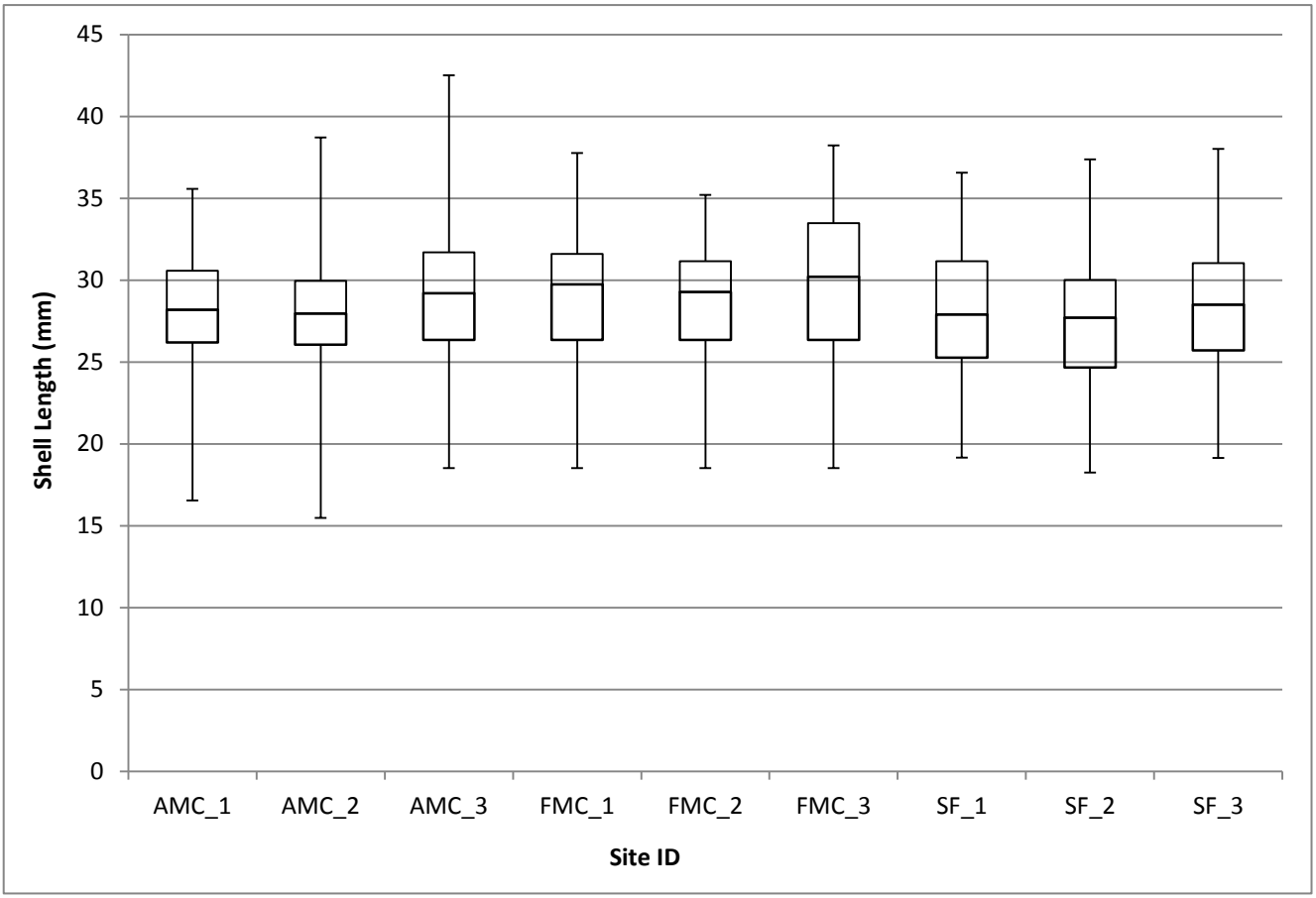


Figure 19a-b. a: Box plot of shell length against site. Box intervals represent median and quartiles 1 and 3, whiskers represent max/min values. b: Bar plot of mean shell length. Error bars represent standard deviation.

Chapter 5: Case Study Conclusion

- There was no significant difference between rope types trialled within the Bantry area
- Seed performance has varied across all three sites
- Frank McCarthy's site has suffered complete loss of seed and will not present an economic return
- Mobility of seed at Arthur McCarthy's site may prove experimentally problematic
- Stephen Foley's site presents the best site for ongoing monitoring of the seed
- Future surveys should be mindful of the patchy distribution and mobility of seed