An Bord Achomhairc Um Cheadúnais Dobharshaothraithe
Aquaculture Licences Appeals Board

# Submission re T6/466 Gerard O'Reilly

## Received 26 November 2018

## Dooks Area Residents

Cúirt Choill Mhinsí, Bóthar Bhaile Átha Cliath, Port Laoise, Contae Laoise, R32 DTW5
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## Leonard, Brona

**From:** Peter McLaughlin [petermclaughlin3@yahoo.com]
**Sent:** 26 November 2018 16:42
**To:** Alab, Info
**Subject:** Castlemaine Harbour - Site ref. T06/466A Appeal by Gearard O'Reilly Submission by Dooks area residents
**Attachments:** Appeal submission.docx; SEDIMENTARY CHANGES IN CASTLEMAINE HARBOUR_FINAL REPORT-2.pdf

Dear Mary

I attach herewith a submission in relation to the Appeal by Gearard O'Reilly against the decision by the Minister to refuse to grant an aquaculture and Foreshore Licence in relation to the above Site. I also attach herewith the report of Dr Sarah Kandrot and Prof. Robert Devoy referred to therein.

I would appreciate if you could please acknowledge receipt of the attached by return.

Yours sincerely,

Peter McLaughlin

Tonn Toime
Dooks
Glenbeigh
Co.Kerry

The Secretary
Aquaculture Licencing Appeal Board
Kilminchy House,
Dublin Road,
Portlaoise,
County Laoise.
R32 DTWS

26th November 2018

Appeal by Gerard O'Reilly [ the Applicant]
Re Site reference T06/466A Castlemaine Harbour Co.Kerry

Dear Sir/Madam

We confirm that we wish to make a submission in relation to the above Appeal on our own behalf and on behalf of the individuals listed in the schedule hereto who have authorised us to act on their behalf. We ,and a majority of those listed in the schedule hereto, are among those who lodged submissions/ objections with the Minister during the Application process herein. We understand that in excess of 400 objections were lodged incorporating a vast variety of reasons as to why the licence should not be granted herein. We assume the Department will make copies of them available to the Board for its consideration herein.

The Minister refused to grant the Licence herein and confined his grounds for doing so to the Conclusions Statement and the recommendations therein based on the results of the Castlemaine Harbour Appropriate Assessment 2018 [AA]. The Board may find it strange that with all the submissions and objections of the public there is no reference to same in the Ministers Decision. There is a very clear reason for this.

102 Applications were made for Aquaculture Licences in Castlemaine Harbour and the Public Participation Process commenced on different dates in September/October 2018 over a 3-4 week period with the Statutory notices being published in the Kerryman newspaper. On the very day that the first publication appeared in the Kerryman and the Public Participation Period commenced for some of the Applications the Minister's officials held a meeting with all the Applicants in Cromane. The Minister's officials advised the meeting that with 6 exceptions a decision had been made to refuse all the Applications. So in advance of the Public Participation Period the Minister had made his decision herein and clearly gave no consideration to the submissions by the Public. Some of the legal implications of this course of action are dealt with later but as a result of the premature decision we would respectfully submit that the Board must, as part of the Appeal process herein, review the submissions made by the Public in relation to the Site and it will be evident therefrom that there are many

other grounds which the Minister could have relied upon to refuse the Application.

The Site is located in that part of Castlemaine Harbour known as Rossbeigh/Caragh Creek and comprises the bay [the Bay] area between Rossbeigh and Dooks into which the rivers Caragh and Behy flow. It is very evident that the AA is not as comprehensive as it should be and a lot of issues were not addressed and up to date surveys carried out . While the absence of same has not had any adverse effect on the Applicant they would certainly have a major bearing on whether or not a Licence should be granted if they had been dealt with. We set out below a number of such issues;

Erosion

[a] Very surprisingly the AA has only 3 lines in it concerning the issue of erosion. The extent of the erosion and the movement of sand, mud and sediment in the Bay and the speed thereof have never been witnessed in this area before. The impact of same has resulted in massive physical changes and the prognosis from experts is that it will continue, with possibly greater ferocity, resulting to the further opening up of the Bay to the elements and in particular the impact of the sea. The protection afforded the Bay by the spit at Rossbeigh is forecast to likely reduce significantly and may disappear over the next 20 years. There are major movements of sand around the Bay with an estimated one million tons plus being shifted on an annual basis. The changes can be very severe with sand banks rising and falling by as much as a metre or more during a month long period. Likewise sediment and mud beds on the foreshore are also being materially disturbed and moved around the Bay and indeed it will be shown that these elements are also being drawn out of the Bay and effecting the feeding grounds of the birds. The composition of the sediment and mud flats is changing and the adverse effect of this has not been determined. In the Application made herein it has been claimed that the ground on the application site is firm or solid and with respect nothing further could be the case. It is clear that the Bay area is one of the most unstable in Kerry

Experts Report

[b] As a follow on from the issues dealt with in [a] above we attach herewith a Report prepared by Dr Sarah Kandrot and Professor Robert Devoy [ the Authors] in relation to the erosion in the Bay and at Inch. The Authors are members of UCC and have along with others being carrying out studies for over 25 years into the erosion in the area and the prognosis for the future. Studies and surveys have been carried out on an annual basis and indeed only recently a group from the University spent a number of days at the Bay updating measurements and reviewing changes. It would be fair to say that the Authors are the leading experts on the erosiontaking place at Castlemaine Harbour and that no similar studies have been carried out as part of the AA or previous Assesments. You will see from the Report the extent of the erosion todate and the prognosis for the short to medium term future. The consequences of the erosion is massive for the wildlife in the Bay and demonstrate the total unsuitability of the Bay for Oyster

farming. The Authors have confirmed that the likely level of sand movement in the Bay alone would make oyster farming impossible and exceptionally risky both as a business and for causing damage to its surrounding areas. ALAB has received over 30 appeals for other areas of Castlemaine Harbour and one of the common themes running through same is the existence of difficulties of moving sand and the adverse effect it is having on their existing farms.

The effect of Algae and Toxins outbreaks

[c] . It is surprising to note that no reference to the Red Tide Algae outbreaks has been mentioned in the AA . Over the last 12 years and more Dingle Bay has been seriously effected on numerous occasions by outbreaks of Red Tide algae which has resulted in fishing activities being closed for long periods and thousands of tons of shellfish being lost. The adverse effect of the Algae resulted in the closure of the Castlemaine Harbour fisheries [comprising an area of approximately 55 square kilometres] for over 7months in 2013/14. The conditions in Dingle bay including the rising of sea water temperatures and the increasing ferocity of storms make it likely that Red Tide algae will very much be a continuing problem in the future for the area. Should a serious incident of Red Tide Algae occur in the Bay in the future [which based on recent history is a realistic possibility] it will result in huge losses of shellfish which in turn will result in a huge amount of debris being distributed around the Bay. We appreciate that the Licences require that there should be no debris permitted however in reality and from past experiences around the country that is unlikely to happen in practice. The Licencees will have suffered big financial losses, will have to restock and it is only to be expected that short cuts will be taken which will result in debris being released from the farms to pollute the Bay,

Non native oyster seed

[d] The Applicant does not state where he intends to procure the seed but if he follows all other oyster farmers in the Harbour he will import non native oyster seed from England and France. The species of oyster proposed for the development is "C-Gigas" These are a type of Pacific oyster that are not native to Ireland It begs the question how can a non –native species proposed in the Application and farmed at an industrial scale not have an adverse impact on the conservation objectives of the SAC and the SPA No studies have been carried out in the Bay to determine the effect foreign seed may have but in a recent countrywide study it has been concluded that"...it is clear that the establishment of Pacific oysters can significantly alter diversity, community structure an ecosystem processes. The AA and the Conclusion Statement both make reference to the fact that it is a concern. It has been established in other studies that blue mussels have little resistance to pacific oysters so to allow more oysters into an area which is very extensively used for mussel farming is very dangerous. It has already been established as an invasive alien species in other parts of the country and in particular loughs Foyle , Swilly and Strangford and no evidence has been produced to confirm that it would not happen in the Bay. Because it has not happened to date does not mean it will not happen in the future . Proper consideration has not been given to the fact that the seed is to be imported from

France which is experiencing major issues with diseases in its oyster industry and there are already cases of the diseases following to Ireland.

Kerry County Development Plan

[e] The development of new Oyster Farms in the Bay would be contrary to several sections of the Kerry County Council Development Plan particularly the requirements to preserve the landscapes and areas of exceptional beauty and most importantly those adjacent to the Wild Atlantic Way/ Ring of Kerry and the planned Greenway from Glenbeigh to Valencia. The Council has banned the construction of holiday homes and imposed major restrictions for new homes in rural areas so as to preserve the landscapes. The development of one or more fish farms in the Bay would be totally contrary to the requirements of the Council and contrary to good planning principles. The Development Plan also prohibits shellfish farms being established adjacent to Blue Flag beaches of which Rossbeigh and Inch are two. Kerry County Council has a statutory duty to prepare the Development Plans and to ensure that the environment is fully protected .The Development Plan is approved by the elected Councilors and it is they on behalf of the public have put in place the restrictions and protections outlined above. If the Licence sought herein and the others pending were granted this would be in total conflict with the wishes of the public as represented by the County Council.

Birdlife – surveys

[e] It is difficult to understand how it could be considered in order to do an Appropriate Assessment under the Birds and Habitats Directive without carrying out as part hereof a complete up todate bird and habitat survey of Castlemaine Harbour and in particular the Bay. To be relying on old or non site specific surveys is not acceptable to enable a true and complete assessment to be made. The physical changes in the Bay since the last full survey was done 8 years ago have been enormous as is the likely effect on the wildlife therein. Clearly a very thorough and complete study needs to be carried out on the present conditions within the bay and the likely impact of further erosion and soil movement. The presence of an oyster farm would bring further risks to what is already a serious situation.

Effect on local amenities

[f] The Bay includes 2 beaches and these are the nearest ones to Killorglin, Killarney, ,Milltown and surrounding areas They serve a population of over 30000 and along with tens of thousands of tourists the Bay is enjoyed by thousands on a weekly basis especially during the Spring .Summer and Autumn seasons. The activities carried on include pony trekking, swimming, windsurfing sailing, walking, skiing, fishing and other usual water sports. A number of these activities would have to be curtailed if the development applied for went ahead and indeed some would have to stop all together because it would be too dangerous. It is a very major amenity area that will be seriously damaged. The numbers using same will be significantly reduced as who wants to walk or sit on

a shell and debris strewn beach looking at row upon row of rusting black trestles with the smell of dead fish in the air. No doubt it will be claimed that all the farms will not have any adverse effect on the existing wildlife within the Bay . There is absolutely no merit for this claim particularly when the opposite is the reality. Part of the areas where the birds feed are going to be covered with trestles and debris from the farm. There will be far greater concentration of activities on the actual water and also greater use of noisy machines. No matter what the Applicants claim and no matter what is contained in the licences very significant amounts of debris and dead shell fish will be washed up on the beaches which are used so much by many many adults and children. Dooks beach is exceptionally popular for families and children particularly during the summer months. The level of activity has trebled in the last 10 years as it is regarded as a safe area to swim and sail and engage in other water sports. The beach is totally unpolluted and this would change if the farms arrive.

We now wish to refer specifically to the Appellant's Application for the licence and would make the following specific comments on same.

[1] The Applicant claims that the ground of the Site is solid and suitable for Oyster farming. We would refer to the Kandrot/Devoy Report which clearly confirms that this is not the case and that the present conditions are likely to get much worse as the protections for the Bay reduce. Inspections of the Site clearly evidences the strong currents in the area and their effect on the river/sea bed. The Applicant has given as the reason he wishes to establish a farm in this location is due to the fact that he is experience problems of high levels of sand movement on other sites he occupies . His problems will be far worse on this Site.

{2] The Applicant gives no details of the projected additional employment [ if any] that will arise as a result of the proposed development.. It is very difficult to see how this project could succeed financially and there would be very major concerns that pollution would be caused if the project was abandoned in a partially completed state

[3] Nearby Lough Yganavan is located in an SAC and is a designated bird Sanctuary as indeed are the areas surrounding the Site. The Lough is served by only one small river and the Site fully straddles the entire mouth of this river. In addition to being a Bird Sanctuary the lough is also very well stocked with wild brown trout and also some sea trout . The presence of the farms at the mouth of the river serving the lough could have a major adverse impact on these fish stocks and access to the lough. Very regretfully Lough Ygnavon suffers its own problems which have been reported to the Local Authority . Over the last 10 years or more an algae or scum forms on the surface of the lake and remains for several weeks until washed away by heavy rains. It is not known what causes this but it is suspected to be from the run off of slurry from neighboring fields. The problem appears to have first arisen following major restoration works having been carried out on neighboring fields and the commencement of regular slurry spreading on same. This algae/scum will eventually make its way to the Site via the river flowing from the Lough.

[4] We would have very major concerns as to the suitability of the Site for the establishment of an Oyster Farm and indeed we wonder what was the extent of

investigation carried out by the Applicant in this regard. The first and most obvious issue is the fact that the oysters will be out of the water for at least 12 hours a day which is likely to give rise to high numbers of mortalities and resulting environmental damage. The area is very shallow and is not covered with water for long periods. No EA Screening has been carried out of the Site as to its suitability and the likely effect an oyster farm would have on the Site and surrounding areas.
[5] The Applicant has advised that access to the Site shall be via boat . The documentation made available by DAFM did not include a map showing the intended access route and there may be serious environmental implications arising from the use of this route. Certainly there will be issues near the Site as access via boat will be difficult if not impossible on occasions because of the absence of water.
[6] The Applicant does not have a Foreshore Licence for the Site and non appears to have been applied for as Part of the Application herein. A Foreshore Licence may also be required for the area from which the Applicant intends to embark via boat to travel to the Site. As advised above we have no knowledge of where this area may be and the effect the Applicants proposed activities there may have.
[7] The Applicant has failed in any way to demonstrate that an oyster farm on the Site would benefit the local economy or community. Indeed the opposite will clearly be the case. The seed will be imported and on maturity exported so in reality the site would become an incubator for foreign oyster seed which is being operated here as it cant be done in its native country. The local community do not want an oyster farm in the Bay as is evidenced from the many hundreds who have lodged objections to the Application and by the thousands who have voiced their opposition to same.

In relation to the Applicants grounds for his Appeal we would make the following specific comments
[1] The Applicant does not in anyway dispute the grounds of the Ministers refusal to grant a Licence herein and indeed makes no reference to same.
[2] The Applicant fails to deal with any of the hundreds of objections lodged by the Public against the Application during the Public Participation stage or attempt to deal in any way with the grounds for such objections.
[3] The Applicant is totally wrong in his claim that the creation of an oyster farm on the Site will not have any effect on swimming or boating activities. The Site and the area adjoining same is regularly used for swimming particularly by local residents. In addition many boating activities including kayaking and canoeing by locals and tourists takes place in the area
[4] The Applicant has chosen to highlight the fact that the creation of the farm on the Site would not impact the views from Dooks Golf Club but has chosen to ignore the very obvious adverse impact it would have on the residents in the houses adjacent to or over looking the Site and on the protected views from the Ring of Kerry /Wild Athlantic routes. The proximity of the Site to residences and to Dooks beach will result in adverse smells and major risk of pollution as well as having a serious adverse impact on the beauty and appeal of this very special area

[5] The Applicant acknowledges major seed losses on other sites he operates and the only reason given that this would not happen on the Site is its proximity to the open sea. It is not understood how this would be relevant or reduce his losses and demonstrates a lack of research into the Site and the impact of the very visable erosion taking place in the bay and the massive amount of sand movement therein.
[6] The Applicant has failed totally to address the very serious effect that the proposed farm would have on the birds that feed in the Site . It is in an area very popular for feeding by Brent Geese ,Egrets, Oystercatchers and other protected birds. Likewise the area is habituated by a family of otters which can be seen in the rivers and on the adjoining foreshore. The adverse effect on the Caragh river has not been considered and the salmon/sea trout therein and while it is claimed that the adverse effect on the water quality may be insignificant this is clearly an acknowledge that there will be an adverse impact.

We have highlighted above the fact that the Decision by the Minister appears to have been made in advance of the Public Participation Period and without consideration being given to the public's views and concerns. Under Irish Statute law [ the Foreshore and Fisheries Acts], the Public Participation Directive and the Aarhus Convention the Minister is obliged to fully engage with the Public and to make available to them all appropriate documentation to enable them to be reasonable well informed prior to making any decision as to whether or not to grant an Aquaculture or Foreshore Licence. It is very evident from the facts herein that the Minister has failed in a material way to comply with his obligations herein. Should the Board decide that the Applicants grounds for his appeal would in the ordinary course of events merit the granting of a Licence we would respectfully submit that due to the Minister's failures the Board cannot grant such Licence. A Licence can only be granted in any case when all the legal obligations of the Minister have been complied with, fully and properly ,which is clearly not the case herein.

We believe it is evident from the above and the enclosed that it would not be correct to allow the Appeal herein. Should you require anything further from us please let us know and we would be happy to oblige. While we do not see grounds for an oral hearing herein however if the Board decides that it is appropriate to hold one we would like to be represented at same and to make submissions.

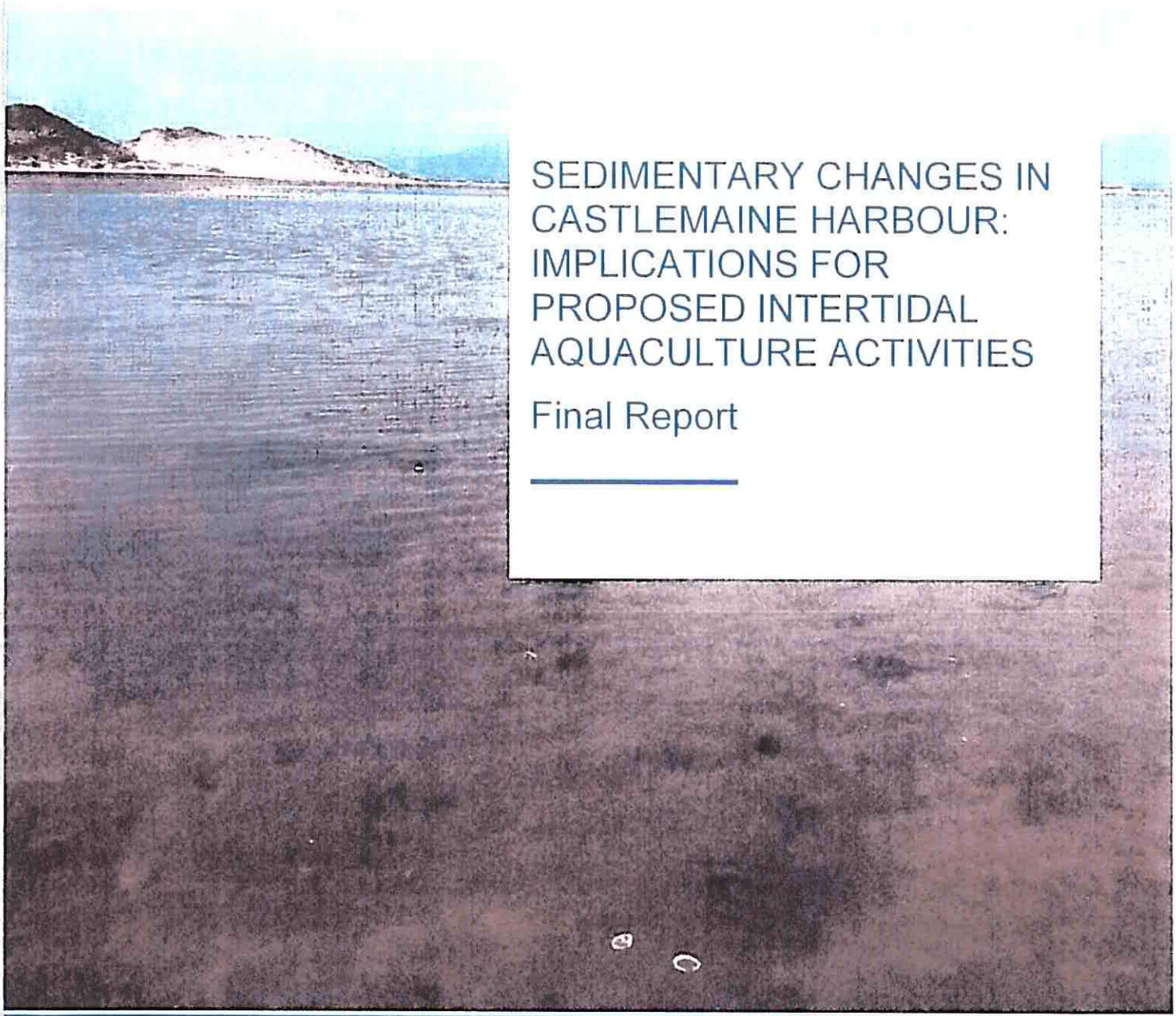
We await hearing from you herein.

Yours sincerely

Paul Inglis/ Peter McLaughlin

Schedule

Dr Patricia Neligan, Muarice Neligan ,John and Sarah Neligan, David Neligan , Justin and Ruth Condon, Marjorie Simmons-Goodings, Thomas Simmons Goodings, Prof. Adrian Dixon,Anne Dixon, Aidan O'Brien, Frank and Mary Shields, Cormac and Kate Shields ,Cal and Patricia Condon, Tadgh and Christine O'Connor Mary Inglis. Stephen and Sinead O'Sullivan Eoin O'Connor, Gary O'Sullivan, Patrick and Raidin O'Connor , David O'Sullivan, Robert and Aisling O'Sullivan, Keith McLaughlin ,Emma Jane Dunne, Marc McLaughlin, Tony and Nell McDowell, John and Lucy Donegan, Marie-Louise McLaughlin, Andrew and Sophie O'Brien, Tadgh and Sally Glesson, Richard Gleeson , Peter Lord, Aimee McLaughlin, Shane O'Neill, Richard Flinn, Penelope Kenny, Richard and Rachel Tierney, John Inglis , Donal and Jean Forbes, Edward and Susan Lynch, Paul and Pam McLaughlin, Conor and Clare Shields, Richard and Aideen Rice, Michael and Rose Cunningham, Dermot and Niambh McMurrough, Justin and Sarah Spain, Alan and Jennifer O'Hanlon, Eamon and Nuala Horan, Peter and Paula Ledbetter, Brian Spain, David Marmion, Aoife O'Donoghue,Brian Cahill, Fran and Julie Anne Mangan, Billy and Hilary O'Sullivan,Jonathan Forbes, Timothy McLaughlin, Brian McLaughlin,Tom and Rita Pickersgill, John and Carol Hanna,Don O'Sullivan,Noel and Kate Coakley,Peter Horan, David O'Sullivan,Robin Cunningham. Peter Cunningham Sylvie McLaughlin,Tim Cahill, Sorcha O.Neill,Tadgh and Jean O'Connor, Cian O'Neill ,Deirdre Carwood, Philip Daly, Catherine Spain,Stephen O'Sullivan, Neill McLaughlin, Michelle O'Sullivan, Aidan Walsh, Caroline Lynch, Paul Farrell,Michael and Annette Hogan, John and Miriam De Vere White,Christine Gallagher, John O'Connor,June Cunningham, Ian Bowell, Eoin and Sorcha O'Connor, Edward and Susan Nicholson, Ciaran Murray, Gerard Shivnan, Edward Guiney.



# SEDIMENTARY CHANGES IN CASTLEMAINE HARBOUR: IMPLICATIONS FOR PROPOSED INTERTIDAL AQUACULTURE ACTIVITIES

## Final Report

Prepared by Sarah Kandrot Environmental Consulting Services on behalf of SaveThisBeach.com

Authored by Dr. Sarah Kandrot &
Prof. Robert Devoy
Date of submission: 23 July 2018

KANDROT

# Table of Contents

## 1 Introduction

***Sarah Kandrot Environmental Consulting Services*** has been commissioned by SaveThisBeach.com to:

1. provide a contemporary assessment of the ongoing sedimentary changes occurring in the Castlemaine Harbour area, and
2. evaluate the implications of these changes for proposed intertidal aquaculture activities, specifically in relation to oyster farming.

Presently, ten aquaculture and foreshore license applications for oyster farming are pending with the Department of Agriculture, Food and the Marine for the area extending from Rossbeigh to Dooks (figure 1). This area is known to be highly dynamic in terms of sediment transfers, especially since breaching of Rossbeigh occurred in 2008 (O'Shea, Murphy and Sala, 2011; O'Shea and Murphy, 2013; Devoy, 2015b, 2015a; O'Shea, 2015; Kandrot, 2016; Kandrot, Farrell and Devoy, 2016). A second breach is now developing, which will have negative implications for the future of the system, especially under climate warming.

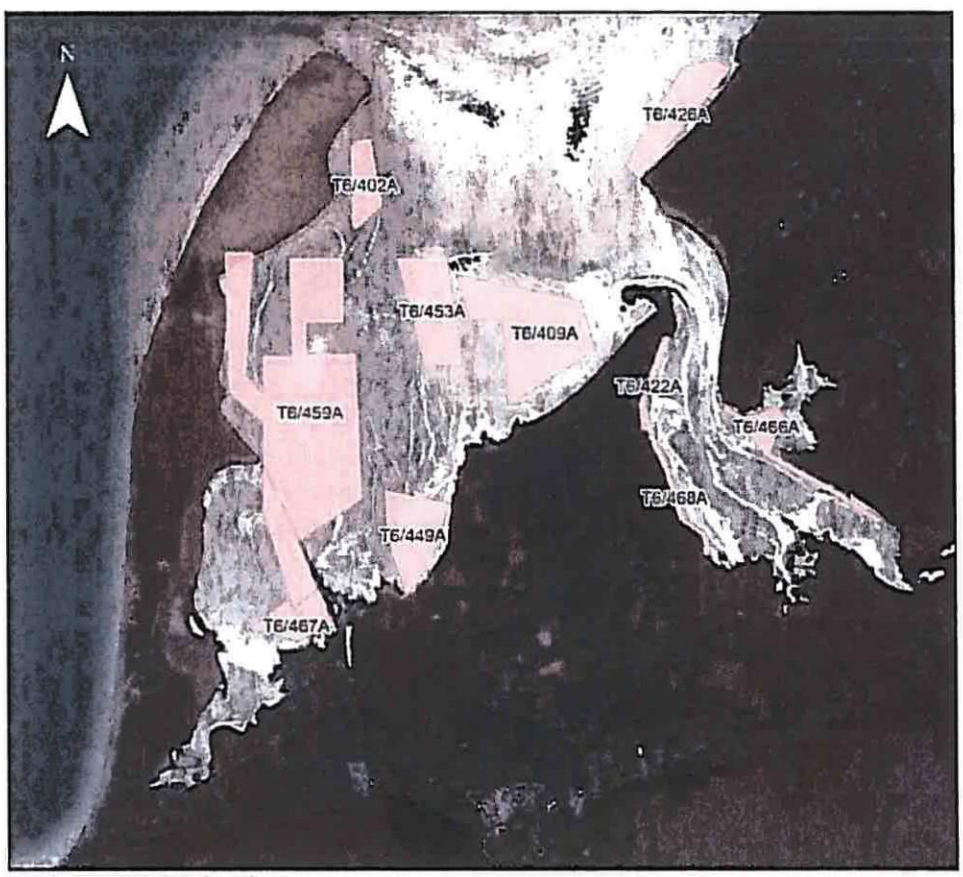



FIGURE 1: Locations of proposed oyster farming operations.

To provide an update on the sedimentary changes occurring in the Castlemaine Harbour area, a field survey of the present shoreline position was undertaken in June 2018. Pre- and post-breach shoreline positions were digitized from historic maps and aerial imagery for comparison with these data. High-resolution (<5 cm accuracy) elevation data was also obtained during the field survey for comparison with aerial LiDAR data, obtained in 2011. Elevation change was assessed for this period. Finally, pre- and post-breaching changes in turbidity (water clarity) were assessed from classified satellite imagery provided by the European Space Agency (ESA).

The results of this work indicate that while the breach is infilling with sediment, the dunes adjacent to the breach are continuing to recede rapidly, leaving the back barrier environment vulnerable to incoming waves during high-energy events. The influx of sediment to the back barrier environment is likely to be coming from this source. The soft cliffs at Reenalaggane, which are directly exposed to incoming waves through the breach, are also receding, representing an additional source of sediment to the system. The ongoing sedimentary changes are likely to have negative implications for planned oyster farming activities in the area, including burial of trestles by sand, obstruction of access routes, and overall shifting shorelines.

## 2 Objectives

The objectives of this report are to:

1. provide an update on post-breaching shoreline and beach elevation change
2. assess post-breach turbidity changes
3. outline the potential implications of these changes for oyster farming activities

## 3 Physical Setting

The area of interest is situated in Castlemaine Harbour, a large, back-barrier estuary in the inner part of Dingle Bay (figure 2). The harbour is fronted on its seaward side by two north-south trending, spit-like sand barriers, Inch and Rossbeigh. The barriers are separated by a deep, narrow tidal inlet and linked by an extensive ebb-tidal delta. A third barrier, Cromane, exists to the east. Inch and Rossbeigh support extensive high dune systems, which are fronted by wide, flat dissipative beaches comprised of course, subaerial sands derived from both fluvial and glacial sources. These features act as significant sediment stores within the system. The dunes are probably founded on underlying cobble or gravel deposits (Carter *et al.*, 1989; Devoy, 1995; Sala, 2010; Delaney, Devoy and C. Jennings, 2012), although further coring and geophysical work is required to establish the basal stratigraphy in detail. As a result of the swash-alignment of Dingle Bay, there is no regional longshore drift component in operation, which limits the supply of sediment to the system. For the purpose of understanding transfers of sediment, Castlemaine Harbour can be compartmentalised into two basins: an inner basin, defined as the area between Cromane in the west and the mainland in the east, and an outer basin, defined as the area enclosed by the seaward sides of Inch and Rossbeigh in the west and Cromane in the east.

The inner basin is characterised by low-energy intertidal sand and mud flats and an extensive saltmarsh fringe. Two rivers – the Maine and the Laune - drain into the inner basin at the easternmost extent of Castlemaine Harbour. The outer basin, where the proposed oyster farming sites are located, is characterised by intertidal mud and sand flats. Here, approximately 1 km east of Rossbeigh, a third river, the Caragh, drains. Fluvial and tidal exchange, mainly through the main inlet channel, facilitates sediment transport within and between the sedimentary environments of the outer basin.

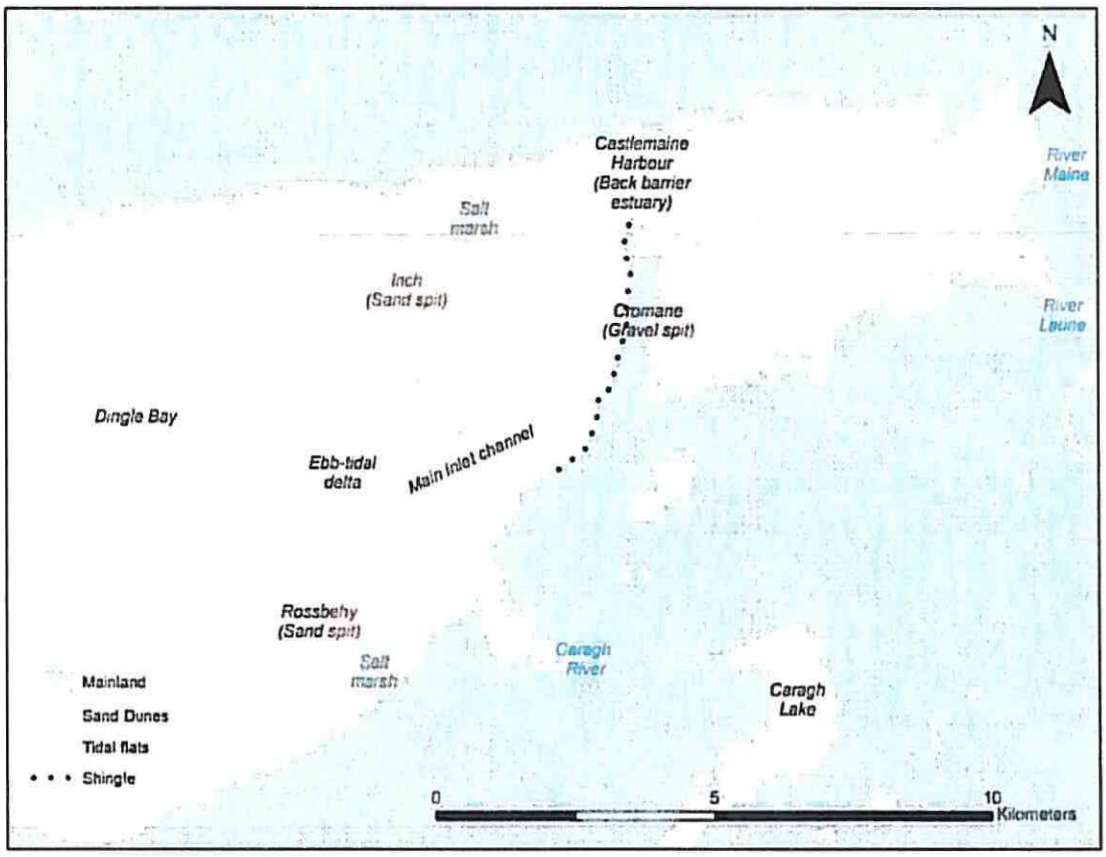



FIGURE 2: Sedimentary environments of Castlemaine Harbour.

## 4 Update on Shoreline & Beach Elevation Changes & Turbidity Assessment

Recent changes in the shoreline position of Rossbeigh and the surrounding area are related to barrier breaching, which occurred in December 2008. Since then, the foredunes in the area adjacent to the breach have been eroding rapidly. For example, between 2012 and 2014, the dunes adjacent to the breach receded by >100 m (Figure 3). Large changes in the shoreline position here occur mainly in winter as a result of high-energy events (storms), whereby wave undercutting can destabilize dune slopes, resulting in erosion and the redistribution of eroded sediment by waves. Sediment is returned to the beach and dunes under low energy wave conditions during summer, and the cycle repeats. If more sediment is eroded in winter than is returned to the dunes in summer, then the shoreline retreats.

The following section discusses in detail pre- and post-breach sedimentary changes that have occurred in the Castlemaine Harbour area. The results of the June 2018 field survey, shoreline and elevation change analyses, and turbidity assessment are presented.

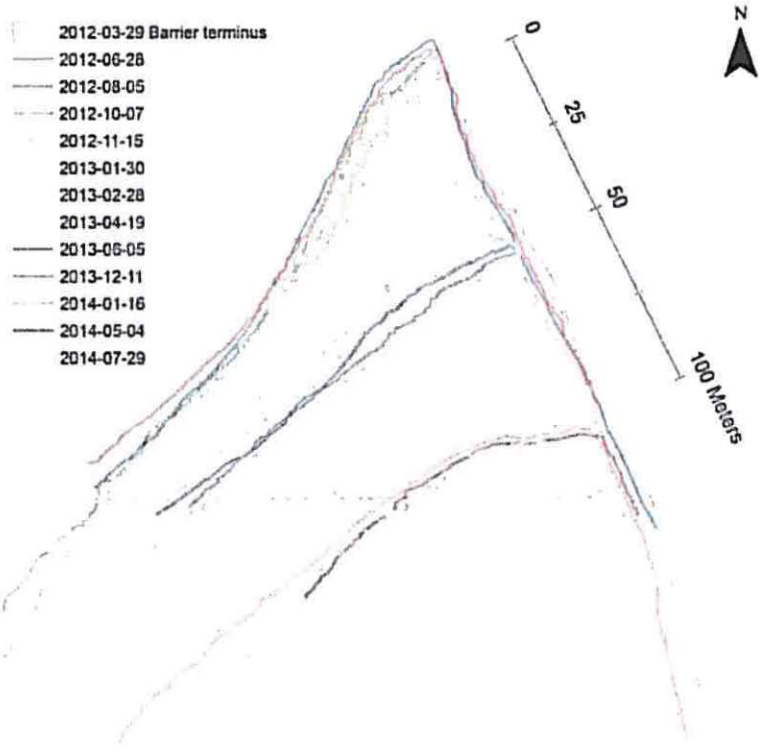



FIGURE 3: Shoreline positions surveyed at Rossbeigh in the area adjacent to the breach from 2012 - 2014. The shoreline is defined as position of the dune toe, or the line along which there is an abrupt change in slope, marking the boundary between the beach and dune. The March 2012 shoreline was digitized from satellite imagery (for reference), while the others were digitized from terrestrial laser scanning survey data. Source: Kandrot (2016)

## 4.1 Field Survey

In order to assess recent sedimentary changes in the area, a field survey was undertaken in June 2018. The shoreline position of the area stretching from Dooks in the East to the island at Rossbeigh in the west was mapped at approximately 25m intervals using a Leica Viva differential GPS system with a positional accuracy of <5 cm. Eight cross-shore beach transects were surveyed in the back-barrier area of Rossbeigh, and a transect across the breach was also surveyed. The surveyed shorelines and elevations were compared with previous data to quantify contemporary shoreline and elevation changes (see sections 4.2 and 4.3).

Field observations made during this and recent trips to the site indicate the development of a second proto-breach at the distal end of Rossbeigh (figure 4). Further to the east, the till cliffs at Reennanallagane were also observed to be eroding. The cliffs are located directly across from the 2008 breach and are orientated perpendicular to incoming waves. Wave undercutting is causing instability in the soft cliffs, causing them to break up and eventually collapse (figure 5).

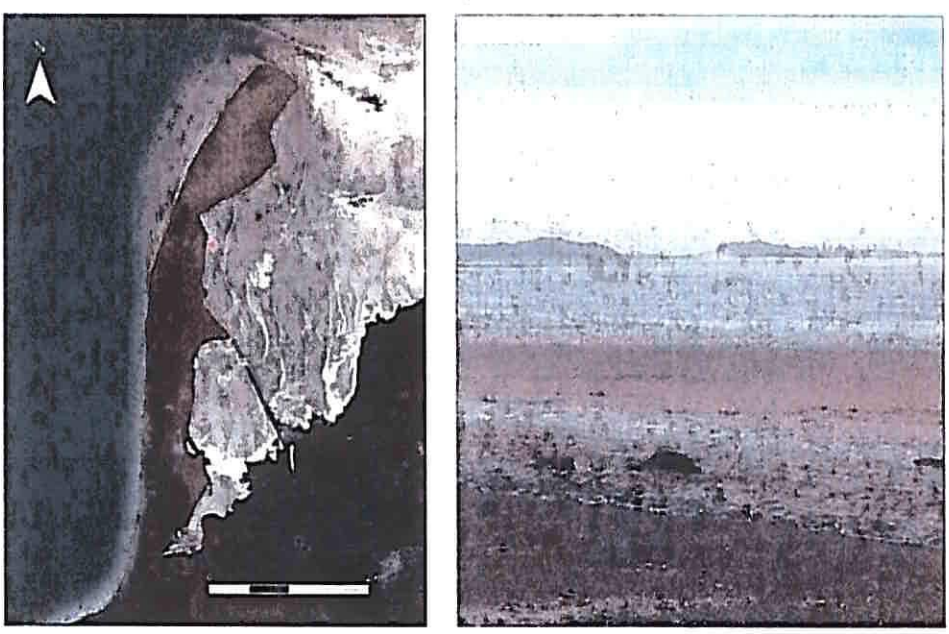


FIGURE 4: Satellite image from 2016 (left) showing the location of a second proto-breach (red arrow) and (right) view of the proto-breach from Reennanallagane (June 2018).

FIGURE 5: Collapsing till cliffs at Reennanallagane (left) and evidence of wave undercutting at the base of the cliff face (right). Using as reference points the positions of newly exposed glacial boulders from the the till-cliff located on the foreshore, it is clear that several meters of cliff-erosion has occurred in the last c.10 years, indicating significant acceleration in shoreline erosion rates in the Outer Harbour area since the 2008 breaching of Rossbeigh Spit (See analysis Section 4.2). This has led to the significant release of sediments into the Harbour area.

## 4.2 Shoreline change analysis

To understand how breaching has affected (and continues to affect) the wider Castlemaine Harbour area, a shoreline change analysis was undertaken for the area extending from White Strand to Dooks Golf Course. Shoreline positions were obtained from the following sources:

- 1894 OSI 6 in maps ('shoreline' represents the high water mark, HWM)
- 1903 OSI 6 in maps ('shoreline' represents the high water mark, HWM)
- 1977 OSI aerial imagery ('shoreline' represents the vegetation line or cliff edge) – 0.4 m resolution
- 2005 OSI aerial imagery ('shoreline' represents the vegetation line or cliff edge) – 1 m resolution
- 2012 ESRI DigitalGlobe satellite imagery ('shoreline' represents the vegetation line or cliff edge) – 0.5 m resolution

- 2016 ESRI DigitalGlobe satellite imagery ('shoreline' represents the vegetation line or cliff edge) – 0.5 m resolution
- 2018 (June) differential GPS Field Survey ('shoreline' represents the vegetation line, dune toe, or cliff edge, where dunes or cliffs are present)

It is important to note that the HWM and dune toe/vegetation line do not always coincide. As such, the 1894 and 1903 shorelines were not used to calculate rates of shoreline change, but are nonetheless presented on the shoreline maps of the site in this report to illustrate long-term change. Pre-breach shoreline change was assessed from the shoreline on the 1977 OSI aerial photo.

For the purposes of this analysis, the area of interest was divided into zones and the analysis was performed on the pre- and post-breach shorelines, for comparison. Following breaching, there was no longer a 'shoreline' at the distal neck of Rossbeigh, apart from the small island north of the breach. As such, shoreline change analyses were conducted for the pre-breach shorelines in the 'recurve zone' and for the post-breach shorelines in the 'island' zone (figure 6).

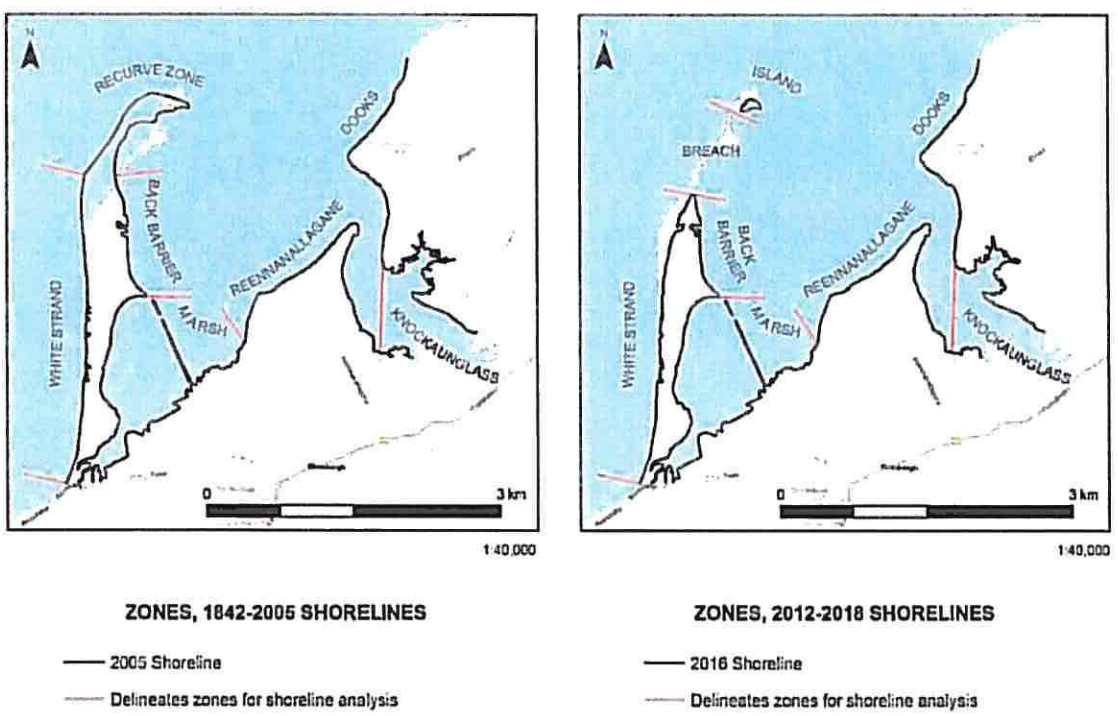



FIGURE 6: Zones in which pre- and post-breach shoreline change analyses were conducted. Following breaching, there was no longer a 'shoreline' at the distal neck of Rossbeigh, apart from the small island north of the breach. As such, shoreline change analyses were conducted for the pre-breach shorelines in the 'recurve zone' (left) and for the post-breach shorelines in the 'island' zone. Elevation change was assessed for the breach along the surveyed transect (see section 4.3).

Figure 7 illustrates the pre- and post-breach shoreline positions across the entire survey area. The main areas experiencing significant shoreline change are the White Strand and recurve/beach/island areas. There have been comparatively smaller changes in the other zones, but these are, for the most part, not large enough to see at the scale of the maps shown in figure 7. As such, these are shown in more detail for each of the zones for the 1842 – 2005 shorelines (figure 8) and 2005 – 2018 shorelines (figure 9).

A series of cross-shore transects were generated in each zone and rates of shoreline change ($m^2$/year) were calculated for each of these transects. Average rates of shoreline change before and after breaching are summarized for the transects in each zone in figure 10. The 'marsh' and 'Reennanallagane' zones have been further subdivided into 'Marsh-North', 'Marsh-South', 'Reennanallagane west' (soft cliffs) and 'Reennanallagane east'.

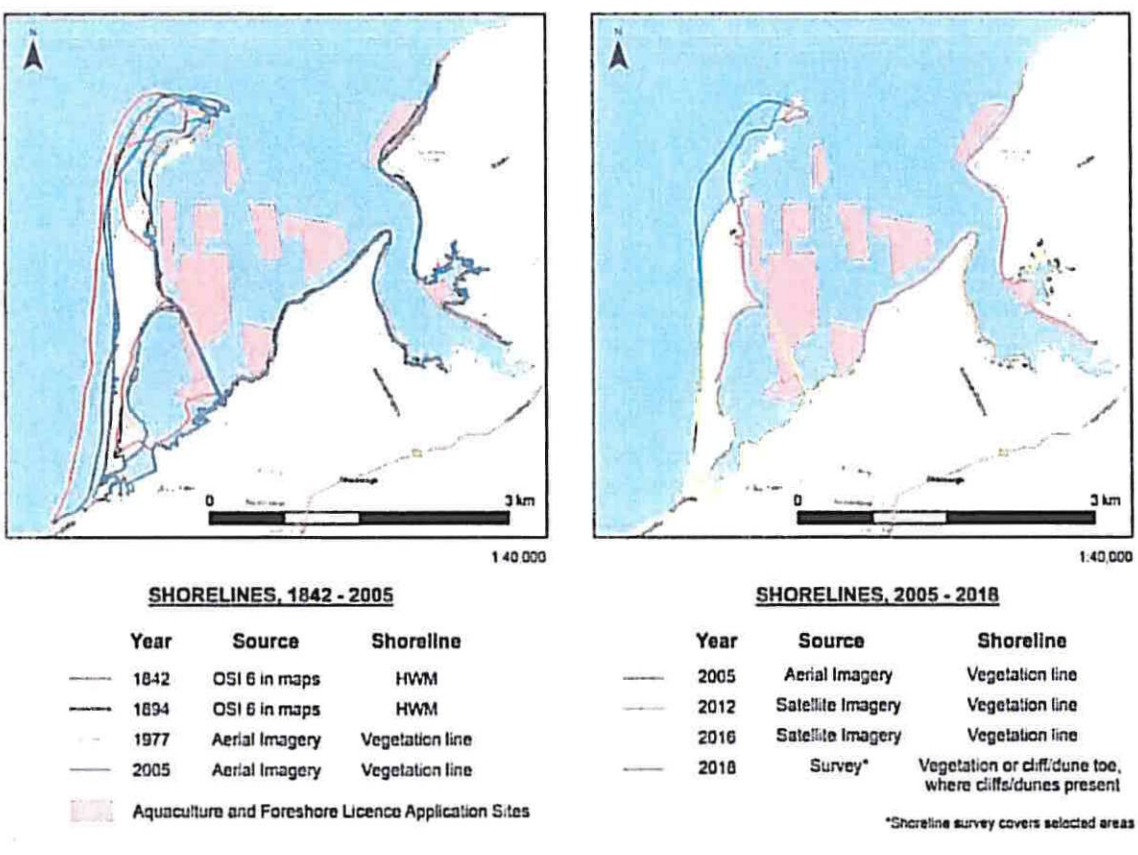



FIGURE 7: Pre- and post-breach shoreline positions across Castlemaine Harbour.

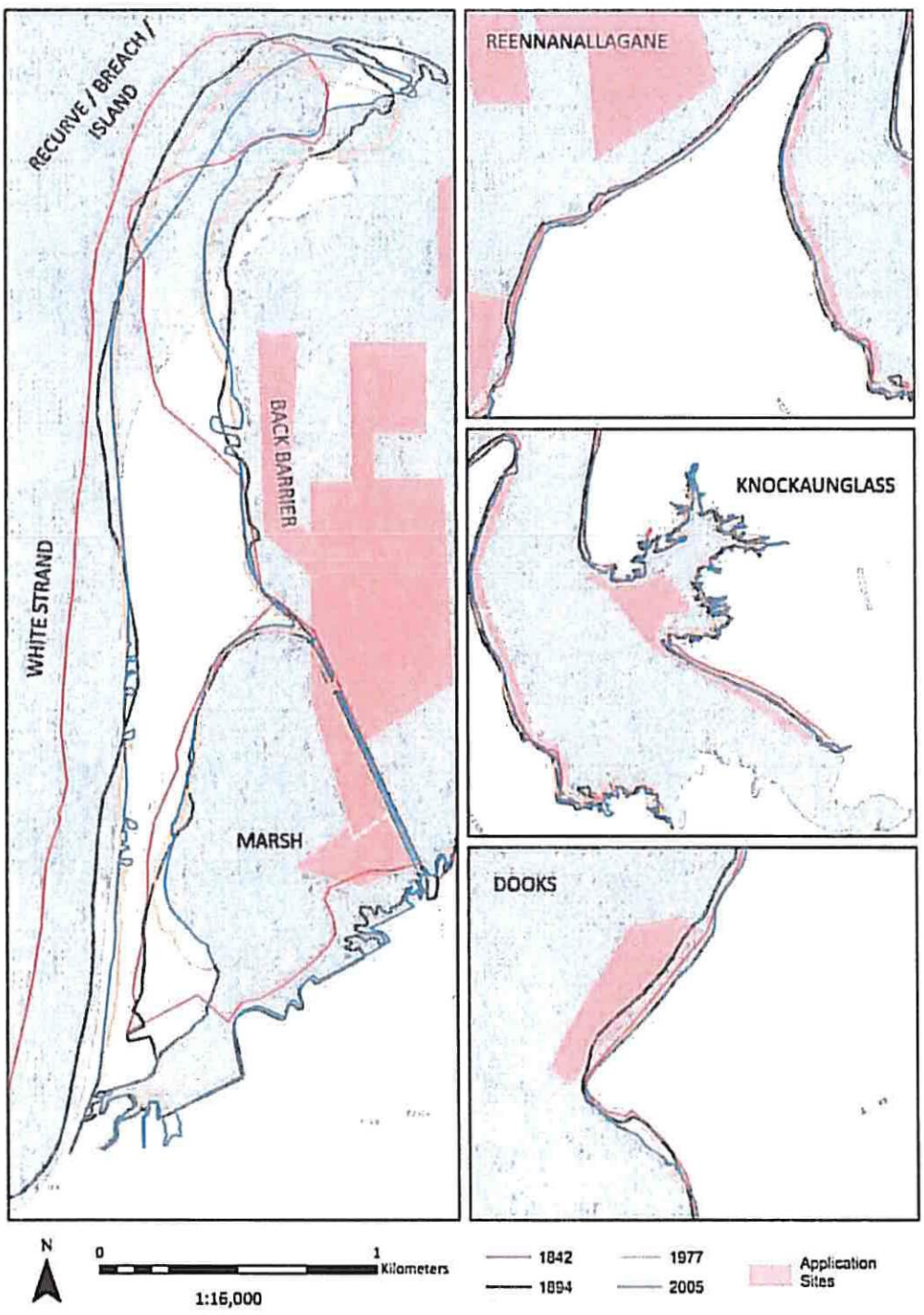



FIGURE 8: Shoreline positions 1842 – 2005.

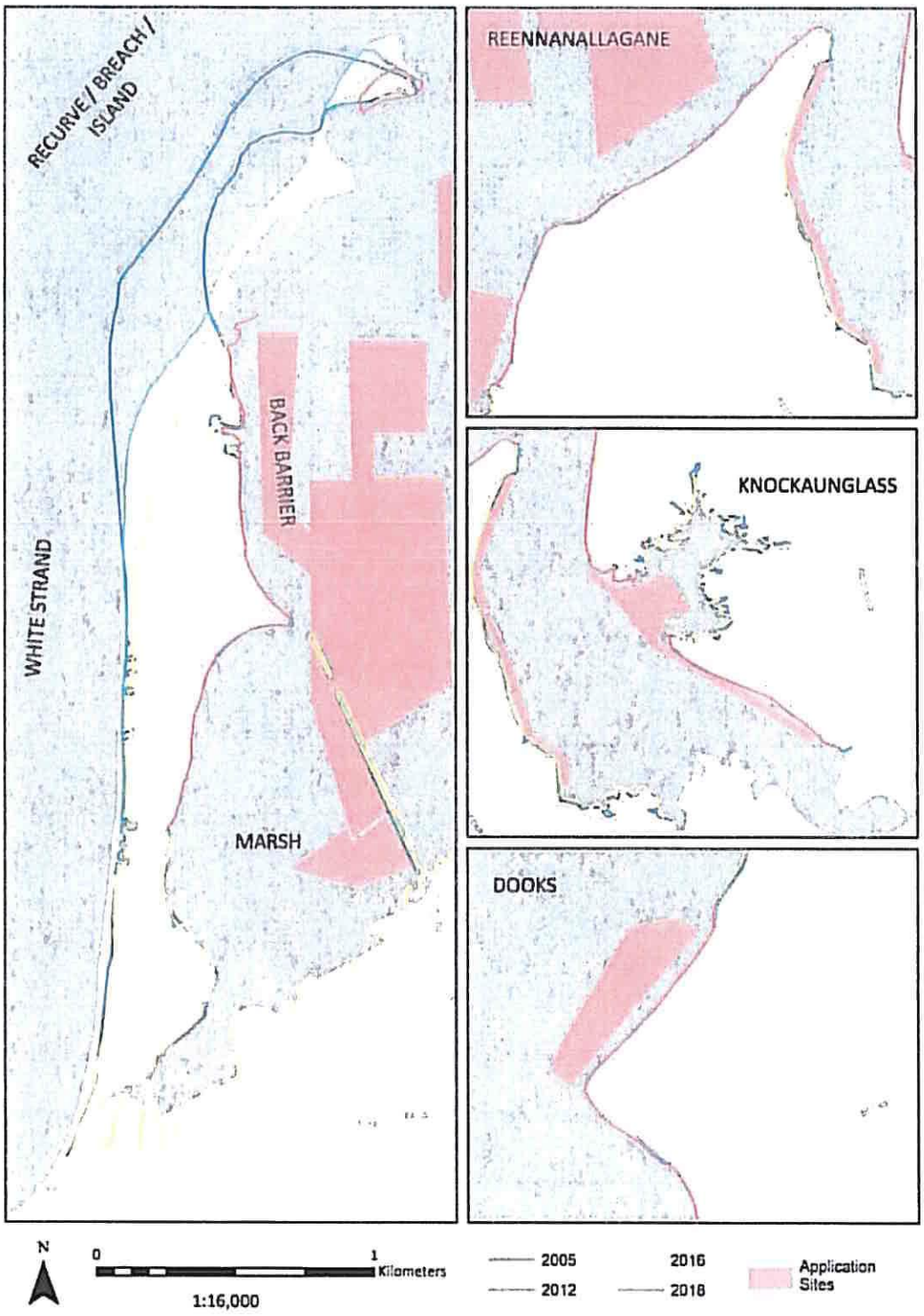



FIGURE 9: Shoreline positions 2005 – 2018.

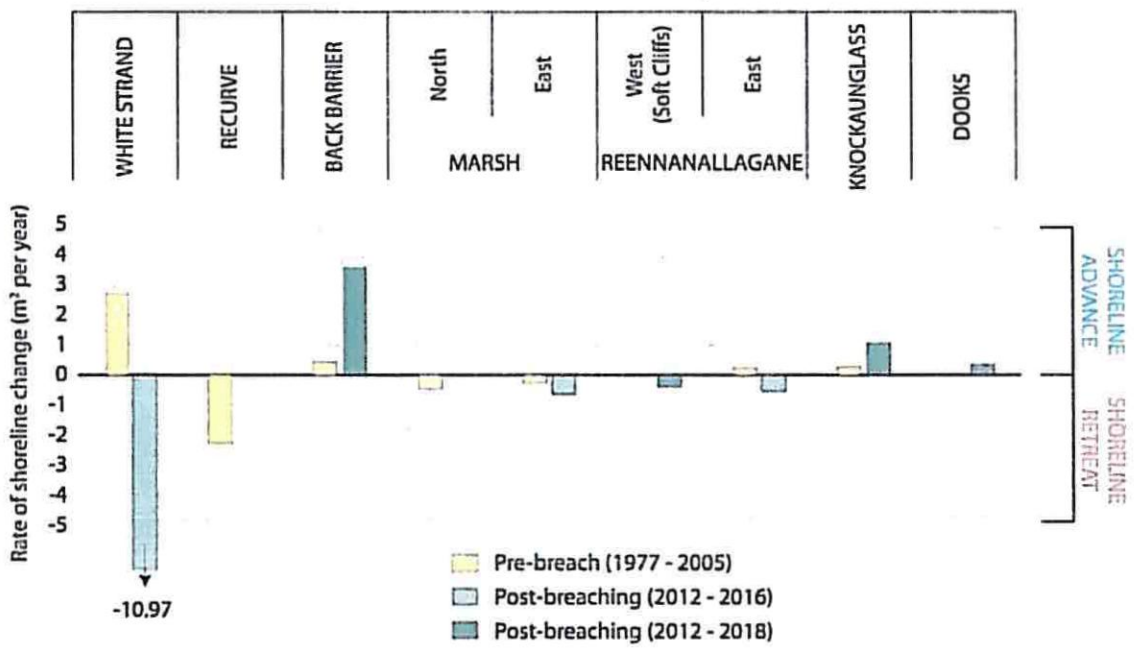



FIGURE 10: Average rates of shoreline change for each zone. As the island shoreline is eroding on its seaward side and advancing at the back, changes in its area are reported (see text). As the 2018 survey did not cover White Strand, the eastern section of the marsh, or the eastern section of Reennanallagane, the 2016 shoreline was used to calculate post-breaching rates of shoreline change.

Between 1977 – 2015, the seaward side of Rossbeigh (White Strand) was advancing at a rate of 2.76 m/yr, while the recurve area was eroding. Following breaching, though, White Strand has been eroding at a rate of 10.97 m/yr, nearly five times the rate of shoreline change for the recurve prior to breaching. The sediment is likely ending up in the back barrier environment, where the rate of shoreline advance has increased eight-fold (from 0.43 m/yr to 3.65 m/yr).

It should be noted that there is some degree of variability in rates of shoreline change along White Strand. The barrier remains relatively stable at its southern neck, but less so nearer the breach.

The island beyond the breach has also been eroding rapidly. Between 2012 – 2018, it decreased in size by more than half (from 36,538 $m^2$ to 17,727 $m^2$). Again, there is some variability with regard to changes in the shoreline position around the island, with the seaward side characterised by retreat and the back-barrier side characterised by (relatively small) advance.

At Reennanallagane, rates of shoreline change went from nearly zero to -0.41 m/yr following breaching. The soft cliffs are particularly vulnerable to incoming waves travelling through the breach during storms.

Elsewhere, rates of shoreline change are relatively low. The shoreline around Dooks is advancing, but this is likely because it is protected (figure 11).

FIGURE 11: Sand fencing and rock armour protect the dunes near Dooks. Here, the system is accreting and a potential source of sediment during storms.

## 4.3 Elevation change analysis

Elevation change along the shoreline was assessed from aerial Light Detection and Ranging (LiDAR) data obtained in 2011 and the differential GPS data from the 2018 field survey. The resolution of the aerial LiDAR data was 2 m with an accuracy in the vertical of 25 cm. A total of 552 dGPS elevation measurements were made across the Castlemaine Harbour area, mainly along the shoreline, with a transect through the breach and eight cross-shore transects in the back barrier area. The vertical accuracy of the dGPS measurements was <5 cm.

Figure 12 summarises statistically elevation changes in each zone. These changes are mapped for each zone in figure 13. The data show that the breach has been infilling with sediment (accreting), probably eroded from the barrier dunes. Incidentally, the area at the base of the dunes on the island and in the back barrier has been lowering.

The beach at Reennanallagane has been accreting. This is likely due to slumping of the receding till cliffs. This slumped material is a source of sediment to the system. During storms, this material can be reworked by waves and enter the nearshore environment. This could result in the burial of oyster trestles seaward of the cliffs.

At Knockaunglass, the marsh fringes are eroding, and at Dooks, the beach is accreting in the north and lowering in the south.

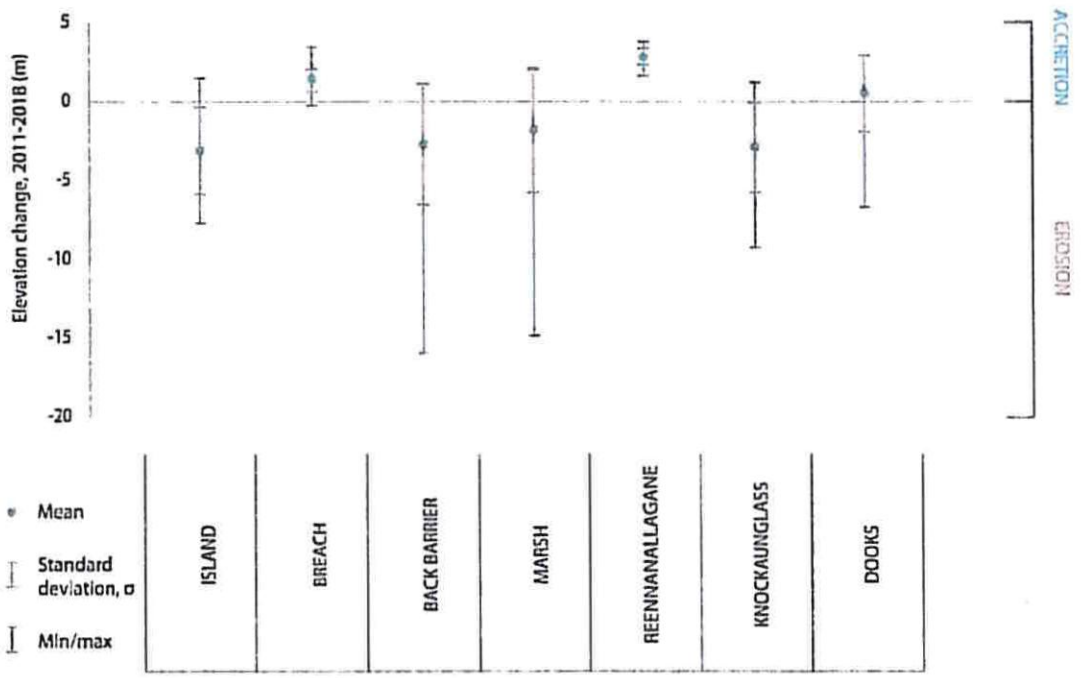



FIGURE 12: Beach elevation change statistics, 2011-2018. Min/max and standard deviation included to show intra-site variability.

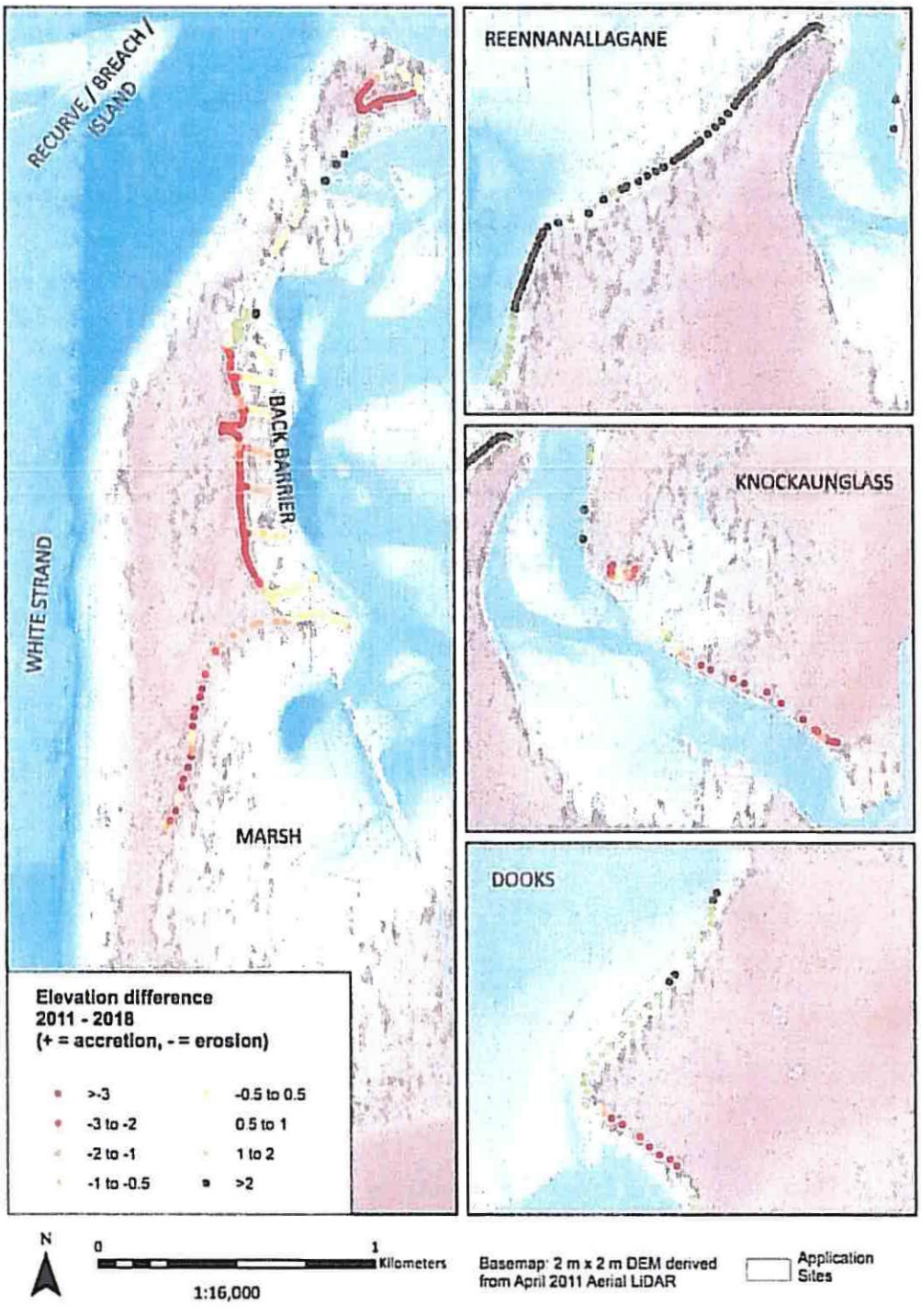



FIGURE 13: Elevation change, 2011 – 2018 per zone.

## 4.4 Turbidity assessment

Oysters are filter feeders that thrive in estuarine environments, taking advantage of the plentiful suspended matter in the water column. However, when total suspended matter (TSM)[1] concentrations rise above certain thresholds, it can be harmful or even deadly. Concentrations of >60 g/m$^3$ have been reported to reduce oysters' ability to effectively filter water, and concentrations of >200 g/m$^3$ can result in saturation of their gills (Gernez, Doxaran and Barillé, 2017).

Increases in energy in estuarine systems (*e.g.* as a result of barrier breaching or during storm events) can increase water turbidity. To see if this was the case following breaching at Rossbeigh, pre- and post-breaching changes in TSM were assessed from classified satellite imagery provided by the European Space Agency (ESA) as part of the GlobColour project. GlobColour data (http://globcolour.info) has been developed, validated, and distributed by ACRI-ST, France. TSM data was available for the site at 4 km x 4 km resolution on a daily or monthly basis spanning the period September 2002 to April 2012. Monthly mean data were downloaded for this period and averaged across five pixels (80 km$^2$) covering the back barrier area. The data are plotted in figure 14.

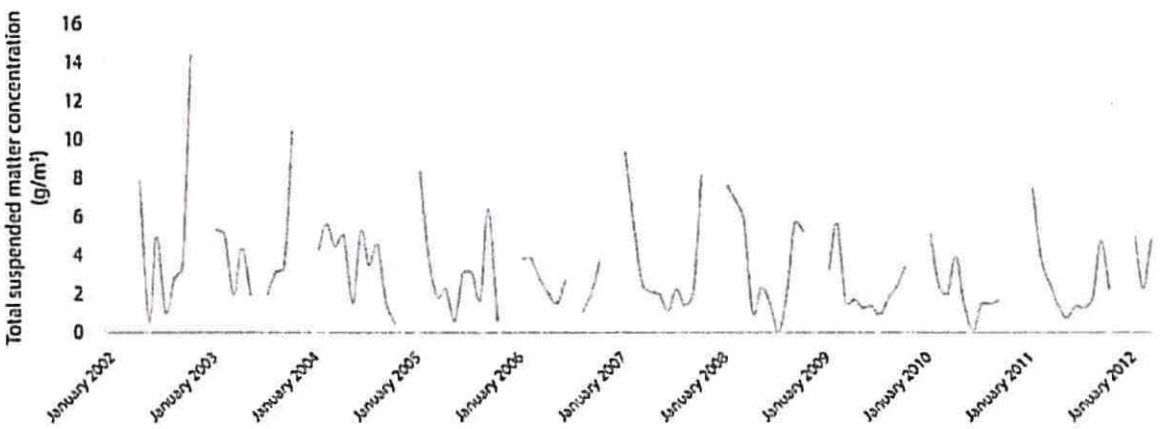



FIGURE 14: Mean monthly total suspended matter concentration (g/m$^3$) derived from GlobColour satellite-derived data for back barrier area. Data gaps are due to cloud cover. The mean for the entire period was 3.29 g/m$^3$, with a max of 25.79 g/m$^3$ (November, 2002). These mean monthly concentrations are well below thresholds for oysters' ability to effectively filter water. However, daily concentrations may exceed these thresholds, but further analysis of the data would be required to test this. Also, the satellite data examined cover only the period to 2012. Since then there have been significant changes in the sedimentary patterns within the Harbour area.

[1] Total suspended matter refers to the concentration of solids in the water column. Increases in TSM result in increases in water turbidity (cloudiness), which can negatively affect ecosystems in the Bay.

There are several gaps in this data, most notably monthly mean TSM for November and December of all years are missing. This is due to obstruction of the visible imagery by cloud cover. Given the fact that turbidity is likely to be highest during storms, the data do not necessarily give a complete picture of turbidity at the site. In addition, monthly means mask intra-monthly variability (*e.g.* daily TSM values may be significantly higher than monthly means, particularly during storms).

From the data that was available, there is no indication of increased turbidity following breaching. The mean monthly value was 3.29 $g/m^3$, with a maximum of 25.79 $g/m^3$ (October 2002). These values are well below the thresholds for oysters' ability to effectively filter water. However, to better understand variability in TSM, an assessment of daily values should be undertaken, especially at times of high energy conditions (*e.g.* where the gaps are in the satellite data).

Also, the available dataset only extends to 2012. It is clear from the shoreline and elevation change analyses that the system is continuing to undergo significant sedimenatary changes up to 2018, with additional sediment entering into the system, especially during storms. It's important to note that storminess and seasonal wind patterns have already begun to alter markedly for the area, releasing more energy into the coastal waters and possibly affecting daily to seasonal TSM levels. Consequently, it would be advisable to undertake water sampling under high-energy conditions at the proposed oyster farming sites and in the Harbour area in general to collect reliable, instantaneous turbidity data. Ideally, this would be monitored regularly, which would give a better understanding of the impacts of the ongoing sedimentary changes on habitats/ecosystems within the bay. Increases in energy/sedimentation can have a profound impact on the structure and function of estuarine ecosystems, reducing their value and representing a significant threat to industries such as fisheries and aquaculture (Thrush *et al.*, 2004). These changes would also have a knock-on effect on birdlife in the estuary, although further work would be required to assess this.

## 5 Sedimentary Changes: Past, Present and Future

In order to best understand the present and future sedimentary changes at Rossbeigh, it's important to look to the past. The Rossbeigh dune-barrier formed in its present position c.4,000 years ago and was linked probably at that time with the similar barrier at Inch. Together these structures closed off the area of the present day Castlemaine Harbour, allowing the development of extensive freshwater wetland environments. Since then there is good evidence of subsequent times of significant breaches of the Rossbeigh dune-barrier and of linked sedimentary changes to Castlemaine Harbour. This is particularly noticeable in the paleoenvironmental record at about 3,000 years ago and particularly in the last 200 years. These were driven primarily by the impacts of storm surges, but also by changes in local - regional sediment supply and patterns of distribution. Sea-level rise has also been a significant underlying driver to the barrier breaching. More recently, the role of climate warming has begun to stimulate this control of sea-level rise and will continue to form a major control to future breakdown of the barrier.

Changes in sediment transfers brought on by barrier breaching of Rossbeigh in 2008 have resulted in highly dynamic morphological behavior of the system over the last decade. From an initial width of 500 m, the breach has widened to >1,600 m as of 2018. Semi-diurnal tidal exchange through the breach was most recently observed in June 2016, although recent field observations in June 2018 suggest the breach has infilled with sediment to the extent that tidal exchange is no longer occurring. Dune erosion in the vicinity, though, is continuing as the drift aligned zone of the barrier (distal end) continues to expand at the expense of the more stable swash-aligned section of the barrier.

Recent modelling work indicates that the local sedimentary environment is likely to remain unstable (Kandrot, 2016). The results of this work suggest that even under conservative projections of sea-level rise (10-50 cm by 2100), storms will contribute to a net offshore movement of sediment in the near shore zone of Rossbeigh. This will inevitably lead to shoreline retreat and could result in the drowning of the barrier if back barrier saltmarsh sediments cannot accumulate fast enough to keep up with rising sea-level. In the absence of a new source of sediment, the net removal of sediment from the system combined with the removal of the protective barrier will likely result in significant changes to the back barrier system. Given the dynamic nature of the locality, it's possible that areas that are currently intertidal may not remain so into the future (short- to medium-term). Where breaching has occurred, the redistribution of sediment from the eroded dunes has caused infilling of the original breach. However, the absence of the dunes means that the back barrier area is still vulnerable to wave attack during periods of high water (e.g. storm surge / storm waves).

The development of a second breach would also cause further instability, including an influx of sediment into the immediate vicinity of the back barrier and the potential for increased exposure of the back barrier environment to high energy

conditions during storm events. The question of when the barrier will breach next depends now upon the behaviour of the off-shore ebb-tidal delta and sediment build up, together with the role of the increasing magnitude of storms, such as Ophelia in 2017 – a hurricane scale event - and particularly the direction of approach of such on-shore storms.

The appearance of the proto breach at Rossbeigh so soon after the 2008 event and the earlier complete breach of the barrier suggests that in spite of the infilling of this 2008 gap, further breaching is imminent. Complete barrier breakdown at Rossbeigh is also possible and even probable within the next 20 years – though much here depends on future storm sizes and the linked sediment dynamics, together with the rates of acceleration in sea-level rise.

In the coming years, further increased storm and daily wave penetration into Castlemaine will occur behind the barrier. Erosion of the rear (eastern edge) of the barrier will occur together with internal dune instability and weakening. In addition, wave erosion of the till – glacial sediment cliffs around the Dooks/outer Castlemaine Harbour area will continue, consequently increasing sediment supply to intertidal areas. Much of this sediment will remain trapped inside this Harbour sedimentary system under continuing strong onshore wave action, leading to increased sediment build up within the harbour and water shallowing.

The potential changes expected for the embayment/back barrier area are outlined as follows:

- Short-term (1-5 yrs): At present the barrier area is still responding as a system to the 2008 and 2014 breaches and remains in flux. Consequently, what will happen in the next two to three years is unclear, but the impacts of these breaches have already caused:
  - **a)** erosion of the back and inner embayment areas,
  - **b)** increased sedimentary movements and overall turbidity of the back-barrier water areas during high wave energy and tidal current action,
  - **c)** shallowing of the intertidal areas, as eroded sands build up under increased sediments supply, and
  - **d)** probable rises in water temperatures, as the water bodies shallow with increased sedimentation.
- Medium-term (5-10 yrs): More breaching and a worsening of the above sedimentary environmental changes. Increased turbidity will have a negative impact on the estuarine ecosystem.
- Long-term (next 20 yrs): Likely barrier destruction and squeeze/set back of coastal systems under increasing storm magnitudes and rates of sea level rise, together with the shifting wind regime (with stronger easterly component winds/ storms driving wave action).

## 6 Implications for Oyster Farming

The changes outlined above are likely to make oyster farming in the embayment unviable. If the operations were to go ahead, the potential impacts of trestles on the seabed (e.g. scouring) are likely to be minimal in comparison to the much larger sedimentary changes occurring in the back barrier area.

The impacts of oyster farms for individual areas are assessed for individual areas as follows:

Back-barrier embayment/Dooks

- Erosion of the dunes and cliffs will initially result in an influx of sediment into the embayment, resulting in burial of the oyster cages by released sands from these sources, especially following high-energy events
- The direct impact of the oyster cages would likely be on the disruption of sediment transfers within the Dooks embayment, resulting in an increase in the build-up of localised sediments.
- The operations are likely to result in changes to water quality and localised pollution from plastics/refuse being trapped by the cages and from the servicing of the oyster bed sites.

Caragh Estuary Area

- The positioning of trestles will lead to the blockage of fine sediments discharging from the Caragh River, though currently this suspended sediment component is low.
- Other changes in water exchanges and tidal flows within the river/estuary will occur as coarse sediments/sands build up in the outer bay under on shore wind and wave action.

Under the current uncertainties (with regard to sediment transfers in the area), dangers in future permission being granted are outlined as follows:

- The current environmental uncertainty about barrier behaviour is a temporary one – significant changes will occur at the site over the next five years.
- Permission now will give a false sense of security to businesses and others intending to develop in these areas of high risk from coastal erosion and ones of overall high vulnerability.
- Permission will provide an unreasonable expectation of security for the oyster farm developers. They are likely to lose their investment money.
- Issues concerning public attitudes of aesthetics should be considered.

## 7 Summary

- Significant dune erosion has been occurring in the area adjacent to the breach at Rossbeigh since 2011, with a second incipient breach developing since 2014
- While the dunes are receding, the breach is infilling with sediment, although in the absence of the protective barrier dunes, the back barrier environment is still vulnerable to wave action during storms
- The rate of erosion of the soft cliffs at Reennanallagne has increased since breaching occurred in 2008 and represents a source of additional sediment to the system. This additional source of sediment could result in the burial of trestles following high-energy events
- Recent modelling work indicates that the sedimentary environment is likely to remain unstable under conservative projections of sea-level rise (10-50 cm by 2100)
- Complete barrier breakdown at Rossbeigh is possible and even probable within the next 20 years – though much here depends on future storm sizes and the linked sediment dynamics, together with the rates of acceleration in sea-level rise
- Increases in water turbidity as a result of breaching are likely to have negative impacts on the ecology of the bay, but more data is required to test this
- Increases in sedimentation will likely negatively impact aquaculture and fishing activities in the area in the medium- to long-term
- The changes outlined in this report are likely to make oyster farming in the embayment unviable in the short- to medium-term

## Author Bios

Sarah Kandrot is a freelance environmental consultant and research support officer in the School of Biological, Earth and Environmental Sciences at University College Cork. Dr. Kandrot earned a PhD in Geography from UCC, where her work on the monitoring and modelling of the coastal barriers in Castlemaine Harbour provided key insights into the response of these systems to sea-level change. The results of this work have been presented at numerous national and international conferences and published in a special edition of the academic journal *Earth Surface Processes and Landforms*. Dr. Kandrot also holds a bachelor's degree in Earth Science from Boston University (Boston, MA, USA) and a first class honours master's degree in Coastal Zone Management and GIS from UCC.

Robert Devoy is Emeritus Professor of Geography and Professor in Physical Geography in University College Cork after retiring in September 2011 as the Head of the School of Geography and Archaeology: The Human Environment. He continues to work as senior scientist and technical advisor at the Centre for Marine and Energy-based Research (MaREI), UCC and is involved with a range of EU Framework, EPA and other nationally funded research projects, dealing particularly with issues of coastal science and management, together with aspects of climate, energy and linked environmental changes. Prof. Devoy was a lead author in the Intergovernmental Panel on Climate Change's (IPCC) Nobel Prize winning Fourth Assessment Report.

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