Improvement Programme for England's Natura 2000 Sites (IPENS) – Planning for the Future IPENS035

Distribution of selected non-native species within the intertidal zone of the North East Kent Marine Protected Areas

Thanet Coast and Sandwich Bay Special Protection Area (SPA)
Thanet Coast Special Area of Conservation (SAC)
Sandwich Bay Special Area of Conservation (SAC)

First published 05 April 2016

www.gov.uk/government/publications/improvement-programme-for-englands-natura-2000-sites-ipens

This project is part of the IPENS programme (LIFE11NAT/UK/000384IPENS) which is financially supported by LIFE, a financial instrument of the European Community.

Foreword

The **Improvement Programme for England's Natura 2000 sites (IPENS)**, supported by European Union LIFE+ funding, is a new strategic approach to managing England's Natura 2000 sites. It is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when they will target their efforts on Natura 2000 sites and areas surrounding them.

As part of the IPENS programme, we are identifying gaps in our knowledge and, where possible, addressing these through a range of evidence projects. The project findings are being used to help develop our Theme Plans and Site Improvement Plans. This report is one of the evidence project studies we commissioned.

A project was commissioned for the North East Kent European Marine Sites, which comprises Thanet Coast Special Area of Conservation (SAC), Sandwich Bay SAC, and Thanet Coast and Sandwich Bay Special Protection Area (SPA), to monitor the distribution of non-native species within the intertidal zone and to record the impact on native species and habitats. This work included the monitoring of established Pacific oyster transects, and well as monitoring the interaction between this species with common mussels and *Sabellaria spinulosa*. The report indicates that pacific oyster distribution has retreated, or remained stable, at eleven of the fourteen transects. The remaining three transects recorded an advance in pacific oyster recruitment, however, the report highlights this is at an early stage of invasion and therefore a prime location for volunteer control work.

During July 2012 and July 2013 a one-year Pacific oyster control trial took place using volunteer labour. This project reviewed this trial and assessed the feasibility of controlling wild Pacific oysters at selected locations within the inter-tidal zones using volunteer labour. The report confirms that oyster numbers reduced at the trial site, in comparison with increases in numbers at the three control sites. The trial highlighted both positive and negative aspects of management, however, demonstrated that in the short-term it was possible to control local populations of pacific oysters using volunteer labour.

The report goes on to make a number of recommendations, to be addressed in future phases, including identifying specific areas for future monitoring as well as further research to determine if pacific oyster control, using volunteer labour, can be sustained in the long-term.

The key audience for this work is the staff within Natural England and land managers and should be used to inform future monitoring and management requirements across the site.

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ISBN 978-1-78354-300-7

Distribution of selected non-native species within the intertidal zone of the North East Kent Marine Protected Areas

Willie McKnight

Introduction

This project was commissioned by Natural England under the title of “Long-term Monitoring Programme of Pacific Oyster Distribution and Recruitment within the inter-tidal components of the North East Kent European Marine Sites”. The project developed on an annual basis (phases) from April until March with the structure of each phase informed by the results of the previous year. The initial aim was to establish a distribution baseline and record the impact on native species and habitats.

Priority sections were identified from the baseline data and a monitoring programme was initiated. This identified Western Undercliff, Ramsgate as a section that was rapidly advancing in terms of recruitment and reef formation. This section is located within the Sandwich and Pegwell Bay National Nature Reserve and concern was raised regarding oyster population expansion resulting in modification of the mussel bed and mudflat habitats.

To impede this threat, a small team of volunteers was recruited, trained and equipped to assess the feasibility of containing the spread of wild Pacific oysters at selected locations using volunteer labour. A one-year field trial was conducted at Western Undercliff during which the team physically removed oysters.

In 2011, following the discovery of *Didemnum vexillum* on the north Kent coast, Natural England added five further non-native species:

- *Didemnum vexillum*
- *Eriocheir sinensis*
- *Sargassum muticum*
- *Undaria pinnatifida*
- *Caulacanthus okamurae*

Since then, the project has been re-named “ Distribution of Selected Non-native Species within the Inter-tidal Zone of the North East Kent Marine Protected Areas”

This phase was conducted between April 2013 and March 2014 and consisted of 10 strands:

1 monitor Pacific oyster transects
2 monitor the inter-action between common mussels *Mytilus edulis* and Pacific oysters
3 monitor the inter-action between *Sabellaria spinulosa* and Pacific oysters
4 monitor Pacific oyster settlement on tidal drift at sediment locations
5 complete the Pacific oyster control trial
6 recruit, train and equip a minimum of six new volunteers
7 schedule a minimum of twenty post trial field events
8 set up a second volunteer team within the Canterbury City Council zone
9 update Natural England’s GIS database
10 horizon scan for *Mnemiopsis leidyi*

Contents

1 Monitor Pacific oyster transects

1.1 Transect 1 Swalecliffe

Aim

The aim was to develop current monitoring techniques, enhance distribution and recruitment data and improve understanding of population dynamics.

Method

The method described was used for all fourteen transects. The North East Kent Marine Protected Areas (NEKMPA) was divided into 14 zones each spanning 3 kilometres of coastline. A transect was randomly positioned within each zone. This arrangement provided a source of representative samples from across the expanse of the NEKMPA.

Each transect was100 meters long and 10 meters wide beginning inshore and running across the profile of the inter-tidal zone. Each start point was positioned on a hard substrate at or near the high water line. Start and end points were recorded using GPS and where possible steel pins were hammered into the substrate to aid location. Transects were positioned randomly using Ordnance Survey eastings in north facing zones and Ordnance Survey northings in east facing zones.

Each transect covered an area of 1000 square meters and was divided into 10 compartments each 100 square meters (referred to as quadrats) which were surveyed individually to provide a record of distribution across the profile of the shore. Figure 1 illustrates a typical example of the transect design.

Figure 1 Typical transect design

Within each quadrat oyster numbers were counted using a hand tally counter. Shell lengths were recorded using steel callipers and the dominant substrate type was recorded. A Ms. Word document was produced to record details per transect and survey data were transferred to a Ms. Excel spreadsheet.

Results

Table 1 shows results for transect 1. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 1 Results from transect 1

Transect 1 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	43	33	37	6	67	98	119	99	131	142	775
Mean Length	66	66	64	49	66	74	78	79	72	66	71
Standard Deviation	17	13.1	15.1	11.2	17.4	19.6	21.8	23.9	24.8	22.7	22
Total Oysters <60mm	15	9	18	5	25	21	30	25	47	61	256
% Population < 60mm	35	27	49	83	37	21	25	25	36	43	33
Total Oysters >100mm	1	0	1	0	0	10	20	18	23	12	85
% Population >100mm	2	0	3	0	0	10	17	18	18	8	11
Mean Density (sq.m)	0.43	0.33	0.37	0.06	0.67	0.98	1.19	0.99	1.31	1.42	0.78
Dominant Substrate	Flint	Flint	Flint	Flint/Water	Flint	Flint	Flint	Flint	Flint	Flint	

Analysis

Figure 2 shows the distribution of Pacific oysters per quadrat across transect 1.

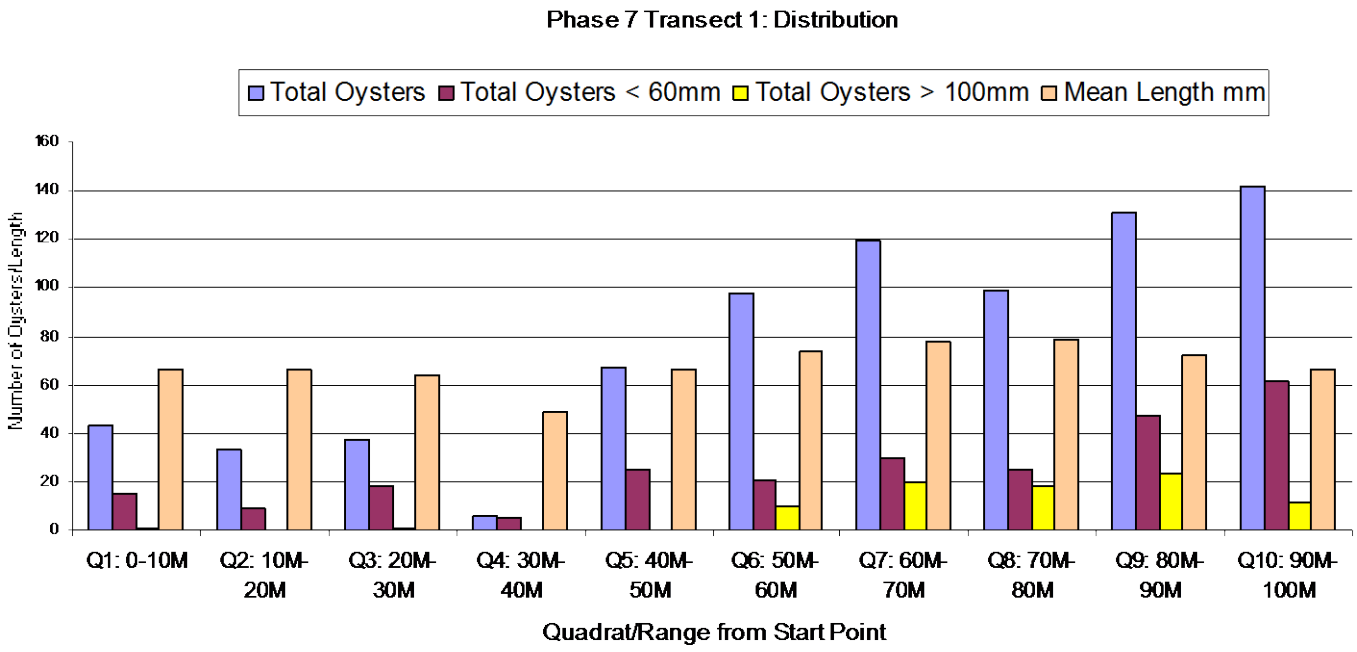

Figure 2 Distribution of Pacific oysters across transect 1

Oyster numbers increased from upper shore to lower shore even though the substrate was uniform across the range. The largest specimens were found in the lower shore zone. Recruitment, represented by oysters <60mm, occurred in all quadrats but was most abundant in the lower shore.

Figure 3 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in August 2013 and phase 6 sample was obtained in July 2012.

It can be seen that oyster numbers have reduced during this period despite the considerable level of recruitment shown in table 1. This suggests that a disturbance has occurred. The disturbance is probably due to the displacement of flint pebbles and shell fragments which form the surface of the substrate. During phase 7 many pebbles were seen with the remains of oysters attached. A steel marker pin which was hammered into the substrate when the transect was set up was now showing 120mm above the surface layer compared to 50mm when originally fixed. This highlights the instability of the surface layer material and the vulnerability of any attached oysters.

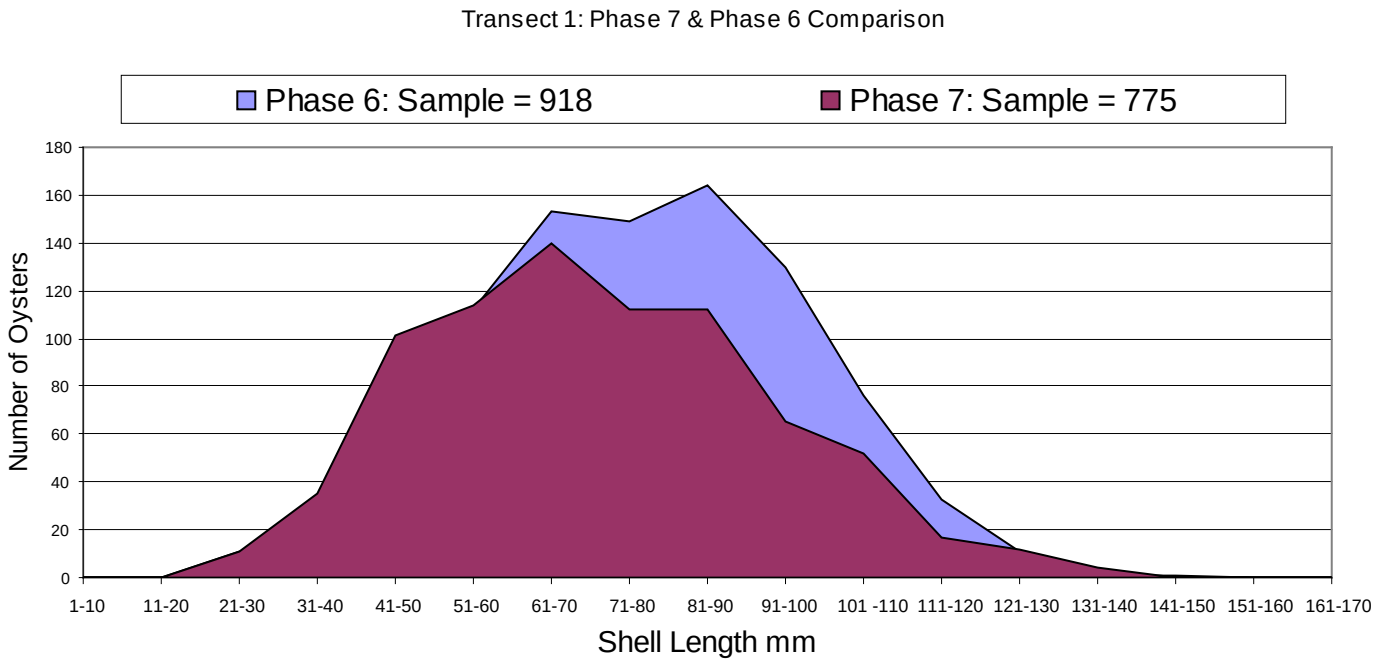

Figure 3 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has retreated. Results show that recruitment and natural control are occurring at this location. Recruitment is affected by the annual temperature regime and natural control is dependent on the prolonged winter storms with associated north-easterly gales which affect this north facing coast. The site is located on a long established spit of pebble, shell fragments and scattered mussels. Although the spit is stable the surface layer material is affected by wave energy during storm periods resulting in displacement and mortality of attached oysters.

These factors could provide a measure of stability in terms of the future oyster population at this site.

1.2 Transect 2 Beltinge

Method
The method used for all 14 transects is described in section 1.1 page 1.

Results
Table 2 records results for transect 2. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 2 Results from transect 2

Transect 2 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	8	18	11	2	9	1	43	5	2	3	102
Mean Length	73	65	64	55	66	64	59	81	76	85	65
Standard Deviation	22.3	11.9	16	6.4	16.4	0	16.1	27.6	14.1	17.5	17.3
Total Oysters <60mm	3	8	4	2	2	0	21	1	0	0	41
% Population < 60mm	38	44	0	100	22	0	0	0	0	0	40
Total Oysters >100mm	1	0	0	0	0	0	0	2	0	1	4
% Population >100mm	0	0	0	0	0	0	0	0	0	0	4
Mean Density (sq.m)	0.08	0.18	0.11	0.02	0.09	0.01	0.43	0.05	0.02	0.03	0.1
Dominant Substrate	Flint	Flint	Flint	Flint	Flint	Flint	Flint Sandstone	Flint	Flint	Flint	

Analysis
Figure 4 shows the distribution of Pacific oysters per quadrat across transect 2.

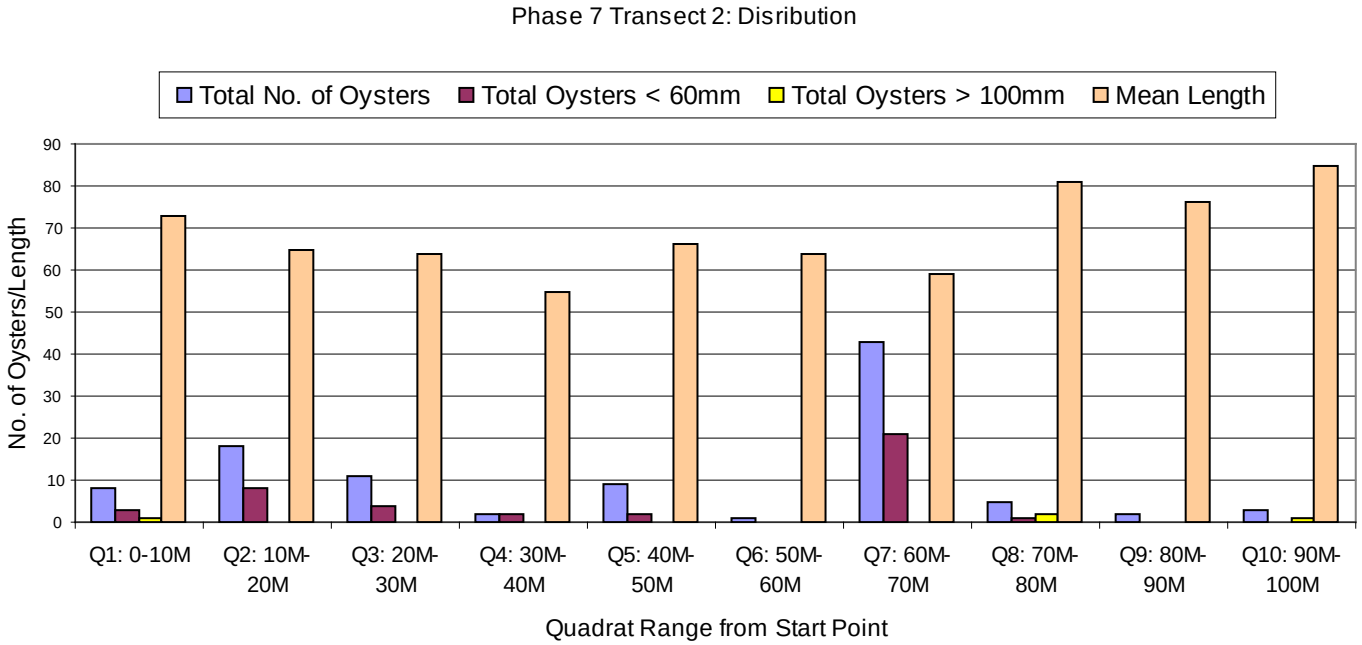

Figure 4 Distribution of Pacific oysters across transect 2

Oysters were present across the shore but peak density occurred in the lower shore zone. The largest specimens were found in the lower shore zone. Recruitment, represented by oysters <60mm,

was patchy but more frequent in the mid shore. Peak settlement and recruitment occurred on sandstone blocks located in Q7.

Figure 5 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in July 2013 and phase 6 sample was obtained in July 2012.
Table 2 shows that recruitment had occurred but overall there had been little change at this location. The sandstone blocks with associated mussel cover provided a favourable substrate for oysters within the transect. Other quadrats consisted of scattered flint pebble on mud.

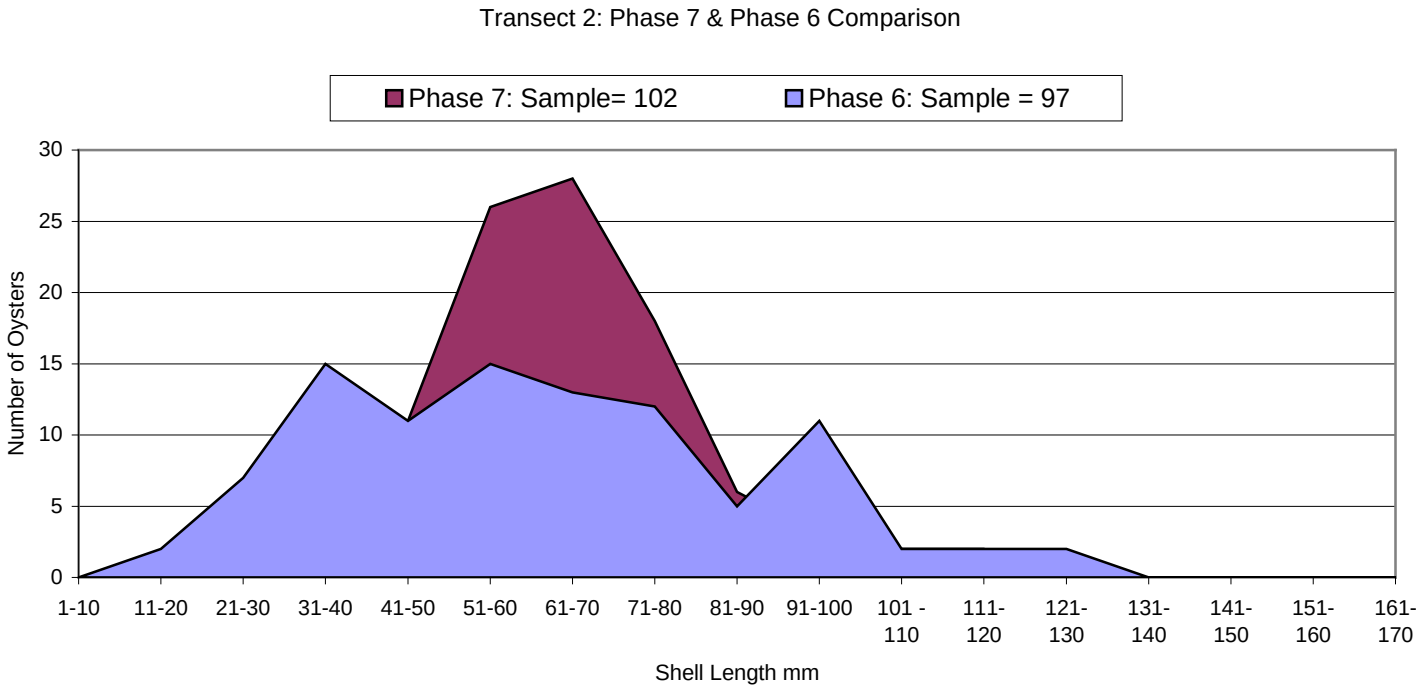

Figure 5 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has remained stable. Results show that recruitment and natural control are occurring at this location. Recruitment is affected by the annual temperature regime and natural control is dependent on the prolonged winter storms with associated north-easterly gales which affect this north facing coast. The displacement of flint pebbles and shell fragments which form the surface layer of the substrate result in the mortality of attached oysters.

These factors could provide a measure of stability in terms of the future oyster population at this site.

1.3 Transect 3 Bishopstone

Method
The method used for all 14 transects is described in section 1.1 page 1.

Results
Table 3 lists results for transect 3. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 3 Results from transect 3

Transect 3 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	0	0	0	0	0	0	0	1	0	0	1
Mean Length	0	0	0	0	0	0	0	41	0	0	41
Standard Deviation	0	0	0	0	0	0	0	0	0	0	0
Total Oysters <60mm	0	0	0	0	0	0	0	1	0	0	1
% Population < 60mm	0	0	0	0	0	0	0	100	0	0	100
Total Oysters >100mm	0	0	0	0	0	0	0	0	0	0	0
% Population >100mm	0	0	0	0	0	0	0	0	0	0	0
Mean Density (sq.m)	0	0	0	0	0	0	0	0.01	0	0	0.001
Dominant Substrate	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment

Analysis
Figure 6 shows the distribution of Pacific oysters per quadrat across transect 3.

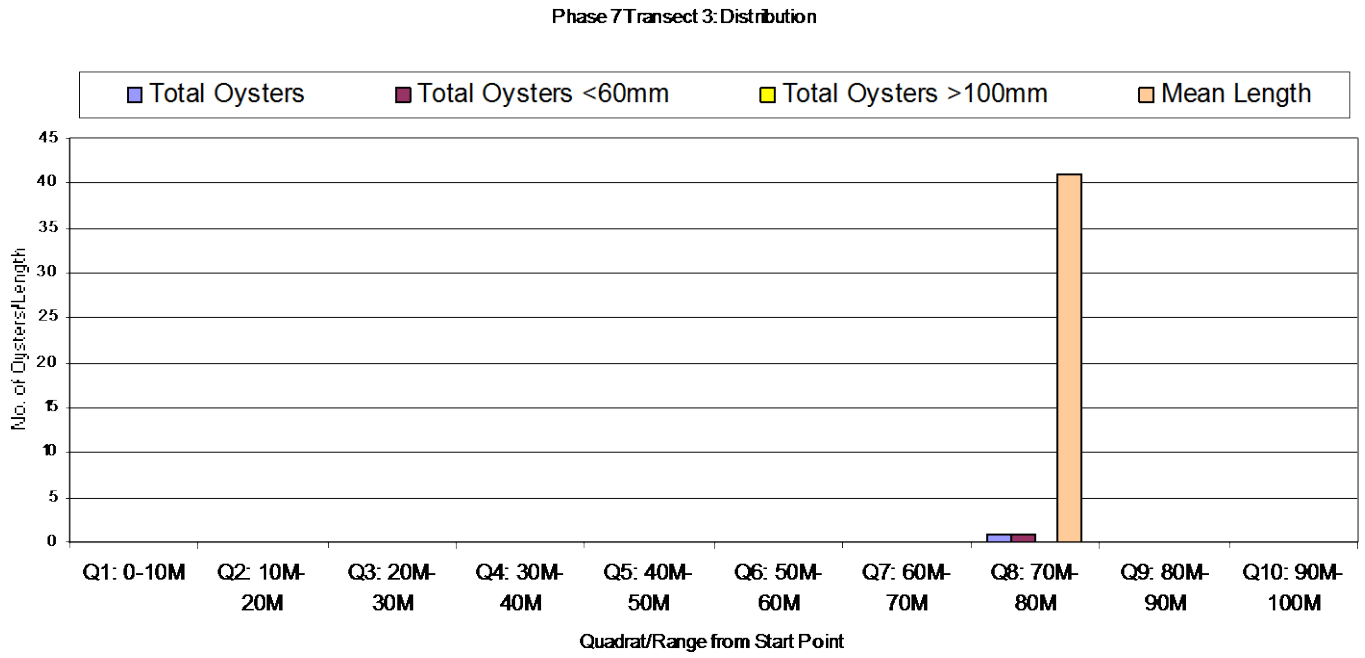

Figure 6 Distribution of Pacific oysters across transect 3

A single spat was seen on a mudstone boulder in the lower shore zone.
Figure 7 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in July 2013 and phase 6 sample was obtained in June 2012.

A single specimen was seen in phase 7. In phase 6 no oysters were seen. Low settlement at this site is probably due to the substrate which consists of mud and fine silt.

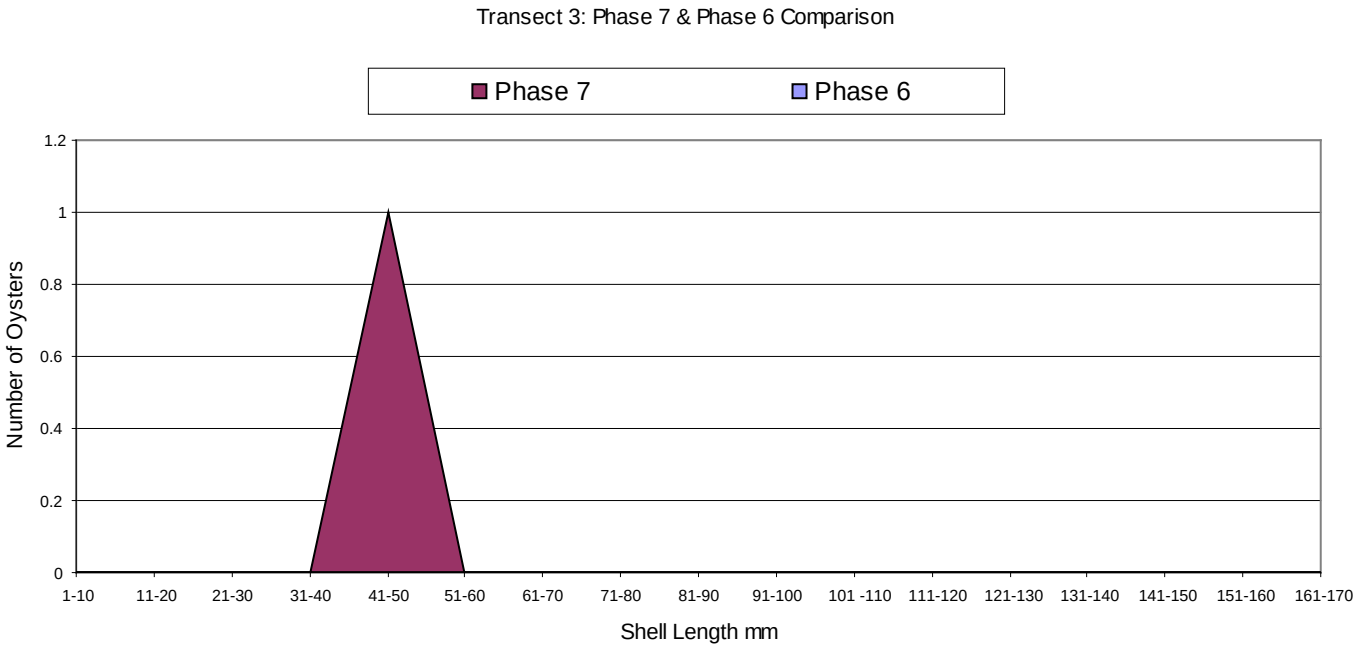

Figure 7 Compares phase 7 and phase 6 samples by shell length

Conclusion

This site is stable. The extensive mud and silt substrate makes this location unfavourable for settlement.

1.4 Transect 4 Coldharbour

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 4 shows results for transect 4. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 4 Results from transect 4

Transect 4 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	6	1	3	6	6	6	3	4	11	21	67
Mean Length	108	39	58	94	53	42	53	50	72	77	71
Standard Deviation	38.4	0	42.1	58.5	25.3	45.9	45.9	24.3	16.8	31.2	35.9
Total Oysters <60mm	1	1	2	2	3	5	2	3	2	7	28
% Population < 60mm	17	100	67	33	50	83	67	75	18	33	42
Total Oysters >100mm	3	0	1	3	0	0	1	0	0	6	14
% Population >100mm	50	0	33	50	0	0	33	0	0	29	21
Mean Density (sq.m)	0.06	0.01	0.03	0.06	0.06	0.06	0.03	0.04	0.11	0.21	0.07
Dominant Substrate	Mussel	Mussel	Mussel	Mussel	Flint	Flint	Flint	Flint	Flint	Flint	

Analysis

Figure 8 shows the distribution of Pacific oysters per quadrat across transect 4.

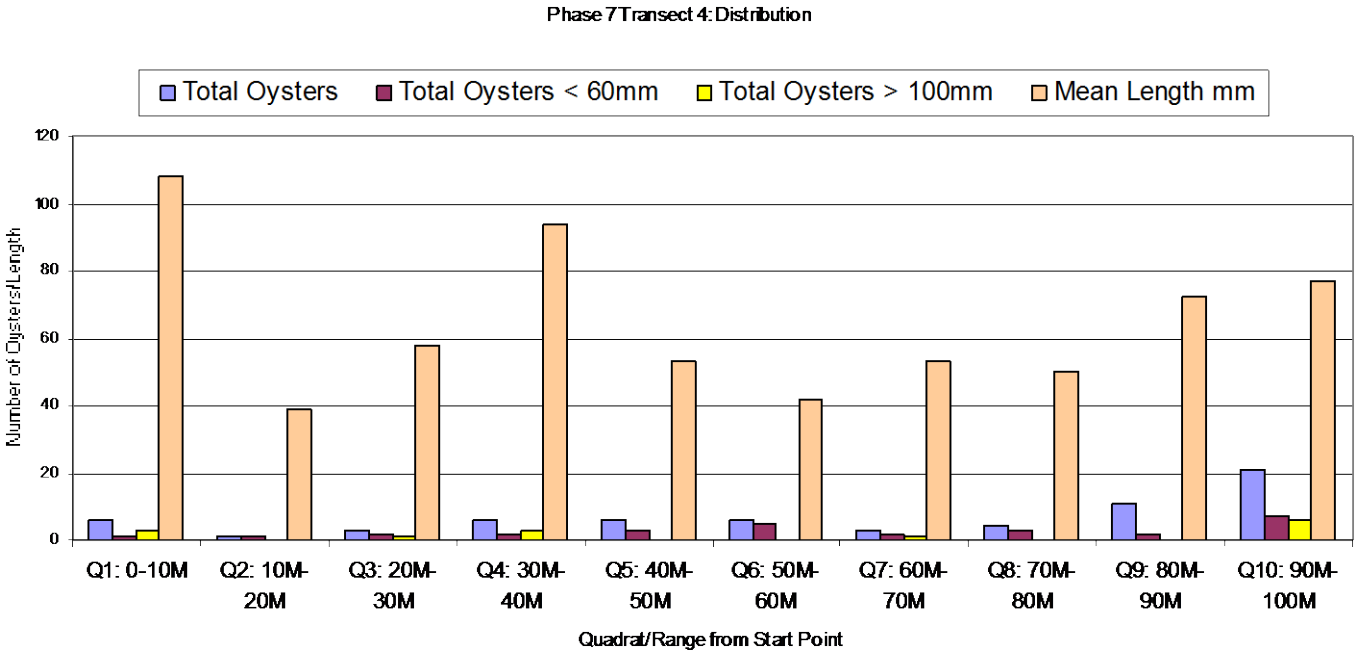

Figure 8 Distribution of Pacific oysters across transect 4

Oyster numbers and size across this transect indicated an abnormal distribution. This suggests that a disturbance had occurred. A large number of dead oysters (gaping shells) were seen. This is possibly due to smothering by the fine silt which was abundant in this section.

Figure 9 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in July 2013 and phase 6 sample was obtained in July 2012.

This site had seen little change since 2012. Recruitment had occurred but a considerable proportion of specimens were not progressing into adulthood. This can be seen in Figure 9 and also by the large number of dead and gaping specimens observed on site.

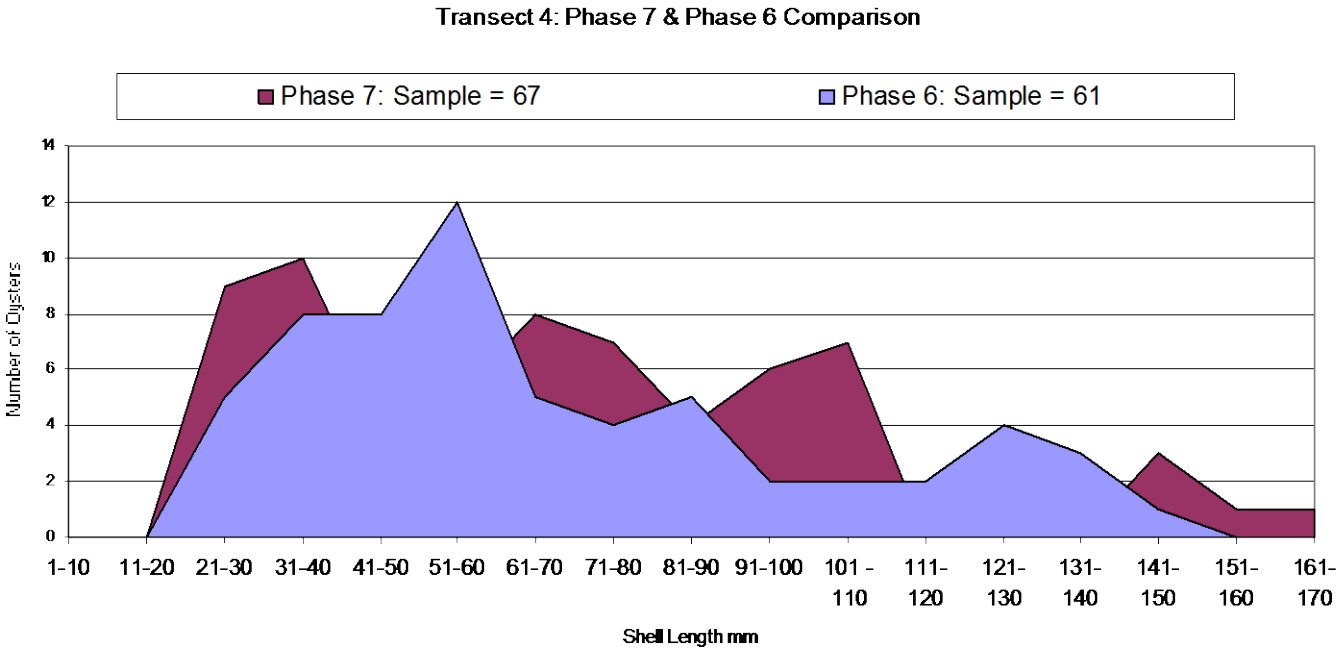

Figure 9 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site is stable. Recruitment is occurring but is offset by mortalities. The main cause of mortality is probably the movement of fine silt which smothers oysters. Other causes may include the displacement of pebbles in the surface layer of the substrate and harvesting which has been observed by Thanet Coast Wardens.

These factors could provide a measure of stability in terms of the future oyster population at this site.

1.5 Transect 5 Minnis Bay

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 5 indicates results for transect 5. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 5 Results from transect 5

Transect 5 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect
Total Oysters	1	0	13	6	10	11	9	2	1	6	59
Mean Length mm	45	0	94	103	87	87	101	77	82	111	94
Standard Deviation	0	0	29.8	21.9	25.9	29.4	29.9	1.4	0	16.4	27.2
Total Oysters < 60mm	1	0	2	0	1	2	1	0	0	0	7
% Population < 60mm	100	0	15	0	10	18	11	0	0	0	12
Total Oysters >100mm	0	0	8	2	4	5	4	0	0	4	27
% Population >100mm	0	0	62	33	40	45	44	0	0	67	46
Mean Density (sq.m)	0.01	0	0.13	0.06	0.1	0.11	0.09	0.02	0.01	0.06	0.06
Dominant Substrate	Standing Water	Standing Water	Chalk with Algal Turf	Chalk with Algal Turf	Chalk with Algal Turf	Chalk with Algal Canopy	Chalk with Algal Canopy	Chalk with Algal Canopy	Chalk with Algal Canopy	Chalk with Algal Canopy	

Analysis

Figure 10 shows the distribution of Pacific oysters per quadrat across transect 5.

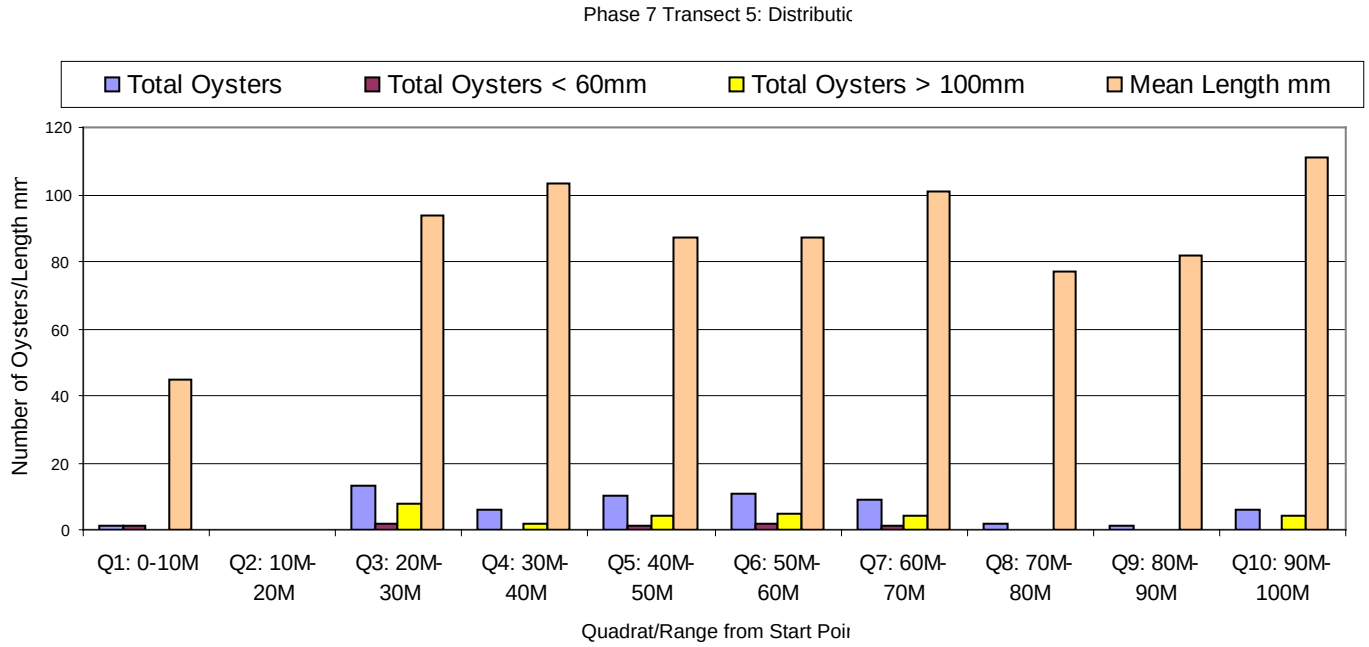

Figure 10 Distribution of Pacific oysters across transect 5

Oyster numbers and size across this transect indicated an abnormal distribution. This suggested that a disturbance had occurred. This may be due to the level of harvesting, reported by Thanet Coast Wardens, which occurs at this location.

Figure 11 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in April 2013 and phase 6 sample was obtained in April 2012.

A low level of recruitment had occurred but the number of specimens recorded within the 80mm – 130mm class had reduced considerably.

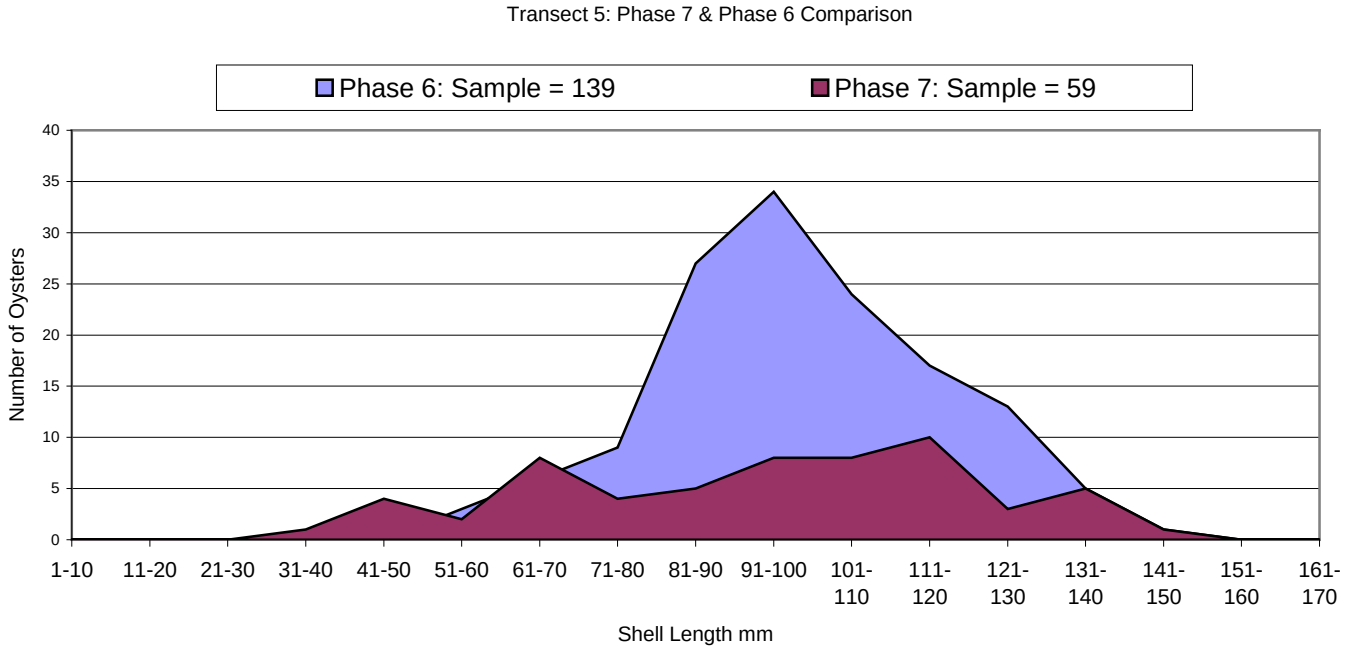

Figure 11 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has retreated. Recruitment has occurred but this has been offset by the reduction of oysters in the 80-130mm class of specimens. This disturbance is unlikely to be caused by natural control since the substrate is stable chalk reef and there is no evidence of smothering by silt.
The class affected is typical of the size range targeted by harvesters. If harvesting continues, this may provide a form of control. However, this may also result in a negative impact on the designated chalk features.

1.6 Transect 6 Epple Bay

Method
The method used for all 14 transects is described in section 1.1 page 1.

Results
Table 6 lists results for transect 6. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 6 Results from transect 6

Transect 6 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	4	1	2	1	10	17	36	261	1880	2280	4492
Mean Length	92	78	86	75	74	72	87	80	76	83	80
Standard Deviation	24.4	0	28.3	0	26.5	17.6	23	24.5	27.8	24.6	19.7
Total Oysters <60mm	0	0	0	0	3	4	6	63	680	440	1196
% Population < 60mm	0	0	0	0	30	24	17	24	36	19	27
Total Oysters >100mm	1	0	1	0	2	0	9	52	440	580	1085
% Population >100mm	25	0	50	0	20	0	25	20	23	25	24
Mean Density (sq.m)	0.04	0.01	0.02	0.01	0.1	0.17	0.36	2.61	18.8	22.8	4.49
Dominant Substrate	Bare Ch	Bare Ch	Bare Ch	Bare Ch	Bare Ch	Bare Ch	Mussel	Mussel	Mussel	P Oyster	

Analysis
Figure 12 shows the distribution of Pacific oysters per quadrat across transect 6.

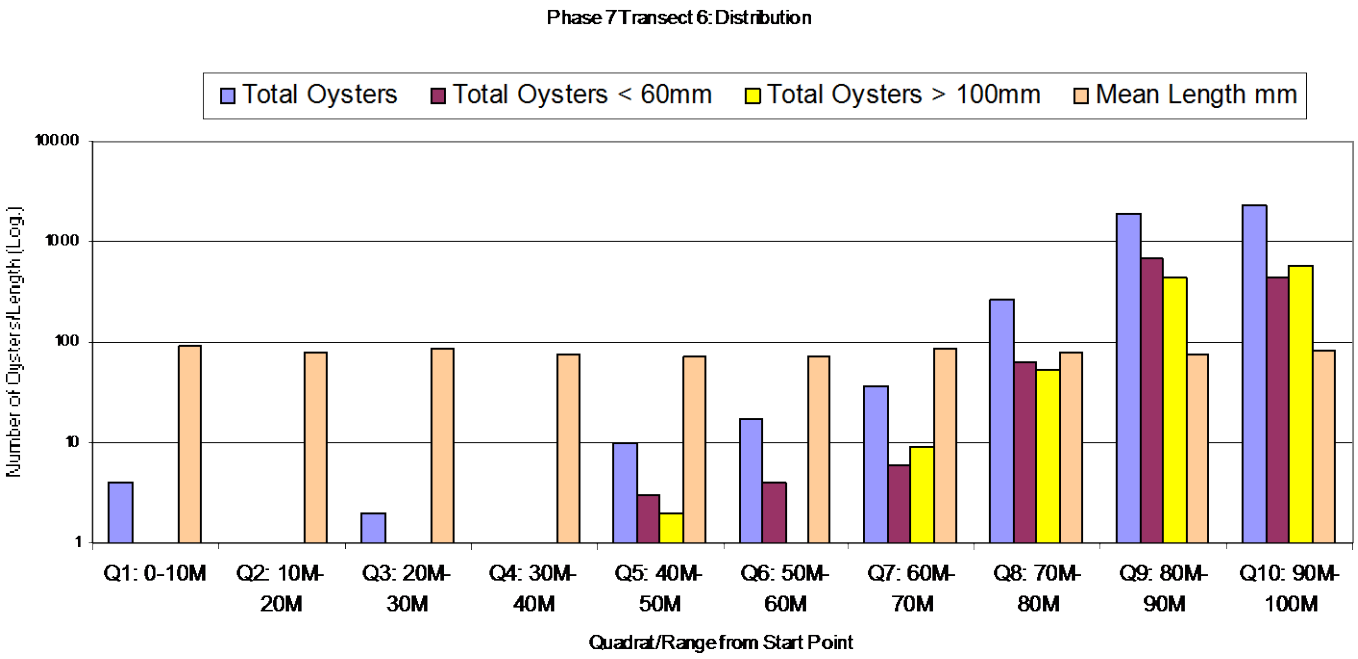

Figure 12 Distribution of Pacific oysters across transect 6

This section recorded the greatest abundance of Pacific oysters seen within the NEKMPA. Reef formation was advanced and in patches oysters were the dominant species. The majority of oyster settlement was seen in the lower shore zone. Attachment was on *Mytilus edulis* and, as the low water mark is approached, *Sabellaria spinulosa* was overlain. Dense settlement was confined to Q8 +Q9 +Q10.

Density and reef formation declined towards Beresford Gap to the west and Westgate Bay to the east. The concentration at Epple Bay may be influenced by local topography. At Epple Bay there was a large arc-ing spit of sediment which created a shallow lagoon at low water. At low-water this may affect local sea temperatures and larval retention thereby benefiting settlement.

Figure 13 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in April 2013 and phase 6 sample was obtained in August 2012.

The number of oysters was considerably reduced. This was most obvious in the lower shore zone (Q8 + Q9 + Q10) where reef formation and clumping had previously been recorded. There were numerous bare patches of chalk now showing in this region, typically 2-8sqm. In Phase 6 these patches had contained dense aggregations of oysters. This change is possibly due to natural control caused by the displacement of dense concentrations of oysters in erect posture by wave energy during storm conditions.

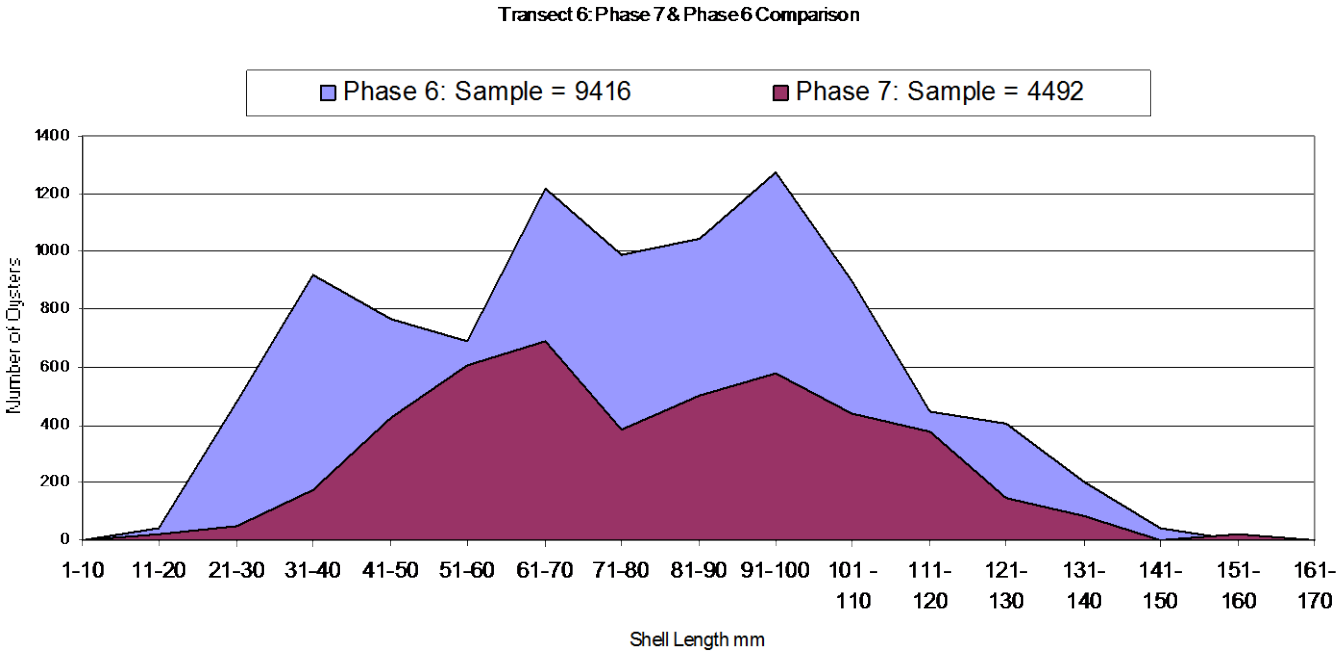

Figure 13 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has retreated considerably. This was probably due to the effect of winter storms with prolonged north-easterly gales which stripped layers of erect oysters back to the bare chalk substrate. This suggests that a cycle of settlement, reef formation and natural control may occur at this location. This form of control could also affect other locations on the north facing coast of the NEKMPA where oyster reef formation becomes established.

1.7 Transect 7 Nayland Rock

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 7 records results for transect 7. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 7 Results from transect 7

Transect 7 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	29	29	47	23	29	33	63	29	29	45	356
Mean Length	84	62	66	79	72	66	65	71	74	76	71
Standard Deviation	27.9	22.9	18.3	23.4	22	18.4	20.7	23.1	21.9	24.4	22.8
Total Oysters <60mm	6	17	23	6	9	13	30	12	9	15	140
% Population < 60mm	21	59	49	26	31	39	48	41	31	33	39
Total Oysters >100mm	5	3	2	4	3	1	4	5	4	9	40
% Population >100mm	17	10	4	17	10	3	6	17	14	20	11
Mean Density (sq.m)	0.29	0.29	0.47	0.23	0.29	0.33	0.63	0.29	0.29	0.45	0.36
Dominant Substrate	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal turf	chalk algal cano	

Analysis

Figure 14 shows the distribution of Pacific oysters per quadrat across transect 7.

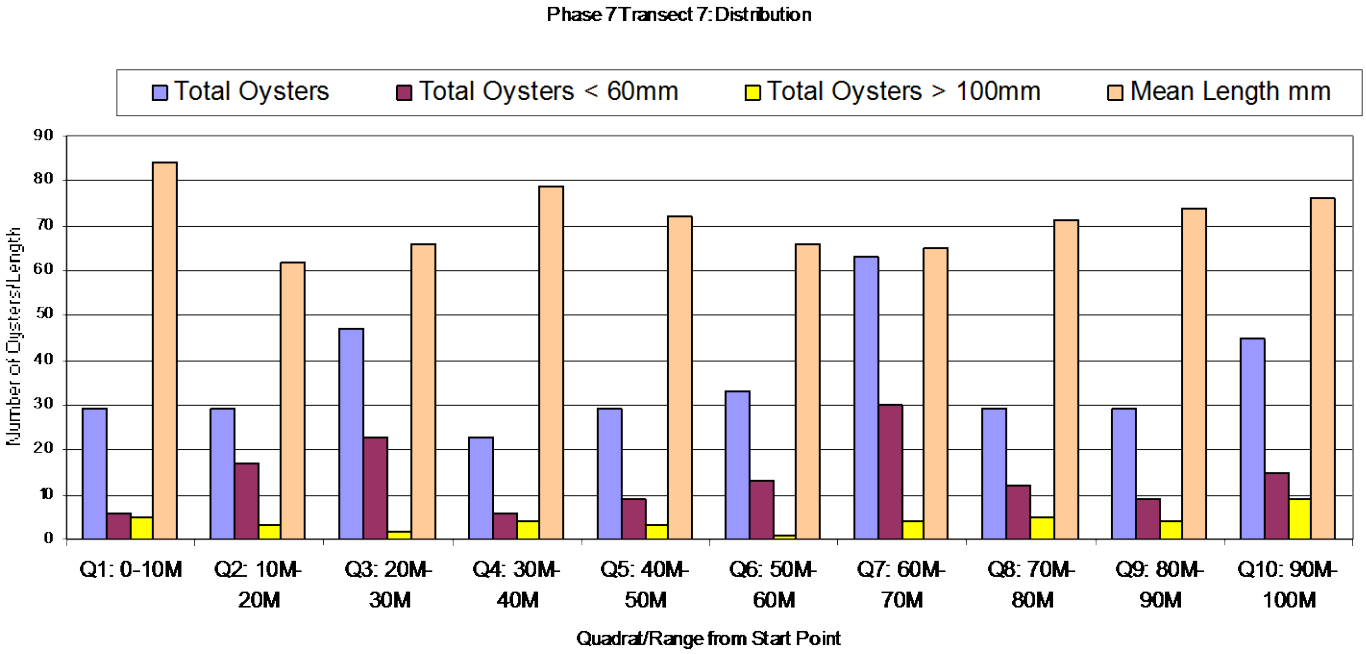

Figure 14 Distribution of Pacific oysters across transect 7

The majority of oyster settlement was seen on the chalk reef within the algal turf zone. There were many large oysters at this site suggesting that it was long established. Recruitment occurred across the site.

Figure 15 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in July 2013 and phase 6 sample was obtained in June 2012.

Recruitment had increased but total oysters were down suggesting that a disturbance had occurred. This is likely to be due to the high level of harvesting which is reported by Thanet Coast Wardens at this location. The effect can be clearly seen in Figure 15 where considerable recruitment is offset by the gap in the 80 – 130mm class of oysters.

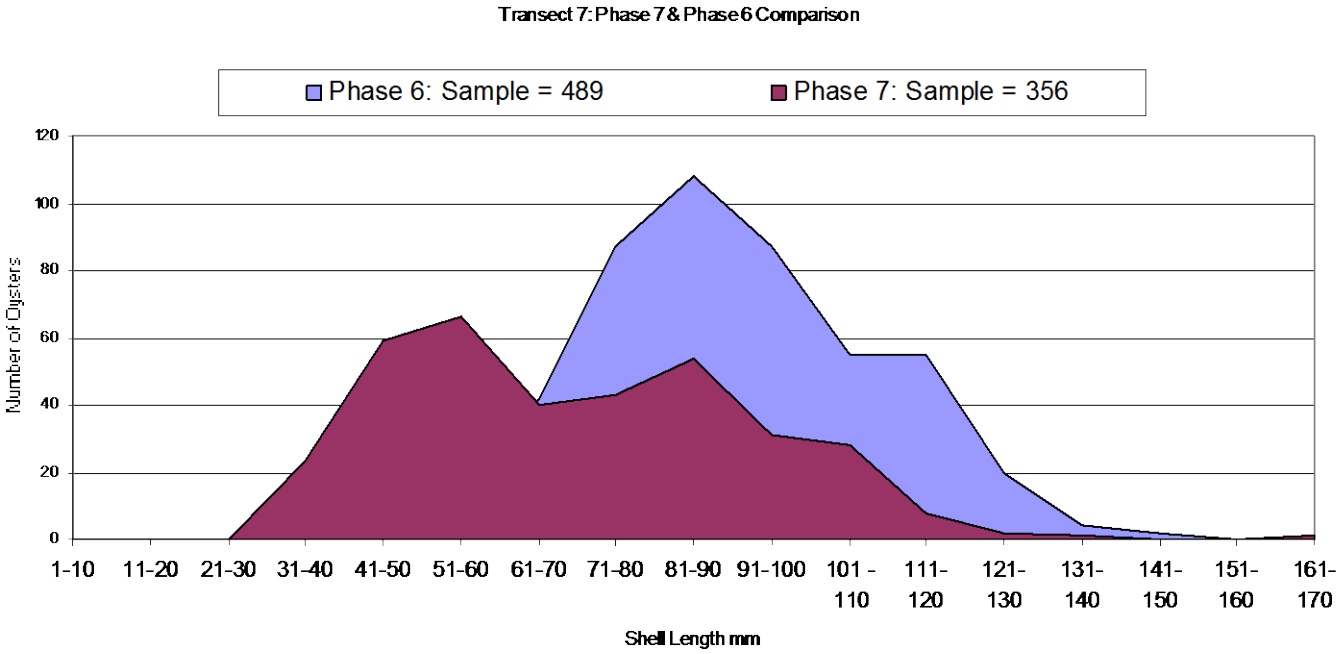

Figure 15 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has retreated. Considerable recruitment has occurred but the overall number of oysters has reduced. Since the substrate is stable chalk reef and there is no silt present, the disturbance is unlikely to be due to natural causes. Oysters have reduced in the 80-130mm size class which is typical of the range targeted by harvesters. This may provide a useful form of control but harvesting practices could also result in physical damage to the designated chalk features.

1.8 Transect 8 Foreness

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 8 shows results for transect 8. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 8 Results from transect 8

Transect 8 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	0	0	6	6	22	34	42	46	44	53	253
Mean Length	0	0	63	79	80	74	71	72	74	77	74
Standard Deviation	0	0	19.1	25.3	19.9	25.1	25	24.6	23.6	23.5	23.8
Total Oysters <60mm	0	0	2	2	4	9	14	11	9	12	63
% Population < 60mm	0	0	33	33	18	26	33	24	20	23	25
Total Oysters >100mm	0	0	0	1	2	4	5	7	5	8	30
% Population >100mm	0	0	0	17	9	12	12	15	11	15	12
Mean Density (sq.m)	0	0	0.06	0.06	0.22	0.34	0.42	0.46	0.44	0.53	0.25
Dominant Substrate	Algal Can	Algal Can	Algal Can	Algal Can	Algal Can	Flint	Flint	Flint	Flint	Flint	Flint

Analysis

Figure 16 shows the distribution of Pacific oysters per quadrat across transect 8.

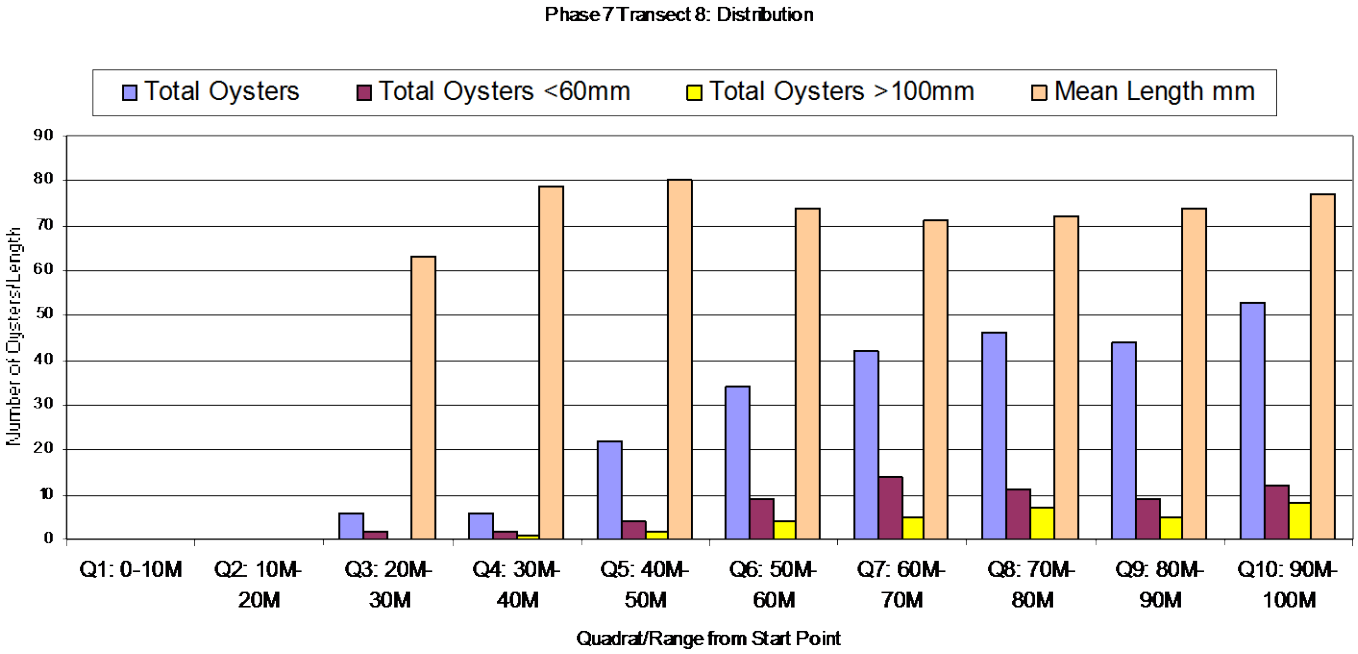

Figure 16 Distribution of Pacific oysters across transect 8

There has been considerable advancement at this site. 25% of the sample was spat < 60mm. Oysters were concentrated in the areas of flint cobble. There were few oysters present within the *Fucus serratus* zone. Sand had accreted along the shore from Botany Bay to Foreness and had piled up against the cliff face overlaying quadrats 1 & 2.

Figure 17 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in April 2013 and phase 6 sample was obtained in June 2012. Figure 17 shows advancement across all classes of size.

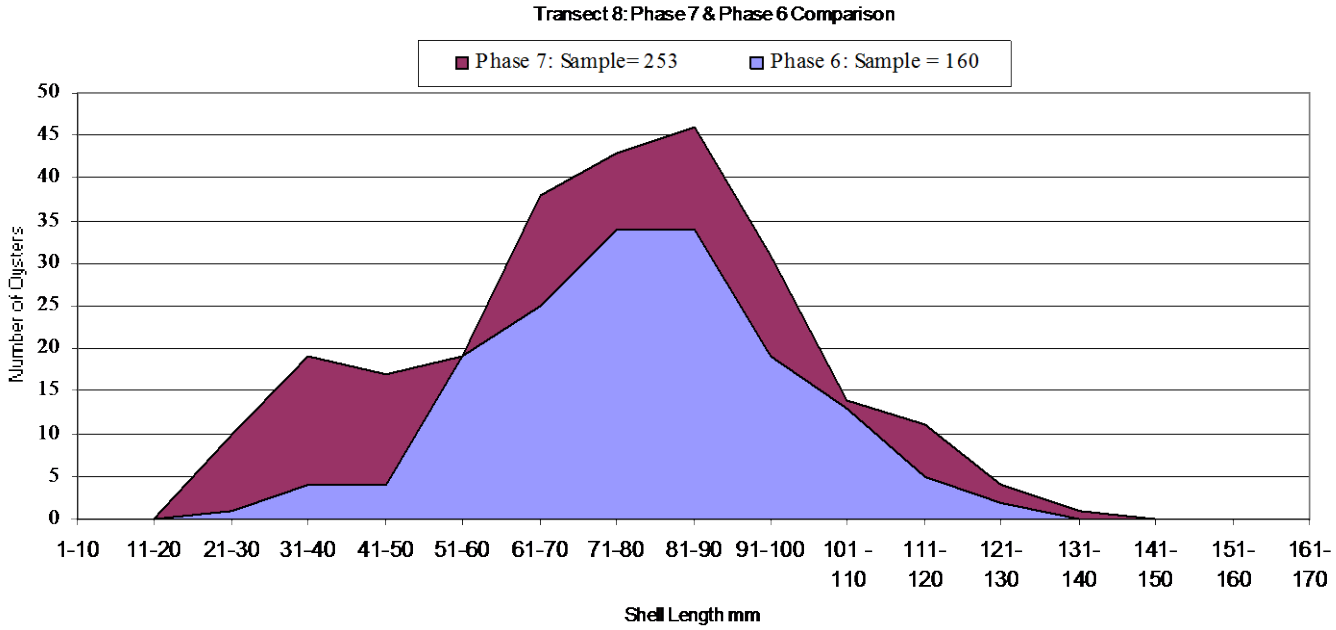

Figure 17 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has advanced but is at an early stage of invasion and therefore a prime site for volunteer control work. New settlement is concentrated on flint cobbles.

1.9 Transect 9 Kingsgate

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 9 indicates results for transect 9. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 9 Results from transect 9

Transect 9 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	1	3	7	9	10	15	47	72	53	67	284
Mean Length	82	63	65	70	71	82	74	73	73	74	73
Standard Deviation	0	13.6	21.9	13	14	12	18.1	15.6	20.2	21.2	18.2
Total Oysters <60mm	0	2	2	1	3	1	9	17	10	16	61
% Population < 60mm	0	67	29	11	30	7	19	24	19	24	21
Total Oysters >100mm	0	0	0	0	0	1	4	5	7	7	24
% Population >100mm	0	0	0	0	0	7	9	7	13	10	8
Mean Density (sq.m)	0.01	0.03	0.07	0.09	0.1	0.15	0.47	0.72	0.53	0.67	0.28
Dominant Substrate	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Flint	Flint	

Analysis

Figure 18 shows the distribution of Pacific oysters per quadrat across transect 9.

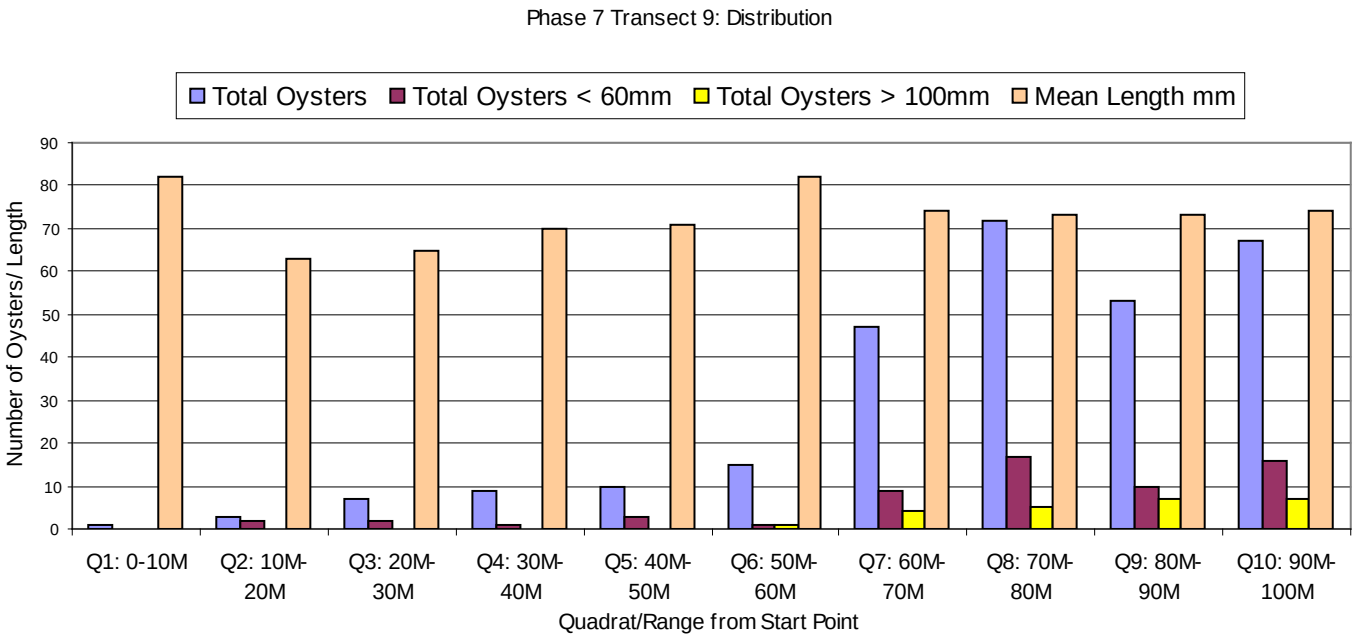

Figure 18 Distribution of Pacific oysters across transect 9

Oysters were present across the transect but were most abundant in the lower shore quadrats. Recruitment was also greatest in this area. Most oysters were attached to chalk blocks in Q7 & Q8 or on flint cobbles in Q9 & Q10.

Oyster numbers have steadily increased in this zone since the 2007 baseline survey. This is possibly facilitated by the chalk and algal turf substrate and abundance of flint cobbles available for settlement.

Figure 19 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in May 2013 and phase 6 sample was obtained in April 2012. Levels of recruitment can be seen in Figure 19.

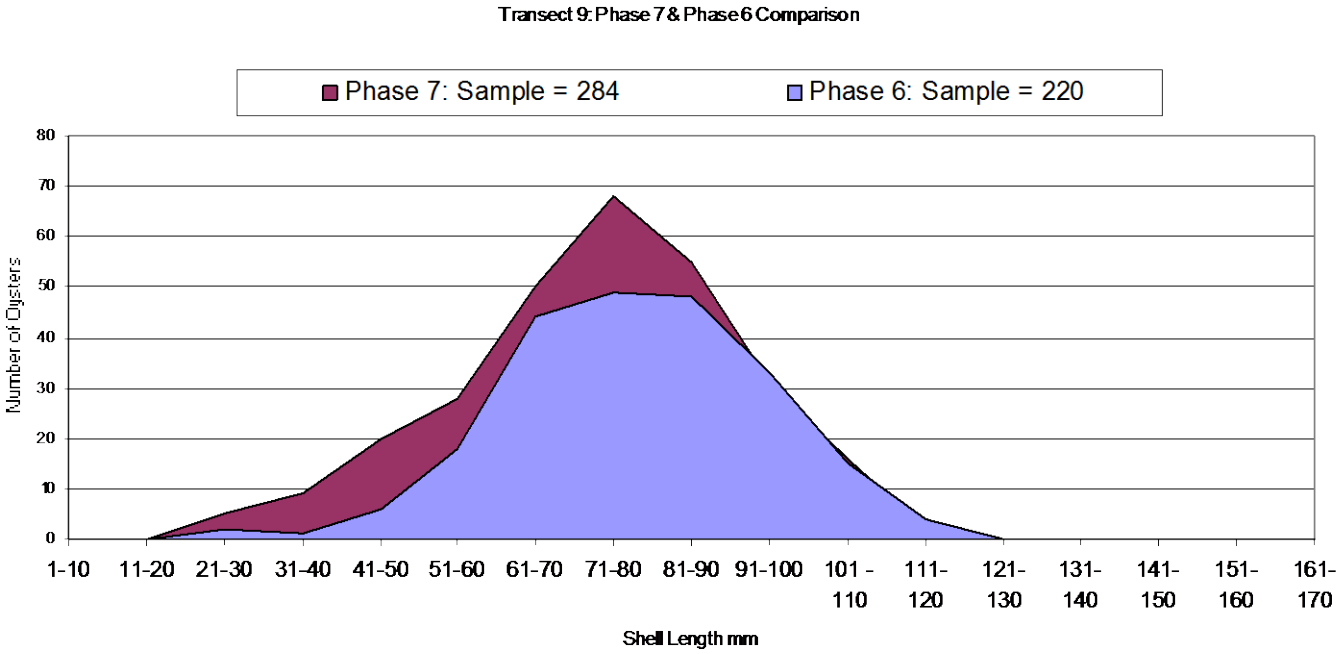

Figure 19 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has advanced but is at an early stage of invasion and therefore a prime location for volunteer control work. New settlement is on flint cobbles and the chalk reef.

1.10 Transect 10 Dumpton

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 10 lists results for transect 10. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 10 Results from transect 10

Transect 10 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	1	4	5	9	0	0	1	0	0	0	20
Mean Length	53	63	75	75	0	0	67	0	0	0	71
Standard Deviation	0	19.6	20.9	18.5	0	0	0	0	0	0	18.4
Total Oysters <60mm	1	2	1	3	0	0	0	0	0	0	7
% Population < 60mm	100	50	20	33	0	0	0	0	0	0	35
Total Oysters >100mm	0	0	1	0	0	0	0	0	0	0	1
% Population >100mm	0	0	20	0	0	0	0	0	0	0	5
Mean Density (sq.m)	0.01	0.04	0.05	0.09	0	0	0.01	0	0	0	0.02
Dominant Substrate	Algal turf	Algal turf	Algal turf	Algal turf	Algal can	Algal can	Algal can	Algal can	Algal turf	S. water	

Analysis

Figure 20 shows the distribution of Pacific oysters per quadrat across transect 10.

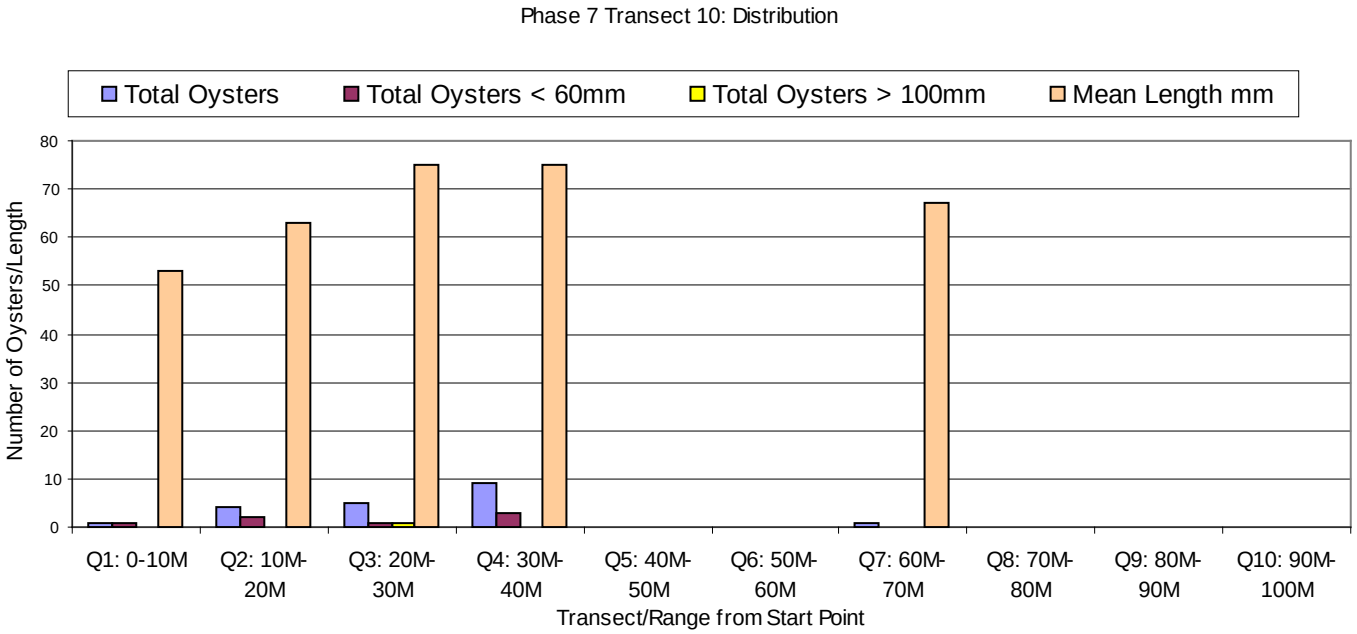

Figure 20 Distribution of Pacific oysters across transect 10

The number of oysters remained low at this site but recruitment had occurred. The % of oysters less than 60mm had increased from 19% to 35%.

The majority of settlement was on the vertical walls of the chalk blocks on the reef. The dense canopy of *Fucus serratus* was likely to be limiting the opportunity for settlement.

Figure 21 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in May 2013 and phase 6 sample was obtained in July 2012.

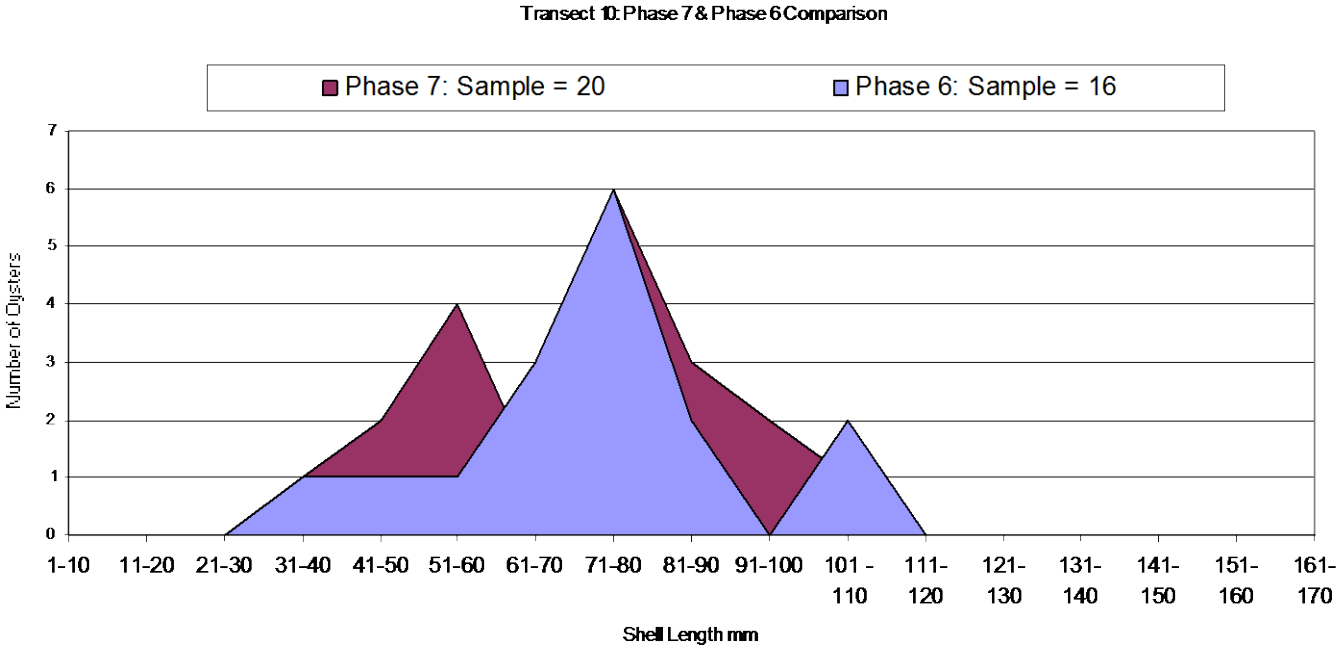

Figure 21 Compares phase 7 and phase 6 samples by shell length

Conclusions

This site has advanced but is at an early stage of invasion and therefore a prime location for volunteer control work. The dense canopy of *Fucus serratus* is likely to be a natural controlling factor with settlement restricted to the vertical faces of chalk gullies and on flint cobbles.

1.11 Transect 11 Western Undercliff Ramsgate

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 11 records results for transect 11. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 11 Results from transect 11

Transect 11 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	0	0	2	1	3	6	16	34	10	0	72
Mean Length	0	0	58	73	65	67	50	41	45	0	48
Standard Deviation	0	0	2.1	0	6.8	11.7	16.5	8.2	11	0	14
Total Oysters <60mm	0	0	2	0	0	2	11	32	9	0	56
% Population < 60mm	0	0	100	0	0	33	69	94	90	0	78
Total Oysters >100mm	0	0	0	0	0	0	0	0	0	0	0
% Population >100mm	0	0	0	0	0	0	0	0	0	0	0
Mean Density (sq.m)	0	0	0.02	0.01	0.03	0.06	0.16	0.34	0.1	0	0.07
Dominant Substrate	Man Made	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Chalk with algal turf	Mussel	Mussel	Bare Chalk	Bare Chalk	Sediment	

Analysis

Figure 22 shows the distribution of Pacific oysters per quadrat across transect 11.

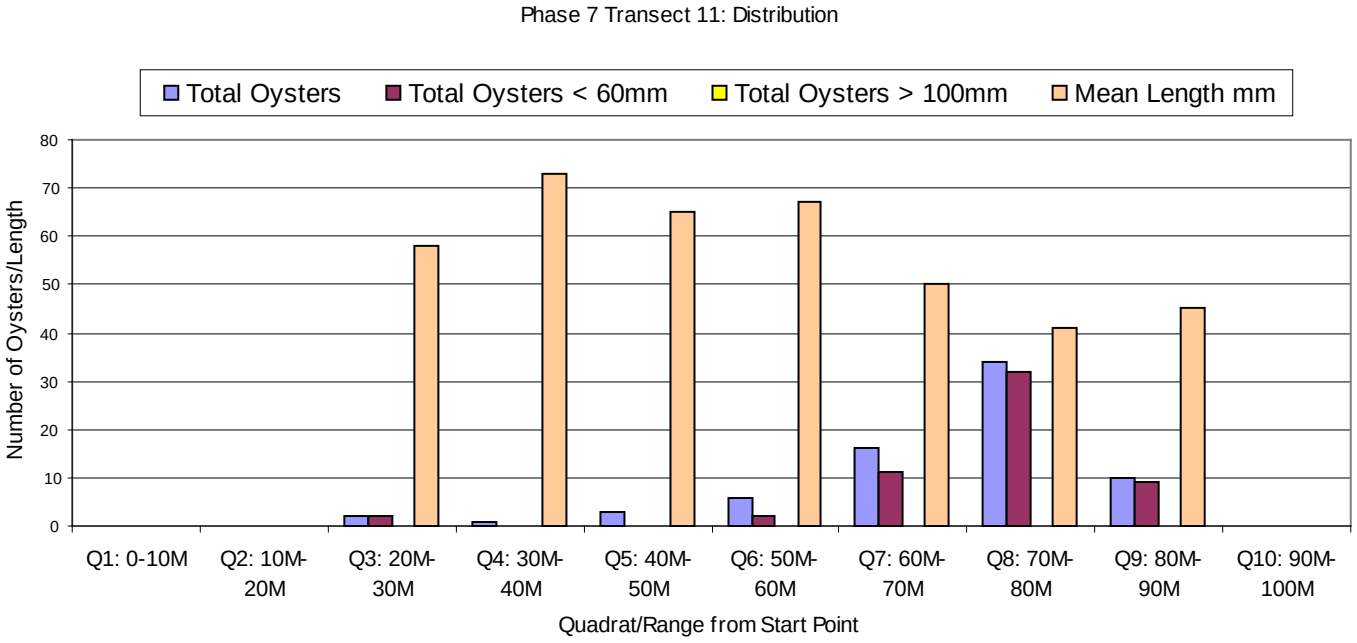

Figure 22 Distribution of Pacific oysters across transect 11

Transect 11 results reflected the impact of a control trial undertaken between July 2012 and July 2013 by the CoastBusters volunteer team. Details of this trial are recorded in section 5 of this report.

Following the trial oyster numbers and mean length were considerably reduced. Almost all of the oysters recorded were spat <60mm from the 2012 spawning season.

Settlement was concentrated on the band of bare chalk (Q8 & Q9) in the lower shore zone. Settlement in the mussel bed was much less (Q6 & Q7).

Figure 23 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in May 2013 and phase 6 sample was obtained in May 2012. It can be seen that the number of oysters and mean size have been reduced post trial.

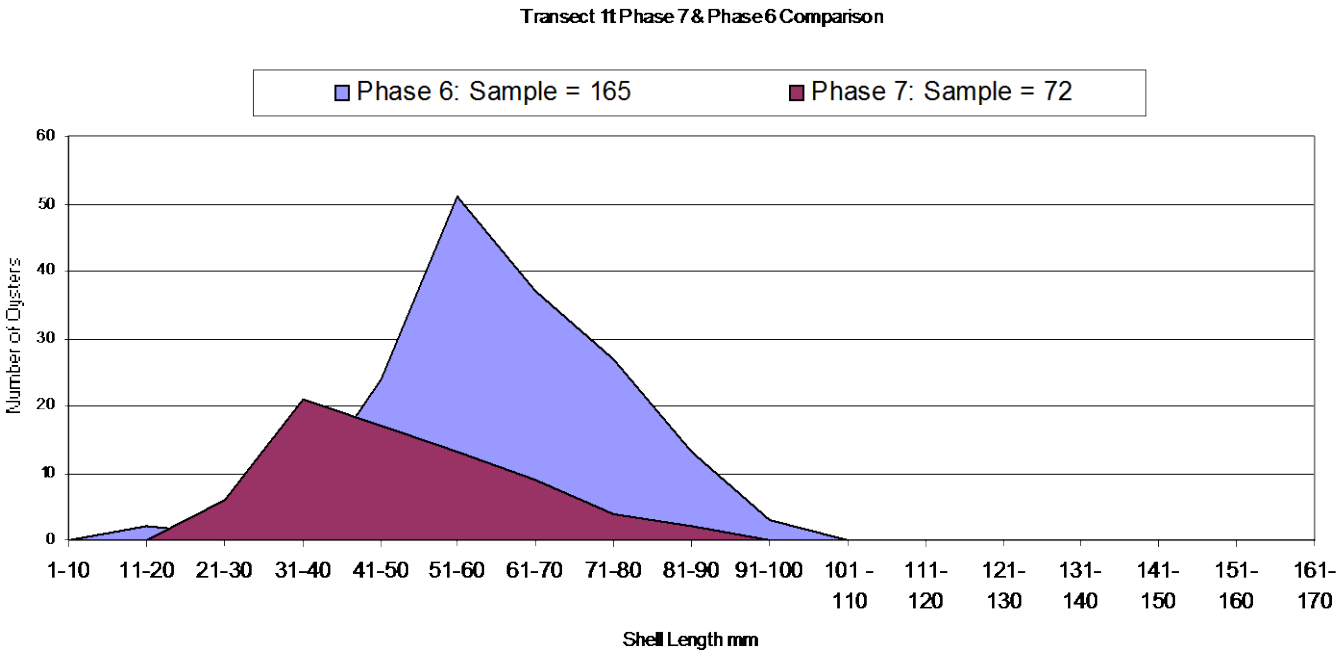

Figure 23 Compares phase 7 and phase 6 samples by shell length

Conclusions

This section has retreated. This is due to the control work undertaken during the one-year trial between July 2012 and July 2013 (see section 5 of this report). Previous to this intervention this section had been advancing.

1.12 Transect 12 Sandwich Bay

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 12 shows results for transect 12. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 12 Results from transect 12

Transect 12 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	0	0	0	0	0	0	0	0	0	0	0
Mean Length	0	0	0	0	0	0	0	0	0	0	0
Standard Deviation	0	0	0	0	0	0	0	0	0	0	0
Total Oysters <60mm	0	0	0	0	0	0	0	0	0	0	0
% Population <60mm	0	0	0	0	0	0	0	0	0	0	0
Total Oysters >100mm	0	0	0	0	0	0	0	0	0	0	0
% Population >100mm	0	0	0	0	0	0	0	0	0	0	0
Mean Density (sq m)	0	0	0	0	0	0	0	0	0	0	0
Dominant Substrate	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	

Analysis

Figure 24 shows the distribution of Pacific oysters per quadrat across transect 12.

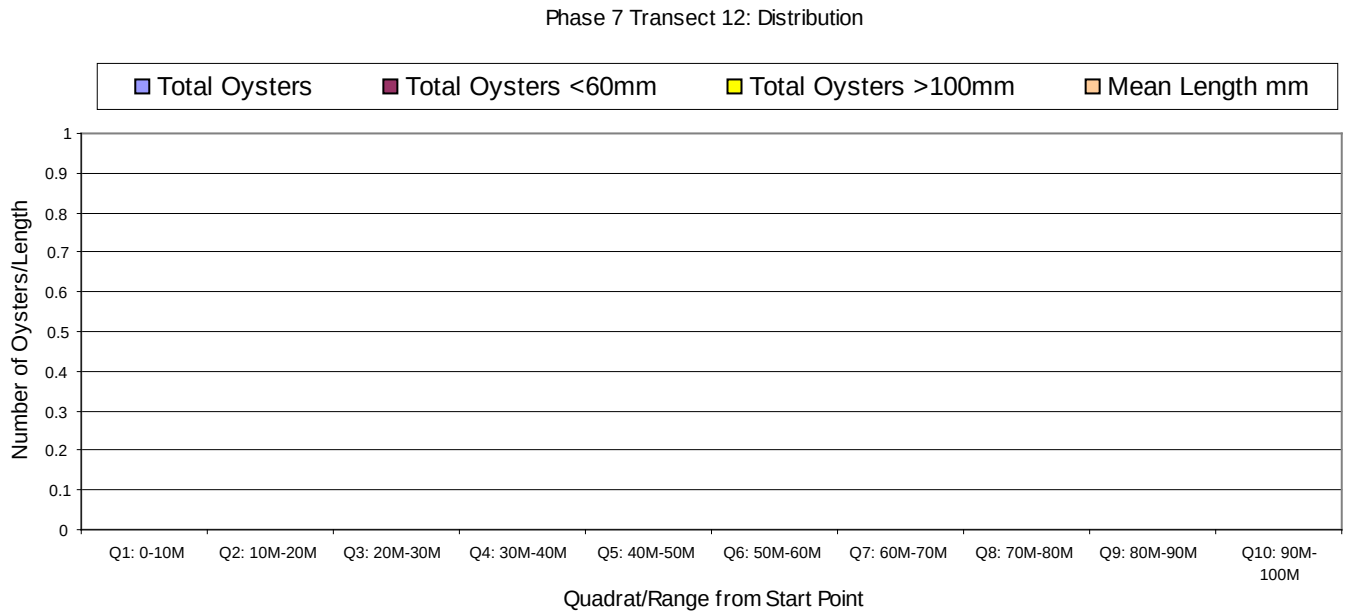

Figure 24 Distribution of Pacific oysters across transect 12

No oysters were seen in transect 12. This is probably due to the lack of stable hard substrates. Tidal drift on the sediment, such as shell fragments and flint pebble, were clear of oyster settlement.

Figure 25 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in May 2013 and phase 6 sample was obtained in April 2012.

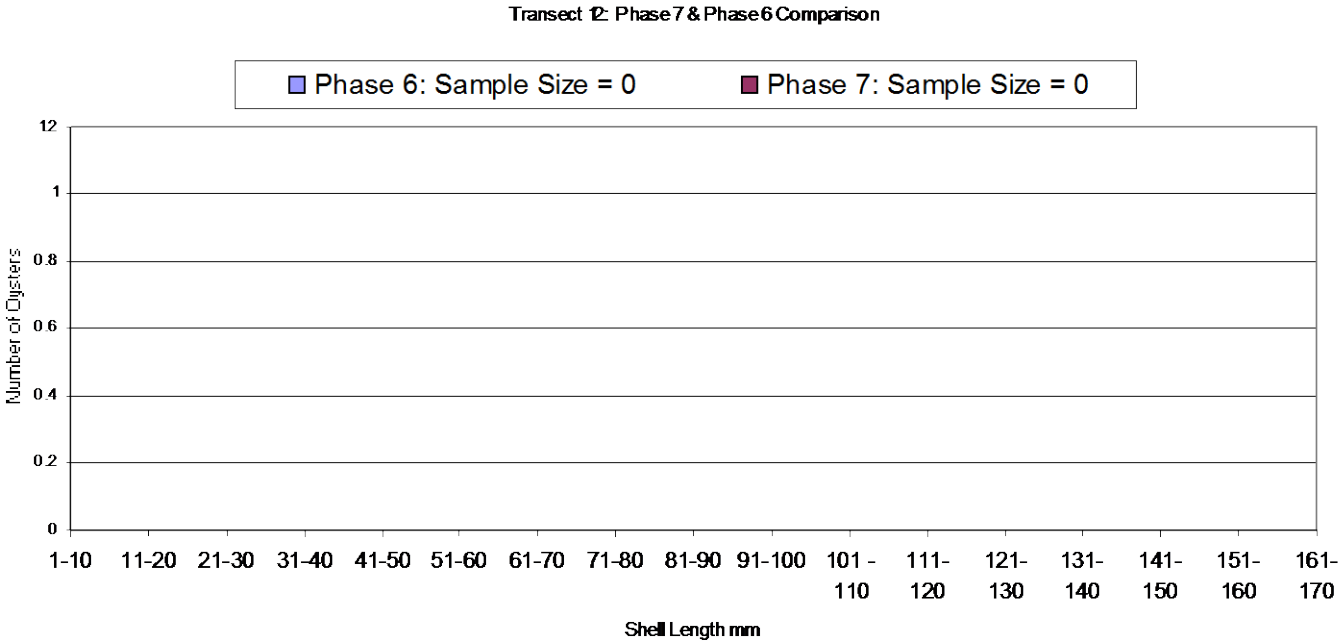

Figure 25 Compares phase 7 and phase 6 samples by shell length

Conclusions

This section is stable. The lack of favourable substrate is likely to impede settlement. However, tidal drift on the mudflats could provide an opportunity for attachment.

1.13 Transect 13 Sandwich Bay

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 13 indicates results for transect 13. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 13 Results from transect 13

Transect 13 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	0	0	0	0	0	0	0	0	0	0	0
Mean Length	0	0	0	0	0	0	0	0	0	0	0
Standard Deviation	0	0	0	0	0	0	0	0	0	0	0
Total Oysters <60mm	0	0	0	0	0	0	0	0	0	0	0
% Population <60mm	0	0	0	0	0	0	0	0	0	0	0
Total Oysters >100mm	0	0	0	0	0	0	0	0	0	0	0
% Population >100mm	0	0	0	0	0	0	0	0	0	0	0
Mean Density (sq m)	0	0	0	0	0	0	0	0	0	0	0
Dominant Substrate	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	

Analysis

Figure 26 shows the distribution of Pacific oysters per quadrat across transect 13.

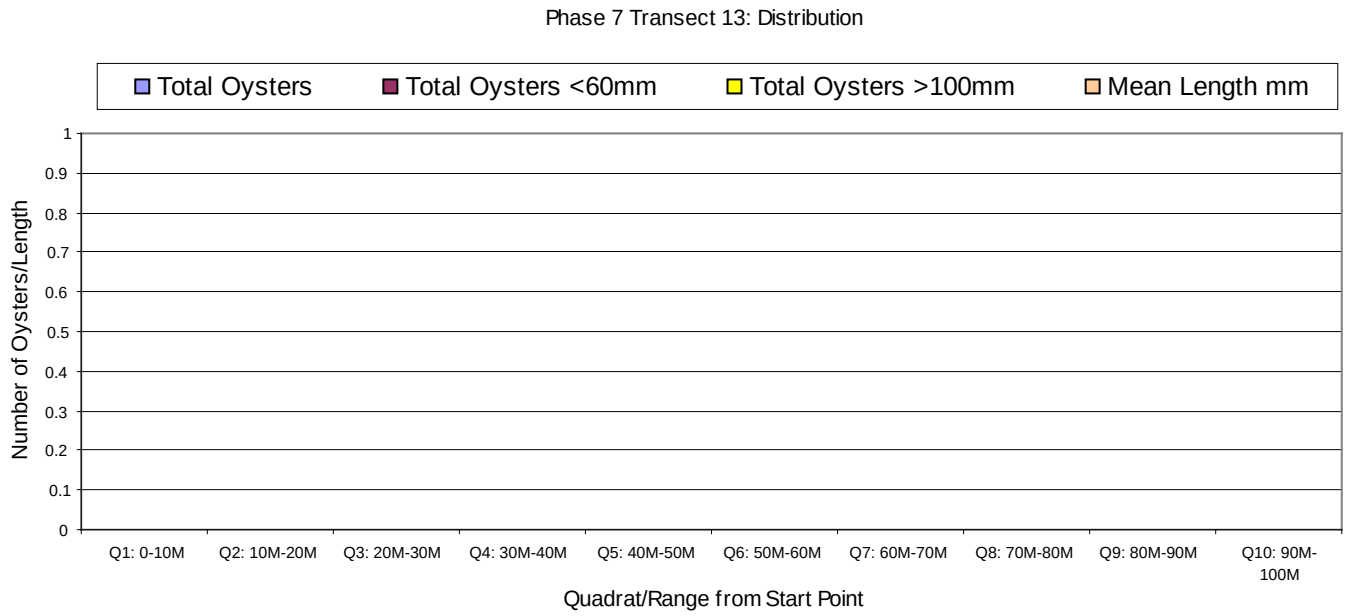

Figure 26 Distribution of Pacific oysters across transect 13

No oysters were seen in transect 13. This is probably due to the lack of stable hard substrates. Tidal drift on the sediment, such as shell fragments and flint pebble, were clear of oyster settlement. Figure 27 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in May 2013 and phase 6 sample was obtained in April 2012.

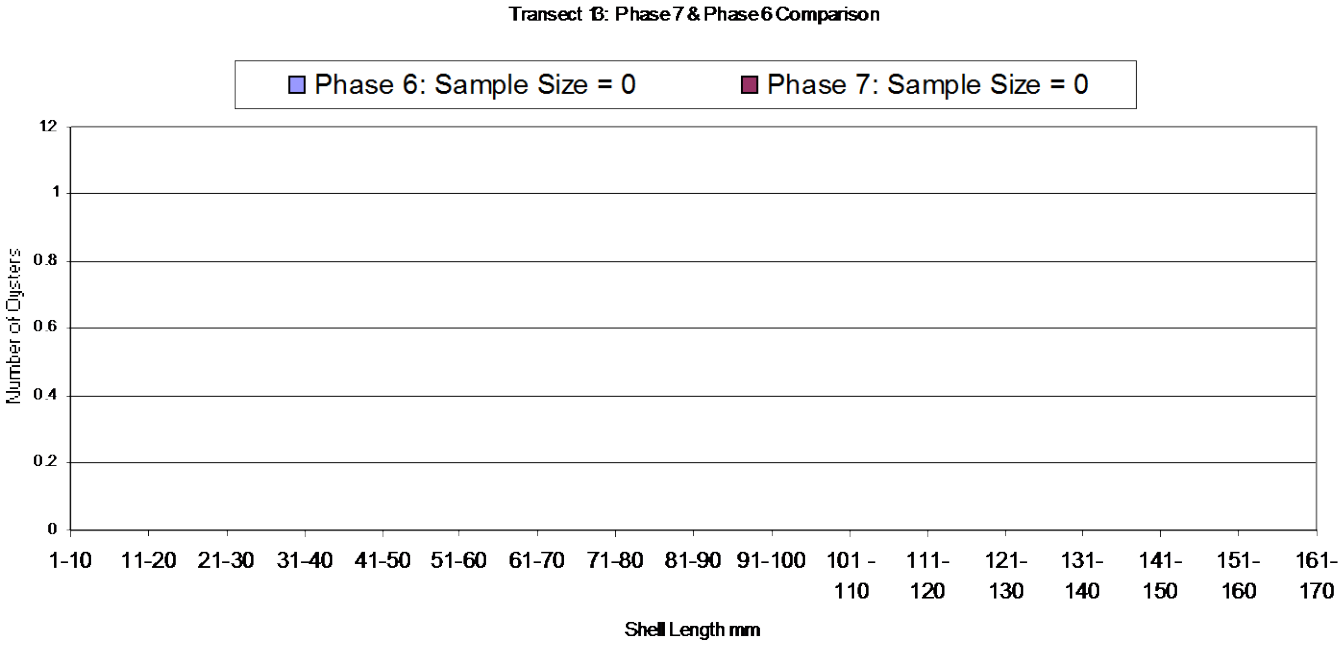

Figure 27 Compares phase 7 and phase 6 samples by shell length

Conclusions

This section is stable. The substrate presents unfavourable conditions for settlement. There are no hard sea defences. The upper shore consists of loose flint pebble and the mid to lower shore zones are mud. However, there is opportunity for attachment on tidal drift across the mudflats.

1.14 Transect 14 Sandwich Bay

Method

The method used for all 14 transects is described in section 1.1 page 1.

Results

Table 14 lists results for transect 14. This includes, per quadrat (Q1 – Q10):

- Total number of oysters
- Mean shell length
- Number of spat <60mm
- Number of adults >100mm
- Substrate type

Table 14 Results from transect 14

Transect 14 Phase 7	Q1 0-10M	Q2 10M-20M	Q3 20M-30M	Q4 30M-40M	Q5 40M-50M	Q6 50M-60M	Q7 60M-70M	Q8 70M-80M	Q9 80M-90M	Q10 90M-100M	Transect Total
Total Oysters	0	0	0	0	0	0	0	0	0	0	0
Mean Length	0	0	0	0	0	0	0	0	0	0	0
Standard Deviation	0	0	0	0	0	0	0	0	0	0	0
Total Oysters <60mm	0	0	0	0	0	0	0	0	0	0	0
% Population <60mm	0	0	0	0	0	0	0	0	0	0	0
Total Oysters >100mm	0	0	0	0	0	0	0	0	0	0	0
% Population >100mm	0	0	0	0	0	0	0	0	0	0	0
Mean Density (sq m)	0	0	0	0	0	0	0	0	0	0	0
Dominant Substrate	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	

Analysis

Figure 28 shows the distribution of Pacific oysters per quadrat across transect 14

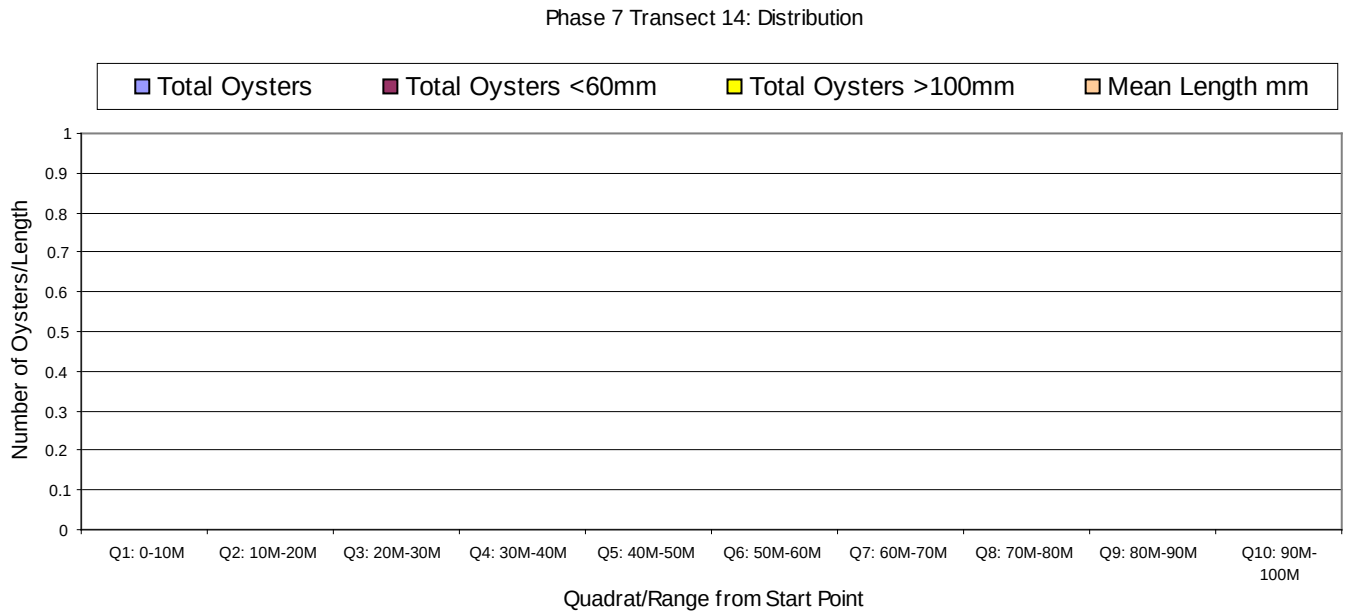

Figure 28 Distribution of Pacific oysters across transect 14

No oysters were seen in transect 14. This is probably due to the lack of stable hard substrates. Tidal drift on the sediment, such as shell fragments and flint pebble, were clear of oyster settlement.

Figure 29 compares phase 7 sample with phase 6 sample in terms of oyster numbers by shell length. Samples are shown in 10mm classes across a range from 1mm to 170mm. Phase 7 sample was obtained in May 2013 and phase 6 sample was obtained in April 2012.

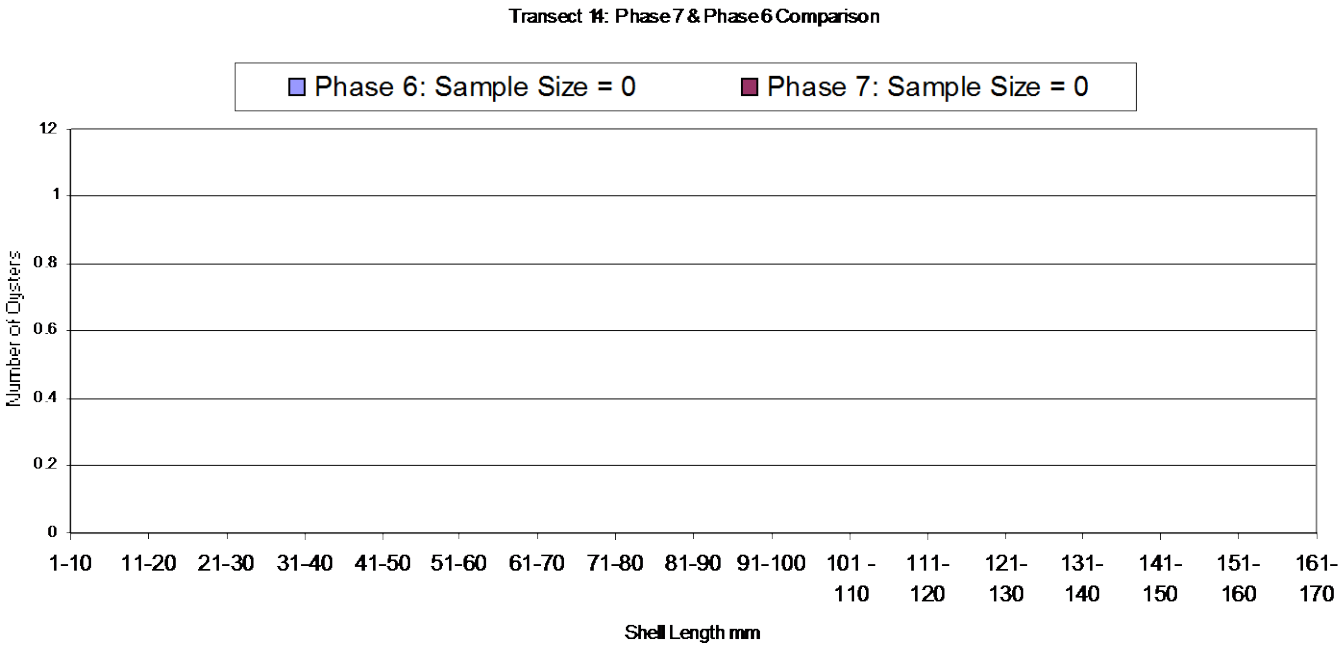

Figure 29 Compares phase 7 and phase 6 samples by shell length

Conclusions

This section is stable. The loose pebbles, mud and absence of hard coastal defences provide little opportunity for settlement. Across the mudflats shell fragments and other tidal drift are of interest as they could provide a suitable substrate to establish a population.

2 Monitor the inter-action between common mussels *Mytilus edulis* and Pacific oysters

Aim

To map and monitor significant stable areas of Common Mussel (*Mytilus edulis)* settlement, identified from the monitoring programme, which may be at risk of biotope modification due to the spread of Pacific Oysters and to record the dynamic relationship and flux between both species.

Method

The following definitions have been produced:

A **Bed** is a Site which has been classified following quantitative analysis of survey results and given a "type" title. Bed Criteria:

- where majority of transect samples were Mussel (M) the Bed type = Mussel Bed
- where majority of transect samples were Mixed (X) the Bed type = Mixed Bed
- where majority of transect samples were Oyster (O) the Bed type = Oyster Bed

Coverage is the quantitative measure of the quality and structure of a Site derived from transect samples and confirms:

- the quality of the Site in terms of the number of Gaps recorded
- the bed type
- total oysters, peak oyster density and mean oyster density per m² within the samples

A **Gap** is a small permitted area included within a Patch or between adjacent Patches belonging to the same Site in which mussel or combined mussel/oyster density is less than 50% surface area cover per m².

A **Patch** is a distinct zone within a Site boundary where the mussel or combined mussel/oyster density consistently reaches a minimum of 50% surface area cover per m². There may be a single unbroken Patch that represents the entire area of a Site or multiple adjacent Patches that are components of the Site.
Patch criteria:

- Mussel or combined mussel/oyster density must be a minimum of 50% surface area cover per m²
- Patches must be within 50m range of a neighbouring patch to be included within the same Site
- Patches beyond the 50m range will be members of separate Sites
- Minimum Patch size = 1000m²

Scatter is mussel or combined mussel/oyster settlement which fails to reach the Patch criteria and is therefore excluded.

A **Site** is a significant stable area of mussel settlement within the inter-tidal zone identified from the monitoring programme. The boundary of a site is defined by a contour within which mussel or combined mussel/oyster density consistently reaches a minimum of 50% surface area cover per m². A Site may consist of a single Patch or multiple adjacent Patches. The minimum site size is 1000 m² , that is, one single patch.

Stable: local knowledge indicates site existence for at least 10 years (not ephemeral).

Figure 30 illustrates typical inter-tidal distribution.

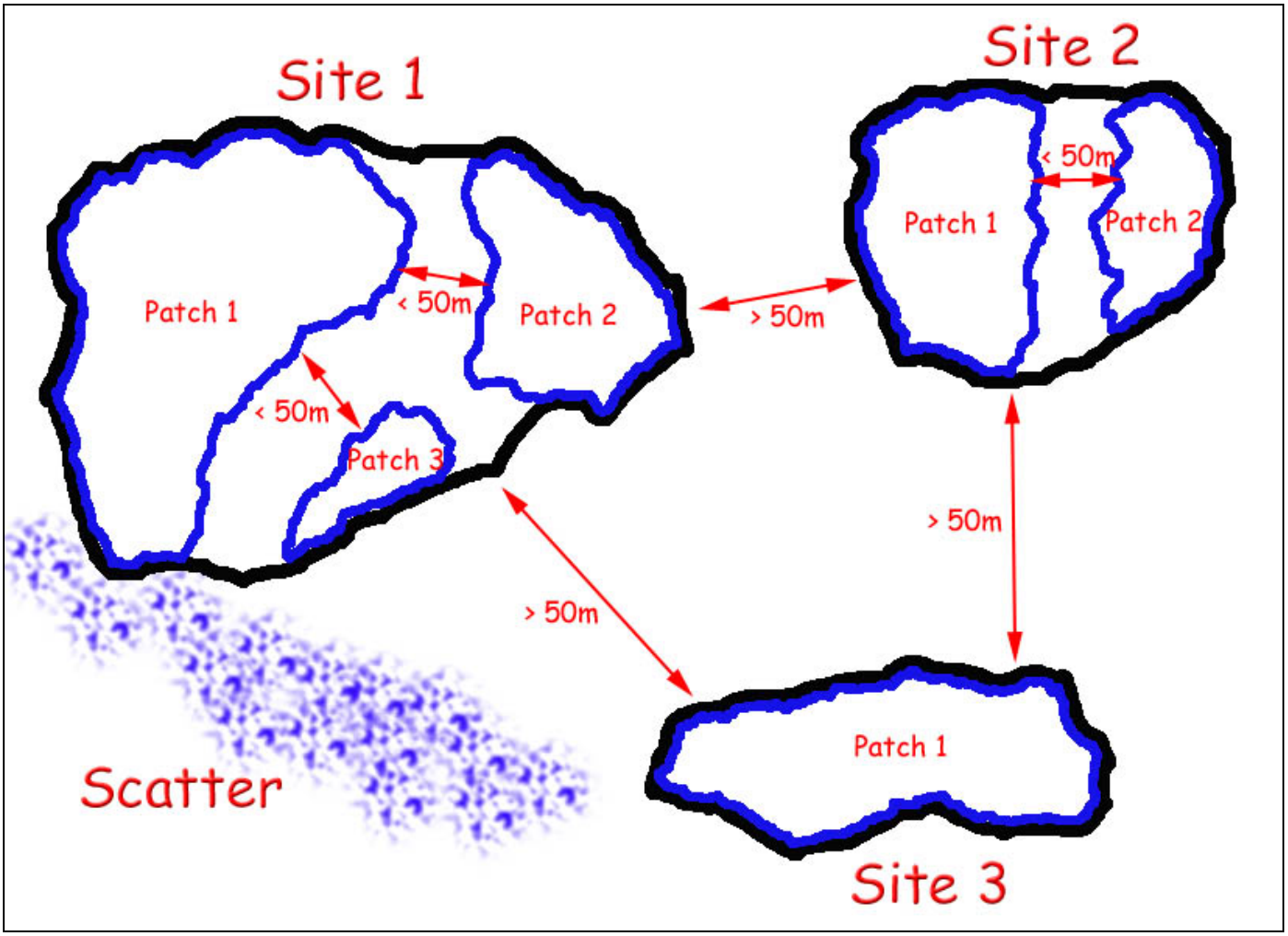

Figure 30 Typical inter-tidal distribution

The method adopted was based on research conducted by the Institute for Marine Resources and Ecosystem Studies (IMARES) into Common Mussel / Pacific Oyster inter-action within the Dutch Wadden Sea (Fey et al 2010).

The process has been modified to suit conditions in the NEKMPA and was designed to facilitate monitoring of mussel/oyster interaction for the NEKMPA Management Scheme 2013-2018 including mussel bed mapping for the Thanet Coast Marine Conservation Zone.
There are 5 distinct stages in the process:

- Site identification
- Patch identification
- Transect sampling
- Site classification
- Pacific Oyster distribution

For each Site, a site document was created in Ms Word and spreadsheet was created in Ms Excel.

Site Identification
Potential Sites were initially identified during Non-Native Species monitoring sessions. This was followed by a detailed survey per location during which:

1. The Site perimeter was established along a contour line within which the surface area covered by mussels or mussel/oyster combination consistently equalled a minimum of 50% per m^2. The perimeter was recorded by a series of GPS fixes.

2. The area of the site was calculated using the GPS fixes.
3. Site details were recorded in a Site document.

Patch Identification
Having recorded the Site details it was then necessary to determine if the Site consisted of a single Patch or multiple Patches.

This was achieved by completing a walkover survey of the Site recording distribution in accordance with Patch criteria. Where individual Patches were identified their perimeters were established along a contour line, within which the surface area covered by mussels or mussel/oyster combination consistently equalled a minimum of 50% per m². The Patch perimeter was recorded by a series of GPS fixes. The area of each Patch was calculated using the GPS fixes. Patch details were recorded in the relevant Site document.

Transect Sampling
Having established the Site boundary the Site area was tested for Coverage. The method used was based on the "Stiefelmethode" (Common Wadden Sea Secretariat 2009) which has been modified to meet NEKMPA conditions. This involved setting up an array of parallel line transects across the area of the Site. Transects were deployed at 5 meter intervals using Ordnance Survey eastings for Sites having an east-west profile and northings for Sites having a north-south profile.

Each transect was walked by the surveyor and at every 5th step the surface type underfoot within 1 m² was sampled.

Figure 31 shows a typical example of transect arrangement within a Site.

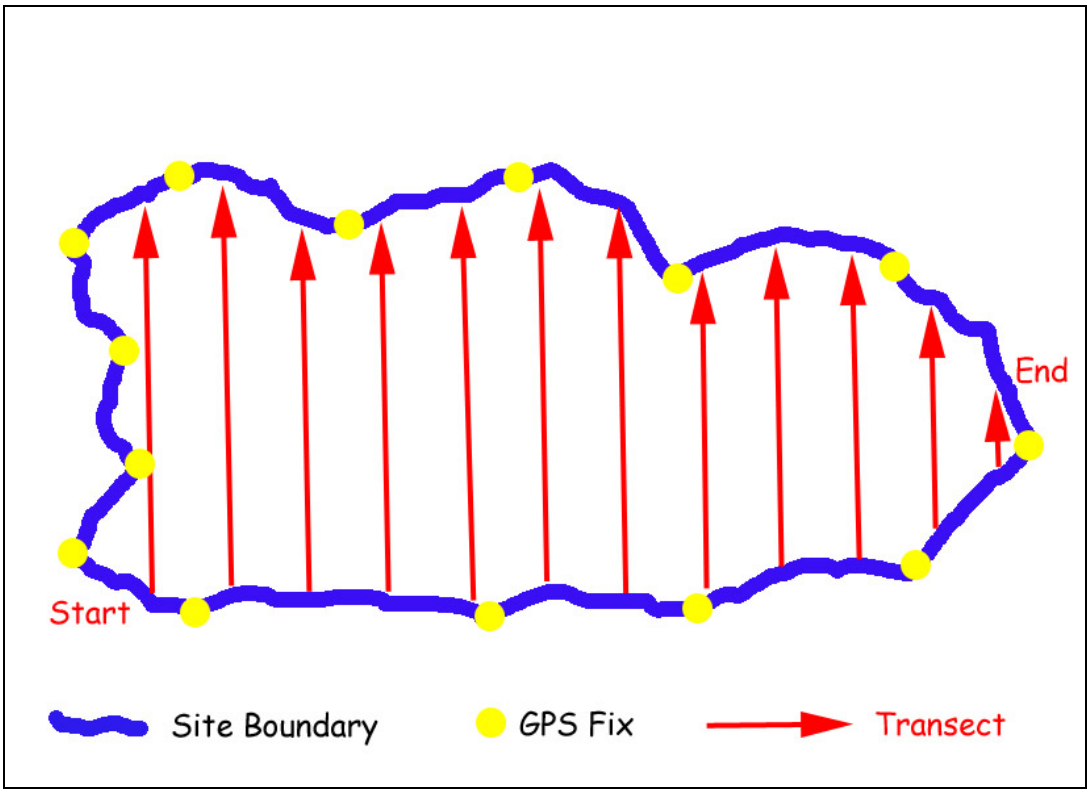

Figure 31 Typical transect arrangement within a site

At each sample point the surface type was recorded in accordance with Bed criteria:

- oyster cover less than 30% = **Mussel Bed** (**M**)
- oyster cover 30% - 60% = **Mixed Bed** (**X**)
- oyster cover greater than 60% = **Oyster Bed** (**O**)

- overall mussel or combined mussel/oyster density <50% = **Gap** (**G**)

The total number of oysters present at each sample point was recorded.

Sample size was proportional to the Site area and therefore determined the total length/number of transects. The minimum ratio was 5 samples per 100 m². Table 15 shows examples of sample size per Site area.

Table 15 Sample size per Site area

Site Area	Minimum Number of Samples
1000 m²	50
5000 m²	250
1 ha	500
5 ha	2500
10 ha	5000

Transect data were recorded on spreadsheets and on the relevant Site document.

Site Classification
To provide each Site with a Bed classification the total number of transect samples were divided into groups titled “Mussel Bed” (M), “Mixed Bed” (X), “Oyster Bed” (O) and “Gap” (G).

Percentages per group of the total number of transect samples were then calculated. The highest resulting percentage between Mussel Bed, Mixed Bed and Oyster Bed determines the Bed classification for the Site.
The percentage between Gap and the total transect samples determines the quality of the Site.

Table 16 indicates an example of Bed classification where Bed type = Mussel and Bed quality = 87.7%

Table 16 Example of Bed classification

	Total Samples	Total Mussel	Total Mixed	Total Oyster	Total Gap	% Mussel	% Mixed	% Oyster	% Gap	Bed Type	Bed Quality
Site 1	4220	3616	78	8	518	85.7	1.8	0.2	12.3	Mussel	87.7

Pacific Oyster Distribution
At each sample point the total number of Pacific Oysters was recorded. This data was configured to show:

- total number of oysters per Site
- peak sample density per Site
- mean sample density per Site

Results: Site 1 Pegwell

Table 17 lists the results in terms of number of Patches, Patch area and total Site area.

Table 17 Patch and Site areas

Date	Patch 1 Area (m²)	Patch 2 Area (m²)	Patch 3 Area (m²)	Patch 4 Area (m²)	Patch 5 Area (m²)	Site Area (m²)
07.11.13	54942	0	0	0	0	54942

Table 18 shows results in terms of transect samples.

Table 18 Transect samples

Date	Total Samples	Total Mussel Samples	Total Mixed Samples	Total Oyster Samples	Total Gap Samples	% Mussel Samples	% Mixed Samples	% Oyster Samples	% Gap Samples
07.11.13	2955	2502	0	0	453	84.7	0	0	15.3

Analysis

Figure 32 indicates site coverage analysis based on the distribution of transect sample types.

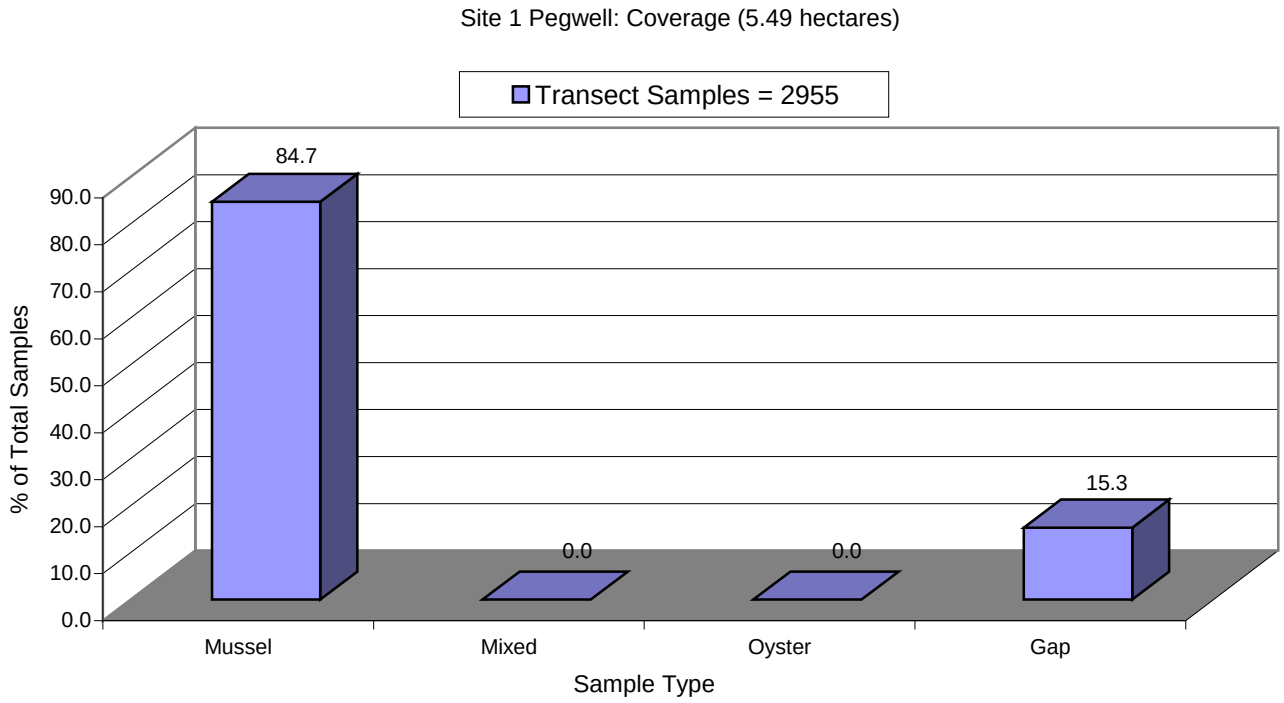

Figure 32 Distribution of transect sample types

It can be seen that Mussel was the dominant sample type. There were no Mixed or Oyster samples present and Gap represented 15.3 % of samples. Using this data, table 19 provides a summary of Site classification based on transect samples.

Table 19 Site classification summary

Date	Site Interaction Classification	Site Quality	Total Area	Number of Patches	Oyster Total	Oyster Peak Density	Oyster Mean Density
07.11.13	Mussel Bed	84.7	5.49 ha	1	97	4	0.002

Conclusions

This is a large, high quality site in terms of mussel/gap.

Oysters are present as scattered individuals.

Part of this site is located within the area of the Pacific oyster control pilot and trial which took place between 2011 and 2013. During this period a total of 75,916 oysters were removed from Western Undercliff which overlaps this mussel bed. It is highly probable that, had this management not occurred, some transect samples would have been recorded as “Mixed Bed” and “Oyster Bed”.

Management details are described in section 5 of this report.

3 Monitor the inter-action between *Sabellaria spinulosa* and Pacific oysters

Aim

To map and monitor significant stable areas of *Sabellaria spinulosa* settlement, identified from the monitoring programme, which may be at risk of biotope modification due to the spread of Pacific Oysters and to record the interaction of both species.

Method

In terms of the inter-action between *Sabellaria spinulosa* and Pacific oysters, the method used was similar to that described in Section 2 Monitor the inter-action between common mussels *Mytilus edulis* and Pacific oysters.

In addition an assessment of the "Reefiness" of the site was made using JNCC guidelines (JNCC 2007).

For each Site, a site document was created in Ms Word and spreadsheet was created in Ms Excel.

Results: Site 1 Western Undercliff Ramsgate

Table 20 records the results in terms of number of Patches, Patch area and total Site area.

Table 20 Patch and Site areas

Date	Patch 1 Area (m²)	Patch 2 Area (m²)	Patch 3 Area (m²)	Patch 4 Area (m²)	Patch 5 Area (m²)	Site Area (m²)
18.02.14	1772	0	0	0	0	1772

Table 21 shows Sabellaria/ Pacific oyster inter-action results in terms of transect samples:

Table 21 Transect samples

Date	Total Samples	Total Sabellaria Samples	Total Mixed Samples	Total Oyster Samples	Total Gap Samples	% Sabellaria Samples	% Mixed Samples	% Oyster Samples	% Gap Samples
18.02.14	124	36	0	0	88	29	0	0	71

Table 22 shows Sabellaria reefiness results in terms of transect samples:

Table 22 Transect samples

Date	Total Samples	Area (m²)	Total Gap Samples	Patchiness % Cover	Samples: Elevation <2cm Not a reef	Samples: Elevation 2-5cm Low	Samples: Elevation 5-10cm Medium	Samples: Elevation >10cm High	Samples: Achieving Reefiness Criteria
18.02.14	124	1772	88	29%	33	3	0	0	2.4%

Analysis

Inter-action between *Sabellaria spinulosa* and Pacific oysters

Figure 33 indicates site coverage analysis based on the distribution of transect sample types.

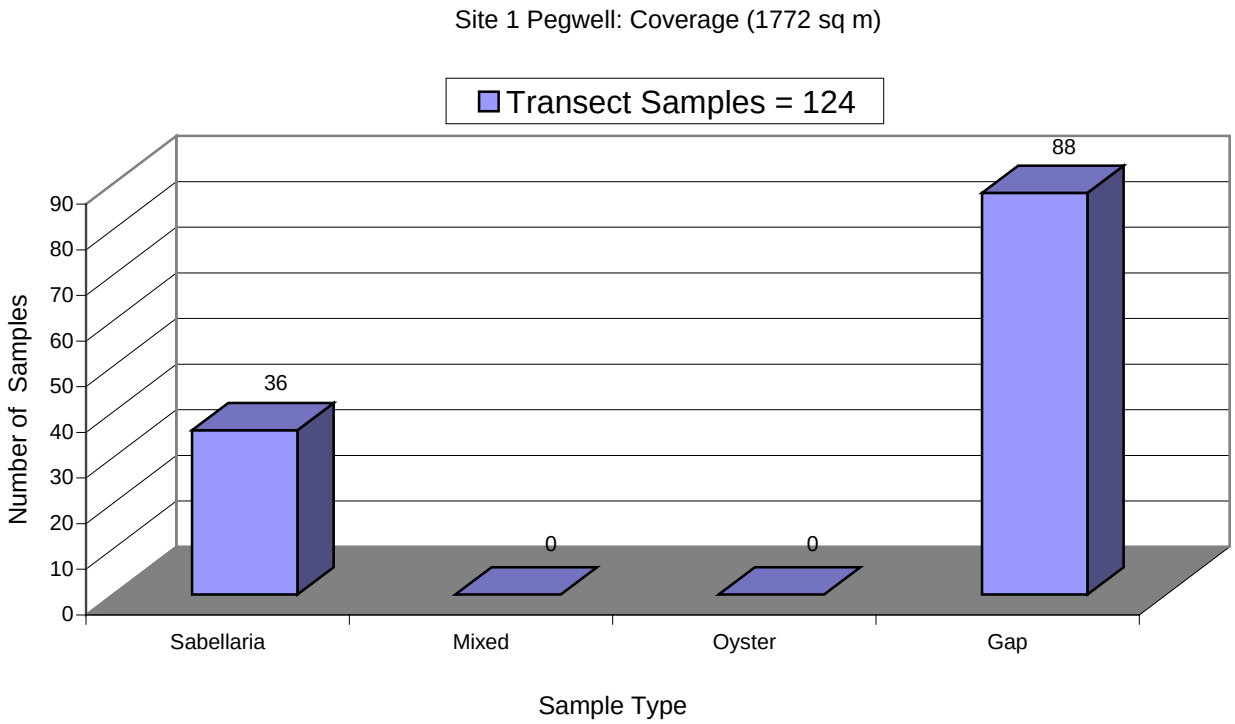

Figure 33 Site coverage based on the distribution of transect sample types.

It can be seen that Gap was the dominant sample type. Gap represents 71% of samples. There were no Mixed or Oyster samples present. A total of 2 oysters were recorded across the area of the site. Using this data, table 23 provides a summary of Site classification in terms of Sabellaria/Pacific oyster inter-action based on transect samples.

Table 23 Site classification summary

Date	Site Interaction Classification	Site Quality	Total Area	Number of Patches	Oyster Total	Oyster Peak Density	Oyster Mean Density
18.02.14	Sabellaria Bed	29%	1772 sq m	1	2	1	0.001

Reefiness

Figure 34 shows nodule elevation based on transect samples.

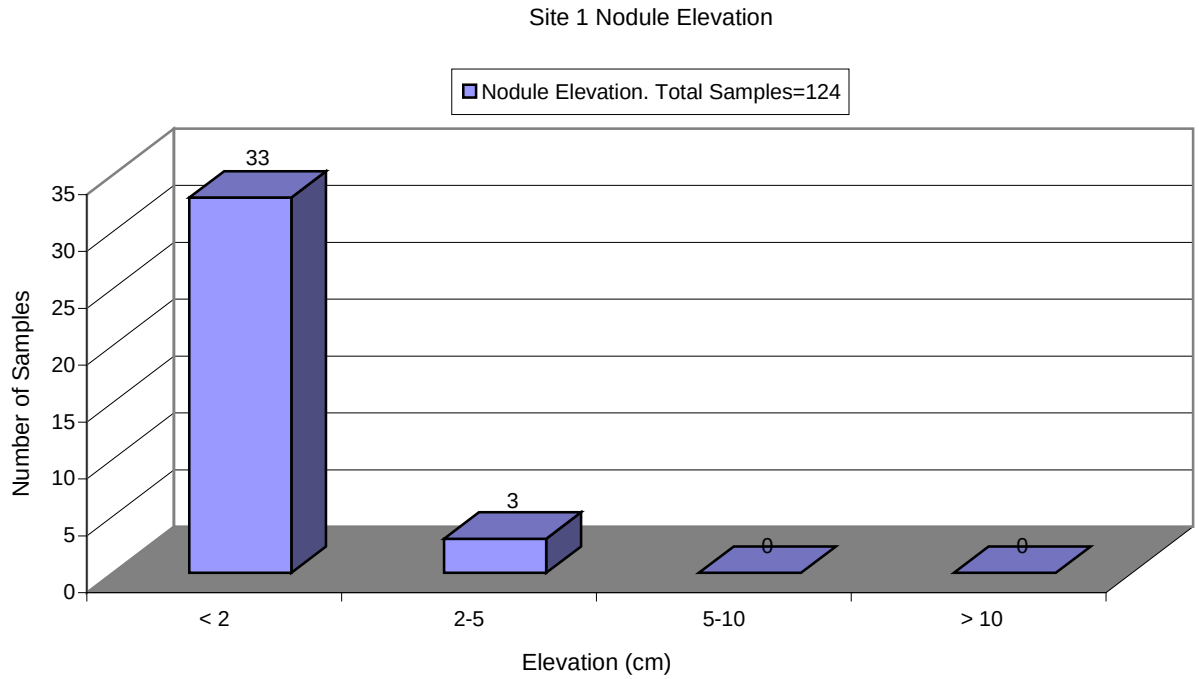

Figure 34 Nodule elevation based on transect samples

It can be seen that the majority of samples showed a nodule elevation less than 2cm. This failed to meet the elevation threshold for reefiness. Using this data, table 24 provides a summary of Site classification in terms of *Sabellaria spinulosa* reefiness based on transect samples.

Table 24 Site reefiness classification based on transect samples

Parameter	Area	Patchiness (% cover)	Elevation	Site "Reefiness" Classification
Result	Low	High	Not a Reef	Not a Reef

Conclusions

In terms of *Sabellaria spinulosa*/Pacific oyster inter-action this site was currently unaffected by oyster settlement. Only 2 oysters were found in samples across the site.

However, this site is located within the area of the Pacific oyster control pilot and trial which took place between 2011 and 2013. During this period a total of 75,916 oysters were removed from Western Undercliff which encloses this *Sabellaria spinulosa* site. It is highly probable that, had this management not occurred, some transect samples would have been recorded as "Mixed Bed" and "Oyster Bed".

In terms of reefiness this site failed to reach the criteria set by JNCC and is therefore a crust rather than a reef. Nodule Elevation was the parameter which caused the failure.

4 Monitor Pacific oyster settlement on tidal drift at sediment locations

Aim

Monitor selected sediment sites, identified from the monitoring programme, which may be at risk of rapid habitat modification due to Pacific oyster settlement.

Method

The following definitions have been produced.

A **Sediment Site** is a significant stable area of sediment within the inter-tidal zone which has been identified from the monitoring programme and conforms with the following criteria:

- the area of the site must be at least 10 hectares
- the site must be stable and have existed for at least 10 years (not ephemeral).
- sand substrates are generally unstable and therefore excluded

A **Patch** is an area of oyster settlement within a Sediment Site. Oysters must be within a range of 50m of a neighbouring oyster to be included within the same patch. Oysters beyond the 50m range will be members of a separate patch. Patch size is determined by the area affected by oyster settlement.

There are six distinct stages in the process:

- identify the site from observations made in the monitoring programme
- record the site boundary and area using multiple GPS fixes
- walk over the entire area of the site to identify individual oyster Patches
- record the boundary and area of each patch using multiple GPS fixes
- record the total number of oysters, peak density and shell length range per Patch
- record the attachment method per Patch

For each Site a site document was created in Ms Word and a spreadsheet was created in Ms Excel.

Results: Site 2 Pegwell Bay

Table 25 records the results in terms of number of Patches, Patch area and total Site area.

Table 25 Patch and Site areas

Patch 1 Area (m^2)	Patch 2 Area (m^2)	Patch 3 Area (m^2)	Patch 4 Area (m^2)	Patch 5 Area (m^2)	Site Area (ha)
0	0	0	0	0	153.89

Analysis

Table 26 shows site assessment based on Pacific oyster settlement, Patch area and Site area.

Table 26 Site assessment

Date	Site Area (ha)	Total Patch Area (ha)	% Patch Area	Total Oysters	Peak Density	Mean Density	Attachment Substrate
24.05.13	153.89	0	0	0	0	0	

No Pacific oysters were recorded. However drift material, mainly common cockle shells *Cerastoderma edule*, was abundant in a band parallel to the shoreline between Cliffsend and Ebbsfleet.

Between waypoints 10 and 11 (OS TR 34512 63188 and 34944 63105) cockle shell drift was very abundant. Green algae had established on shells at this location suggesting that this was a long established site. Figure 35 shows detail. Elsewhere cockle shells were present but at low abundance.

Figure 35 Cockle shell drift between waypoints 10 and 11

In addition drift material was accumulating around clumps of *Spartina anglica* which were spreading across the mudflats parallel to the coastline. Material consisted of various shells, chalk, flint pebble and cobble. Figure 36 illustrates tidal drift accumulating at a Spartina clump.

Figure 36 Tidal drift accumulating at a Spartina clump

Conclusions

Pacific oysters are currently absent from tidal drift material. However, this site is at risk of Pacific oyster settlement facilitated by the adjacent oyster population at Western Undercliff in Ramsgate and the abundant drift material fixed in the mudflats. Areas of particular concern are:

- hard substrates provided by drift material around the Spartina clumps
- drift cockle shells between waypoints 10 and 11

5 Complete the Pacific oyster control trial

Aim

The aim of the trial was to assess the feasibility of controlling wild Pacific Oysters at selected locations within the inter-tidal zone of the North East Kent European Marine Protected Areas using volunteer labour.

Method

The trial was formatted around three guiding principles:

- containment not eradication
- targeted response based on the monitoring programme
- long-term commitment

The one-year trial took place between July 2012 and July 2013 at Western Undercliff in Ramsgate. Before field work began, four transects were set out, one within the trial site and three as controls on the shore adjacent to it. Each was 100 m long and 10 m wide and randomly placed at intervals across the inter-tidal zone from the upper to the lower shore. The number of oysters and individual shell lengths, measured from the hinge across the upper valve using callipers, were recorded within each transect. The initial transect survey was completed during June 2012, prior to both the trial launch and the 2012 spawning period. It was repeated during June 2013 at the end of the trial period.

Additional monitoring took place within the trial section to record and compare recruitment within the site:

- before pilot work began in 2011
- on completion of pilot work in 2012
- on completion of trial work in 2013

This was based on four recruitment measuring sites each consisting of a circle of 5m radius and so with an area of 79 sq m and randomly placed at intervals on the chalk reef in the lower shore.

A schedule of work was produced focused around spring tides when low water reached less than 0.9m. This was essential to access the lower shore zone where oysters were abundant and reef forming. Typically events commenced one hour before low water and had a duration of approximately two and a half hours. Events were sequentially rotated across patches defined by physical features of the site. This ensured that the population was reduced evenly and data was not skewed.

Each event was pre-planned by the volunteer supervisor (W. McKnight) who briefed the team, issued tools and personal safety equipment and supervised the event throughout. Team members removed oysters using best working practices agreed with Natural England during a pre-trial pilot which ran between April 2011 and April 2012 and recorded the total number of oysters removed plus any chalk reef impacts. A target was set at which point if levels fell to the extent that volunteers were, on average, locating twenty or less oysters per hour then it would be unproductive to continue working that section. If this target was achieved for two consecutive sessions the section would be judged to be in favourable condition in terms of Pacific oyster population.

As work progressed on-site, a decision was made to expand the area of the trial to include two additional adjacent sections so extending the scope of control measures further into the National Nature Reserve.

At the end of each session the supervisor recorded the total number of oysters removed, total man-hours on-site, number and details of chalk reef impacts and any health and safety incidents. Data was transferred to Ms Excel spreadsheets. A detailed report was submitted to Natural England at the end of the trial (McKnight 2013).

Results

Table 27 indicates combined results of field data recorded during the pilot and trial.

Table 27 Results from the pilot and trial

Total number of oysters removed	75,916
Total man-hours on-site	367
Average oysters removed per man-hour	207
Total number of chalk reef impacts	14
Total number of health & safety incidents	0

Table 28 lists results from the control and trial transects before and after the trial period.

Table 28 Transect results

Transect (1000 sq m)	Total Oysters Pre-Trial	Total Oysters Post-Trial	Mean Density Pre-Trial	Mean Density Post-Trial	Total Spat Pre-Trial	Total Spat Post-Trial	Spat as % Pre-Trial	Spat as % Post-Trial
Control Site 1	160	253	0.16	0.25	27	63	17	25
Control Site 2	220	284	0.22	0.28	25	61	11	21
Control Site 3	16	20	0.02	0.02	3	7	19	35
Trial Site	165	72	0.17	0.07	80	56	48	78

Table 29 shows results from the recruitment sites within the trial area before and after the pilot and trial periods.

Table 29 Recruitment site results

Year	Site 1 Total Oysters	Site 2 Total Oysters	Site 3 Total Oysters	Site 4 Total Oysters
2011 pre-pilot	221	232	274	266
2012 pre-trial	36	42	78	119
2013 post-trial	1	11	9	7

Analysis

Figure 37 shows the number of oysters recorded in each transect before and after the trial.

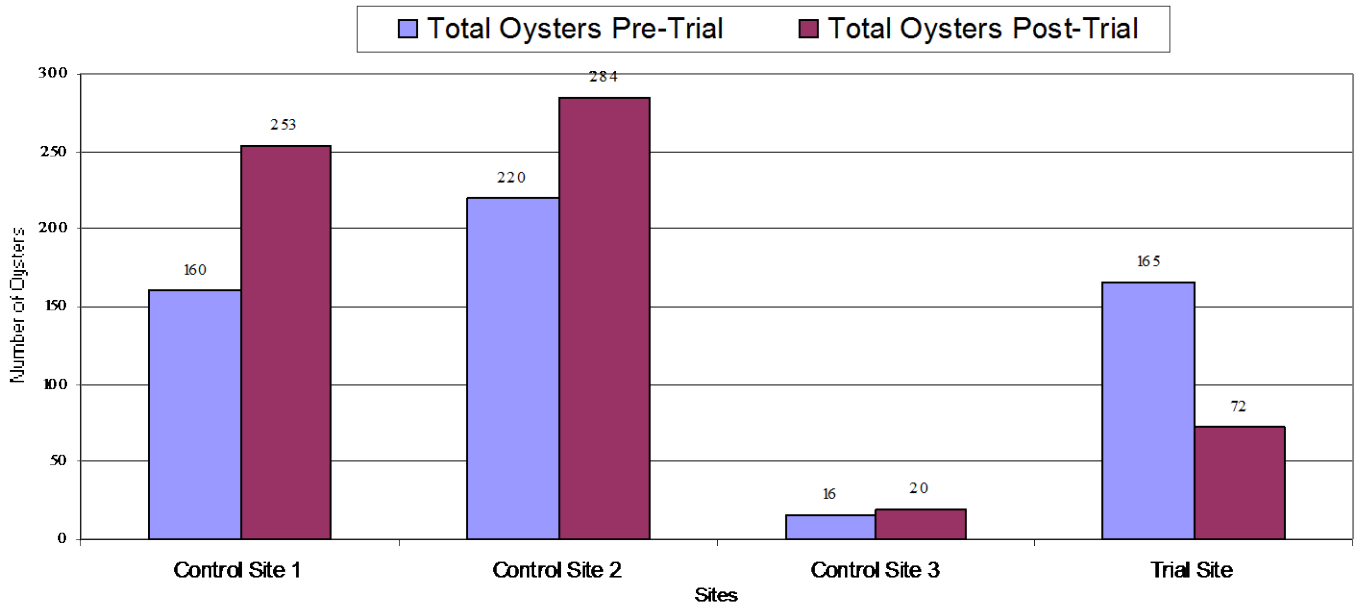

Figure 37 Transect results

It can be seen that during the period of the trial, oyster numbers increased at each of the three control sites. During the same period oyster numbers reduced at the trial site. In addition, recruitment reduced considerably at the four recruitment sites within the trial area during the period of the pilot and trial. This can be seen in Figure 38.

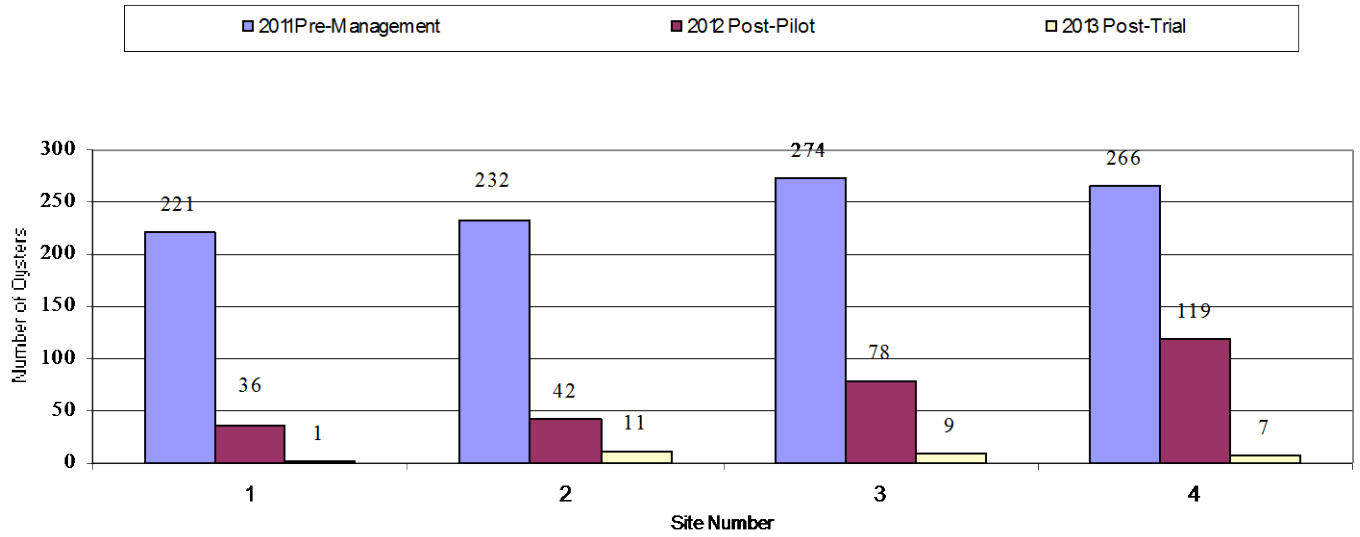

Figure 38 Recruitment within the trial area

Productivity was measured using a target of twenty oysters (mean) removed per man-hour. If this figure could be achieved for two consecutive field events then the section would be considered to be in favourable condition in terms of oyster population. Figure 39 records progress towards this target for the duration of the trial and indicates that the target was not reached although means of thirty-two and thirty-six were achieved on two consecutive field events towards the end of the trial.

At the two additional adjacent sections where oyster abundance was much less the target was rapidly achieved within six sessions and two sessions respectively.

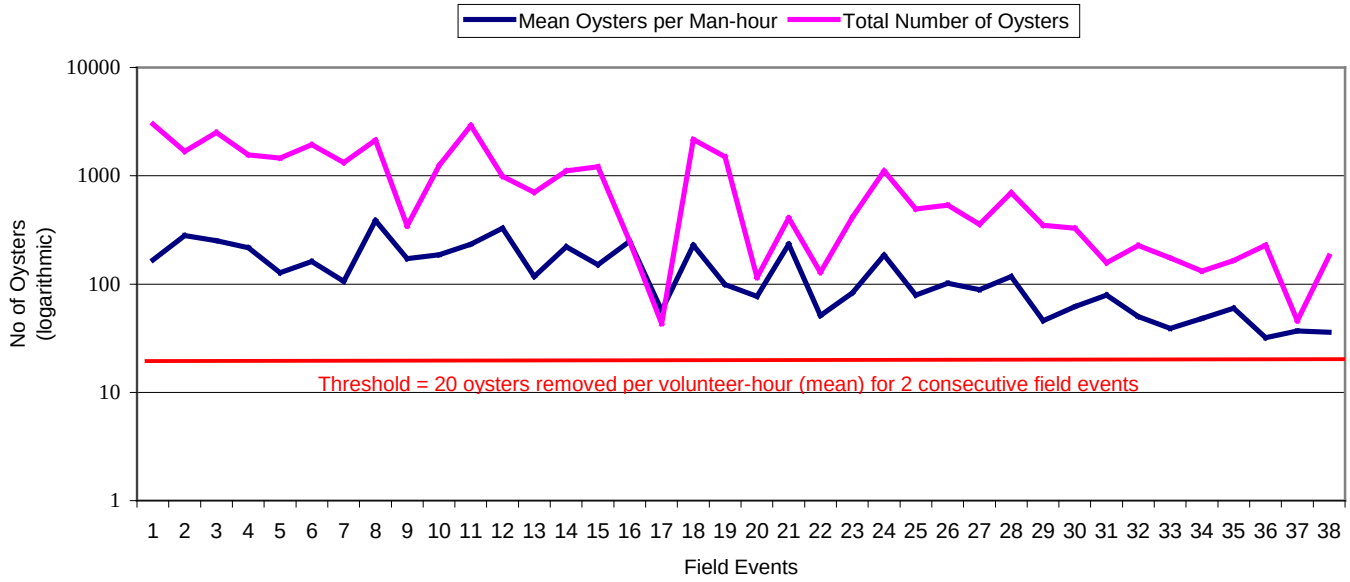

Figure 39 Productivity at trial site

Conclusions

The trial highlighted positive and negative aspects of management. Negative issues included:

- work was labour intensive
- work was physical, repetitive and very messy
- access was possible only on spring tides
- working environment was hazardous
- volunteers were exposed to extreme weather conditions

Positive issues include:

- population was considerably reduced at the trial site
- threat to adjacent locations was reduced
- method used was highly selective and bio-secure
- complied with DEFRA's NNS policy (DEFRA 2003)
- cost effective
- good PR

The trial showed that in the short-term it was possible to control local populations of Pacific Oysters using volunteer labour. However, further research is needed to determine if this can be sustained in the long term.

The productivity target which was set at a mean of twenty oysters removed per manhour for two consecutive sessions did not result in the best use of the volunteer resource. This was an arbitrary figure set to launch the trial. Practical experience has shown that the volunteers would be more gainfully employed if this target was raised.

6 Recruit, train and equip a minimum of six new volunteers

The aim of this strand of the project was to expand the number of CoastBuster volunteers available to support long-term viability and maintain the momentum achieved during the one-year trial.

To stimulate interest, a presentation was delivered to Thanet District Council's coastal wardens at their annual gathering on 19 March 2014. The slide-show described the NEKMPA non-native species project and the criteria needed for volunteer team membership. This resulted in twelve new recruits enrolling for the training course which was scheduled for the 28 March 2014.

Training was based on the session delivered in April 2012 to the trial volunteers but was updated to include best practices for *Sargassum muticum* and references to the NEKMPA. The training session was titled "Control of Selected Inter-Tidal Non-Native Species. An Introduction for Natural England Volunteers". The course ran for four and a half hours and had four modules:

- The North East Kent Marine Protected Areas
- Non-Native Species
- NEKMPA Non-Native Species Project
- Control Methodology

The first field event using the new recruits took place on 5th April. This provided practical experience to enhance classroom learning. Figure 40 shows new recruits deployed at Kingsgate Bay, Broadstairs.

Figure 40 New recruits at Kingsgate Bay

Funding for additional tools and personal safety equipment was provided by Thanet District Council (£288.61) and Kent County Council CC2150 project (£174).

7 Schedule and run a minimum of twenty post trial field events

A programme of field work was created to cover the post-trial period until December 2014. Further events will be added when the 2015 tide tables become available. On-site times were synchronized around low water on spring tides. Locations were selected from priorities identified from the monitoring programme. Table 30 lists field events scheduled between April 2014 and December 2014.

Table 30 Programme of work

Date	Start Time	Location	Maximum Number of Volunteers
Sat 05.04.14	09.00	Kingsgate	8
Sun 04.05.14	08.30	Kingsgate	8
Mon 19.05.14	08.45	Kingsgate	8
Mon 02.06.14	08.00	Kingsgate	8
Wed 18.06.14	09.30	Kingsgate	8
Wed 02.07.14	08.15	Kingsgate	8
Thu 17.07.14	09.15	Kingsgate	8
Thu 31.07.14	08.00	Kingsgate	8
Fri 15.08.14	09.00	Western Undercliff, Ramsgate	8
Sat 16.08.14	09.30	Western Undercliff, Ramsgate	8
Sat 30.08.14	08.00	To be Advised	8
Sat 13.09.14	08.30	To be Advised	8
Mon 29.09.14	08.15	To be Advised	8
Tue 14.10.14	09.15	To be Advised	8
Thu 30.10.14	08.30	To be Advised	8
Thu 13.11.14	08.15	To be Advised	8
Sun 30.11.14	10.45	To be Advised	8
Fri 12.12.14	08.00	To be Advised	8

In addition to the programme shown in Table 30, the following events have been completed:

- 03.02.2014 at Western Undercliff: Greenwich University MSC students (total 8)
- 05.02.2014 at Western Undercliff: Natural England INNS team (total 8)
- 04.03.2014 at Western Undercliff: Natural England CoastBusters team (2)
- 05.03.2014 at Western Undercliff: Natural England CoastBusters team (5)

8 Set up a second volunteer team within the Canterbury City Council Zone

Phase six of the project identified that it would be beneficial to have a second volunteer team based in the west of the NEKMPA. This would increase the rate of work, contribute to the long-term viability of the project and enable the original team to focus on locations in the east so reducing travel time and cost. A useful demarcation point was identified as the boundary between the Canterbury City Council zone and the Thanet District Council zone.

In phase seven, quality standards were set for prospective volunteers recruited to the new team. In practice this means new recruits must:

- attend the CoastBuster training course
- comply with best practices on-site
- maintain the integrity of data
- work under approved supervision
- work at priority sections identified from the monitoring programme

Kent Wildlife Trust and Canterbury City Council were approached regarding the establishment of a second volunteer team.

An enthusiastic response was received from Kent Wildlife Trust's marine officers. Work is in hand to secure funding and identify potential recruits from the ranks of their Shoresearch volunteers. In anticipation, a provisional date has been set in October 2014 to run a CoastBuster training course in their visitor centre at Reculver.

Response from Canterbury City Council is at an early stage.

9 Update Natural England's GIS database

Data were submitted and maps and tables were produced on Natural England's "Thanet Coast" GIS dataset. This included:

- non-native species sites identified in phase 6
- site 1, common mussel/Pacific oyster interaction
- site 1, *Sabellaria spinulosal*/Pacific oyster interaction
- site 2, Pacific oyster settlement on tidal drift at sediment locations

Figure 41 shows the non-native species sites graded by impact factor. Sites are shown as spot references and consist of the six non-native species selected in phase five:

- *Crassostrea gigas*
- *Didemnum vexillum*
- *Eriocheir sinensis*
- *Sargassum muticum*
- *Undaria pinnatifida*
- *Caulacanthus okamurae*

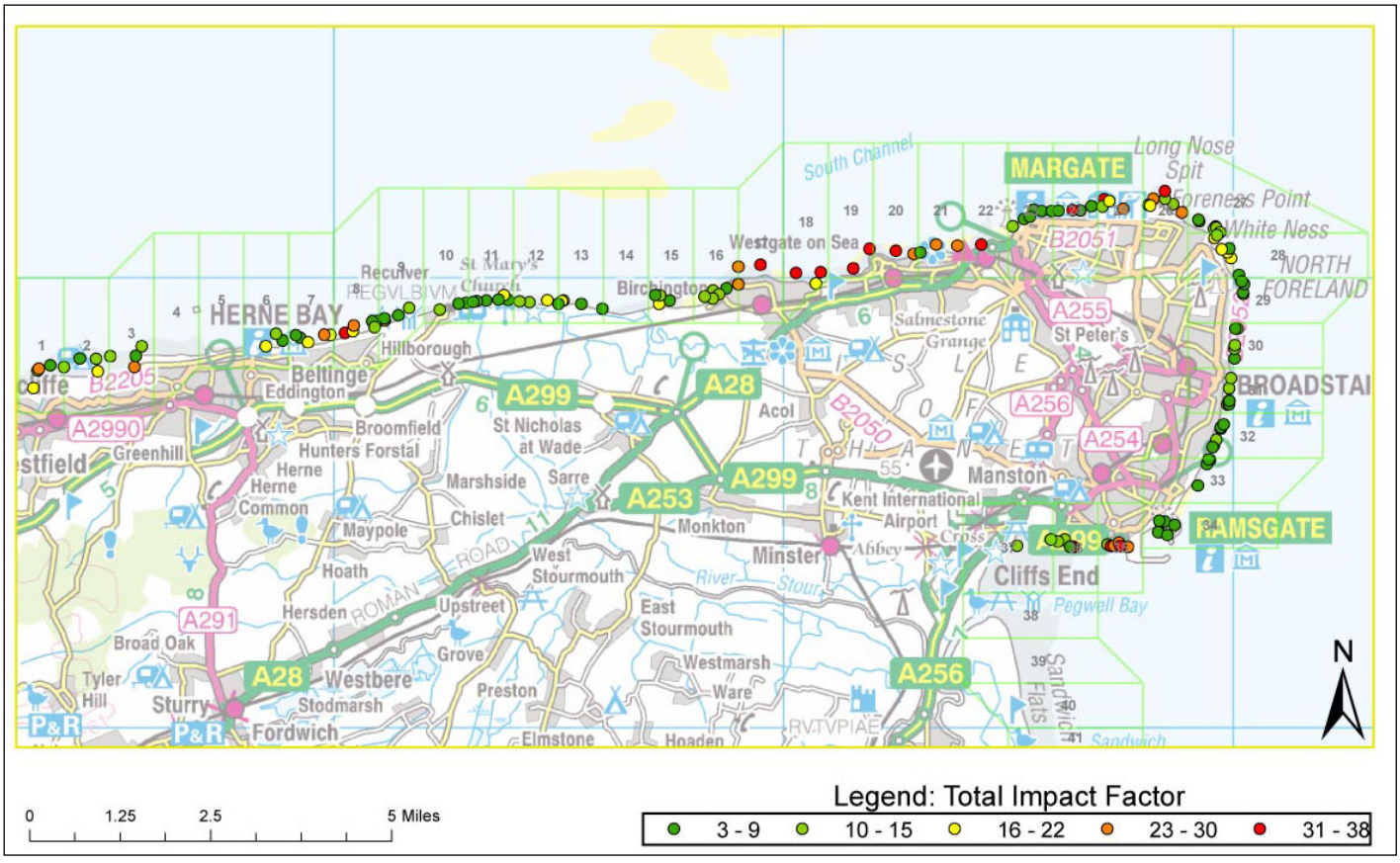

Figure 41 Selected non-native species sites by impact factor

Figure 42 shows site1 common mussel/Pacific oyster interaction, site 1 Sab*ellaria spinulosal*/Pacific oyster interaction and site 2 Pacific oyster settlement on tidal drift at sediment locations. Sites are shown as polygons.

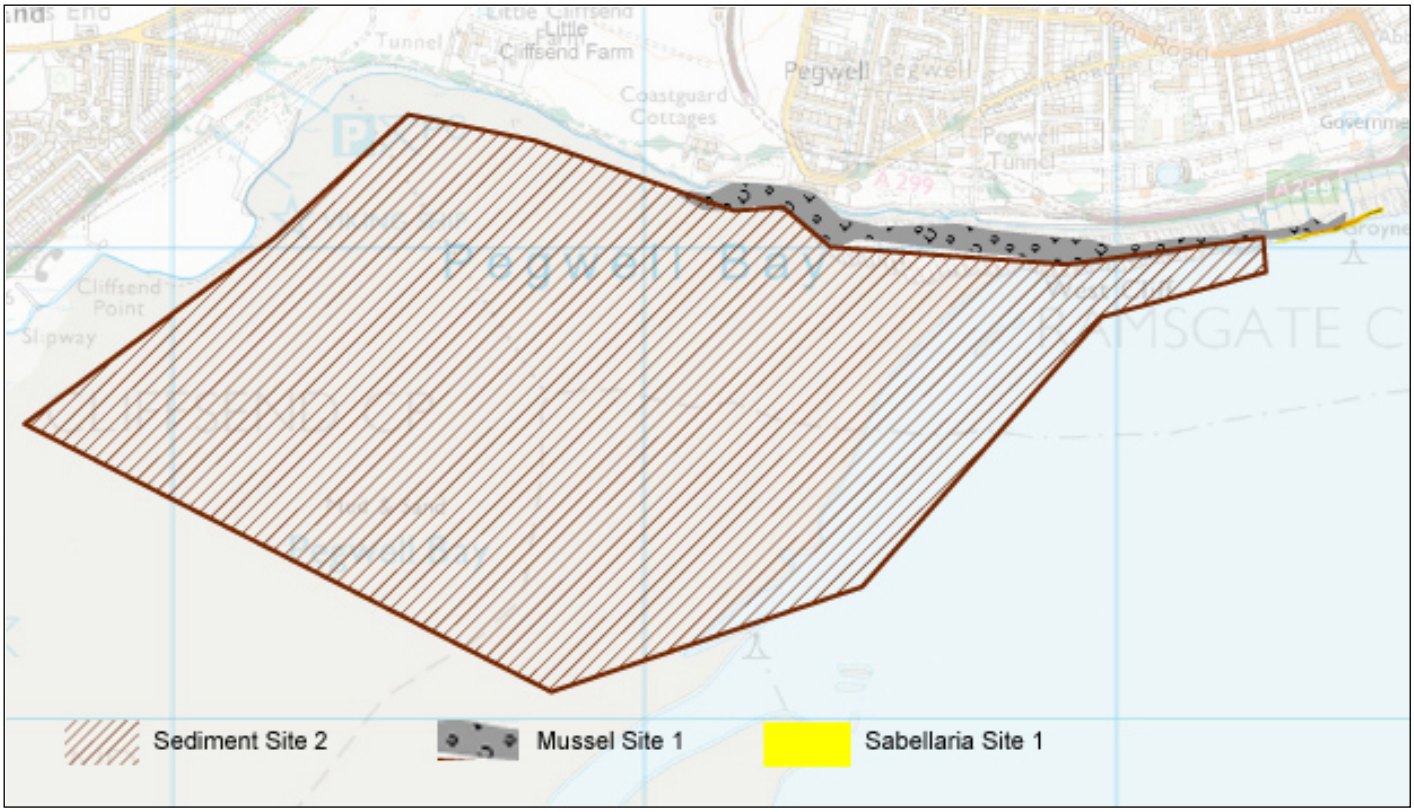

Figure 42 Mussel, Sabellaria and sediment sites

10 Horizon scan for *Mnemiopsis leidyi*

The aim of this strand was to search for specimens of *Mnemiopsis leidyi* within the NEKMPA inter-tidal and report findings to CEFAS.

This invasive ctenophore was first recorded in the North Sea in 2006 (Boersma 2007). The species is also present in the Baltic Sea where it is considered to be a threat to fish stock such as Cod *Gadus morhua* and Sprat *Sprattua sprattus* (Haslob 2007). In the 1980's *Mnemiopsis leidyi* was introduced to the Caspian Sea where it has had a major impact on biodiversity resulting in the decline of fish stock (Finenko 2006).

Project "MEMO" has been set-up across several European nations to monitor the spread in EU waters. CEFAS is leading for the UK. Their prime role is modelling. The Thames Estuary and southern North Sea are identified as potential hot-spots and the likely first location for UK populations.

Contact has been made with CEFAS and arrangements made to record and forward *Mnemiopsis leidyi* data gathered during Natural England's non-native species monitoring programme (inter-tidal).

Details of this species and project MEMO have been forwarded to Kent and Essex Inshore Fisheries and Conservation Authority (IFCA) who may be able to assist with offshore scanning within the Thames estuary and southern North Sea during normal fishery patrol duties.

11 Recommendations

R.1 Monitor Pacific oyster transects

In Phase 8 transects 8 to 14 should be monitored. This will provide data for the area between Foreness and Deal. This represents approximately fifty percent of the NEKMPA inter-tidal area and contains the sections where Pacific oyster populations advanced and new settlement of *Sargassum muticum* were recorded in Phase 7.

R.2 Monitor Pacific oyster transects

Monitoring the original batch of twelve recruitment sites set-up in Phase 3 should be discontinued. These sites provided a total of forty-eight square meters and have been made redundant by the Pacific oyster transects set-up in Phase 6 which now provide a total of fourteen thousand square meters.

R.3 Monitor Pacific oyster transects

Data from transect monitoring should be a key indicator to prioritise worksites for the CoastBuster team.

R.4 Monitor the inter-action between common mussels and Pacific oysters

In Phase 8 a new inter-tidal mussel/oyster site should be added to the database. This should be the mussel beds located at Foreness Point, Margate.

R.5 Monitor the inter-action between *Sabellaria spinulosa* and Pacific oysters

In Phase 8 a new inter-tidal *Sabellaria spinulosa* /oyster site should be added to the database. This should be the Sabellaria site located at Beresford Gap in Birchington.

R.6 Monitor Pacific oyster settlement on tidal drift at sediment locations

In Phase 8 a new inter-tidal sediment site should be added to the database. This should be the area between the south side of the estuary of the River Stour and the NEKMPA boundary at Deal.

R.7 Monitor Pacific oyster settlement on tidal drift at sediment locations

Monitoring of the mudflats at Pegwell Bay (Site 2) should continue on an annual basis. This will provide an early warning of new settlement on tidal drift including the Spartina clumps at this important location and will prompt a rapid response from the CoastBuster volunteer team.

R8. CoastBuster volunteer team

Complete a minimum of twenty field events at priority locations identified from the monitoring programme between Foreness and Deal. This will include revisits to Western Undercliff to monitor and respond to post-trial recruitment.

R9. CoastBuster volunteer team

The productivity target should be adjusted from twenty (mean) oysters removed per manhour for two consecutive field events to forty (mean) oysters for two consecutive field events.

R10. CoastBuster volunteer team

Efforts should continue to set up a second CoastBuster volunteer team based in the west of the NEKMPA. This will involve liaising with agencies such as Kent Wildlife Trust and Canterbury City Council.

R11. CoastBuster volunteer team

Review the possibility of Natural England paying travel expenses (mileage allowance) to CoastBuster volunteers.

R.12 Horizon Scan for *Mnemiopsis leidyi*

In Phase 8 every site visit should be an opportunity to scan for this new threat with data recorded on a spreadsheet and forwarded to CEFAS.

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