Natural England Commissioned Report NECR044

The sustainability of shellfish harvesting and its effects on the reef habitats within the Northeast Kent European Marine Sites (inter-tidal)

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The North East Kent European marine sites consist of Thanet Coast Special Area of Conservation (SAC), Sandwich Bay SAC and Thanet Coast & Sandwich Bay Special Protection Area (SPA).

Shellfish harvesting is a long established practice across the inter-tidal chalk reef platforms of the Thanet coast. In recent years, public concern has grown at the increasing levels of observed harvesting. The presence of large organised groups of harvesters has been of particular concern.

Natural England commissioned this work to assess the effects that current levels of harvesting are having on the inter-tidal reef habitats and to determine if current levels are sustainable.

Natural England is in support of the four recommendations identified in the report and we are working closely with the North East Kent European marine sites Management Group to implement them. Natural England chairs the management group and the recommendations of the report were explored at the last management group meeting. Additionally, we are also working with the Thanet Coast Project who coordinate the Coastal Warden scheme within the marine sites and they contribute to the monitoring of the activity.

The findings in this report will be used to try to establish a baseline for future monitoring work. They will also help provide information for the 100 or so coastal wardens that work along the coast as well as be used as the basis to inform and reassure the public.

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A collection of harvested shellfish

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Further information
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Background

This report results from research commissioned by Natural England in order to assess the effect and establish the sustainability of shellfish harvesting on the reef habitats within the north east Kent European marine sites.

Acknowledgements

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My thanks also goes to the Thanet coastal wardens who supplied “People“ data from their field observations and in particular to Sue Andrews who was responsible for the coastal area around Foreness, Margate.

Summary

Shellfish harvesting is a long established practice across the inter-tidal chalk reef platforms of the Thanet coast. In recent years, public concern has grown at the increasing levels of observed harvesting. The presence of large organised groups of harvesters has been of particular concern.
This project aims to assess the effects that current levels of harvesting are having on the inter-tidal reef habitats and to determine if current levels are sustainable.

The Edible Periwinkle *Littorina littorea* has been identified as the species most targeted by harvesters and has been selected as representative. Twelve survey sites were selected at random within areas of reef having similar physical and biological profiles. Selected species within each site were surveyed on 4 occasions. During this period, details of observed harvesters were recorded by Thanet coastal wardens. Data was used to investigate population trends against harvesting trends.

Results showed stability across all sites which ranged from 0 harvesters to 441 harvesters observed during the duration of the project.
It was possible to classify harvesters into 3 typical groups:

- Casual
- Local
- Organised Groups

Shellfish taken and methods employed by Casual and Local harvesters were considered to be sustainable at current levels. However, the long term impact of Organised Groups is unpredictable and must be considered in conjunction with natural disturbances, climate change and rising sea levels.

Recommendations were made for:

- ongoing monitoring at prioritised sites favoured by Organised Groups
- improved control of vehicle access to the foreshore
- establishment of a point of legal intervention
- improved communication with the public

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1 Introduction

North East Kent European Marine Sites

The north east Kent European marine sites are located on the north east coast of Kent, on the south side of the Thames estuary, from Swalecliffe to just north of Deal but excluding Herne Bay town frontage. The coastal track distance is approximately 50Km. The sites consist of Thanet Coast Special Area of Conservation (SAC), Sandwich Bay SAC and Thanet Coast & Sandwich Bay Special Protection Area (SPA).

Thanet Coast SAC interest features are:

- Reefs
- Sea Caves.

Sandwich Bay SAC interest feature is:

- Dune System.

Thanet Coast & Sandwich Bay SPA interest features are:

- Breeding little tern *Sterna albifrons*
- Wintering golden plover *Pluvialis apricaria*
- Wintering turnstone *Arenaria interpris.*

Thanet Coast Project (TCP) has been created to assist with the implementation of the management scheme for the sites. Approximately 100 coastal wardens have been recruited and trained to monitor coastal habitats and activities. The North East Kent Scientific Coastal Advisory Group (NEKSCAG) has been created to advise the north east Kent European marine sites Management Group.

Plate1.1 Edible Periwinkle *Littorina littorea*

Shellfish harvesting

Shellfish harvesting occurs across the inter-tidal area of the north east Kent European marine sites but is concentrated around the chalk reef platforms of the Thanet Coast. Observations by Thanet coastal wardens have been recorded since 2004 showing that the main targeted species is the Edible Periwinkle *Littorina littorea* (Plate 1.1).
Harvesting is a long established local tradition but since 2004 increasing public concern regarding the levels, progressing from low impact recreational activity towards a high impact commercial activity, has prompted the set up of this project.

Aim & objectives

Aim:

- Establish whether current observed levels of shellfish harvesting are ecologically sustainable and assess it's effects on the reef habitats from Minnis Bay to Pegwell Bay within the north east Kent European marine sites.

Objectives:
At selected sites:

- Monitor the population trend of selected species
- Monitor the demography of *Littorina littorea*
- Monitor physical reef damage caused by harvesting activities
- Monitor levels of harvesting
- Test correlation between levels of harvesting and condition of reef habitats.
- Create a photographic record.

2 Methodology

Strategy

The project scope was established with input from Natural England, The Environment Agency, Canterbury Christ Church University and Kent Wildlife Trust.

Species selected for monitoring were Edible Periwinkle *Littorina littorea,* Common Limpet *Patella vulgata* and Common Mussel *Mytilus edulis*. In addition, dominant and secondary algae species plus % algae cover were recorded.

The species selected were considered to be direct or indirect indicators of shellfish harvesting within Thanet. Twelve survey sites were selected having a similar physical and biological profile and distributed across approximately 22km of inter-tidal chalk reef within the north east Kent European marine sites. Selected locations were “typical” habitats likely to be used by shellfish harvesters (chalk reef with *Littorina littorea*, *Mytilus edulis* and low abundance of algae). Harvesting data supplied by the Thanet Coastal Project provided people information which identified levels of harvesting at each survey site.

Surveys were scheduled for:

- October 2007 (survey 1)
- March 2008 (survey 2)
- October 2008 (survey 3)
- March 2009 (survey 4).

Initially, ten quadrats per site were recommended for survey 1 followed by five quadrats per site for survey 2. A variance test conducted on the results of surveys 1 and 2 would then determine the best number of quadrats per site for the remaining surveys.

Site selection

Thanet Coast Project has divided the area of the European sites into 48 sections each approximately 1km in length. Eleven sections were identified as suitable for survey and within each section a standard survey site of 30 x 20 meters was randomly selected. At Foreness section, a known harvesting location, 2 survey sites were created. Harvesting is known to occur across the entire expanse of the Thanet reefs. It was not possible, therefore, to pre-select a control site. However, from analysis, site 3 proved to be free from harvesting during the period of the project and can be considered as a control site. All sites can be located/re-located from a fixed physical reference point using a compass and tape or by GPS. At each site the distance from the nearest legal vehicle access point was recorded.

Fig. 2.1 shows the distribution of survey sites around the Thanet coast. Plate 2.1 shows a typical site with the centre line aligned with it’s fixed reference point.

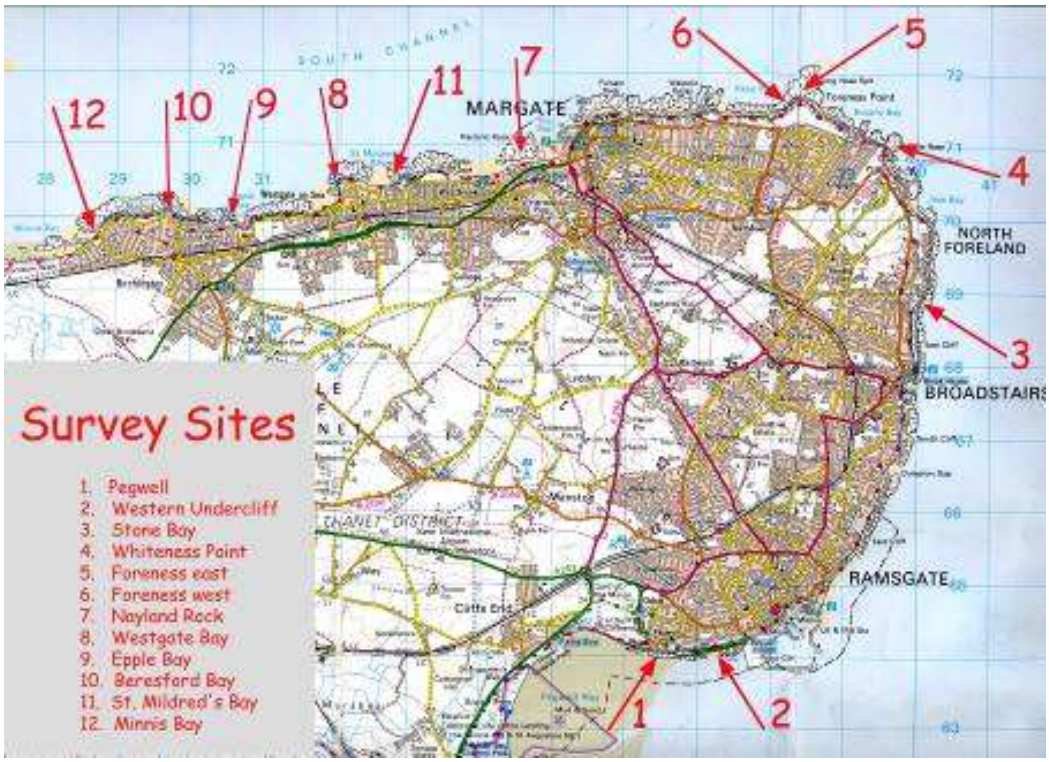

Figure 2.1 Distribution of survey sites around the Thanet coast

Plate 2.1 showing a typical site with centre line aligned with reference point

Survey techniques

- Each site was surveyed 4 times at approximately 6 month intervals between October 2007 and March 2009 using an 1 square meter quadrat.
- As recommended, 10 quadrat samples per site were taken during survey 1 (October 2007) and 5 quadrat samples per site were taken during survey 2 (March 2008).
- A variance test was then completed indicating that 5 quadrats per site could be used for the remainder of the project. Tables 3.1 & 3.2 show results.
- To maintain uniformity, only data from quadrats 1 to 5 at survey 1 will be used for analysis.

- Quadrat samples were pre-selected randomly using a grid numbering scheme representing the area of the rectangular site. Appendix 1 shows typical quadrat distribution (site 2 : surveys 1-4).
- To minimise habitat disturbance, no boulder, cobble or algae was moved during surveys.
- At each survey, sites were checked for signs of physical damage caused by harvesting activities.

At each quadrat, the following items were recorded:

- Total number of Littorina littorea
- Total nunber of Patella vulgata
- Mytilus edulis estimated % cover
- Mytilus edulis estimated average length
- Total algae estimated % cover
- Dominant algae estimated % cover
- Secondary algae estimated % cover
- Photograph of quadrat in situ
- Photograph of area adjacent to quadrat.

In addition, at each site 100 *Littorina littorea* were gathered at random and size recorded to produce a profile of population demography. Size was recorded as height in mm (vertical distance from base aperture to body summit).

Canon EOS 350D and 40D cameras with wide angle lenses were used to record quadrat images. Littorina numbers were recorded using a digital tally counter and size recorded using digital calipers.

Human activity

Observers

Information on shellfish harvesters was sourced from:

- Reports received by Thanet Coast Project from the public
- Reports received by Thanet Coast Project from Thanet Coastal Wardens.

To raise project awareness within the warden community, a handout was distributed by the Thanet Coast Project describing aim and objectives and encouraging reporting of all observations of shellfish harvesting within the period of the project. The handout included a bespoke recording document designed to simplify and stimulate the reporting process. Details recorded per observation included date, location, number of harvesters seen, observer's name and status. Appendix 2 shows an example of the summary sheet compiled from warden's individual reports.

Harvesters

This included individuals and groups collecting shellfish from the chalk reef platform and excluded bait diggers and crab collection for bait.

Data collection

Collected data were transferred to Excel spreadsheets "Species", "People" and "Littorina Demography" following each survey session.

3 Results

Variance

Variance tests were conducted using the results of attribute “Littorina littorea Total” from survey 1 and survey 2. This amounts to data from a total of 180 quadrats (12 x 10 survey 1) + (12 x 5 survey 2). Table 3.1 shows results from survey 1. Table 3.2 shows results from survey 2.

Anova: Single Factor Survey 1 (October 2007)

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10	2440	244	41875.33
Column 2	10	3051	305.1	28254.32
Column 3	10	770	77	3242.889
Column 4	10	1004	100.4	5683.378
Column 5	10	725	72.5	2253.833
Column 6	10	988	98.8	7943.511
Column 7	10	1151	115.1	1613.878
Column 8	10	2730	273	19368.22
Column 9	10	1862	186.2	4719.511
Column 10	10	1016	101.6	3592.267
Column 11	10	1500	150	13748.44
Column 12	10	1762	176.2	4657.733

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	691636.4	11	62876.04	5.509267	6.22E-07	1.878387
Within Groups	1232580	108	11412.78			
Total	1924216	119				

Table 3.1 showing variance results from survey 1

Anova: Single Factor (Survey 2 March 2008)

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	1603	320.6	4918.8
Column 2	5	2574	514.8	35279.2
Column 3	5	323	64.6	639.3
Column 4	5	381	76.2	1153.7
Column 5	5	388	77.6	776.3
Column 6	5	295	59	1561.5
Column 7	5	649	129.8	368.7
Column 8	5	1161	232.2	8670.7
Column 9	5	760	152	3449
Column 10	5	996	199.2	7072.7
Column 11	5	413	82.6	7351.3
Column 12	5	958	191.6	151.3

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	983993	11	89453.91	15.03585	4.75E-12	1.994579
Within Groups	285570	48	5949.375			
Total	1269563	59				

Table 3.2 showing variance results from survey 2

Selected species

Tables 3.3 to 3.14 show summary results of selected species from surveys 1 to 4 at sites 1 to 12. Appendix 3 shows sample of raw data. Note that survey 1 at all sites = 10 quadrats and all other surveys = 5 quadrats.

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	2440	1603	1118	1629
Littorina littorea Average Size (mm)	8	7.4	6.3	7
Patella vulgata Total	14	11	9	2
Mytilus edulis Average Est.% Cover	38	46	41	27.2
Mytilus edulis Average Est.Ave.Size (mm)	29	28	21	20
Algae Average Est.% Cover	0	2	1	0.4

Table 3.3 showing selected species survey data summarized for site 1

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	3051	2574	1765	2366
Littorina littorea Average Size (mm)	7.5	7.3	6	7.2
Patella vulgata Total	41	20	13	6
Mytilus edulis Average Est.% Cover	10.1	7	20	7.2
Mytilus edulis Average Est.Ave.Size (mm)	37	29	24	27
Algae Average Est.% Cover	21.2	29	25	11

Table 3.4 showing selected species survey data summarized for site 2

Attribute	Survey 1	Survey2	Survey 3	Survey 4
Littorina littorea Total	770	323	71	314
Littorina littorea Average Size (mm)	12.4	11	11.4	10.9
Patella vulgata Total	12	6	9	12
Mytilus edulis Average Est.% Cover	0	0	0	0
Mytilus edulis Average Est.Ave.Size (mm)	0	0	0	0
Algae Average Est.% Cover	49.5	39	34	32

Table 3.5 showing selected species survey data summarized for site 3

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	1004	381	878	942
Littorina littorea Average Size (mm)	9.8	9.6	9.2	9.3
Patella vulgata Total	8	2	1	5
Mytilus edulis Average Est.% Cover	20.5	28	24	63
Mytilus edulis Average Est.Ave.Size (mm)	21	23	23	21
Algae Average Est.% Cover	44	11	43	27

Table 3.6 showing selected species survey data summarized for site 4

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	725	388	498	585
Littorina littorea Average Size (mm)	10.8	10.9	10.8	10.8
Patella vulgata Total	3	1	3	2
Mytilus edulis Average Est.% Cover	22.5	10	11	11
Mytilus edulis Average Est.Ave.Size (mm)	48	40	34	37
Algae Average Est.% Cover	33.6	31	51	66

Table 3.7 showing selected species survey data summarized for site 5

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	988	295	577	929
Littorina littorea Average Size (mm)	11.1	10.1	10.2	9.7
Patella vulgata Total	11	0	9	1
Mytilus edulis Average Est.% Cover	20	40	26	32
Mytilus edulis Average Est.Ave.Size (mm)	37	35	25	30
Algae Average Est.% Cover	41	44	52	43

Table 3.8 showing selected species survey data summarized for site 6

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	1151	649	900	1019
Littorina littorea Average Size (mm)	10.6	10.7	10.6	10.4
Patella vulgata Total	15	1	7	2
Mytilus edulis Average Est.% Cover	11.6	6.4	6.2	7.4
Mytilus edulis Average Est.Ave.Size (mm)	41	40	34	32
Algae Average Est.% Cover	19.4	13	29	12

Table 3.9 showing selected species survey data summarized for site 7

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	2730	1161	1206	1750
Littorina littorea Average Size (mm)	8.6	8.6	9.5	9.6
Patella vulgata Total	8	1	4	1
Mytilus edulis Average Est.% Cover	19	24	32.2	18.2
Mytilus edulis Average Est.Ave.Size (mm)	38	28	28	31
Algae Average Est.% Cover	27.2	47	25	49

Table 3.10 showing selected species survey data summarized for site 8

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	1862	760	852	707
Littorina littorea Average Size (mm)	11.3	10.6	11.1	11
Patella vulgata Total	7	0	5	0
Mytilus edulis Average Est.% Cover	10.3	13.2	7.6	7.6
Mytilus edulis Average Est.Ave.Size (mm)	33	30	28	30
Algae Average Est.% Cover	14.3	22.2	16.2	11.4

Table 3.11 showing selected species survey data summarized for site 9

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	1016	996	125	214
Littorina littorea Average Size (mm)	11.5	11.1	10.9	11
Patella vulgata Total	0	0	0	0
Mytilus edulis Average Est.% Cover	4.9	4.4	2.6	4.8
Mytilus edulis Average Est.Ave.Size (mm)	33	28	23	24
Algae Average Est.% Cover	39	25	6.6	4.2

Table 3.12 showing selected species survey data summarized for site 10

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	1500	413	380	900
Littorina littorea Average Size (mm)	11.6	11.1	10.7	10.7
Patella vulgata Total	6	1	1	0
Mytilus edulis Average Est.% Cover	4.3	2.6	4.2	1
Mytilus edulis Average Est.Ave.Size (mm)	35	22	24	6
Algae Average Est.% Cover	36.5	12	36.6	28

Table 3.13 showing selected species survey data summarized for site 11

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Littorina littorea Total	1762	958	908	793
Littorina littorea Average Size (mm)	9.5	9.8	10.5	9.9
Patella vulgata Total	4	0	1	1
Mytilus edulis Average Est.% Cover	9.5	1.8	2.6	1
Mytilus edulis Average Est.Ave.Size (mm)	34	23	24	27
Algae Average Est.% Cover	6.4	10.4	35	27

Table 3.14 showing selected species survey data summarized for site 12

Littorina demography

Figs. 3.1 to 3.12 show summary results for Littorina demography from surveys 1 to 4 at sites 1 to 12. Each survey consists of a random sample of 100 specimens per site. Size was recorded as height in mm from base aperture to body summit. Appendix 4 shows raw data.

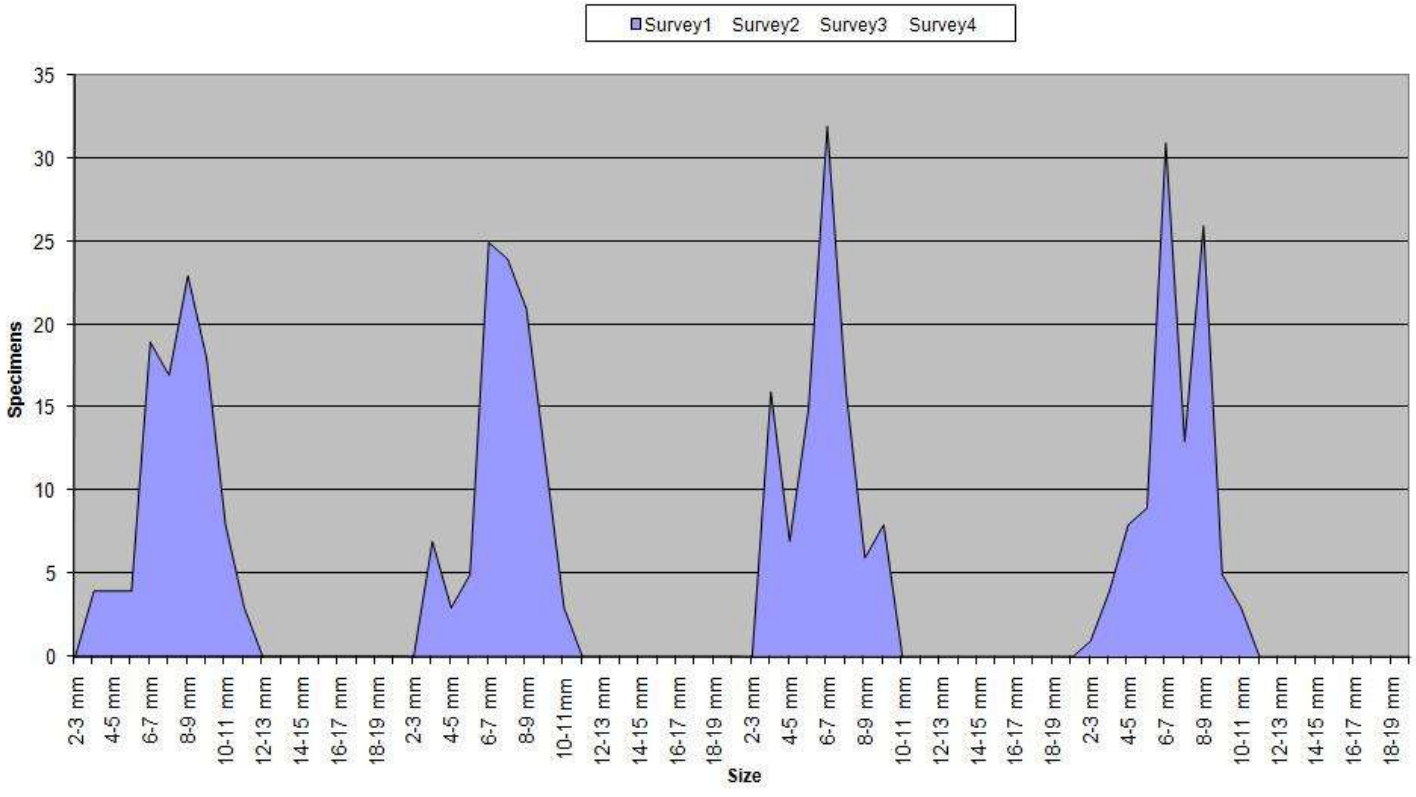

Figure 3.1 Littorina demography - Site 1

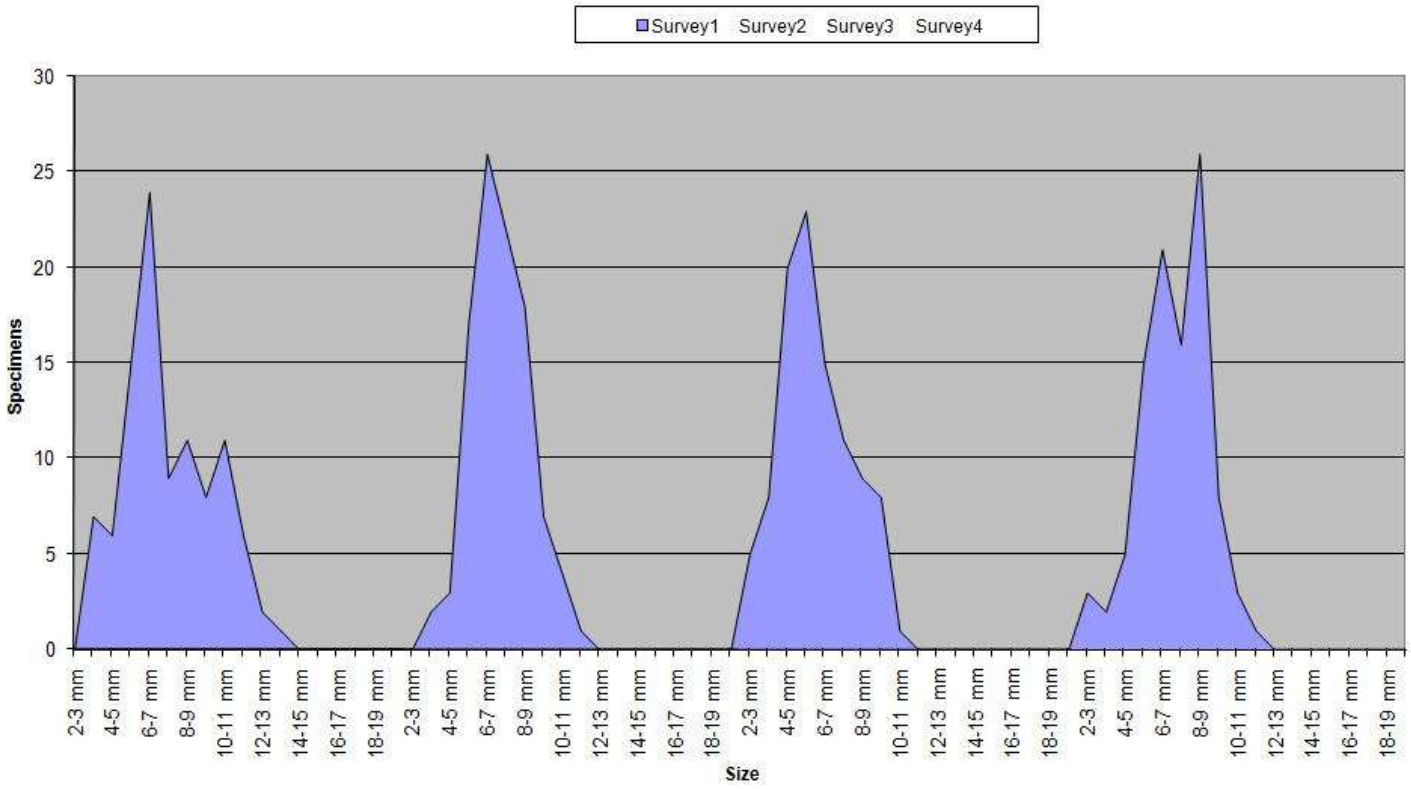

Figure 3.2 Littorina demography - Site 2

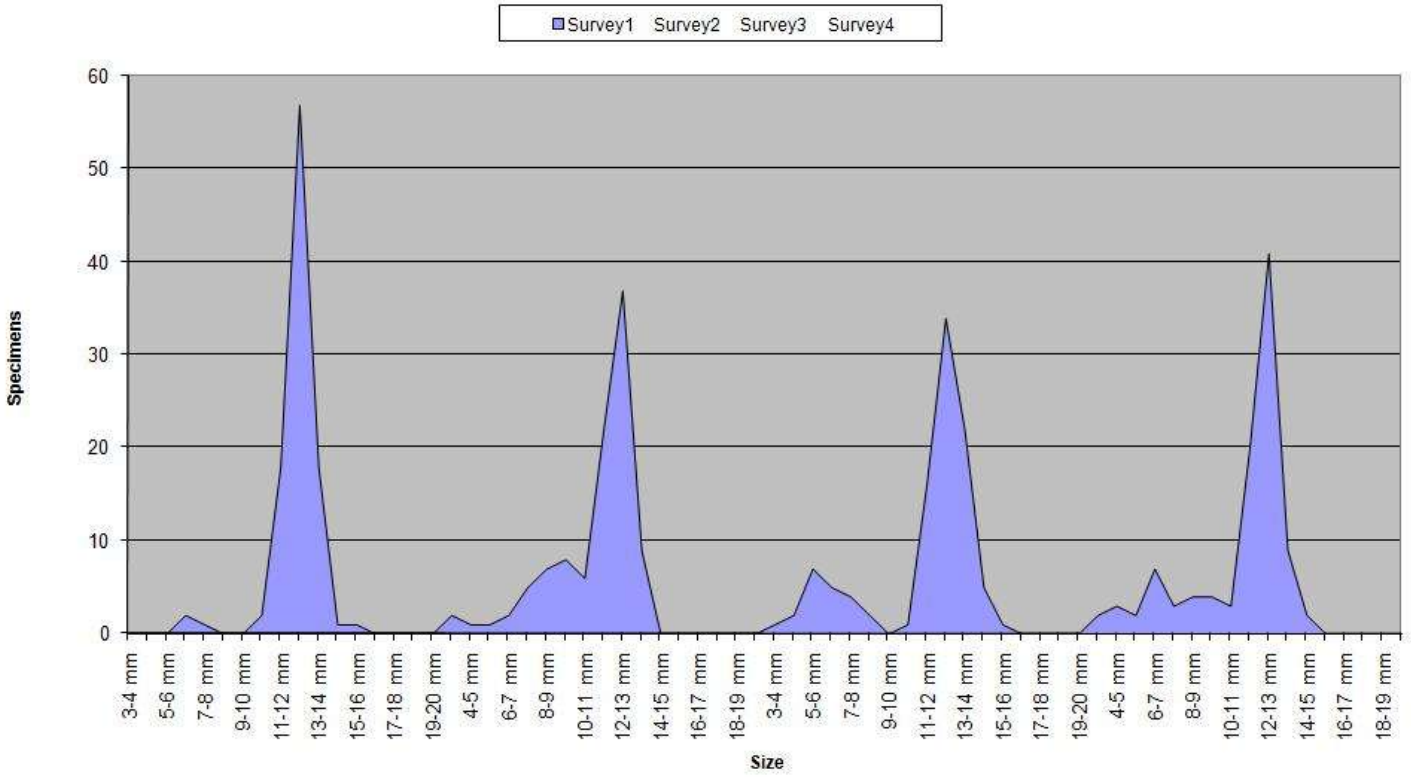

Figure 3.3 Littorina demography - Site 3

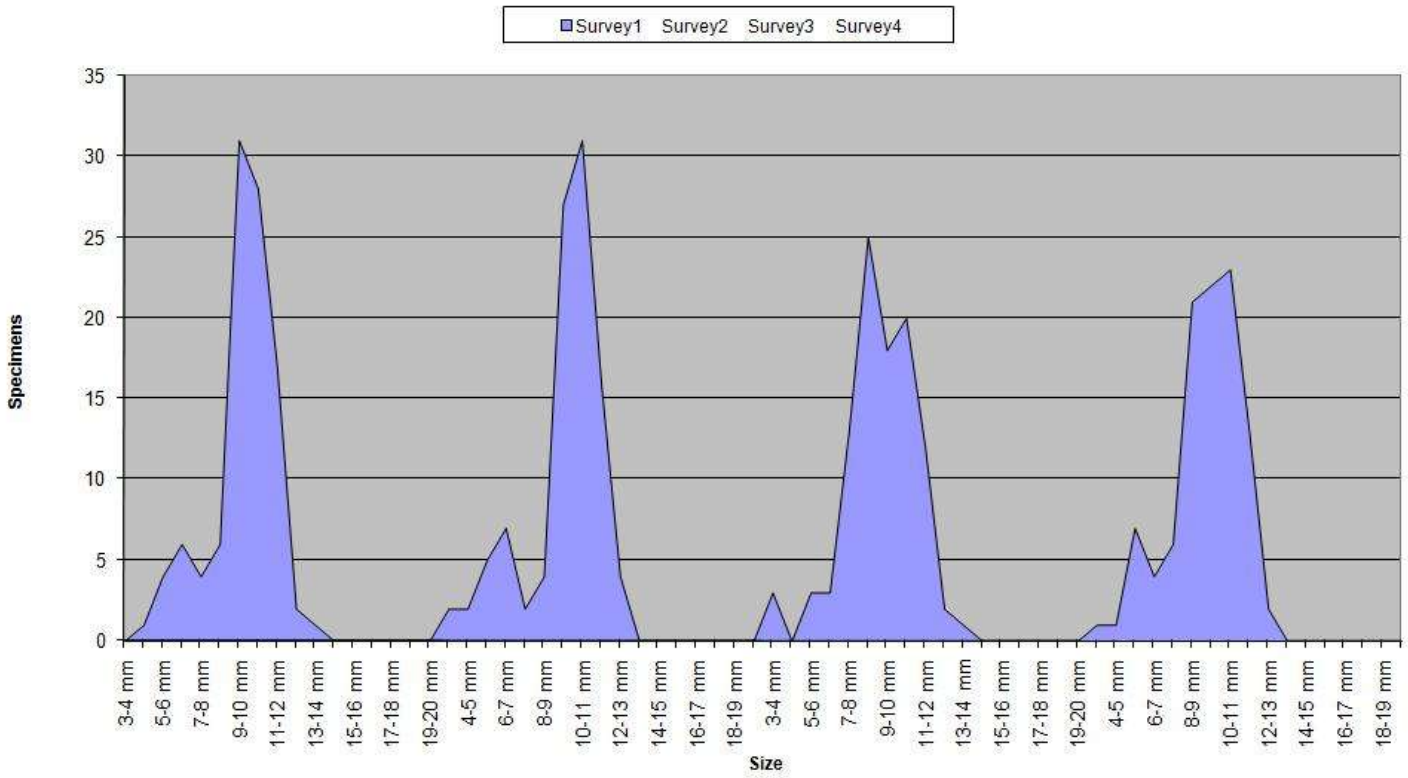

Figure 3.4 Littorina demography - Site 4

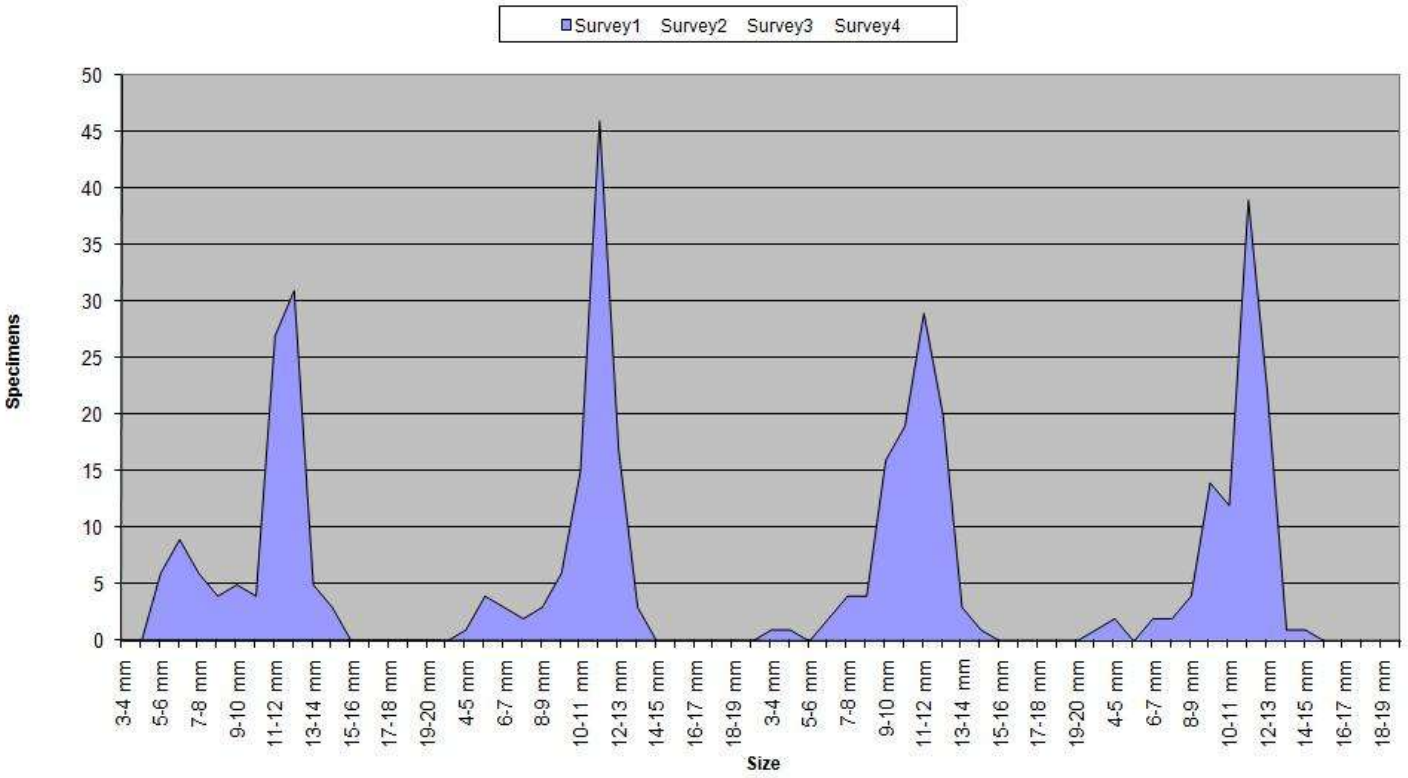

Figure 3.5 Littorina demography - Site 5

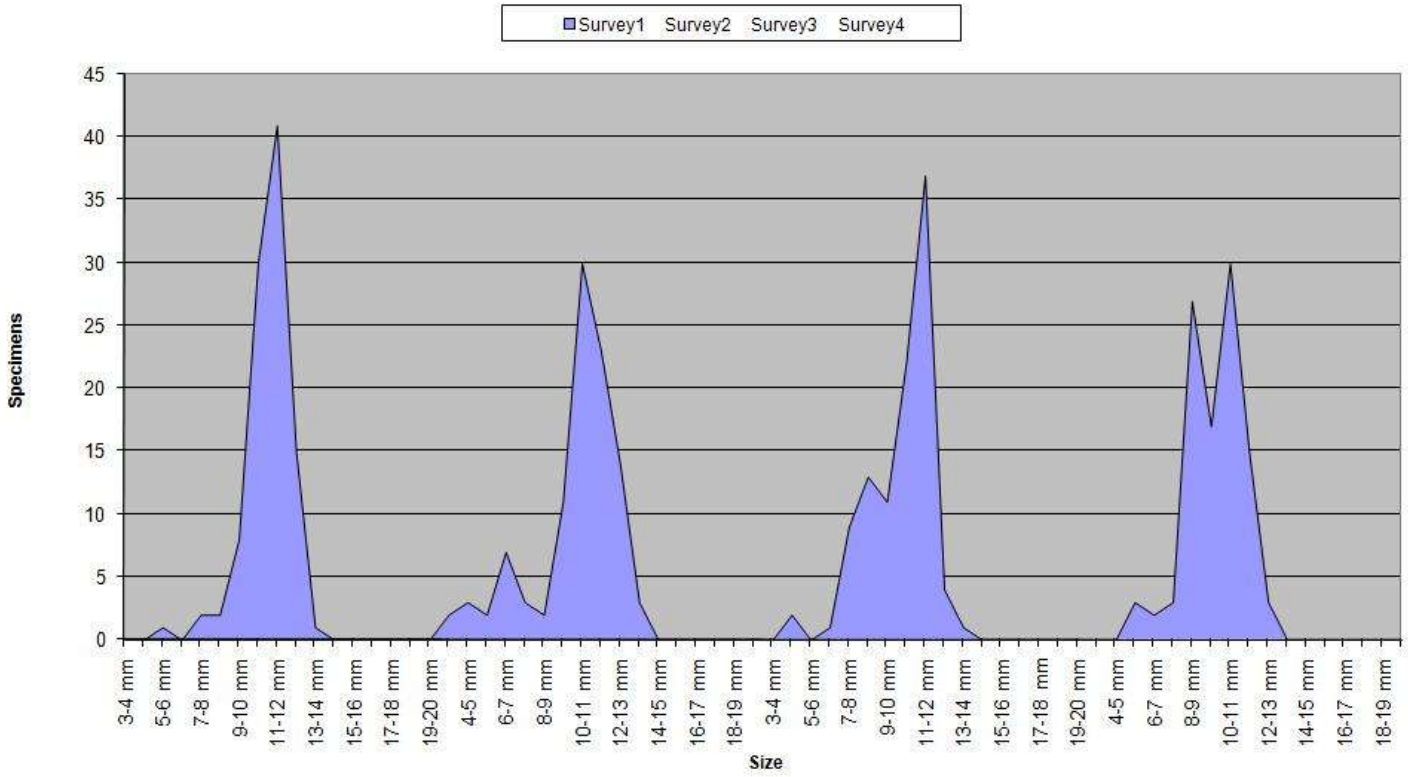

Figure 3.6 Littorina demography - Site 6

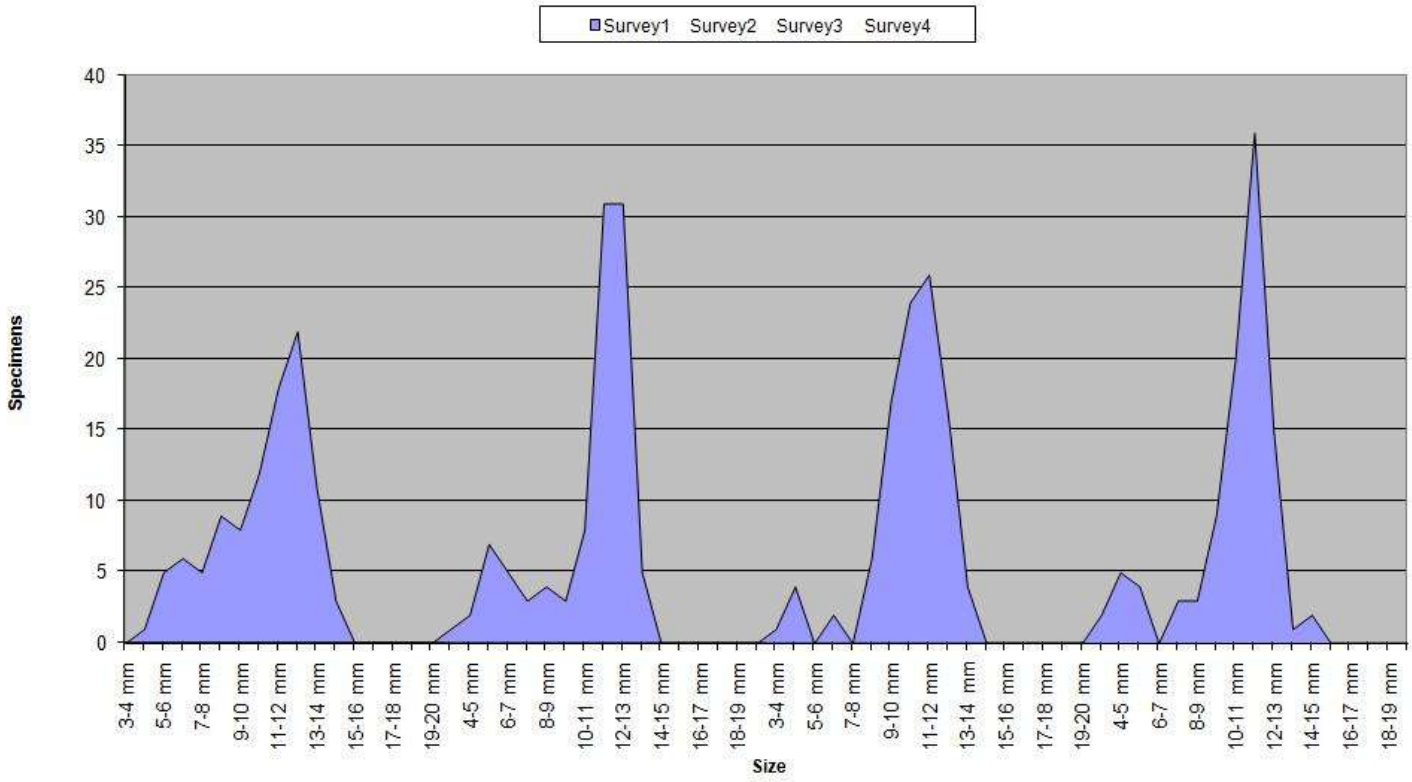

Figure 3.7 Littorina demography - Site 7

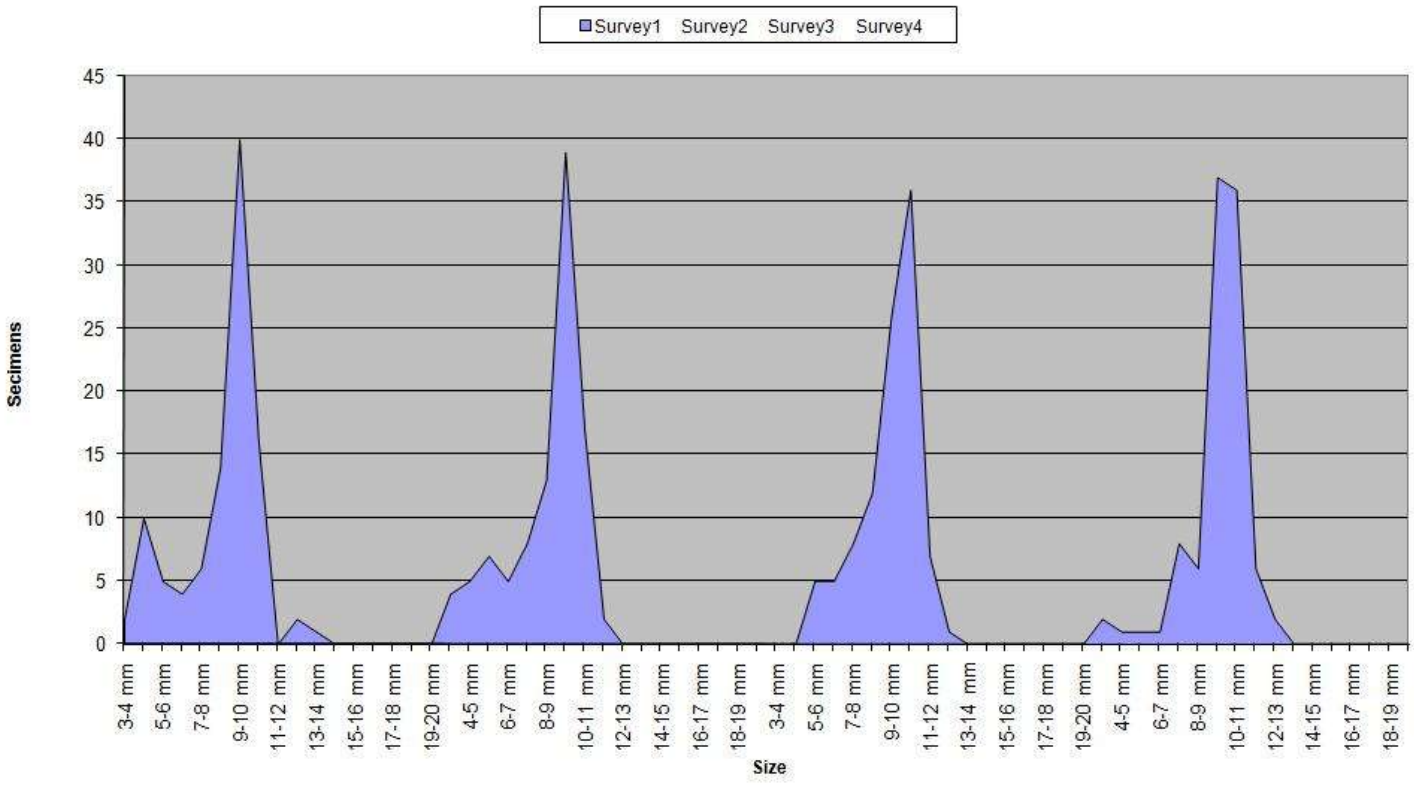

Figure 3.8 Littorina demography - Site 8

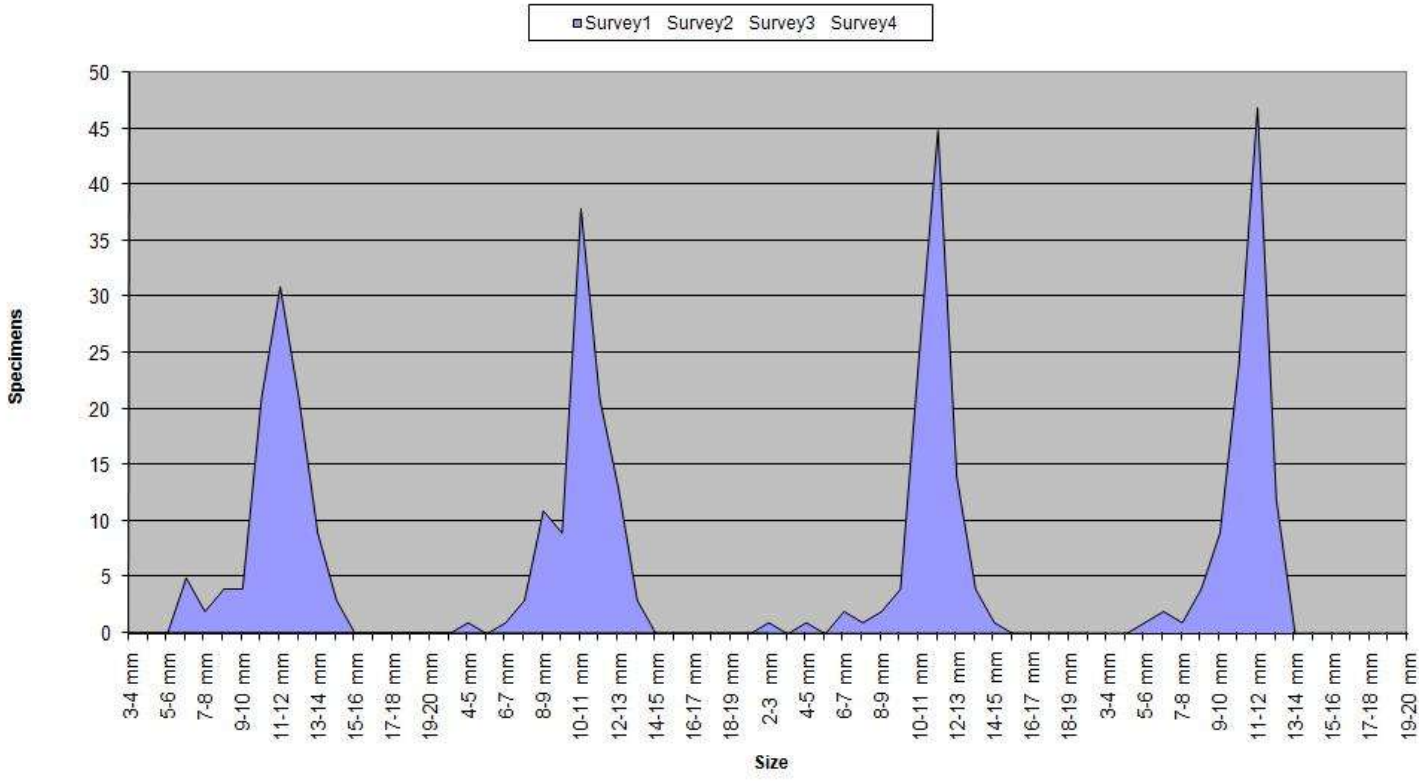

Figure 3.9 Littorina demography - Site 9

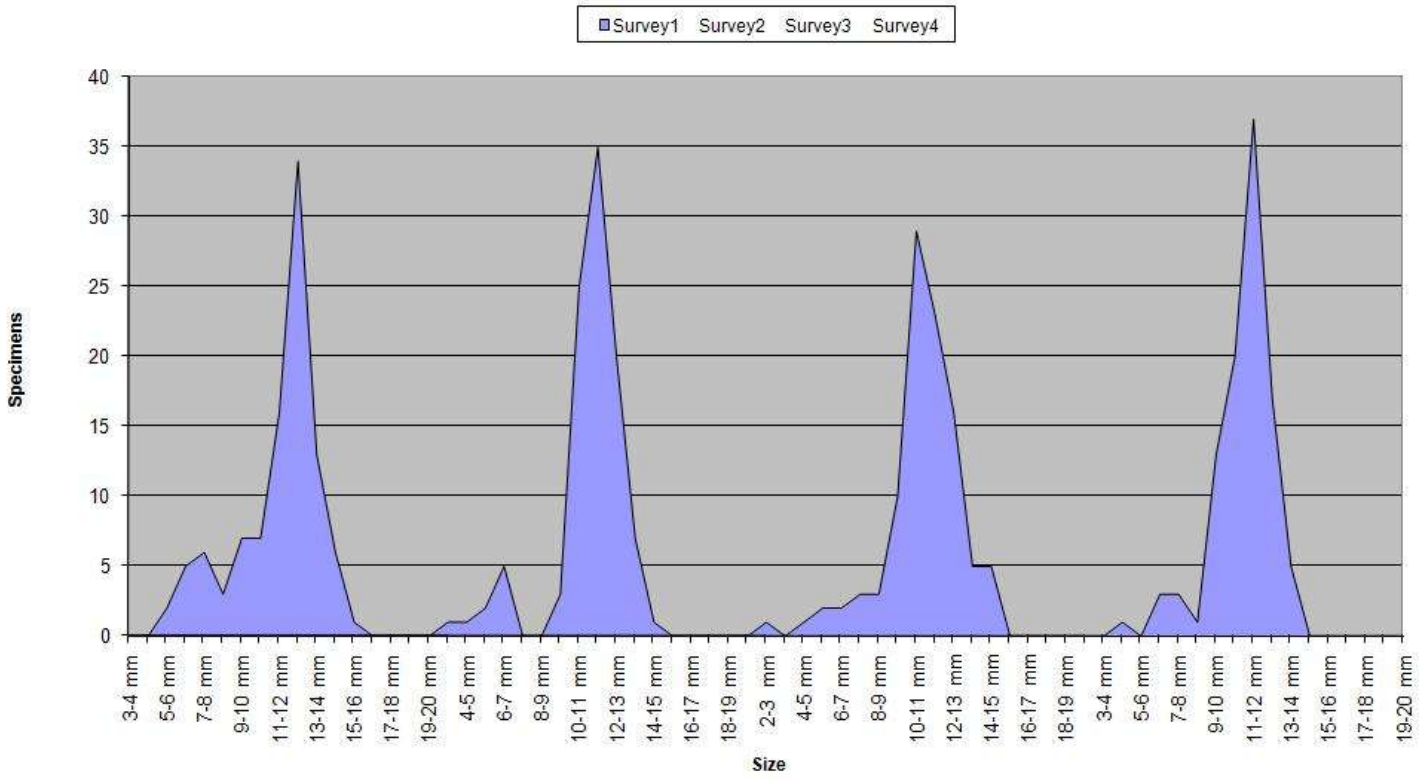

Figure 3.10 Littorina demography - Site 10

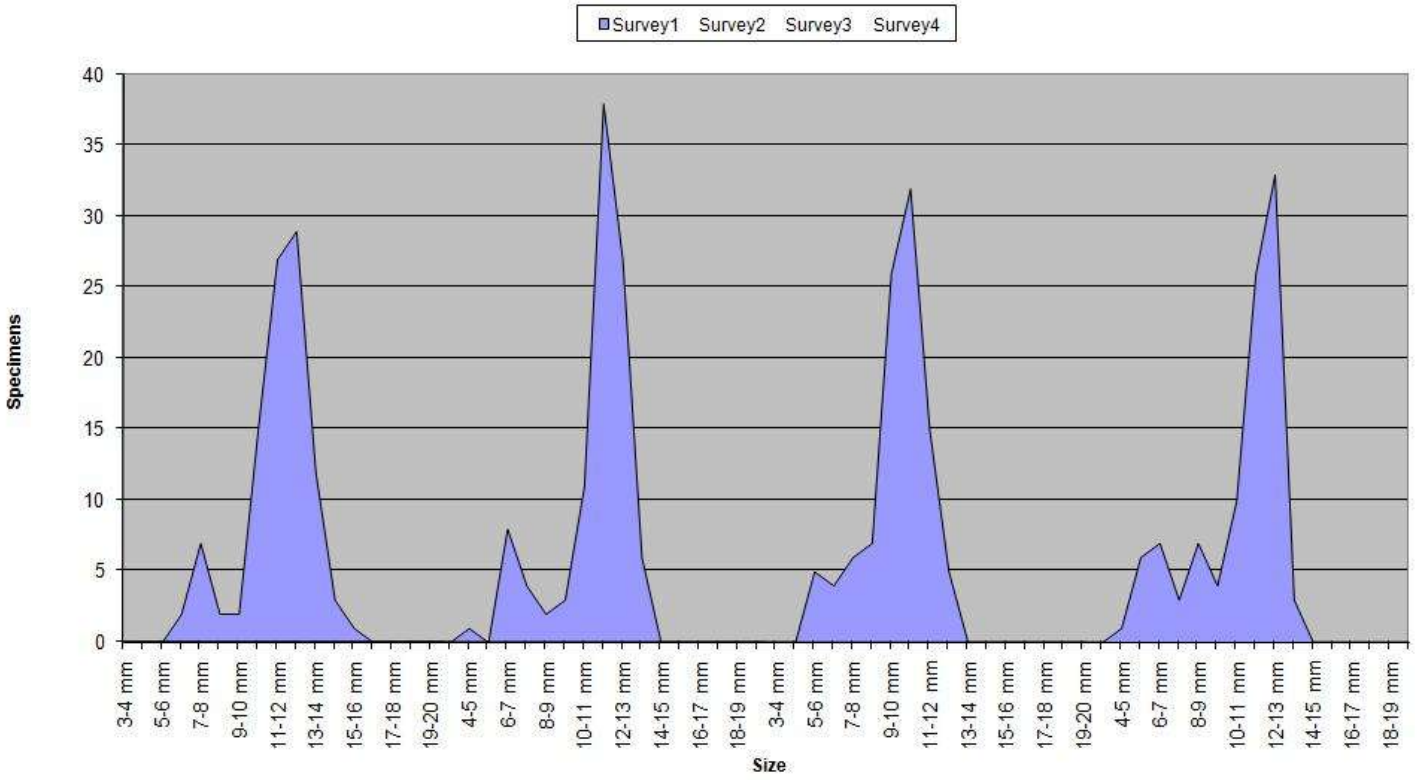

Figure 3.11 Littorina demography - Site 11

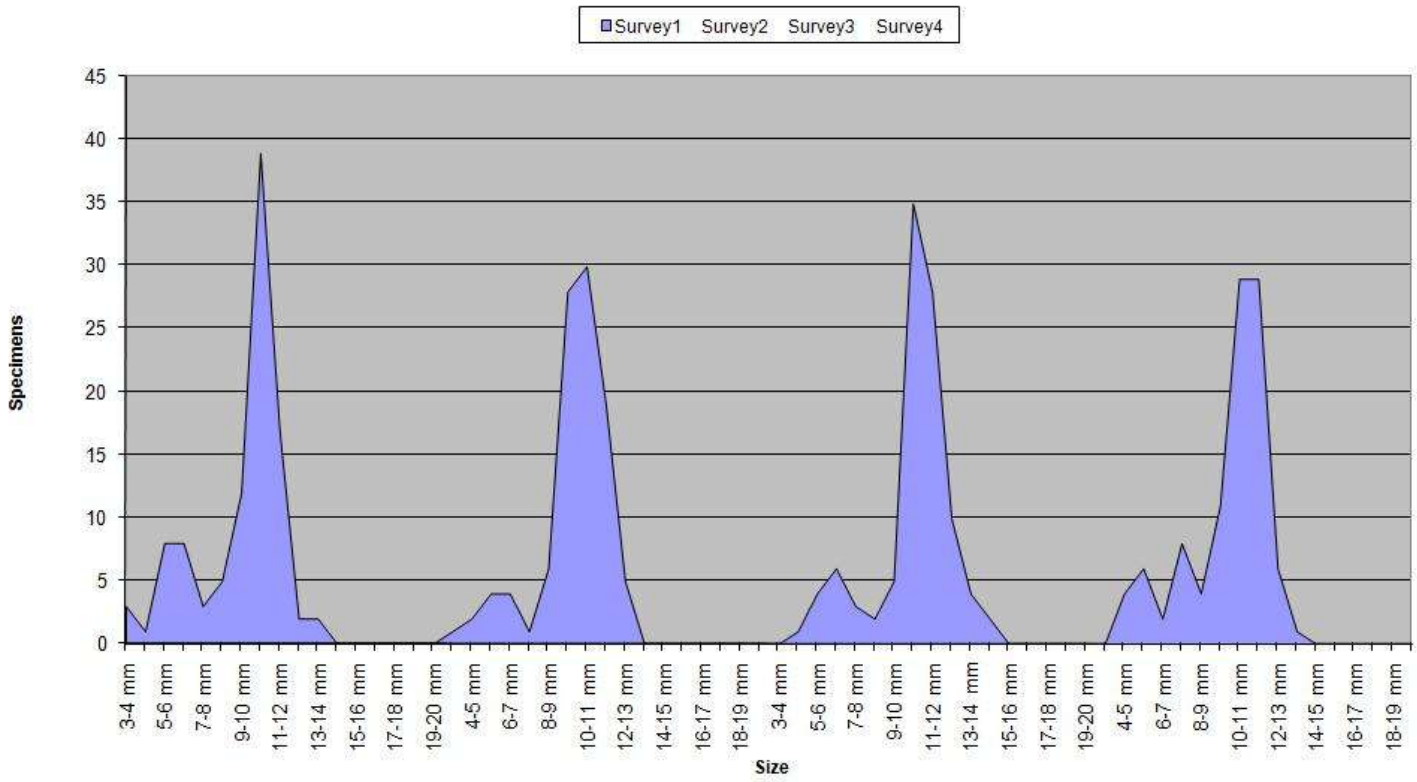

Figure 3.12 Littorina demography - Site 12

Human activity

Fig 3.13 shows the distribution of observed harvesters across the 11 Thanet Coast Project sections for the duration of the project based on data submitted by Thanet coastal wardens. Y axis scale is logarithmic.

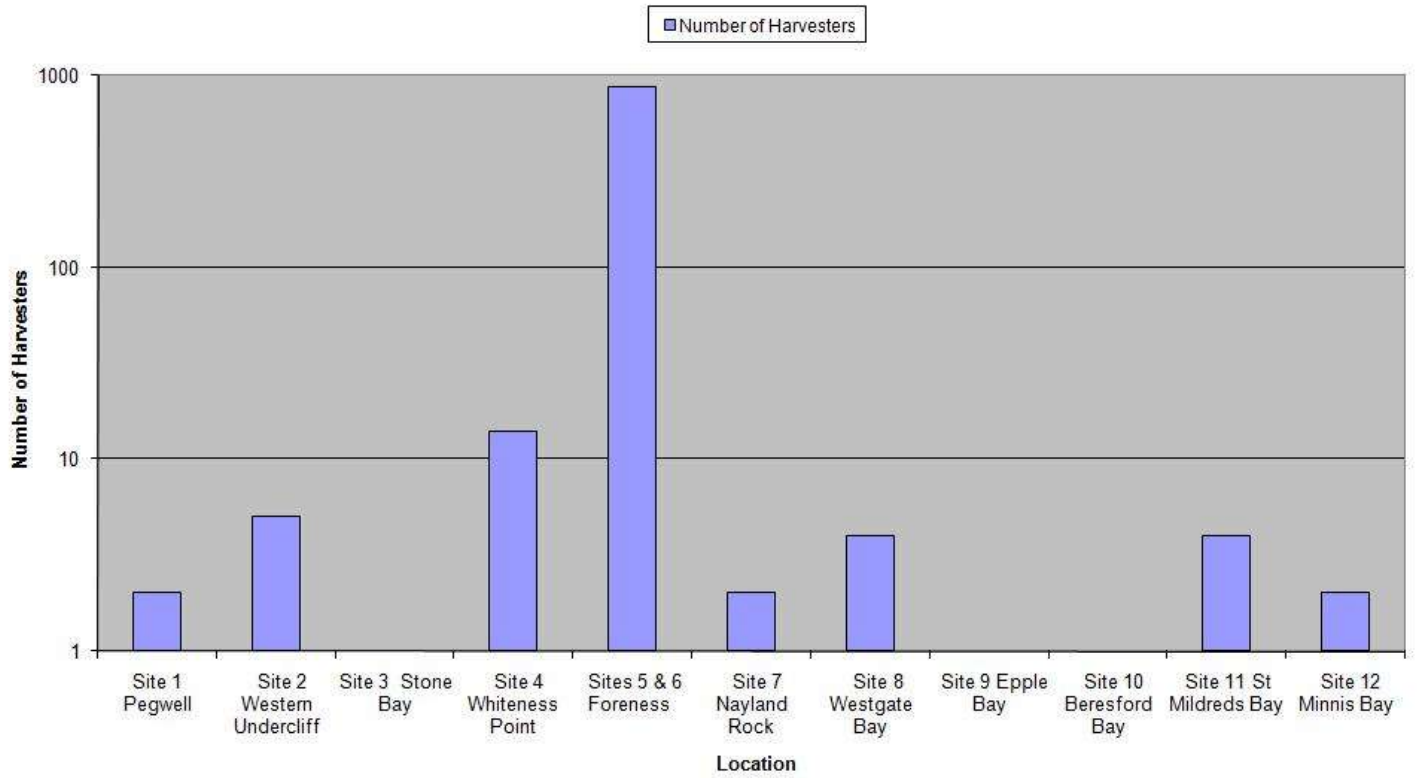

Figure 3.13 showing distribution of observed harvesters

Fig. 3.14 shows the seasonal frequency of observed harvesters across Thanet for the duration of the project based on data submitted by Thanet coastal wardens.

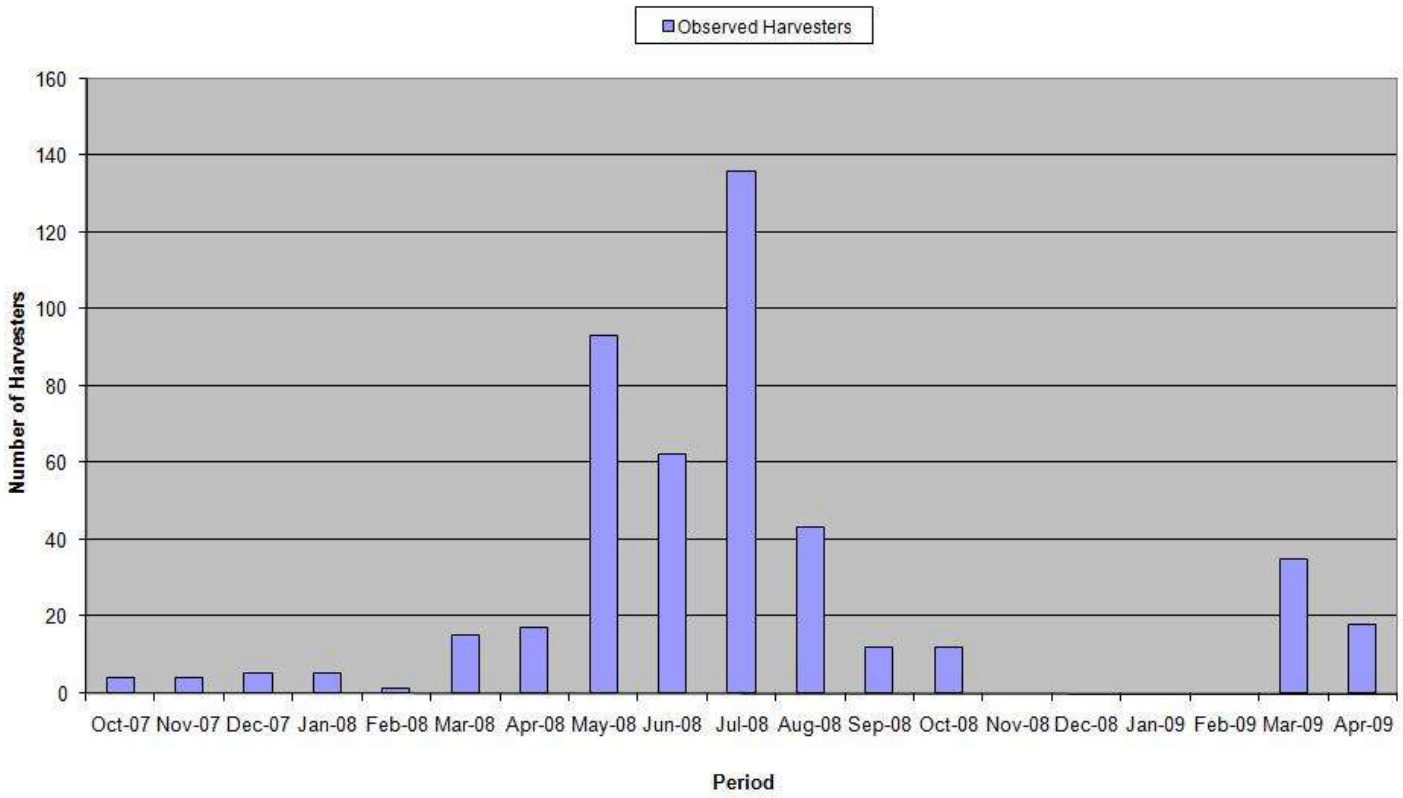

Figure 3.14 showing frequency of observed harvesters

Fig. 3.15 shows the relationship between the number of observed harvesters and site range from the nearest open or public vehicle access point based on data submitted by Thanet coastal wardens during the period of the project. Y axis scale is logarithmic.

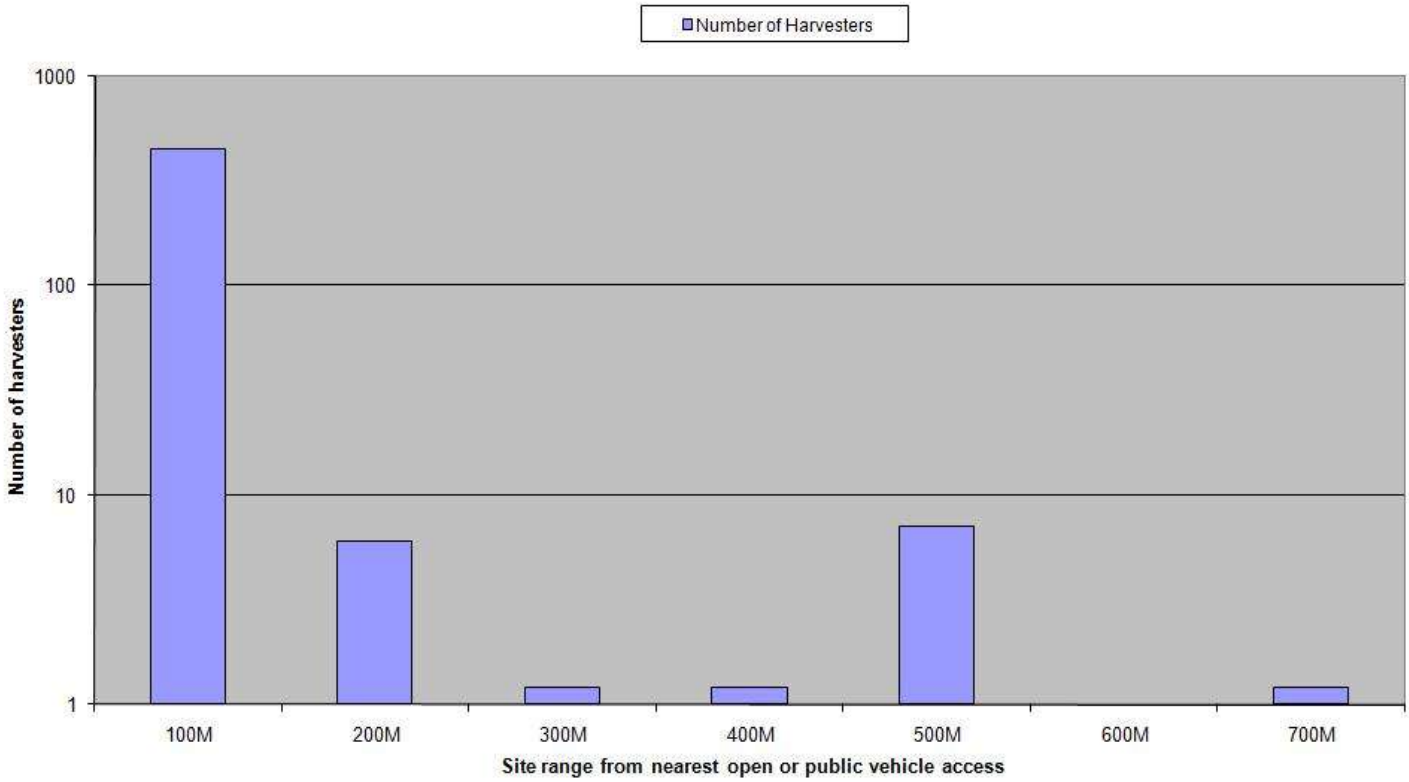

Figure 3.15 showing number of observed harvesters per vehicle access range

Table 3.15 compares the volume of shellfish harvesting reports received from the Thanet coastal wardens since their launch in 2004 using traditional reporting methods and for the period of the shellfish harvesting project using traditional and bespoke project reporting document.

Period	Source	Total Number of Reports Received	Total Number of Harvesters Recoded
Warden Launch 2004 – Apr 2009	Traditional Warden Surveys	1586	29
Oct 2007 – Apr 2009	Traditional Warden Surveys	35	0
Oct 2007 –Apr 2009	Project Reporting Document	129	462

Table 3.15 showing volume of reports from wardens

Physical damage

At Foreness there was evidence of damage to the chalk reef caused by hand tools being used to remove Pacific oysters from the chalk. Approximately 50 oyster imprints were visible surrounded by broken chalk. The area affected was adjacent to the west wall of the concrete groyne at OS TR 38183 71592.
No further physical damage was seen at any other site. This includes overturned boulders and trampling.

Photography

Each quadrat was photographed in situ followed by a second image of the the surrounding area minus the quadrat. This resulted in a total of 800 digital images deposited with Natural England available as a reference for future coastal morphology study.
Plate 3.1 shows a typical quadrat image and Plate 3.2 shows it's surrounding area.

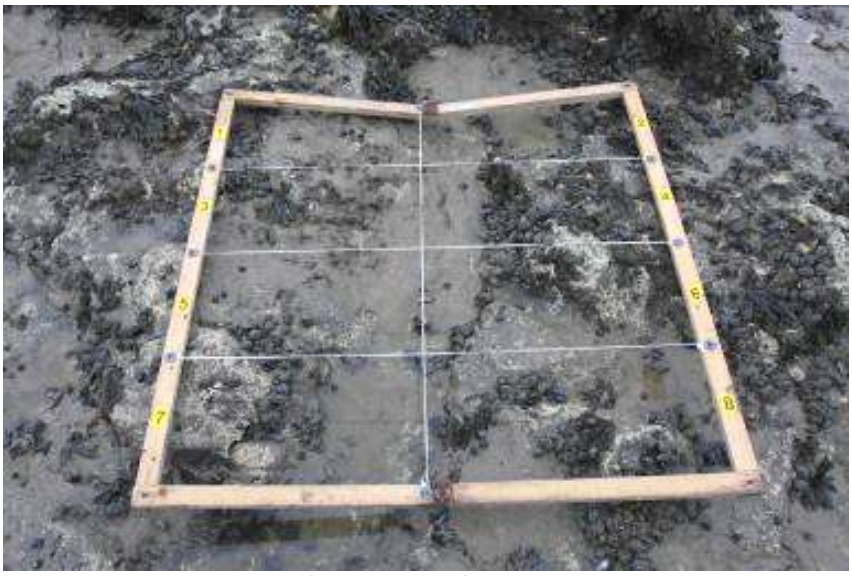

Plate 3.1 Quadrat area

Plate 3.2 Quadrat adjacent area

4 Analysis

Variance

Table 4.1 shows Anova Single Factor analysis of “Littorina Total” for surveys 1, 2, 3 & 4. Result per survey is shown as P-value.

Analysis	Variable	Survey	P-value
Anova Single Factor	Littorina Total	1	6.22E-07
Anova Single Factor	Littorina Total	2	4.75E-12
Anova Single Factor	Littorina Total	3	2.29E-06
Anova Single Factor	Littorina Total	4	2.25E-06

Table 4.1 shows Anova Single Factor analysis of “Littorina Total” for surveys 1, 2, 3 & 4

On completion of survey 2, Anova Single Factor tests were conducted using the “Littorina Total” counts from survey 1 which used 10 quadrats per site and from survey 2 which used 5 quadrats per site. The resulting P-values indicated that the survey 1 and survey 2 populations were similar. Surveys 3 & 4 were then conducted with 5 quadrats per site based on this result.

Human activity

A total of 129 shellfish harvesting reports were received from Thanet coastal wardens during the period of the project using the bespoke reporting document (Appendix 2). This compares with zero shellfish harvesting reports submitted during the same period from 35 traditional warden surveys and a grand total of 29 shellfish harvesting reports from 1586 warden surveys since the scheme was launched in 2004. This suggests that the reporting document designed for the project successfully stimulated warden activity.

Using comments from the warden reports and personal observation it’s possible to classify shellfish harvesters into 3 general types:

- Casual
- Local
- Organised Group

Casual

Casual harvesters are seasonal and seen mainly in the summer months in the vicinity of tourist bays. Their presence on the shore is recreational. They operate singly, in pairs, or in small family groups. Volume of shellfish taken is very low typically using a polythene bag, child’s bucket or even a hat for collection! The amount collected suggests personal consumption.

Local

Local harvesters operate throughout the year. Their locations are more selective than Casual harvesters preferring reef areas where Littorina is abundant. They operate singly or in pairs with the same individuals repeatedly identified by wardens at varying locations throughout the seasons. Their presence on the shore is exclusively to collect shellfish. Shellfish are collected in sacks or bins. Amounts collected suggests beyond personal consumption.

Organised group

Organised groups are seasonal and seen mainly in the summer months at Foreness, Margate. They operate in large co-ordinated groups of up to 30 individuals. Their presence on the shore is exclusively to collect shellfish which are collected in bins and sacks and loaded into a fleet of vehicles. Warden observations have recorded the removal of Edible Periwinkle *Littorina littorea,* Common Limpet *Patella vulgata,* Edible Crab *Cancer pagurus,* Shore Crab *Carcinus maenus,* Pacific Oyster *Crassostrea gigas* and unidentified species of algae by these groups. The amount collected suggests a structured commercial or extended family operation.

Selected species

Site 1 Pegwell

Fig. 4.1 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

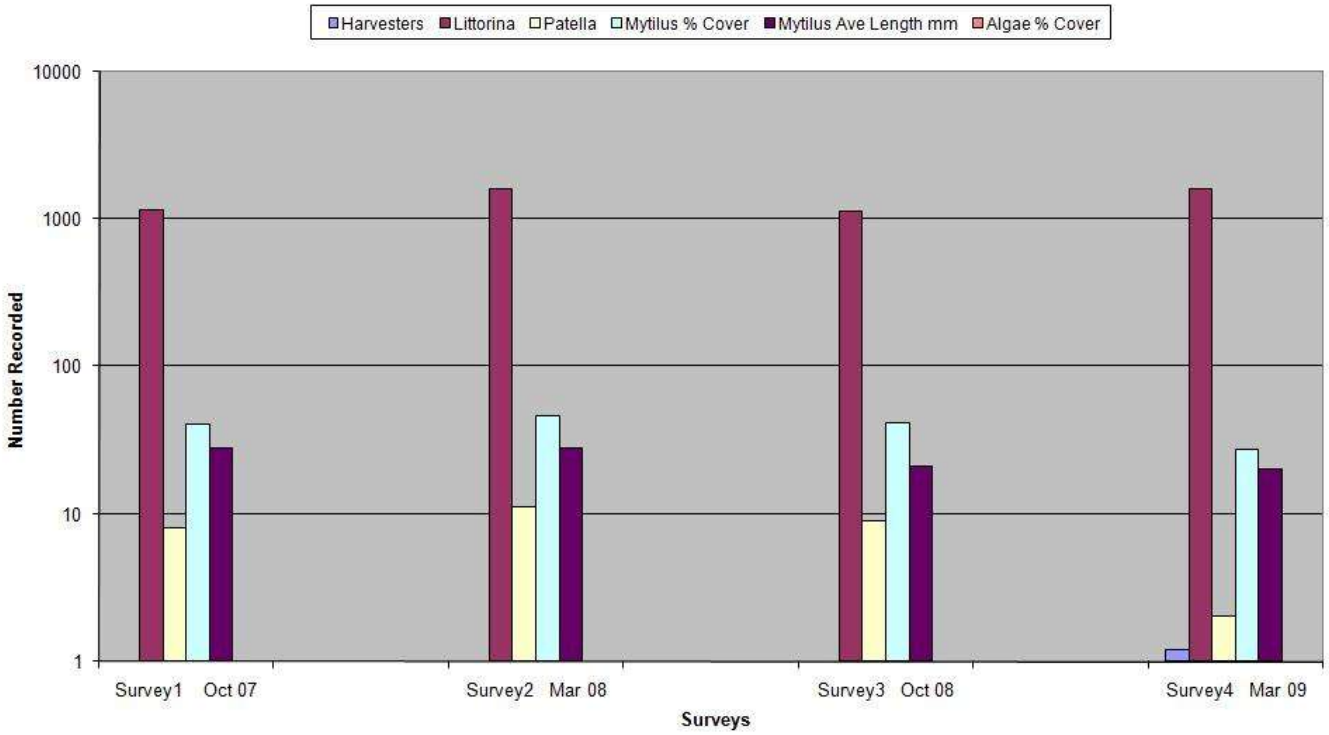

Figure 4.1 Selected species / No. of harvesters - Site 1

Fig. 4.2 shows correlation between total Littorina & harvesters for surveys 1 to 4.

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 2 & 3. However, from Fig. 4.1 & Fig. 4.2 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. This site was algae free and *Patella vulgata* abundance was occasional.

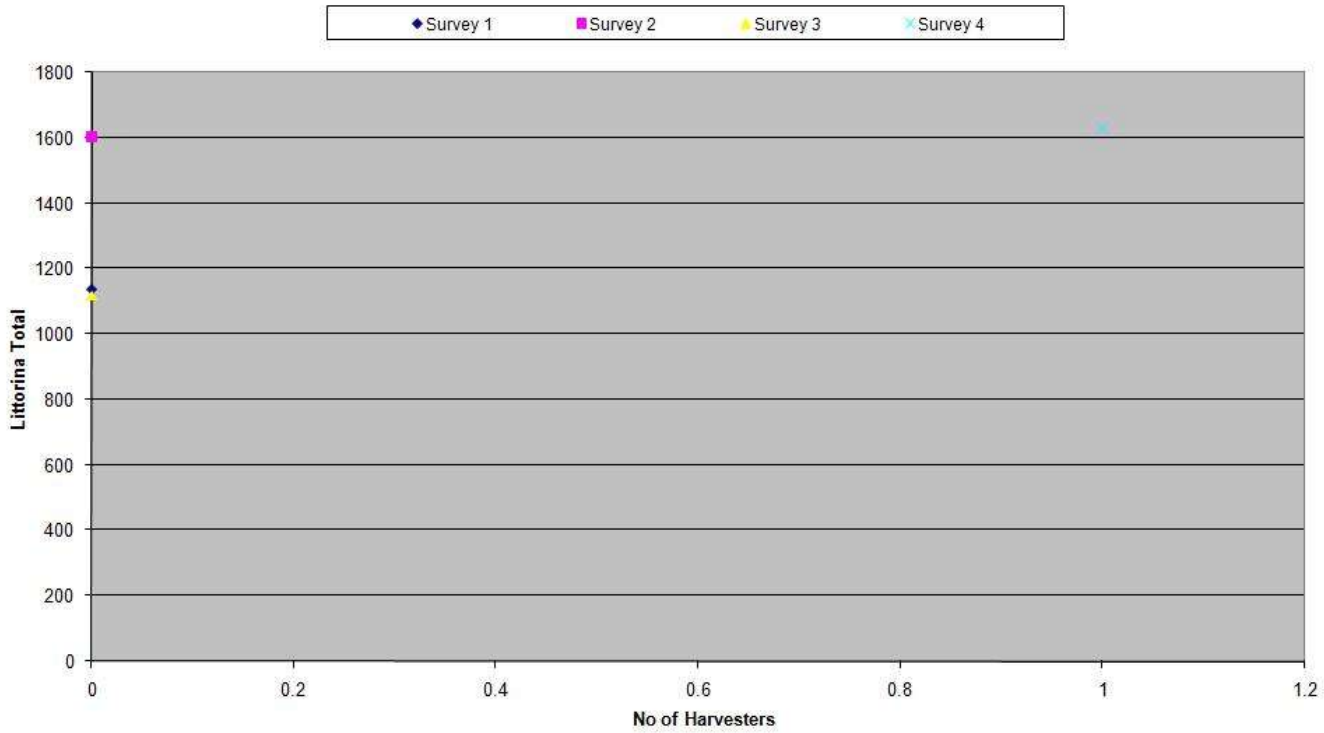

Figure 4.2 Littorina total / No. of harvesters correlation - Site 1

Selected species

Site 2 Western undercliff Ramsgate

Fig. 4.3 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

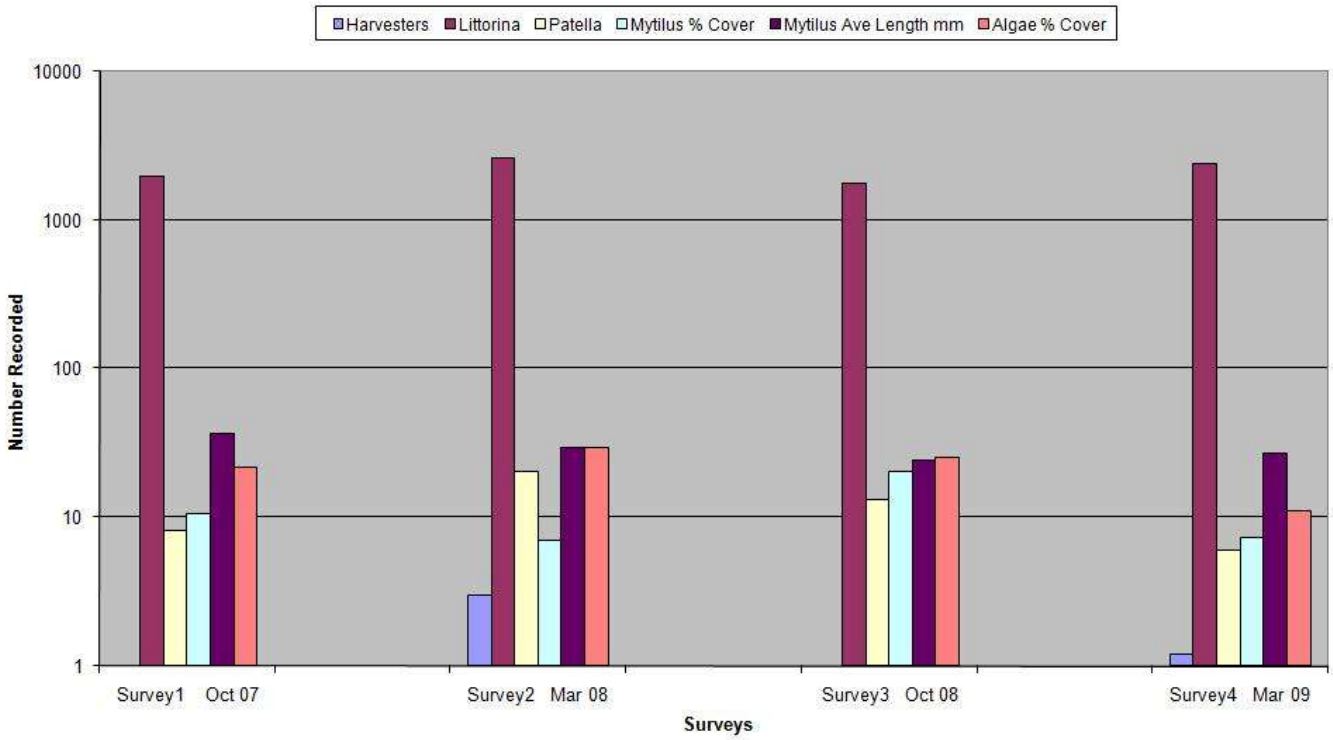

Figure 4.3 Selected species / No. of harvesters - Site 2

Fig. 4.4 shows correlation between total Littorina & harvesters for surveys 1 to 4.

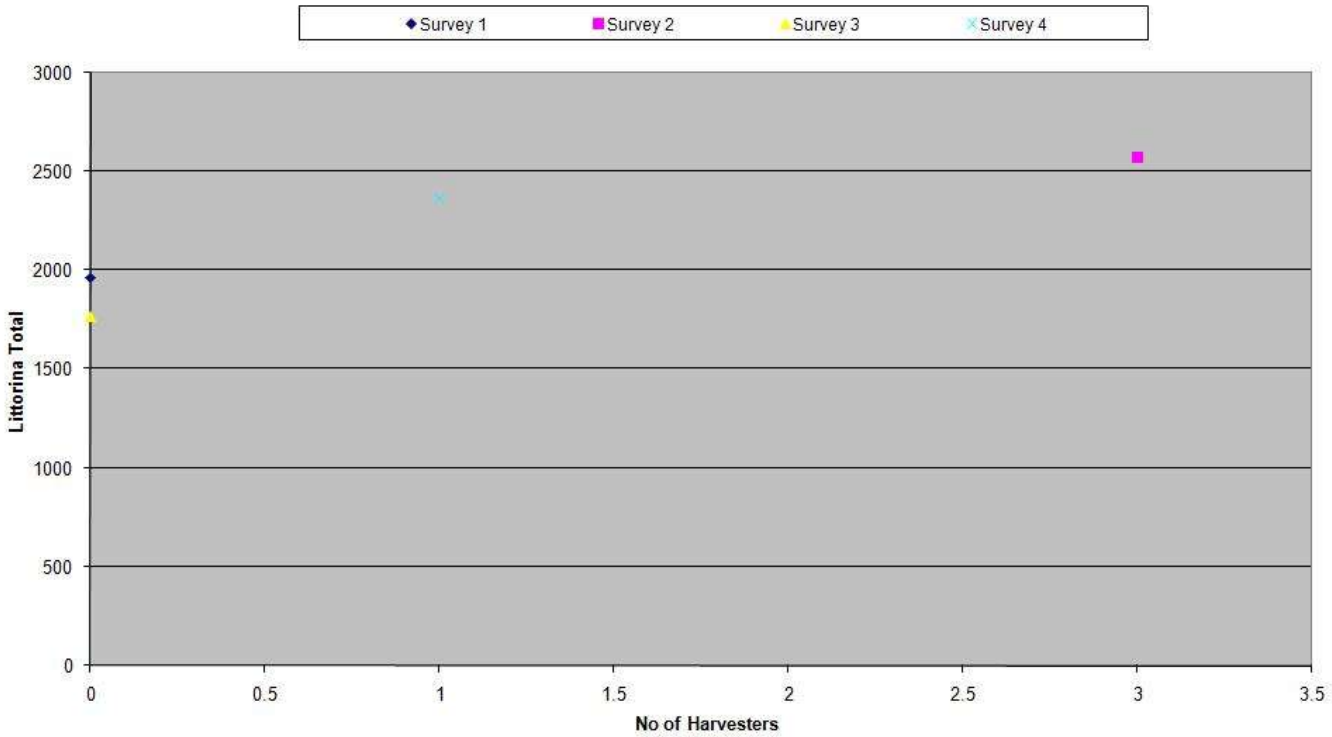

Figure 4.4 Littorina total / No. of harvesters correlation - Site 2

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1 & 3. However, from Fig. 4.3 & Fig. 4.4 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. *Patella vulgata* abundance was occasional.

Selected species

Site 3 Stone Bay, Broadstairs

Fig. 4.5 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic). Survey 3 low abundance is due to drift sand deposits on the upper shore at quadrats 1,2 & 5.

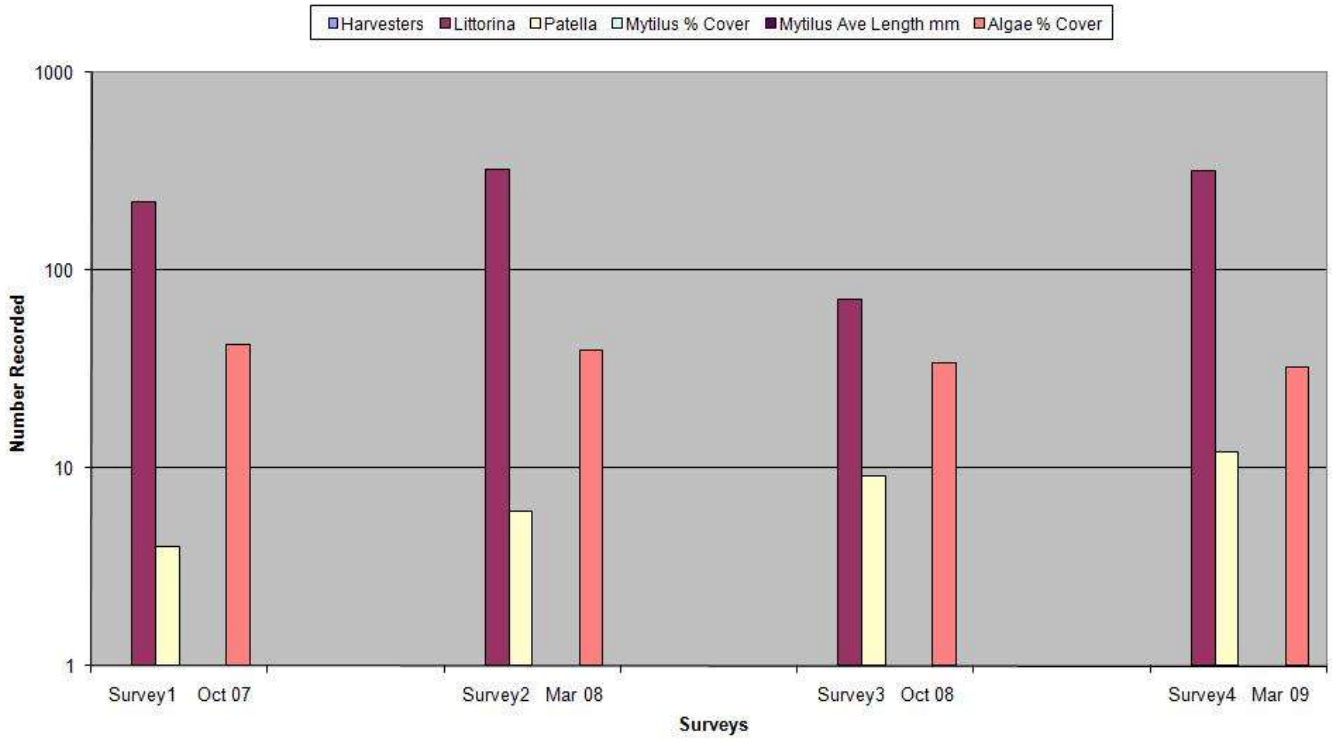

Figure 4.5 Selected species / No. of harvesters - Site 3

Fig. 4.6 shows correlation between total Littorina & harvesters for surveys 1 to 4.

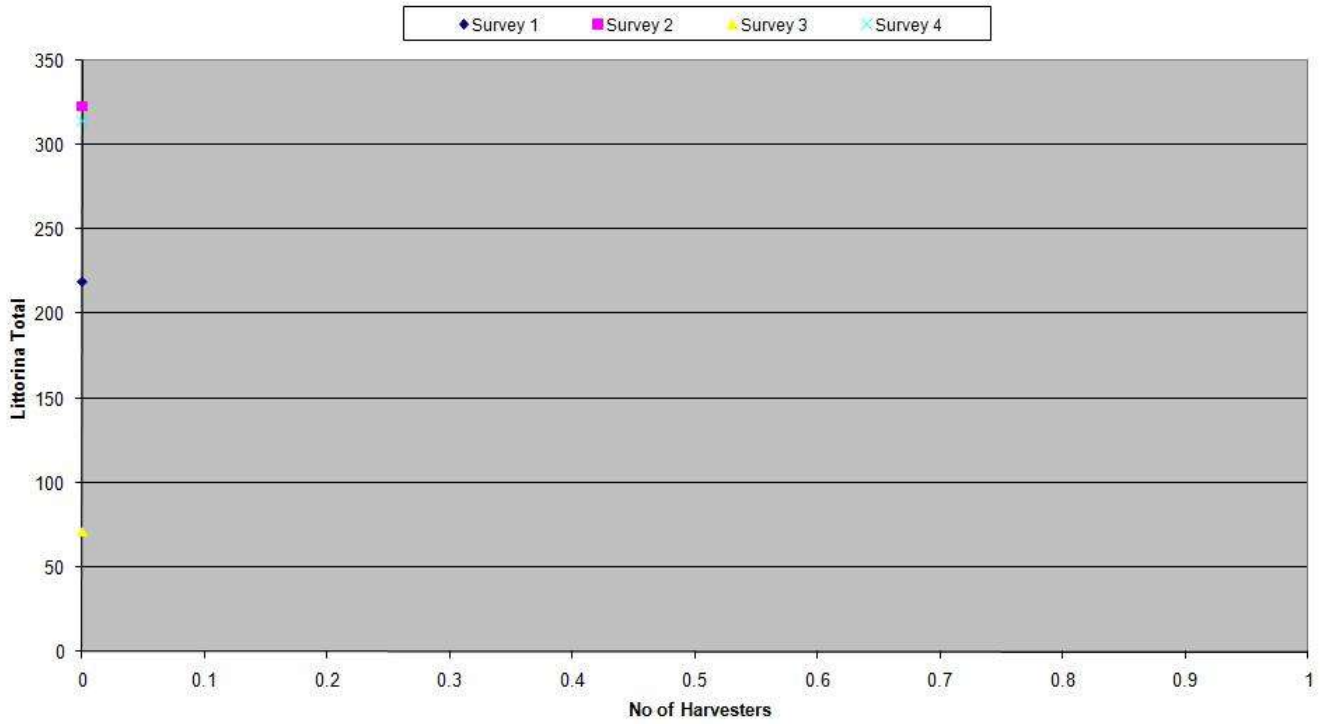

Figure 4.6 Littorina total / No. of harvesters correlation - Site 3

Correlation co-efficient is not statistically viable given zero number of harvesters observed. This is the only site where no harvesters were observed during the period of the project and could therefore be considered a control site. Littorina numbers and other selected species showed no significant trend. Mytilus edulis was absent.

Selected species

Site 4 Whiteness Point, Broadstairs

Fig. 4.7 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

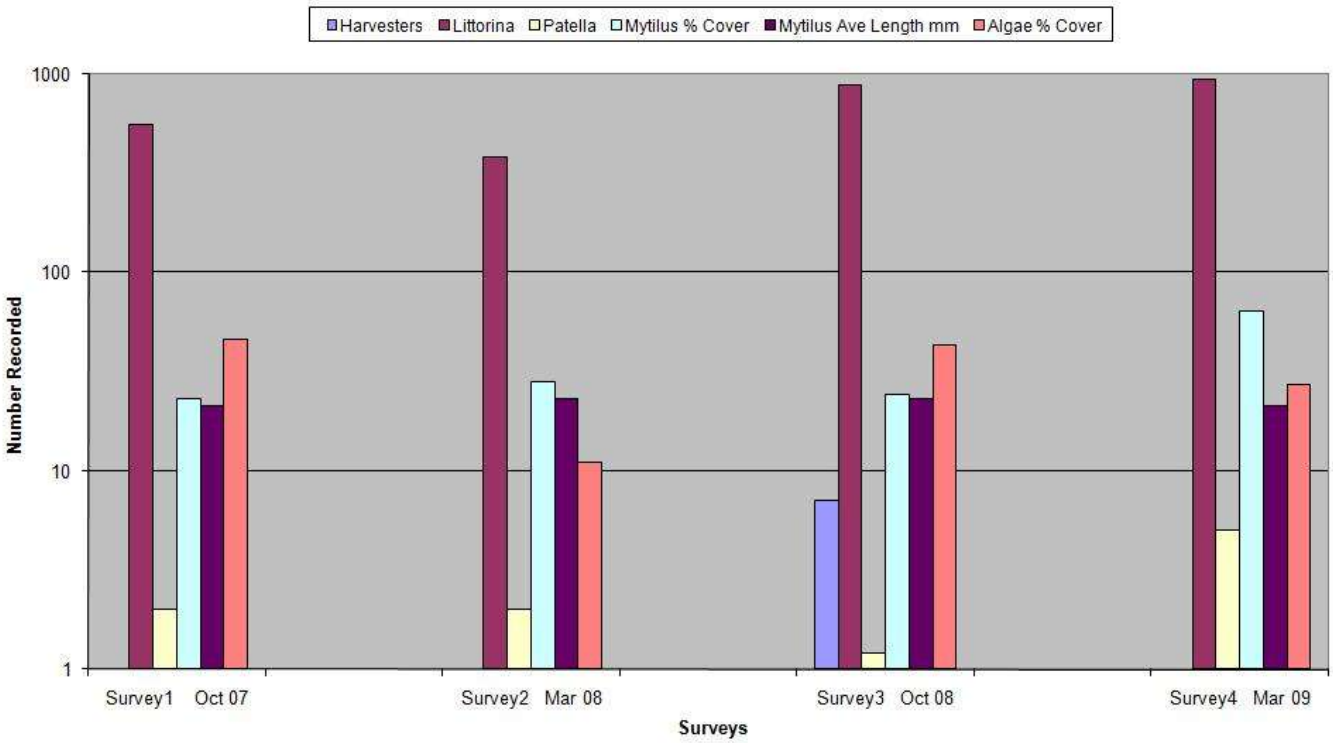

Figure 4.7 Selected species / No. of harvesters - Site 4

Fig. 4.8 shows correlation between total Littorina & harvesters for surveys 1 to 4.

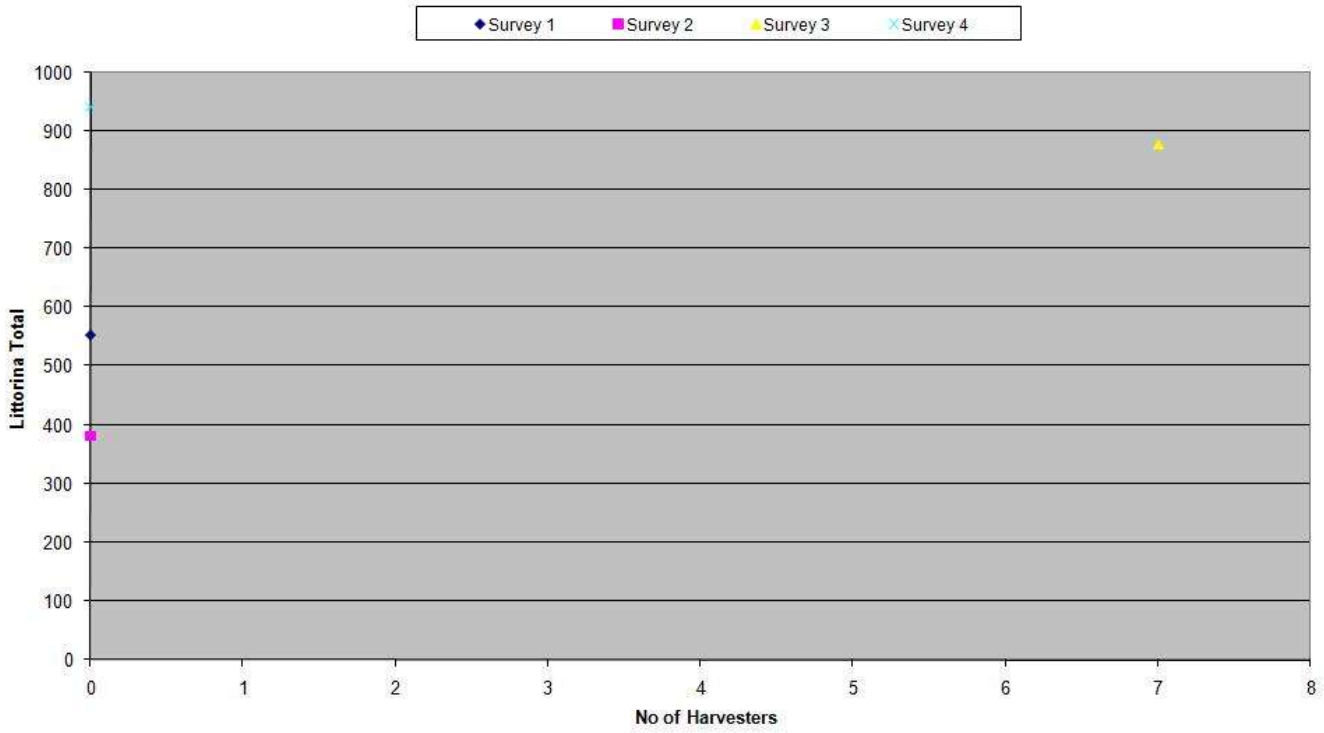

Figure 4.8 Littorina total / No. of harvesters correlation - Site 4

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 2 & 4. However, from Fig. 4.7 & Fig. 4.8 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. *Patella vulgata* abundance was occasional.

Selected species

Sites 5&6 Foreness, Margate

Fig. 4.9 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

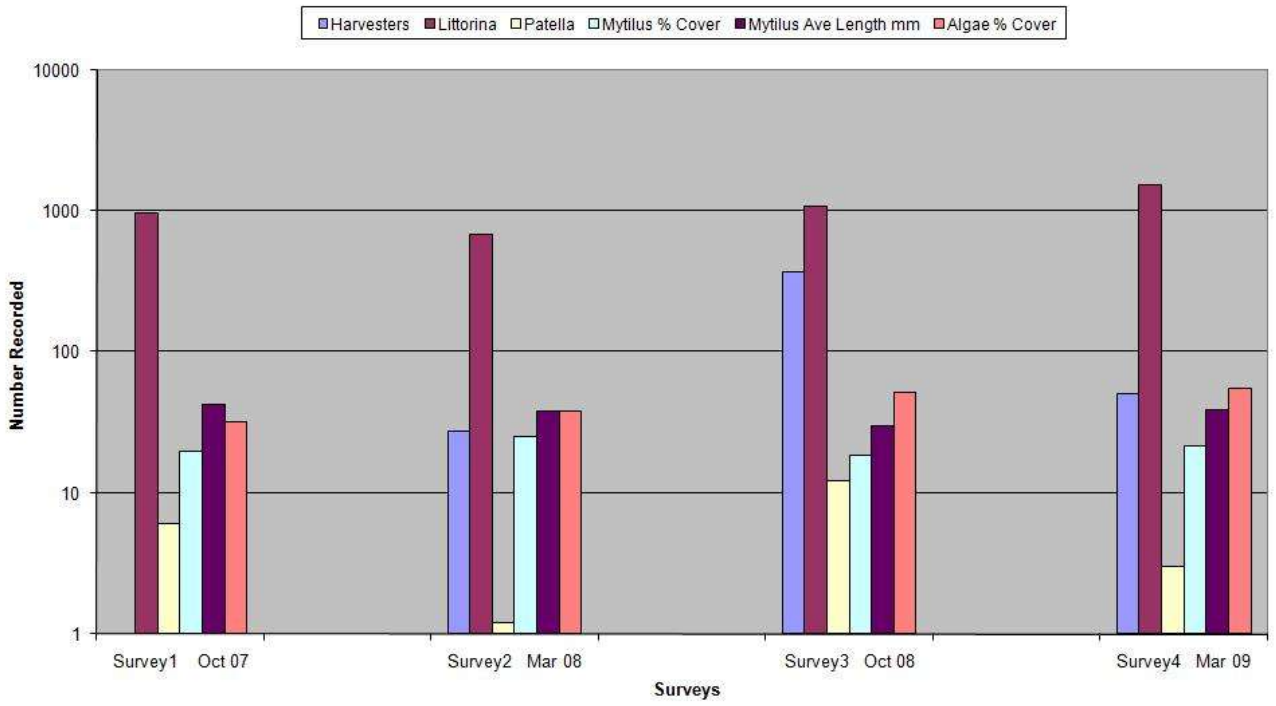

Figure 4.9 Selected species / No. of harvesters - Sites 5 & 6

Fig. 4.10 shows correlation between total Littorina & harvesters for surveys 1 to 4.

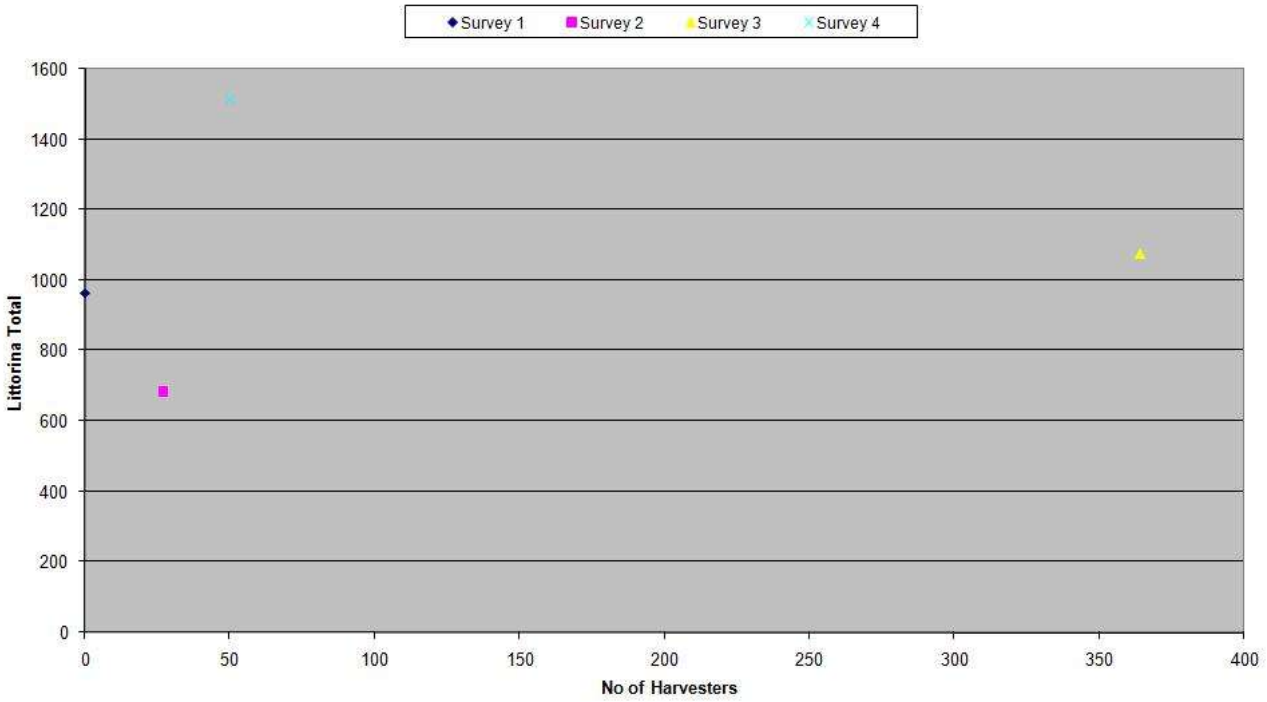

Figure 4.10 Littorina total / No. of harvesters correlation - Sites 5 & 6

At Foreness, a known harvesting location, 2 survey sites were selected approx 200m apart on the same section of reef to enable a more detailed cover of this “hotspot”. Whilst it was possible to collect discrete bio data for each site, it was not always possible for wardens to identify which individual site observed harvesters were using. To accommodate this anomaly, analysis involving the association of harvesters at Foreness regards sites 5 & 6 as a single site but analysis involving absolute bio measurements regards sites 5 & 6 as separate.
For Fig. 4. 10, a correlation co-efficient of 0.104 was recorded indicating no significant association between Littorina total and the No. of harvesters. *Patella vulgata* abundance was occasional.

Selected species

Site 7 Nayland Rock, Margate

Fig. 4.11 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

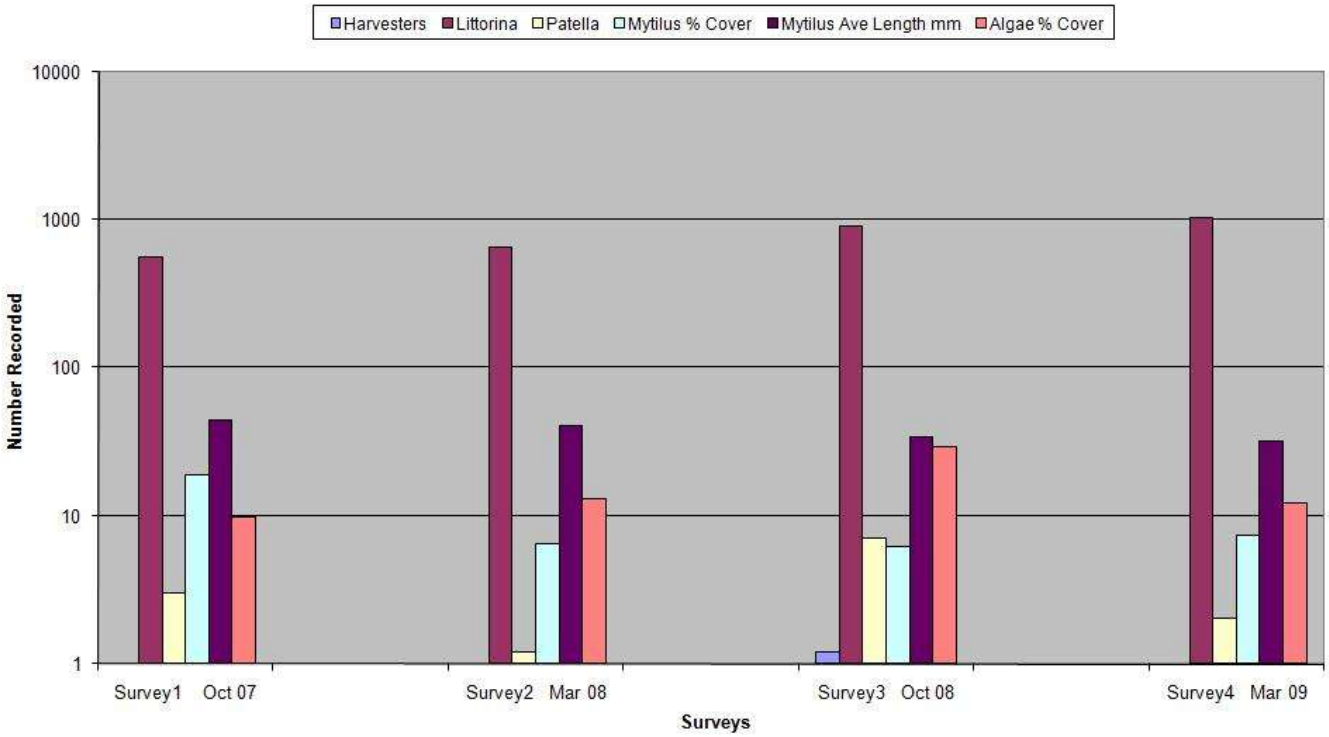

Figure 4.11 Selected species / No. of harvesters - Site 7

Fig. 4.12 shows correlation between total Littorina & harvesters for surveys 1 to 4.

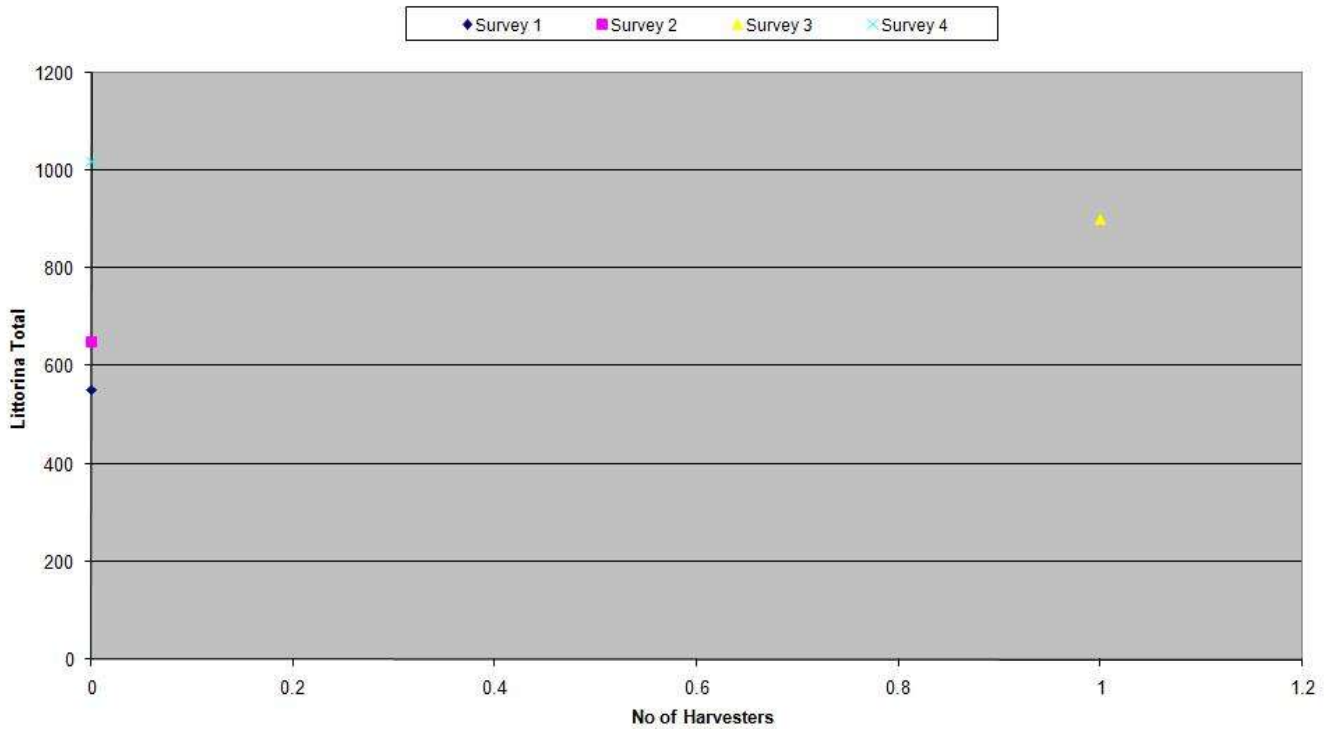

Figure 4.12 Littorina total / No. of harvesters correlation - Site 7

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 2 & 4. However, from Fig. 4.11 & Fig. 4.12 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. *Patella vulgata* abundance was occasional.

Selected species

Site 8 Westgate Bay, Westgate

Fig. 4.13 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

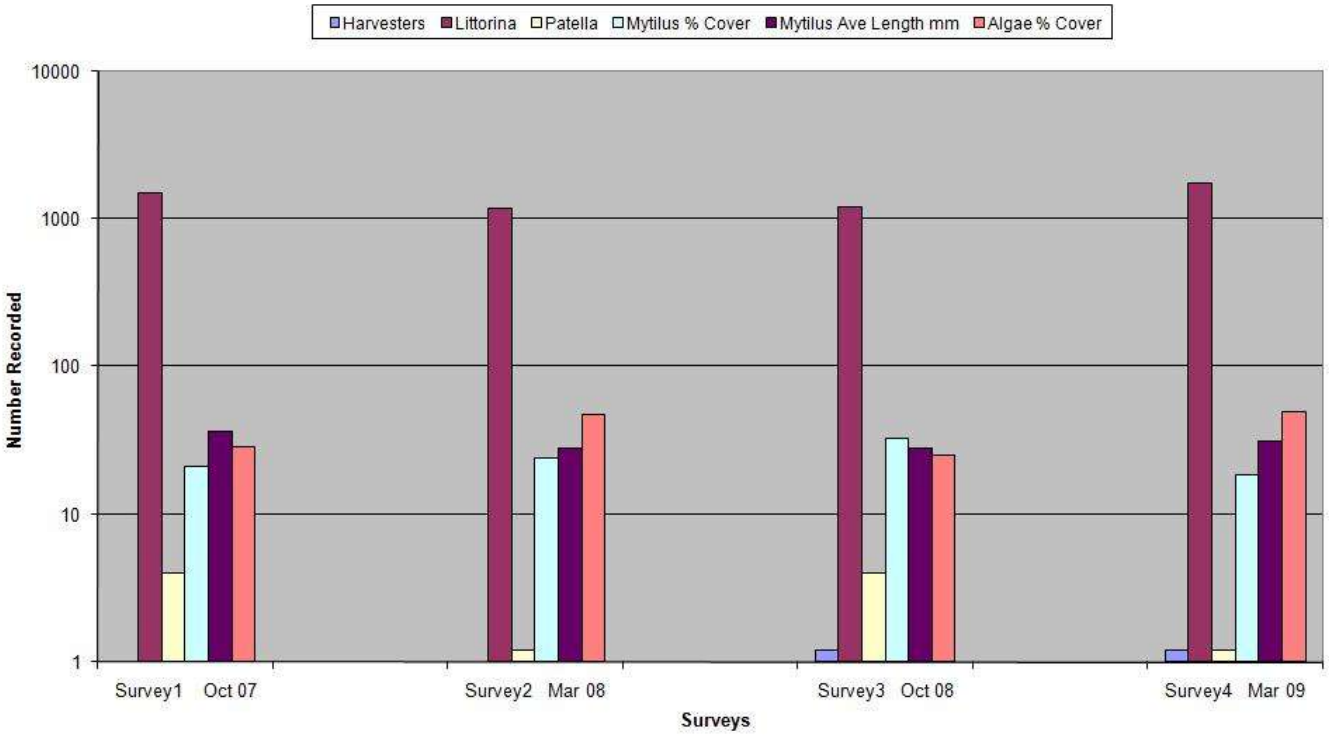

Figure 4.13 Selected species / No. of harvesters - Site 8

Fig. 4.14 shows correlation between total Littorina & harvesters for surveys 1 to 4.

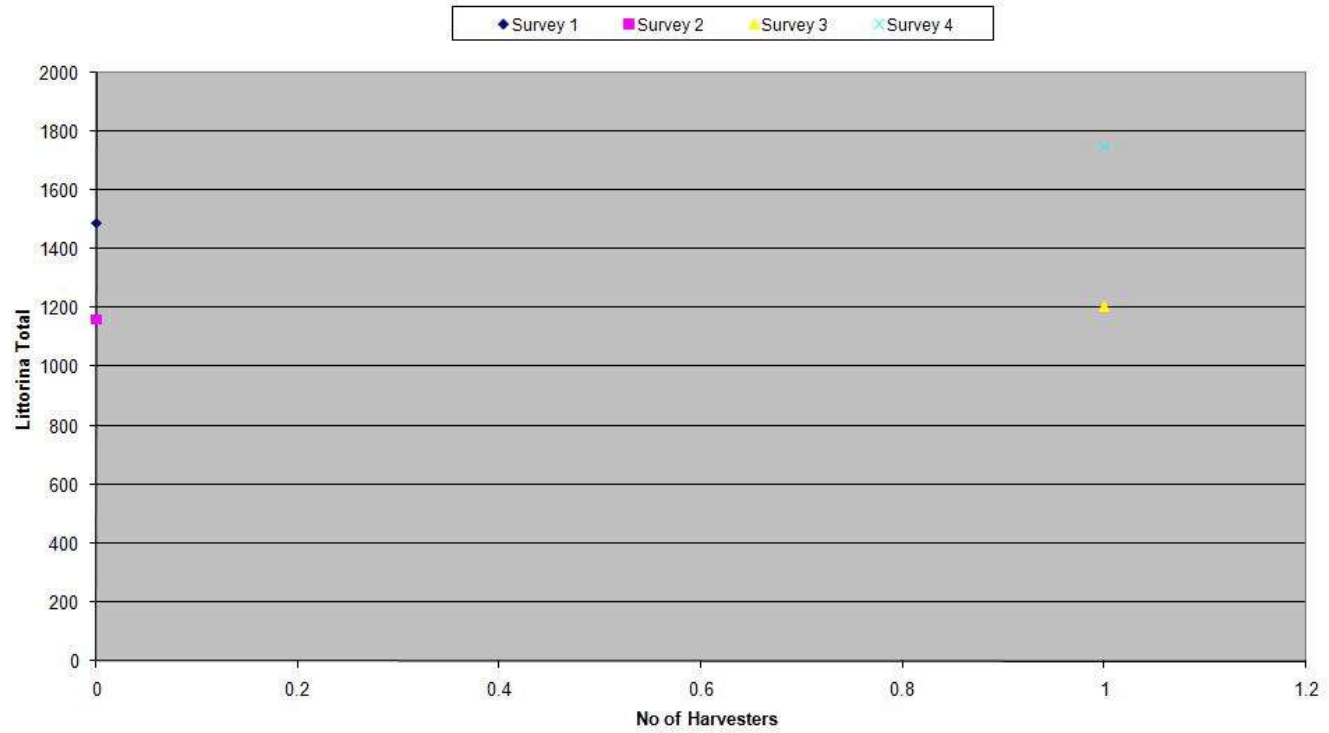

Figure 4.14 Littorina total / No. of harvesters correlation - Site 8

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1 & 2.

However, from Fig. 4.13 & Fig. 4.14 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. *Patella vulgata* abundance was occasional.

Selected species

Site 9 Epple Bay, Birchington

Fig. 4.15 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

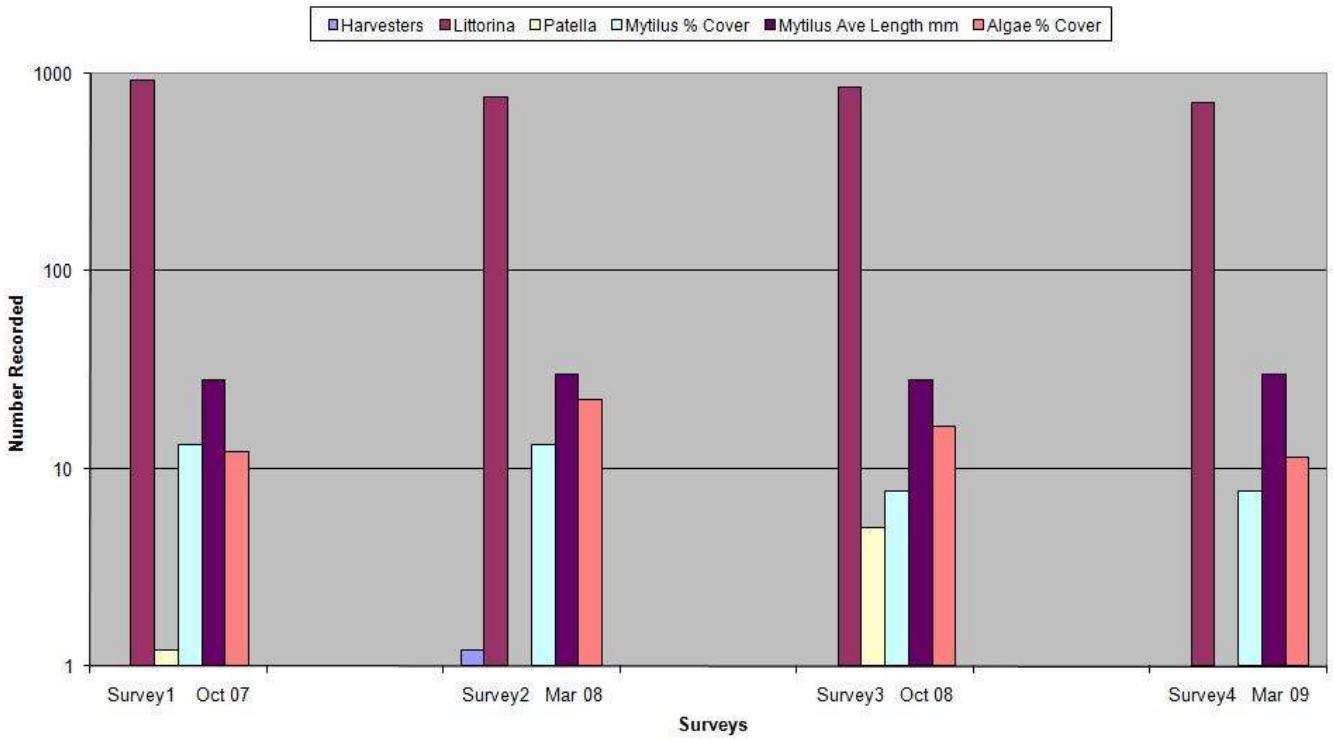

Figure 4.15 Selected species / No. of harvesters - Site 9

Fig. 4.16 shows correlation between total Littorina & harvesters for surveys 1 to 4.

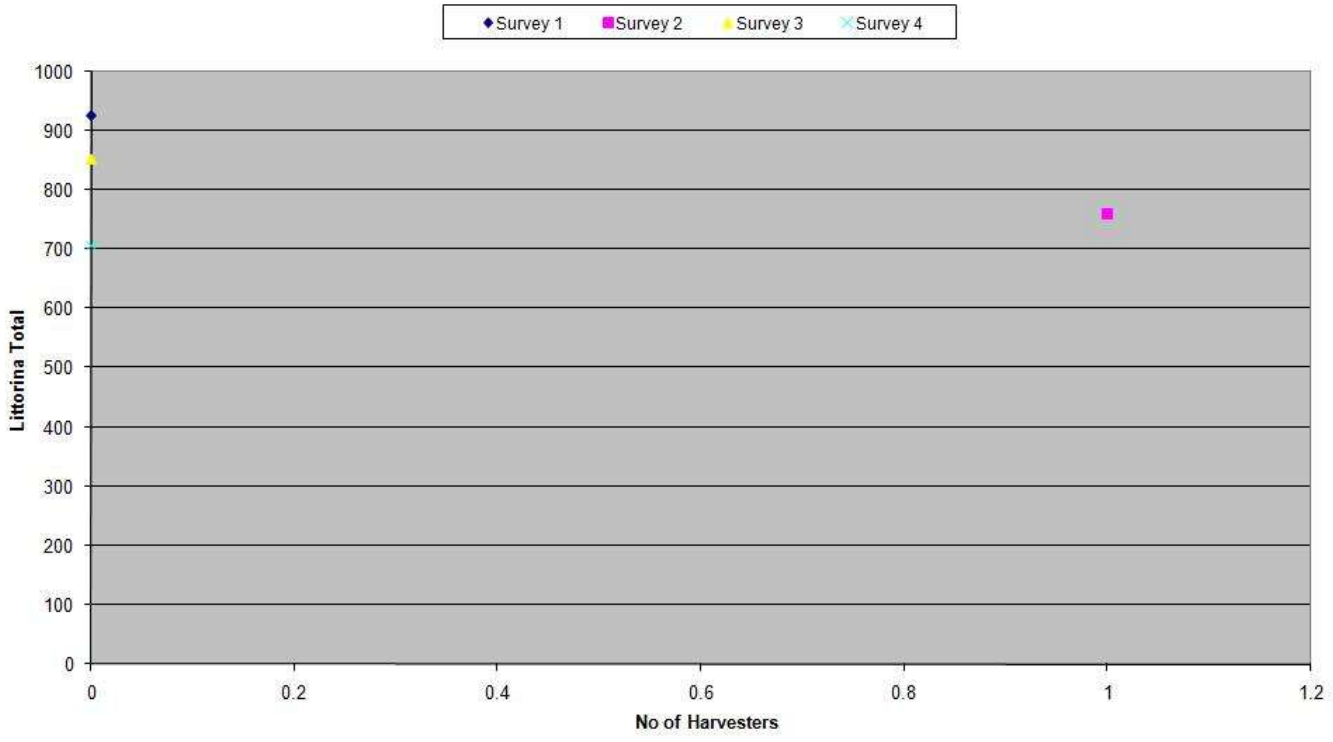

Figure 4.16 Littorina total / No. of harvesters correlation - Site 9

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 3 & 4. However, from Fig. 4.15 & Fig. 4.16 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend.*Patella vulgata* abundance was occasional.

Selected species

Site 10 Beresford Bay,Birchington

Fig. 4.17 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

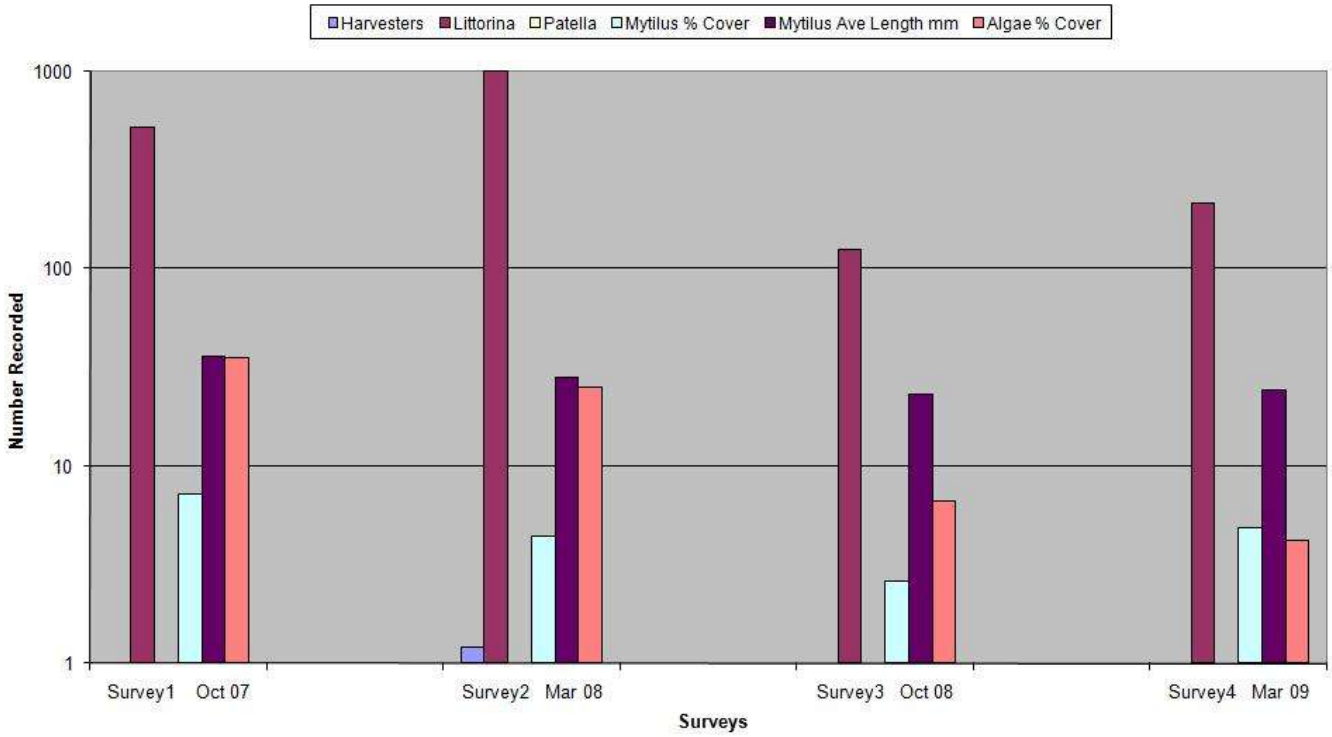

Figure 4.17 Selected species / No. of harvesters - Site 10

Fig. 4.18 shows correlation between total Littorina & harvesters for surveys 1 to 4.

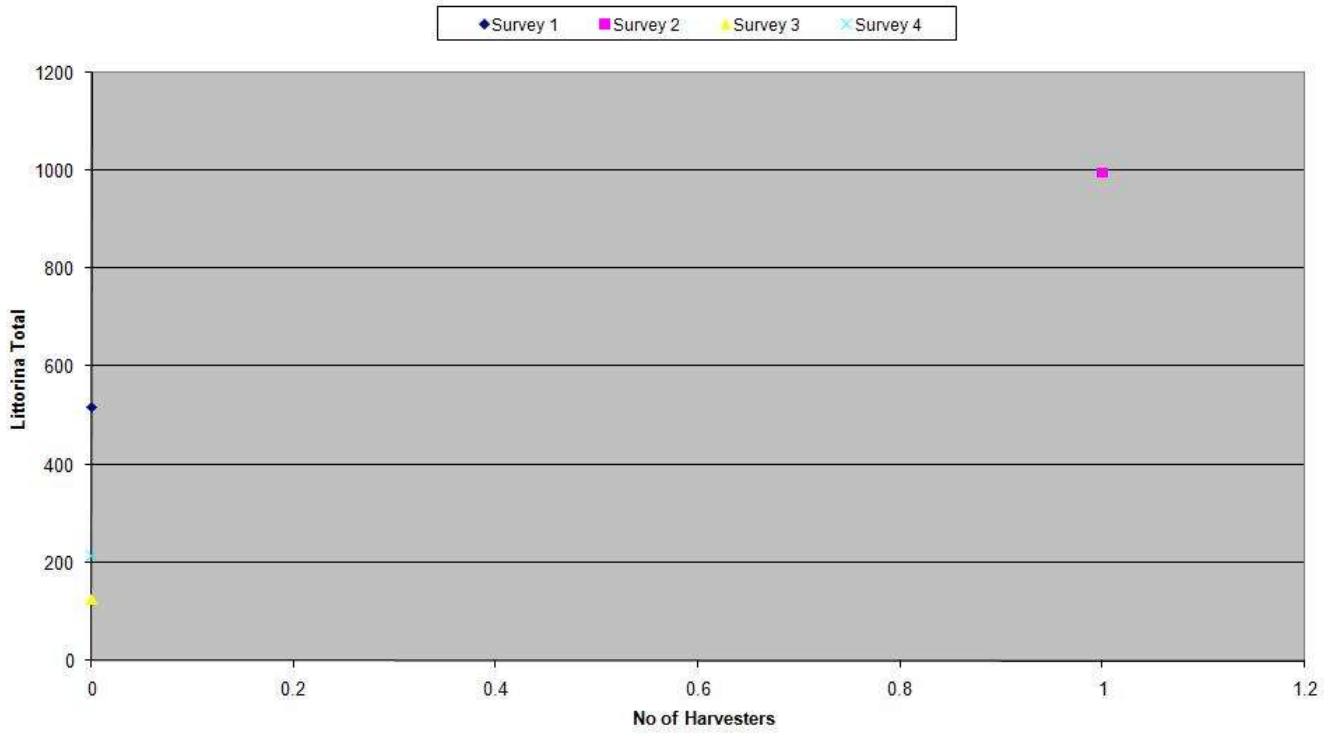

Figure 4.18 Littorina total / No. of harvesters correlation - Site 10

In November 2008, this site was affected by a natural disturbance which accounts for the significant reduction of Littorina numbers recorded on survey 3. Details are given under “Natural Disturbance” page 38. Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 3 & 4. However, from Fig. 4.17 & Fig. 4.18 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. *Patella vulgata* were absent.

Selected species

Site 11 St Mildred’s Bay,Westgate

Fig. 4.19 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

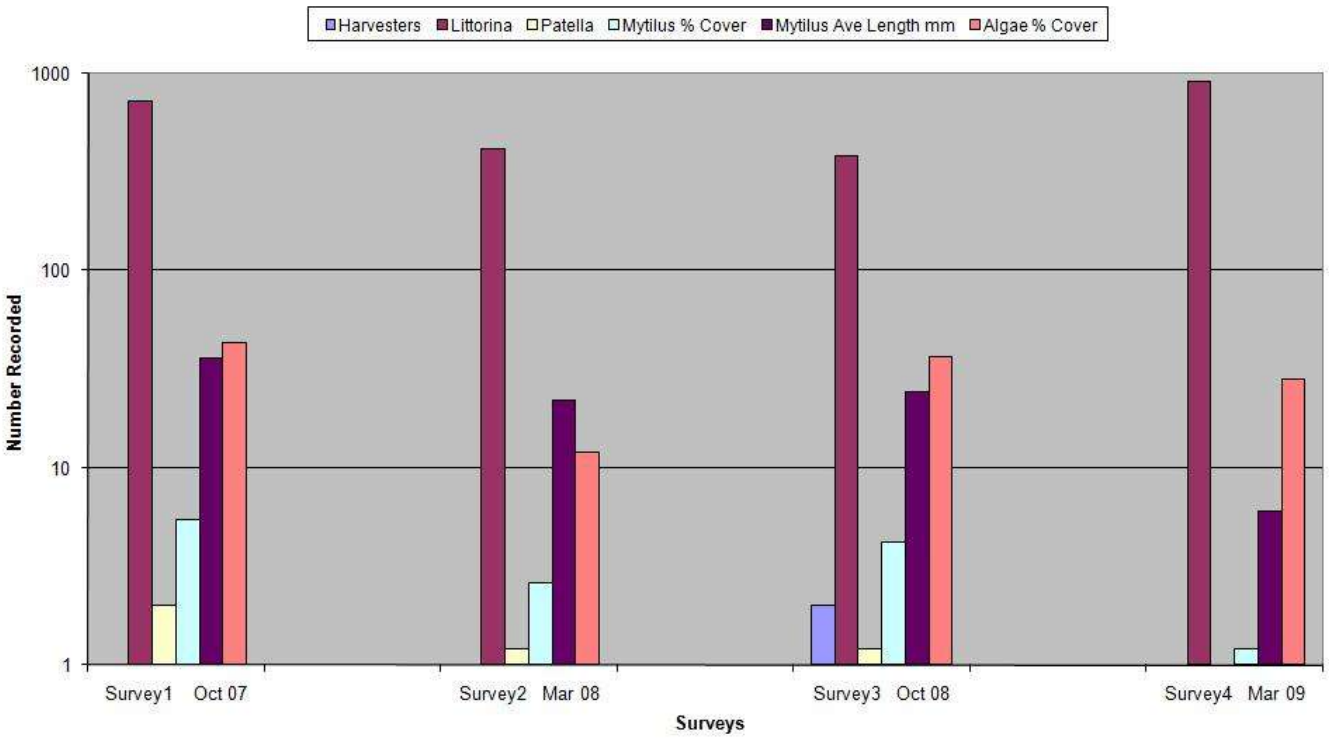

Figure 4.19 Selected species / No. of harvesters - Site 11

Fig. 4.20 shows correlation between total Littorina & harvesters for surveys 1 to 4.

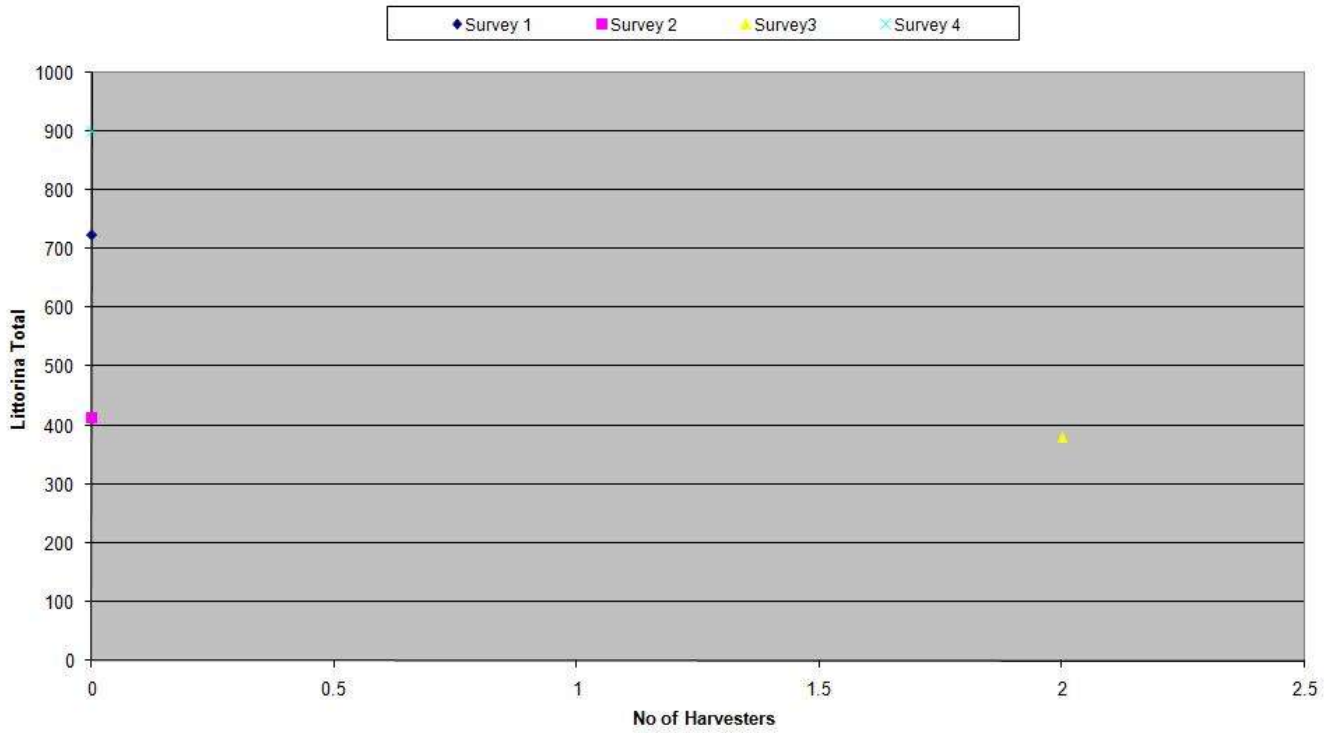

Figure 4.20 Littorina total / No. of harvesters correlation - Site 11

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 2 & 4. However, from Fig. 4.19 & Fig. 4.20 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend. *Patella vulgata* abundance was occasional.

Selected species

Site 12 Minnis Bay, Birchington

Fig. 4.21 shows the summary of selected species against the associated number of harvesters for surveys 1 to 4 (Y axis is logarithmic).

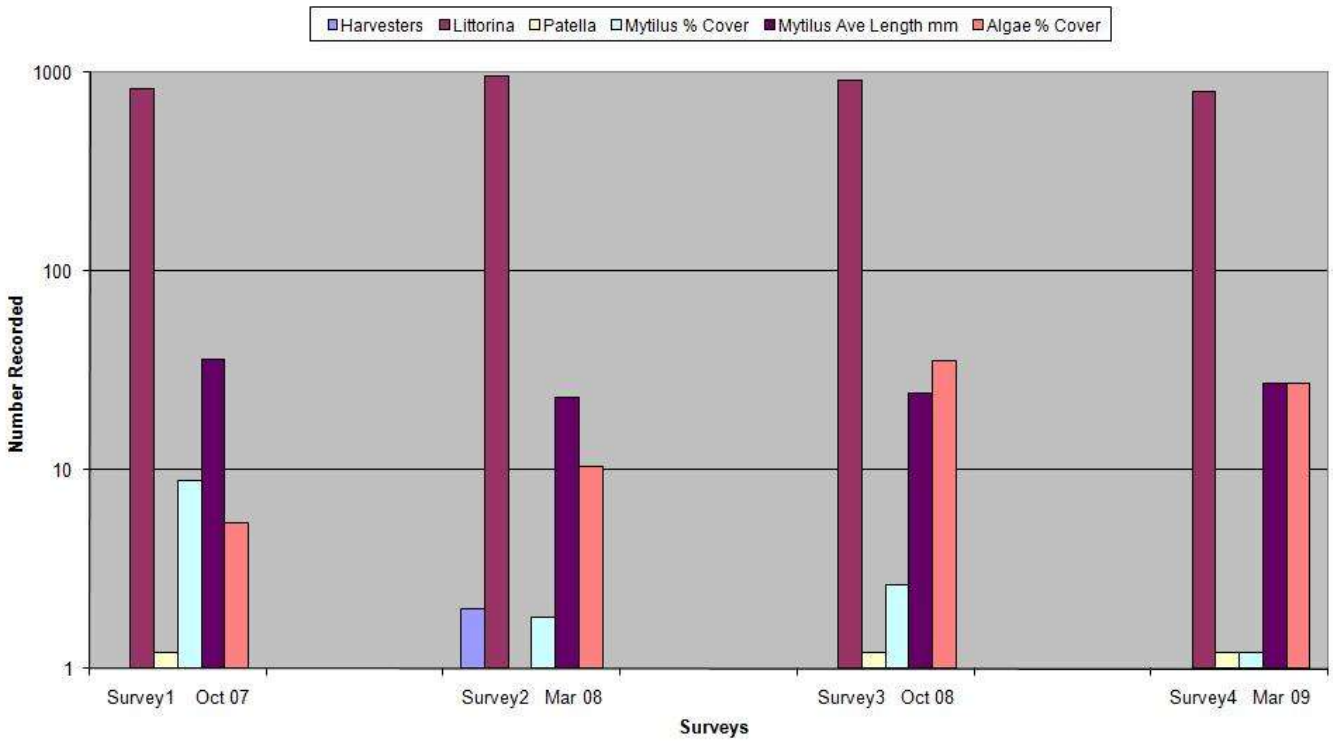

Figure 4.21 Selected species / No. of harvesters - Site 12

Fig. 4.22 shows correlation between total Littorina & harvesters for surveys 1 to 4.

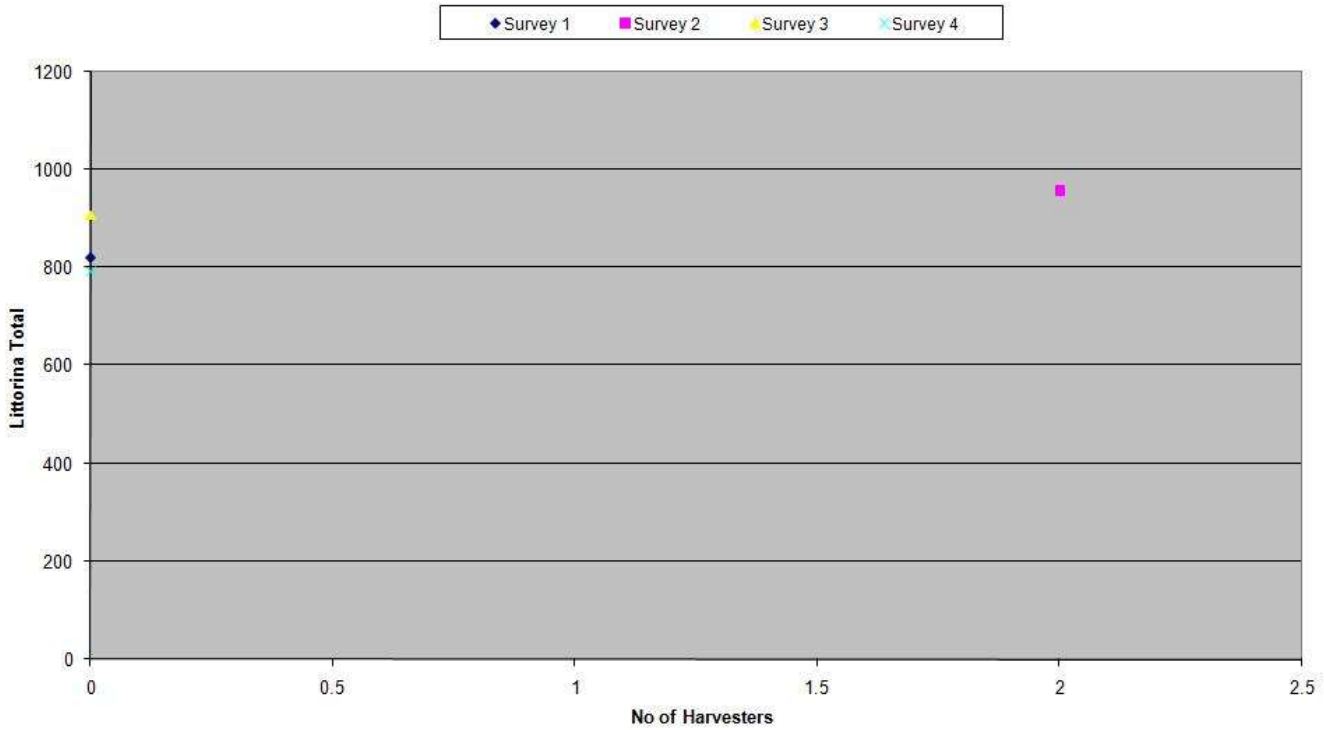

Figure 4.22 Littorina total / No. of harvesters correlation - Site 12

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 3 & 4. However, from Fig. 4.21 & Fig. 4.22 it can be seen that this site experienced a very low level of harvesting over the project period. Littorina numbers and other selected species showed no significant trend.*Patella vulgata* abundance was occasional.

Littorina demography

Site 1 Pegwell

Fig.3.1 page 8 shows a normal distribution for Littorina population across the 4 survey samples with an overall ◴ site value at 7.2mm.

Fig. 4.23 shows the average specimen size for this population at each survey against the associated number of harvesters. Average size at this site is consistantly smaller than at other survey sites.

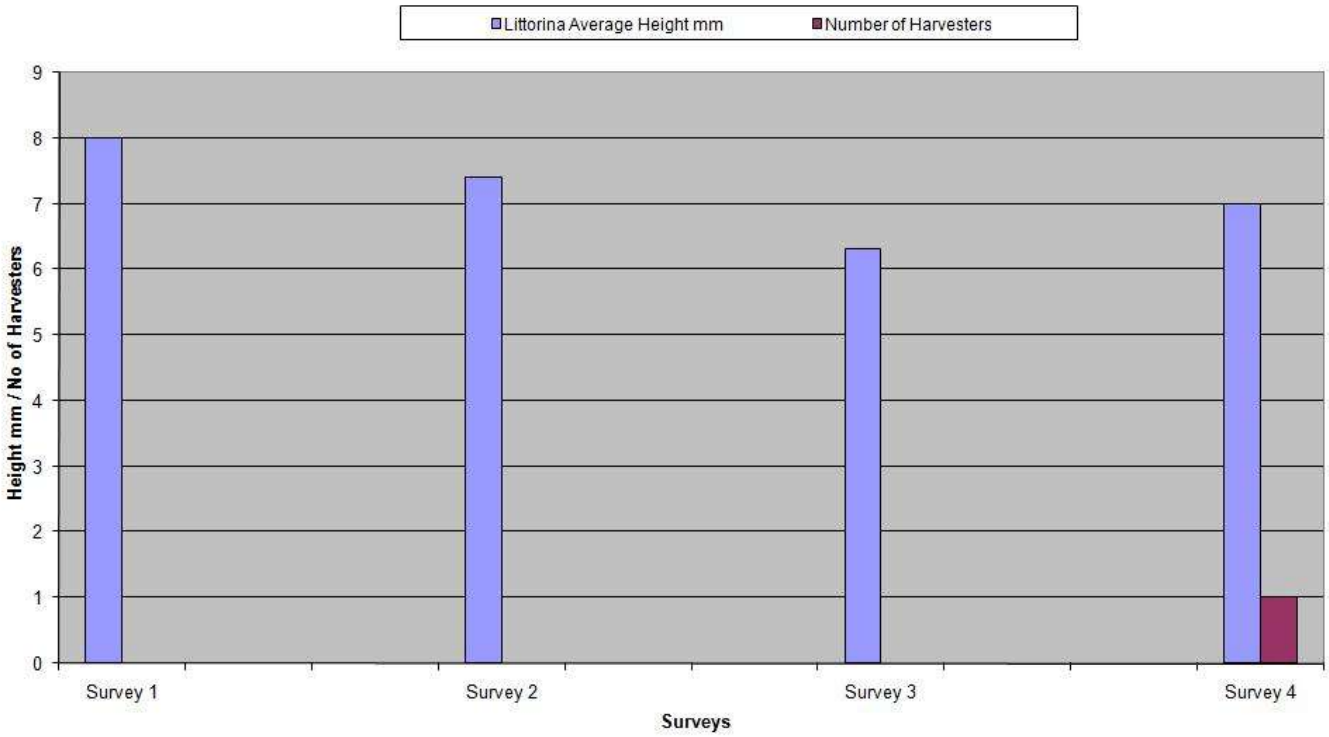

Figure 4.23 Littorina average size / No. of harvesters - Site 1

Fig. 4.24 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

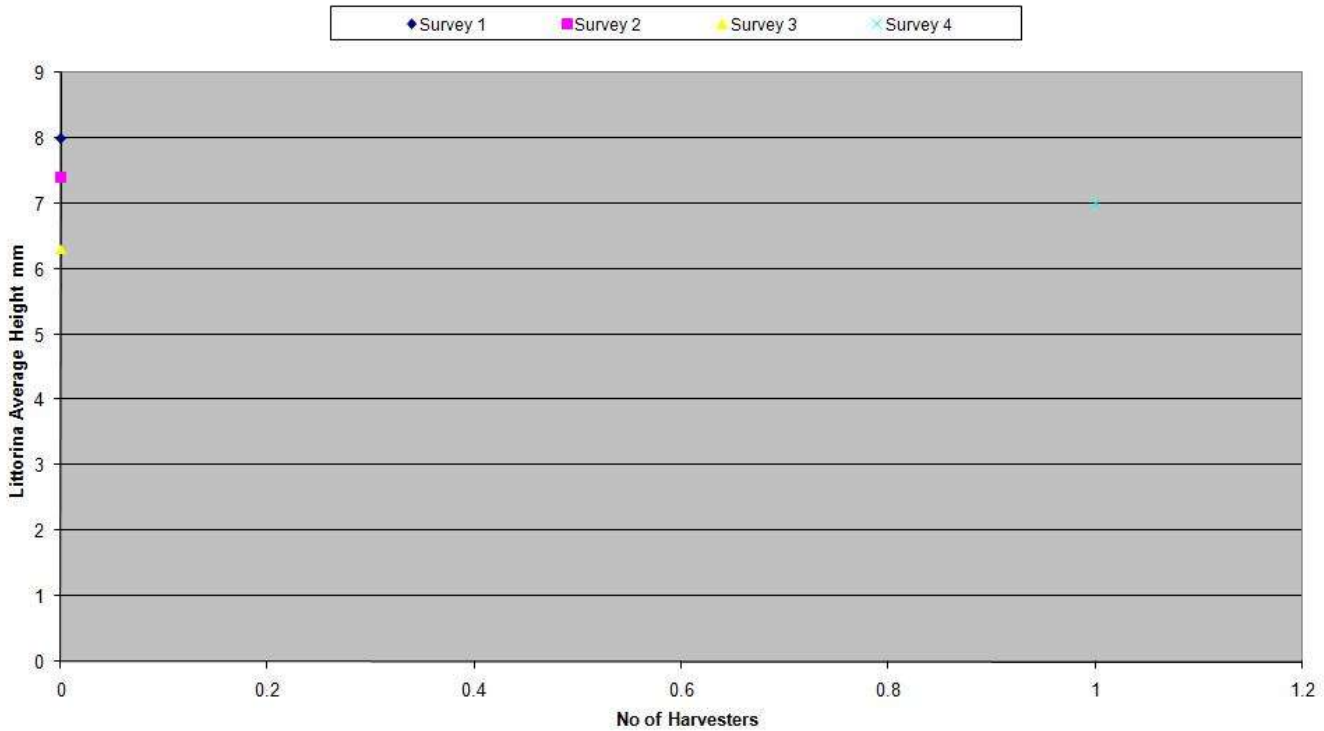

Figure 4.24 Littorina average size / No. of harvesters correlation - Site 1

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1, 2 & 3. However, from Fig. 4.23 & Fig. 4.24 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 2 Western Undercliff, Ramsgate

Fig.3.2 page 8 shows a normal distribution for Littorina population across the 4 survey samples with an overall ◴ site value at 7mm.

Fig. 4.25 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

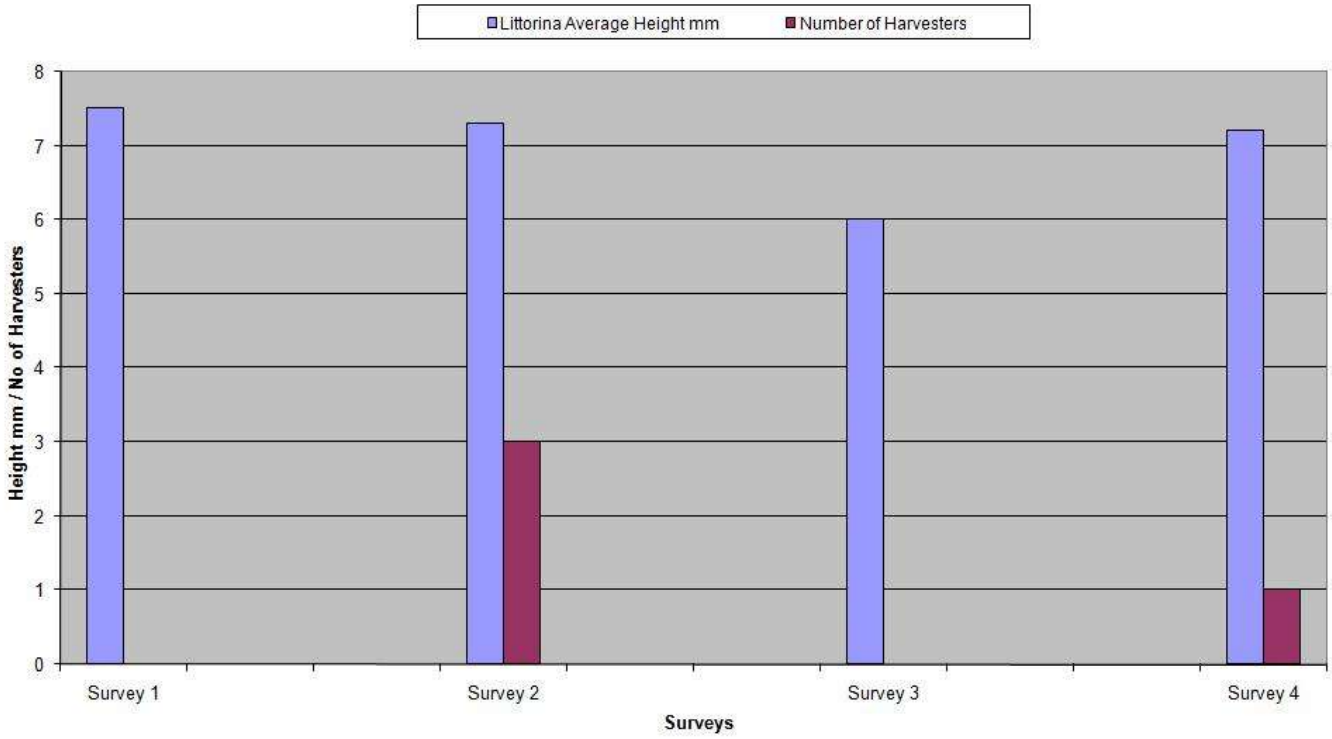

Figure 4.25 Littorina average size / No. of harvesters - Site 2

Fig. 4.26 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

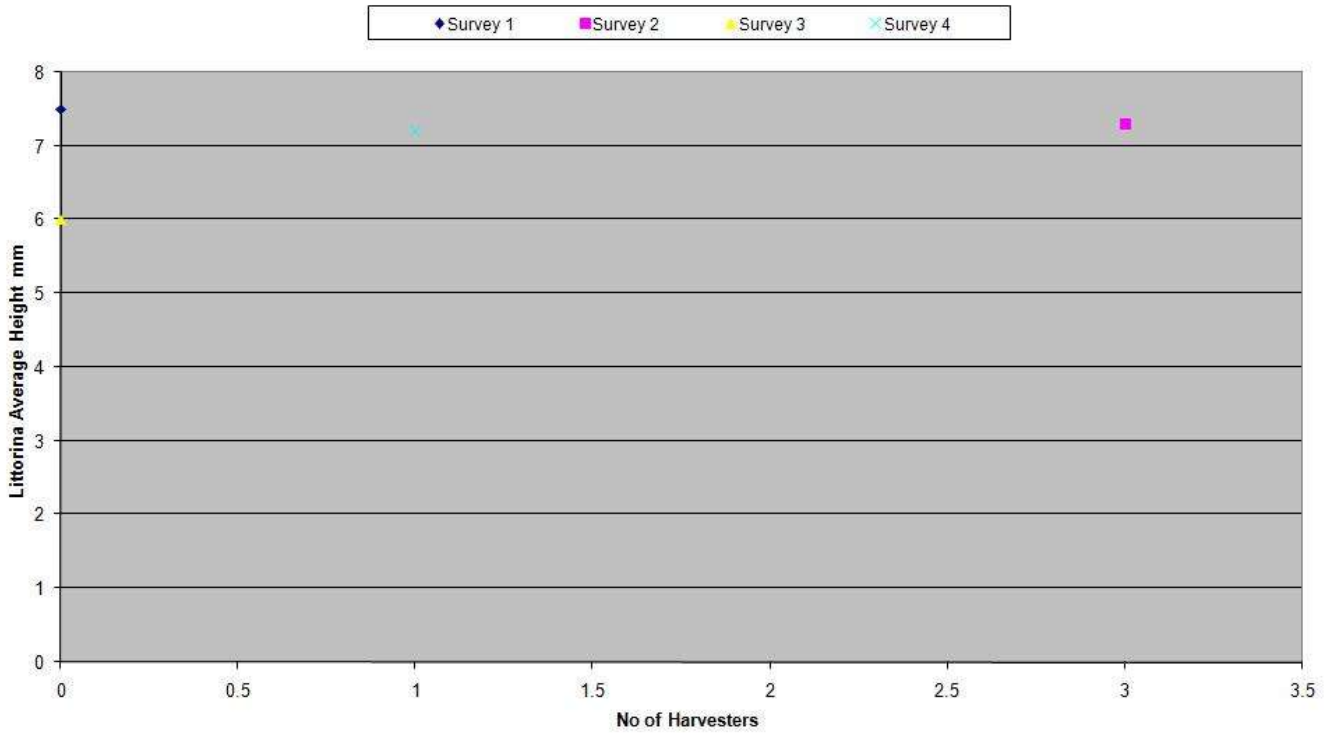

Figure 4.26 Littorina average size / No. of harvesters correlation - Site 2

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1 & 3. However, from Fig. 4.25 & Fig. 4.26 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 3 Stone Bay, Broadstairs

Fig.3.3 page 9 shows a normal distribution for Littorina population across the 4 survey samples with an overall ◴ site value at 11.4mm. Fig. 4.27 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

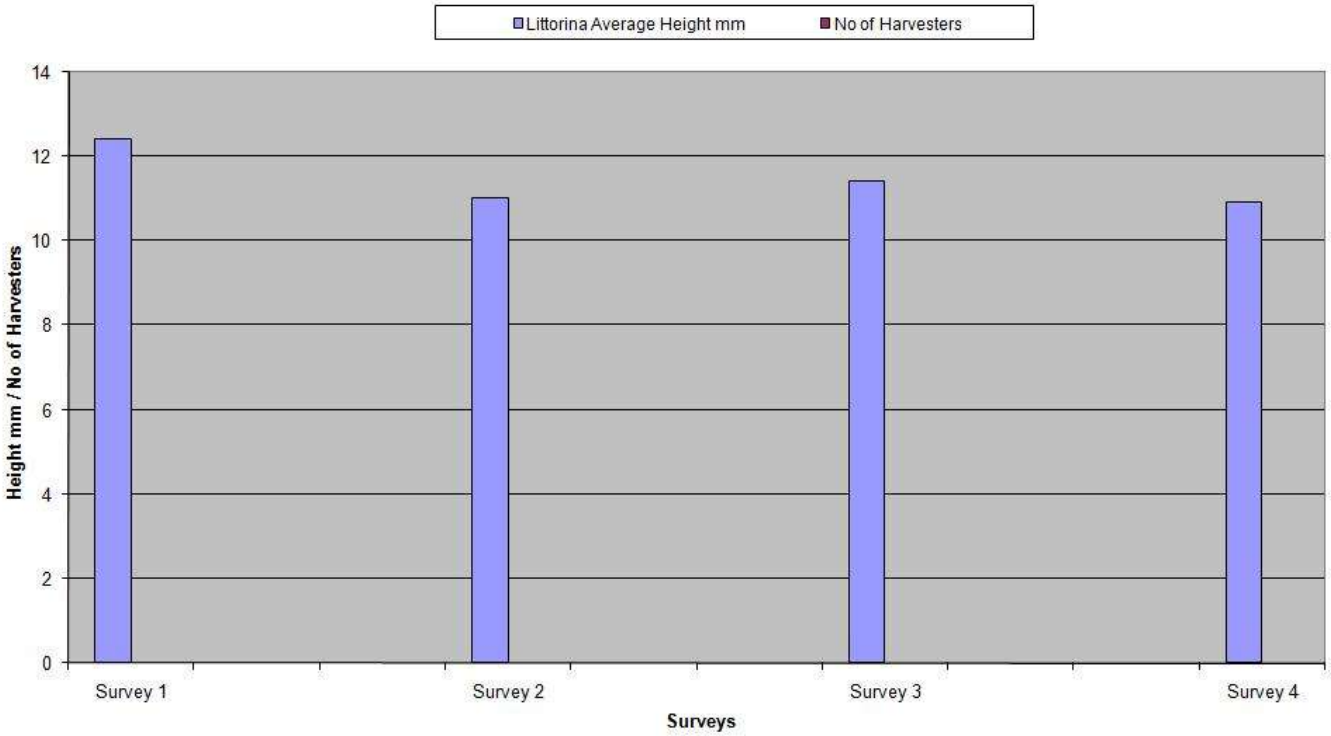

Figure 4.27 Littorina average size / No. of harvesters - Site 3

Fig. 4.28 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

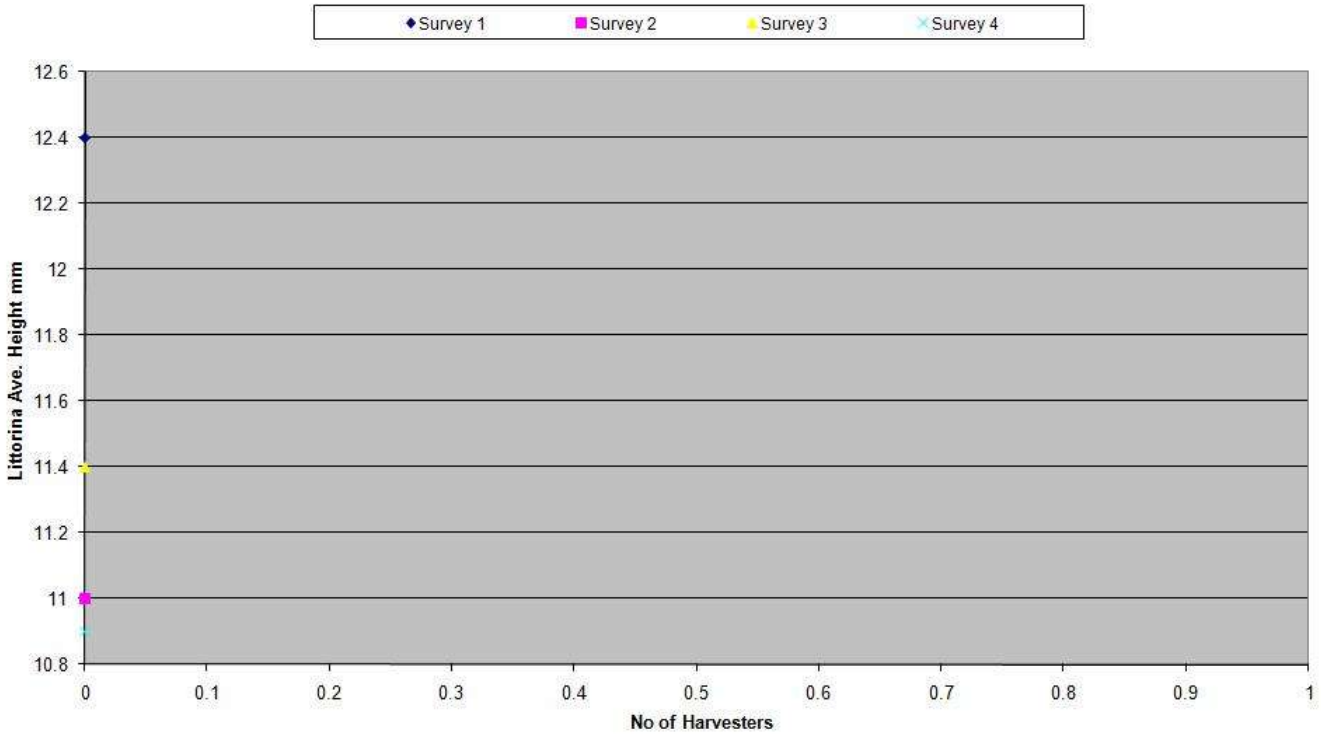

Figure 4.28 Littorina average size / No. of harvesters correlation - Site 3

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1 - 4.

However, from Fig. 4.27 & Fig. 4.28 it can be seen that this site experienced zero level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 4 Whiteness Point, Broadstairs

Fig.3.4 page 9 shows a normal distribution for Littorina population across the 4 survey samples with an overall ◴ site value at 9.5mm. Fig. 4.29 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

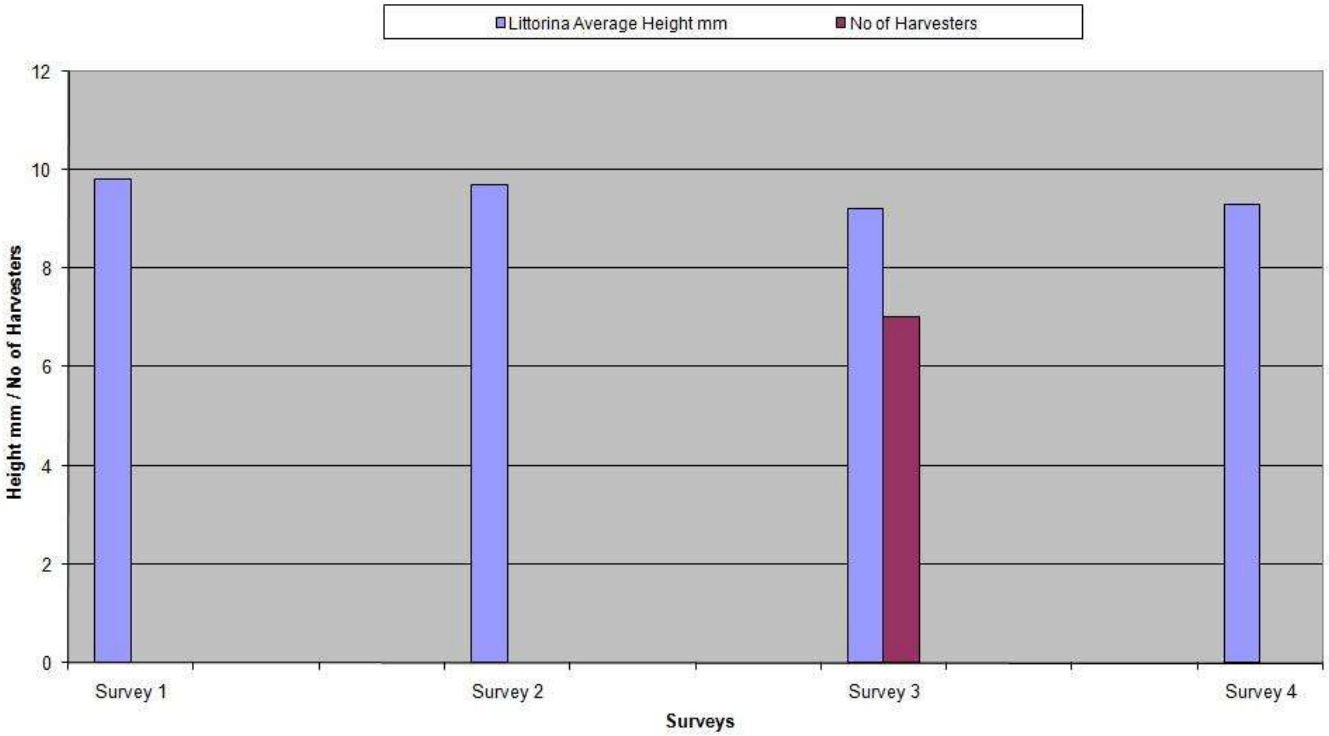

Figure 4.29 Littorina average size / No. of harvesters - Site 4

Fig. 4.30 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

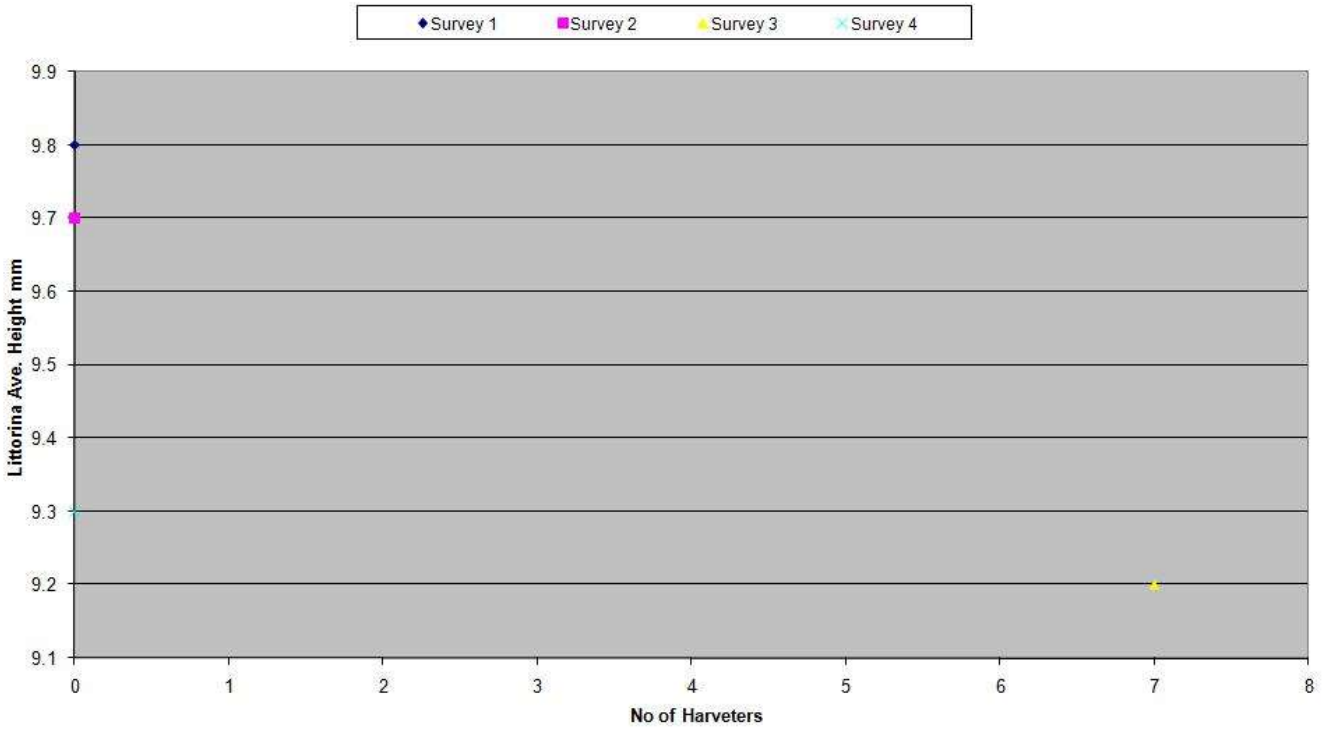

Figure 4.30 Littorina average size / No. of harvesters correlation - Site 4

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1,2 & 4. However, from Fig. 4.29 & Fig. 4.30 it can be seen that this site experienced a low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Sites 5 & 6 Foreness, Margate

Figs. 3.5 & 3.6 pages 9 & 10 show normal distribution for Littorina population across the 4 survey samples with an overall 🕘 site value at 10.6mm. Fig. 4.31 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

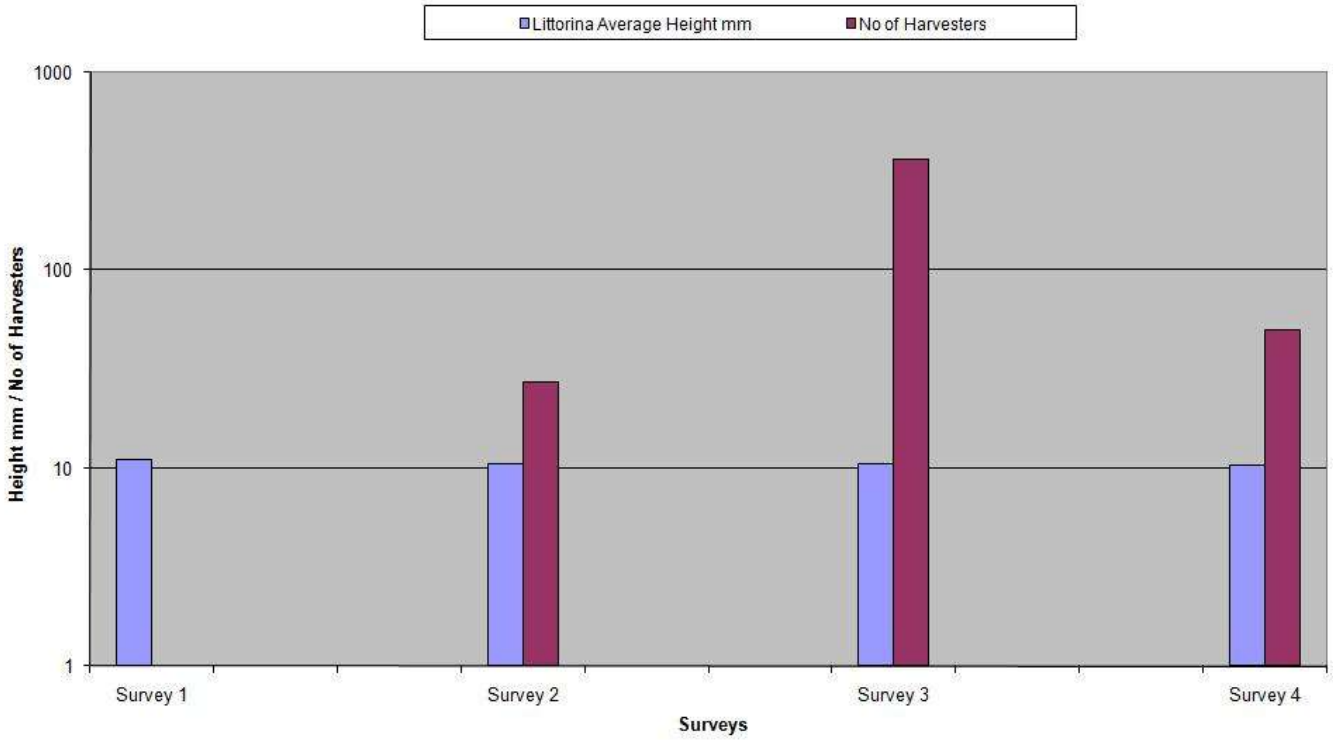

Figure 4.31 Littorina average size / No. of harvesters - Sites 5 & 6

Fig. 4.32 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

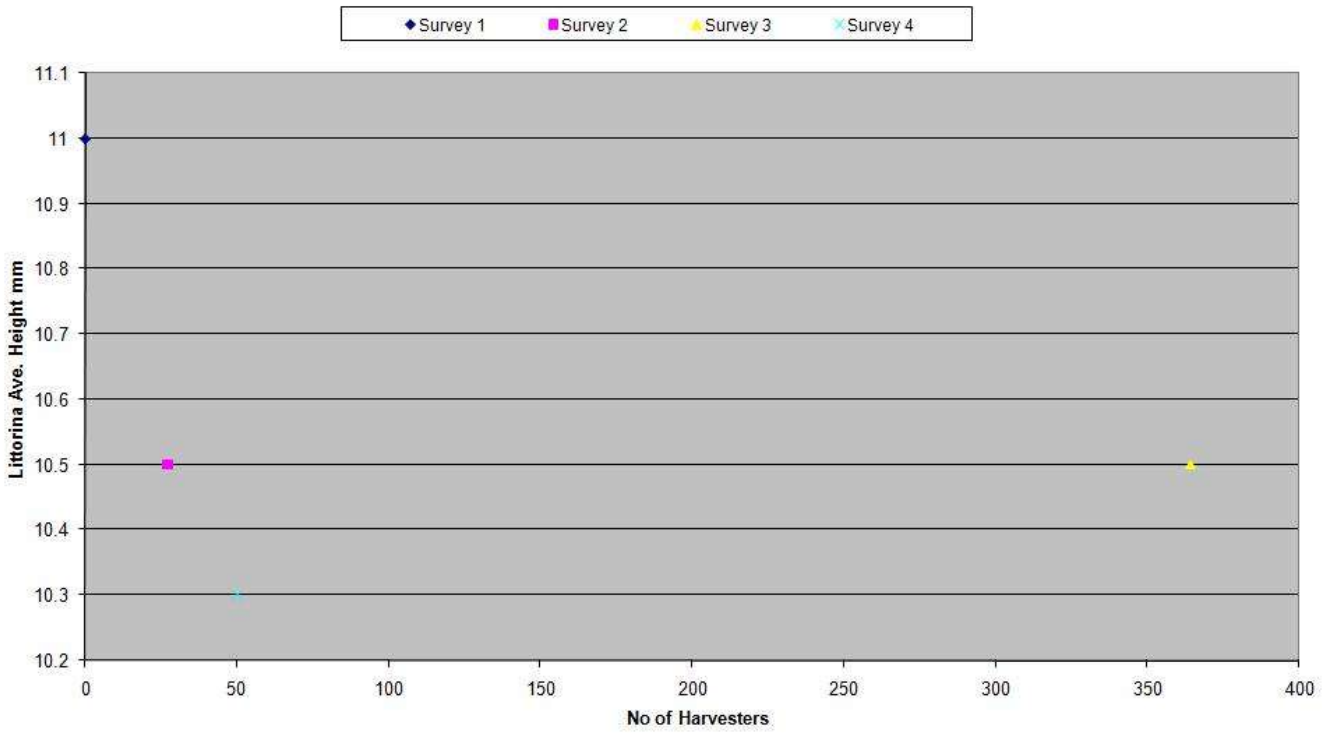

Figure 4.32 Littorina average size / No. of harvesters correlation - Sites 5 & 6

At Foreness, see page 20 for an explanation of difficulties encountered identifying the precise site boundaries for observed harvesters.
For Fig. 4. 32, a correlation co-efficient of -0.28 was recorded indicating no significant association between Littorina size and the No. of harvesters.

Littorina demography

Site 7 Nayland Rock, Margate

Fig.3.7 page 10 shows a normal distribution for Littorina population across the 4 survey samples with an overall 🕘 site value at 10.6mm. Fig. 4.33 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

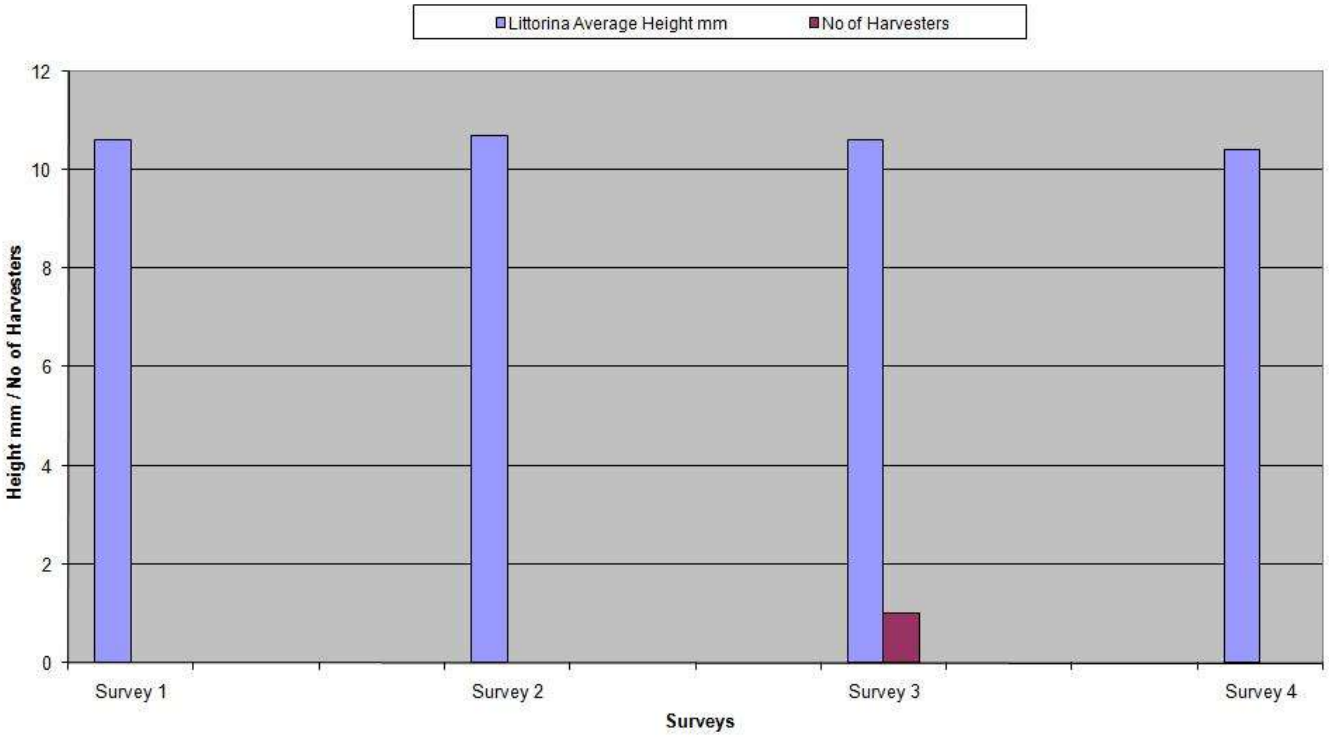

Figure 4.33 Littorina average size / No. of harvesters - Site 7

Fig. 4.34 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

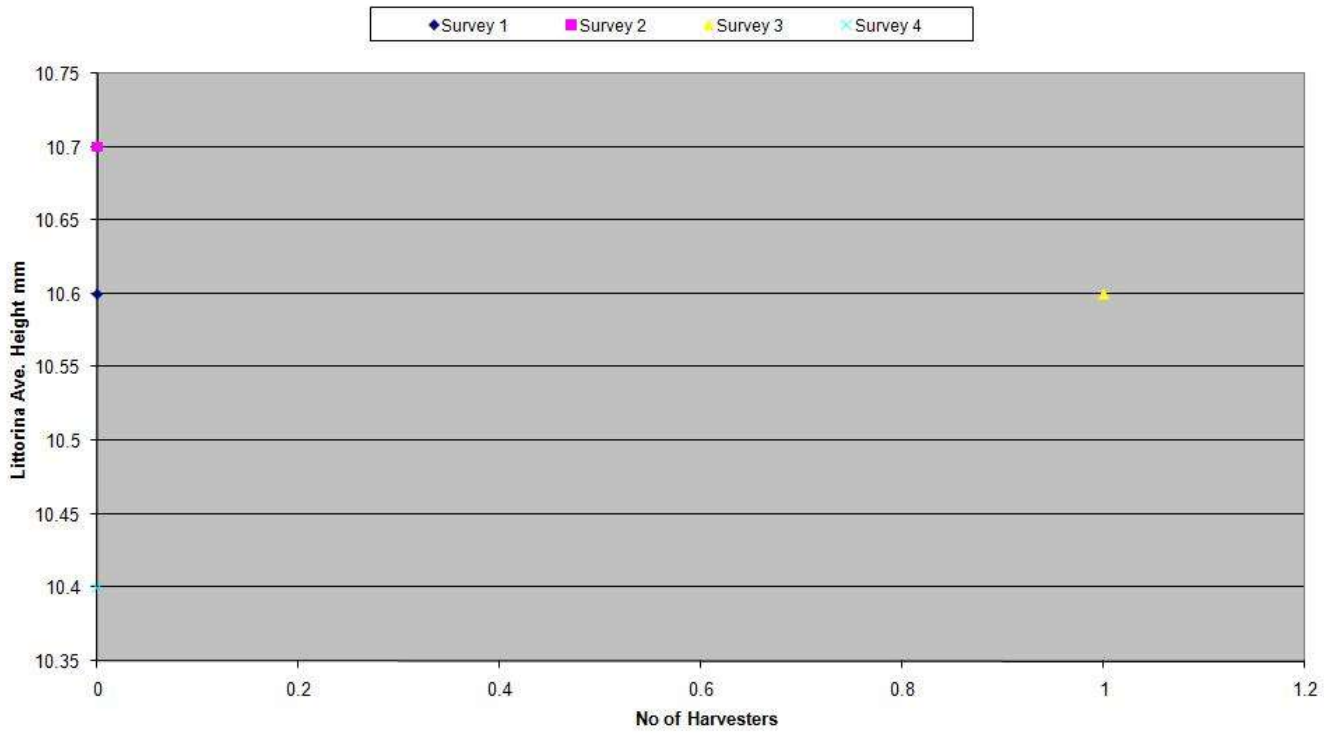

Figure 4.34 Littorina average size / No. of harvesters correlation - Site 7

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1,2 & 4. However, from Fig. 4.33 & Fig. 4.34 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 8 Westgate Bay, Westgate

Fig.3.8 page 10 shows a normal distribution for Littorina population across the 4 survey samples with an overall 🕘 site value at 9.1mm. Fig. 4.35 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

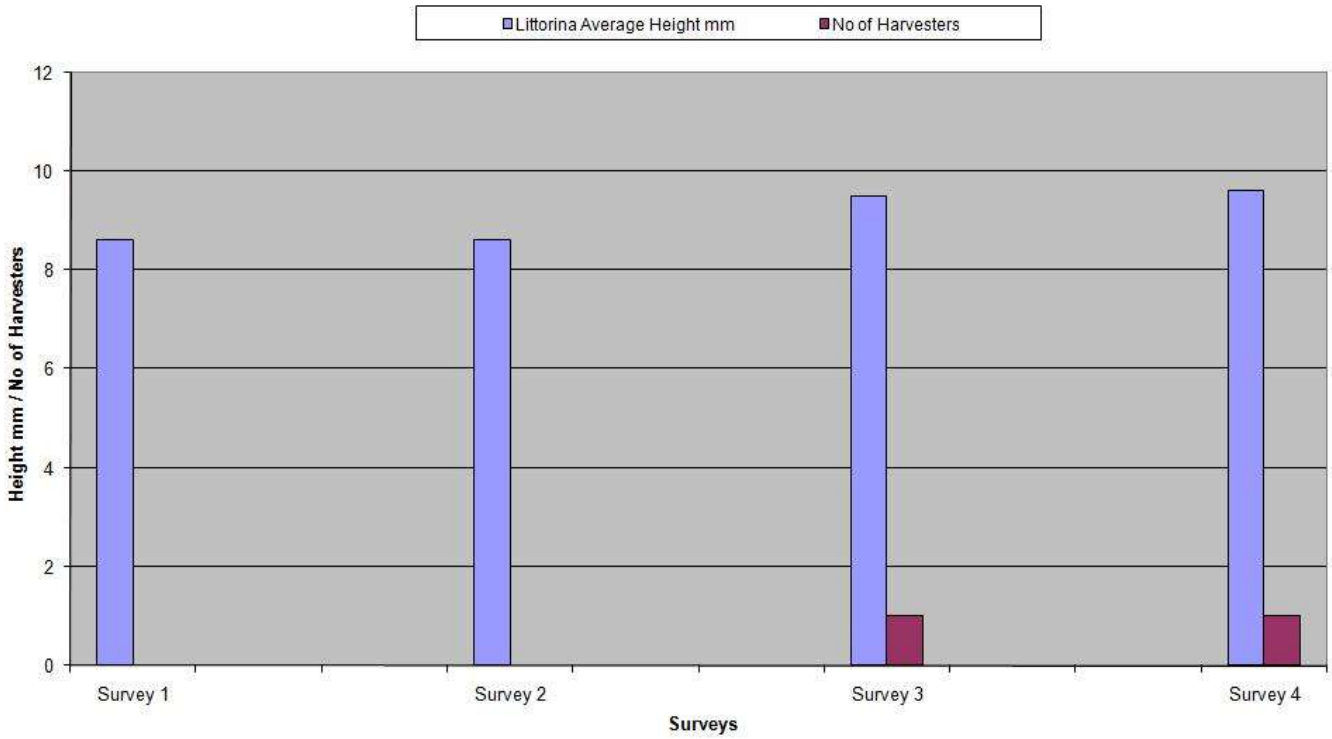

Figure 4.35 Littorina average size / No. of harvesters - Site 8

Fig. 4.36 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

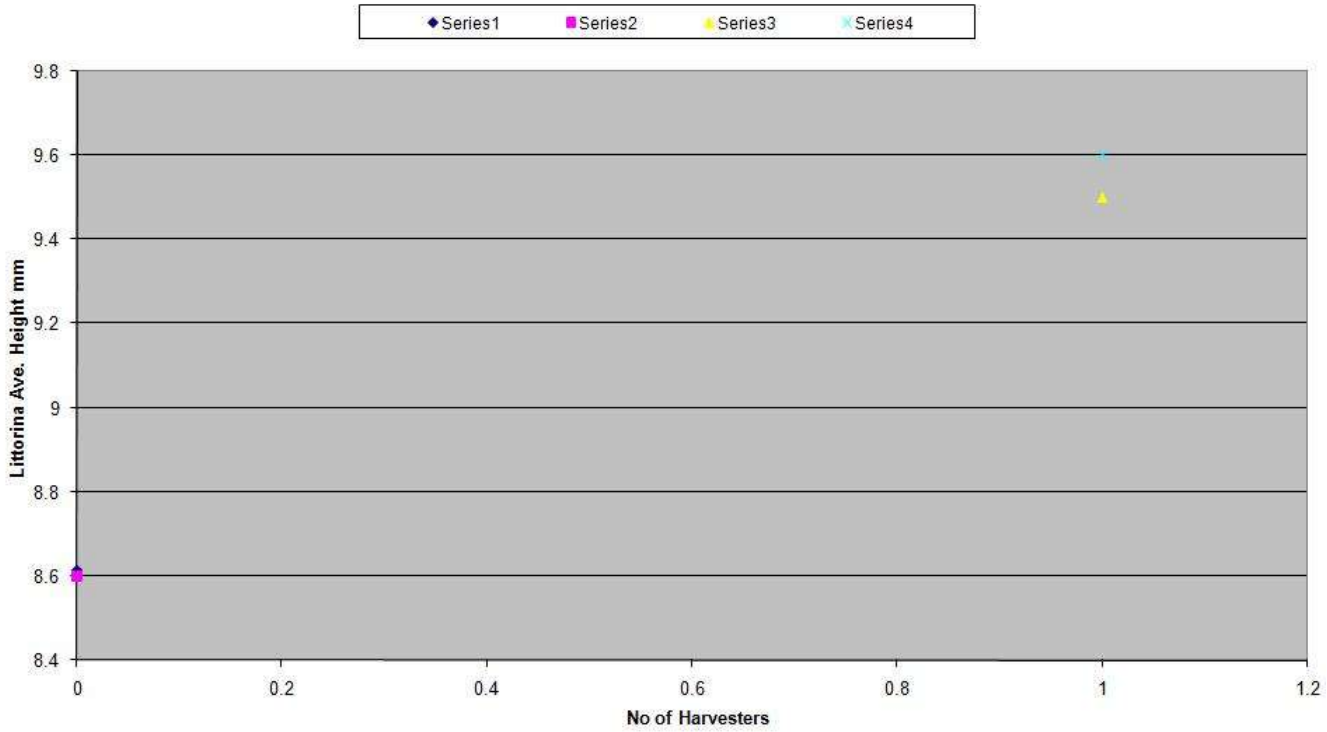

Figure 4.36 Littorina average size / No. of harvesters correlation - Site 8

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1& 2. However, from Fig. 4.35 & Fig. 4.36 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 9 Epple Bay, Birchington

Fig.3.9 page 11 shows a normal distribution for Littorina population across the 4 survey samples with an overall 🕘 site value at 11mm. Fig. 4.37 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

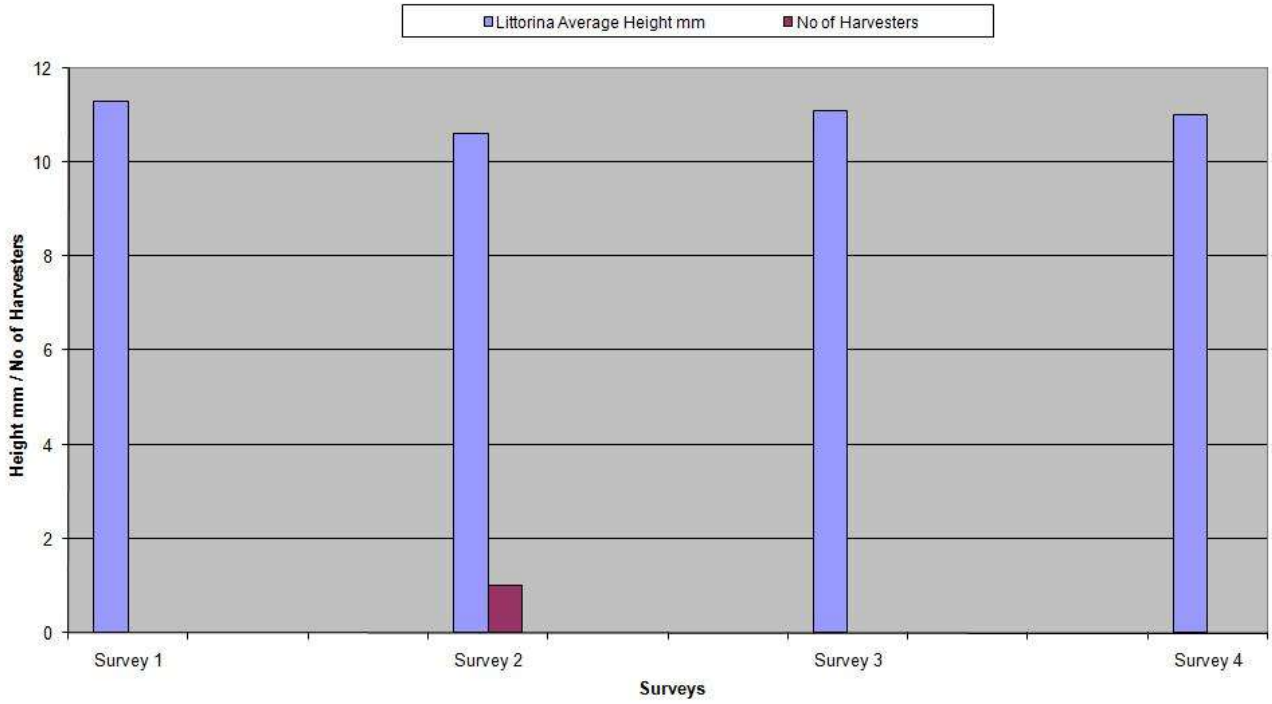

Figure 4.37 Littorina average size / No. of harvesters - Site 9

Fig. 4.38 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

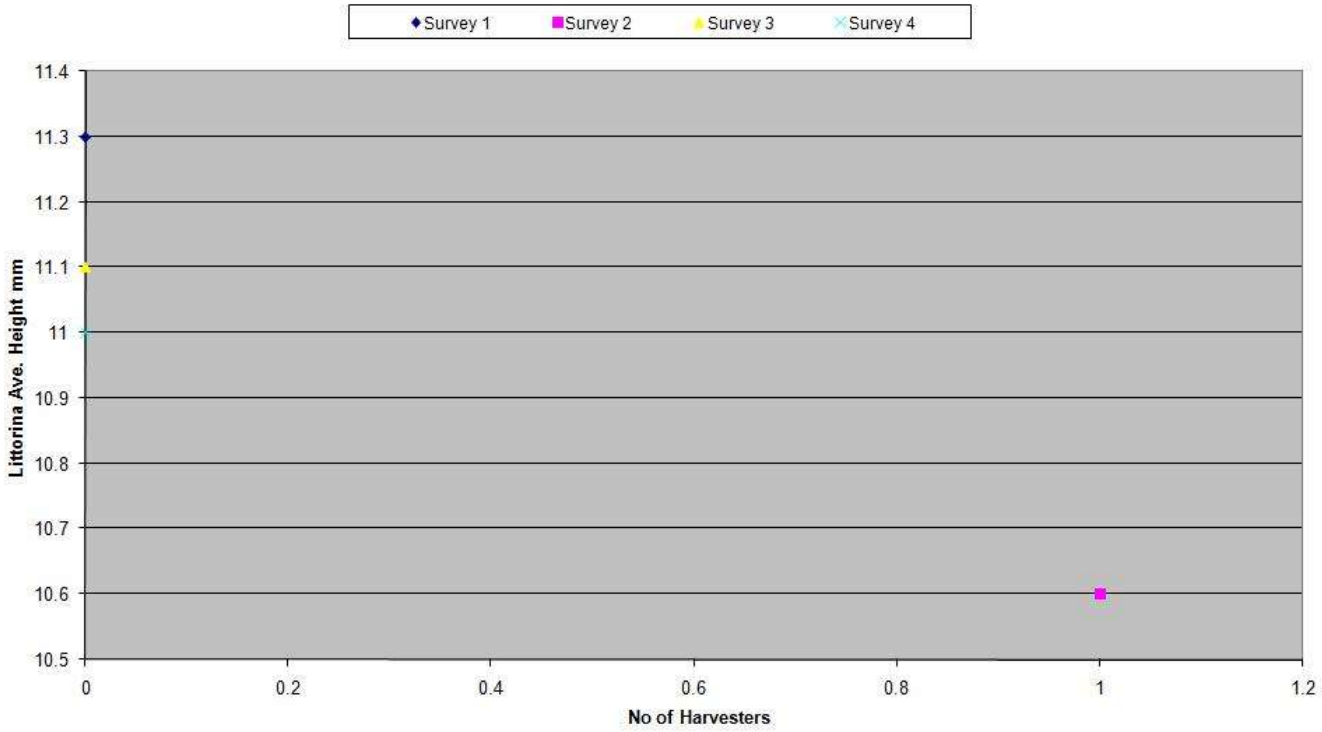

Figure 4.38 Littorina average size / No. of harvesters correlation - Site 9

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1,3 & 4. However, from Fig. 4.37 & Fig. 4.38 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 10 Beresford Bay, Birchington

Fig.3.10 page 11 shows a normal distribution for Littorina population across the 4 survey samples with an overall 🕘 site value at 11.2mm. Fig. 4.39 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

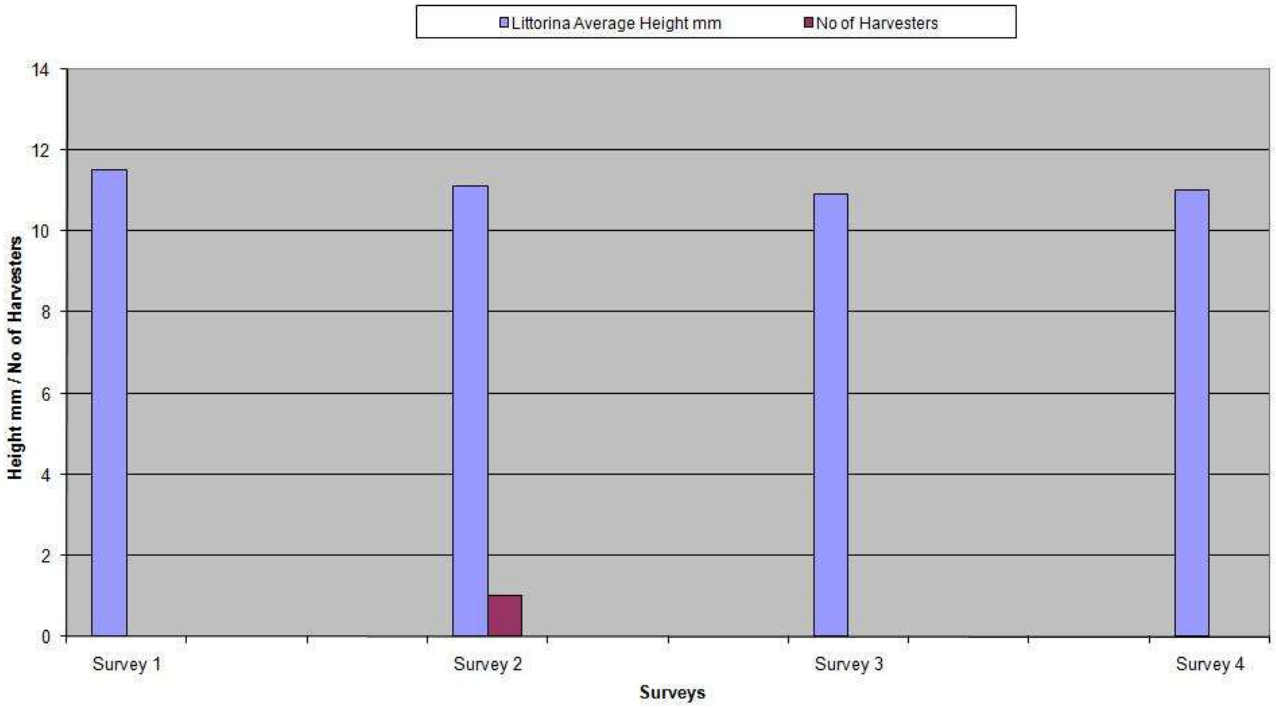

Figure 4.39 Littorina average size / No. of harvesters - Site 10

Fig. 4.40 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

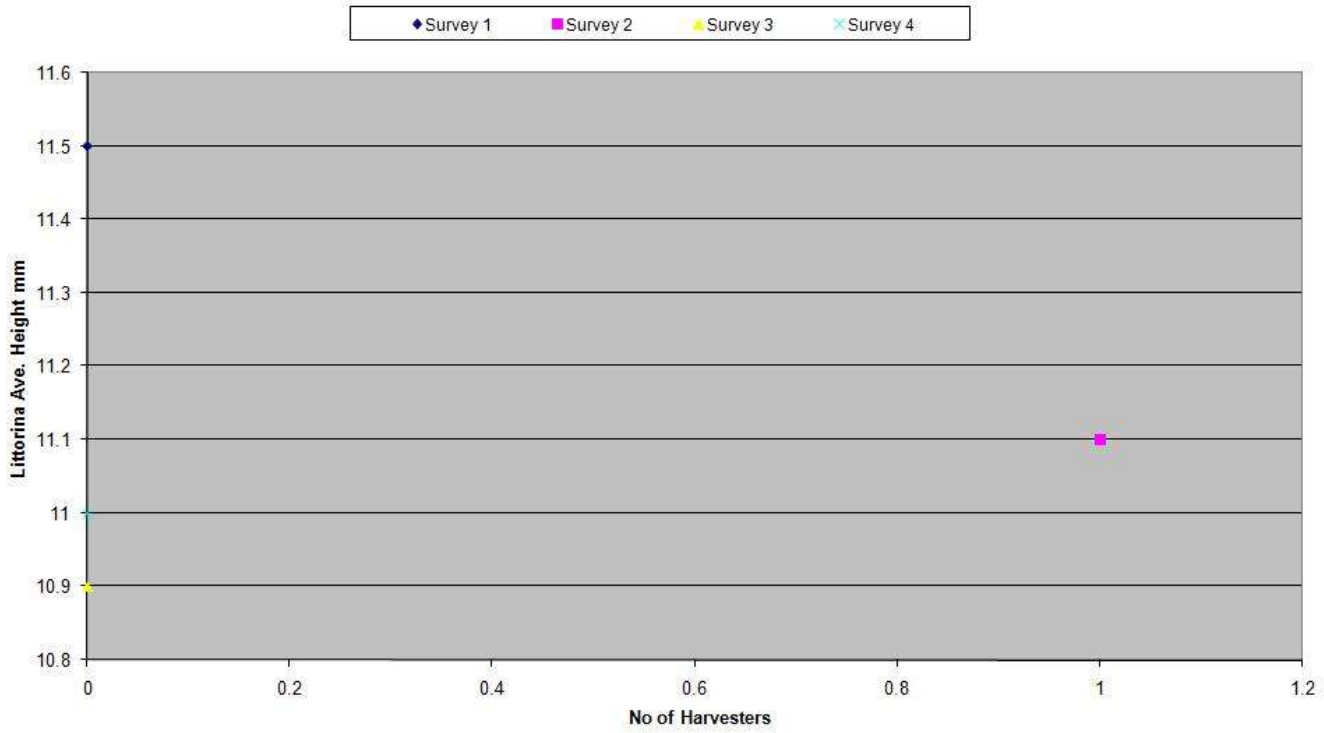

Figure 4.40 Littorina average size / No. of harvesters correlation - Site 10

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1,3 & 4. However, from Fig. 4.39 & Fig. 4.40 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 11 St Mildred's Bay, Westgate

Fig.3.11 page 11 shows a normal distribution for Littorina population across the 4 survey samples with an overall ◴ site value at 11.1mm. Fig. 4.41 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

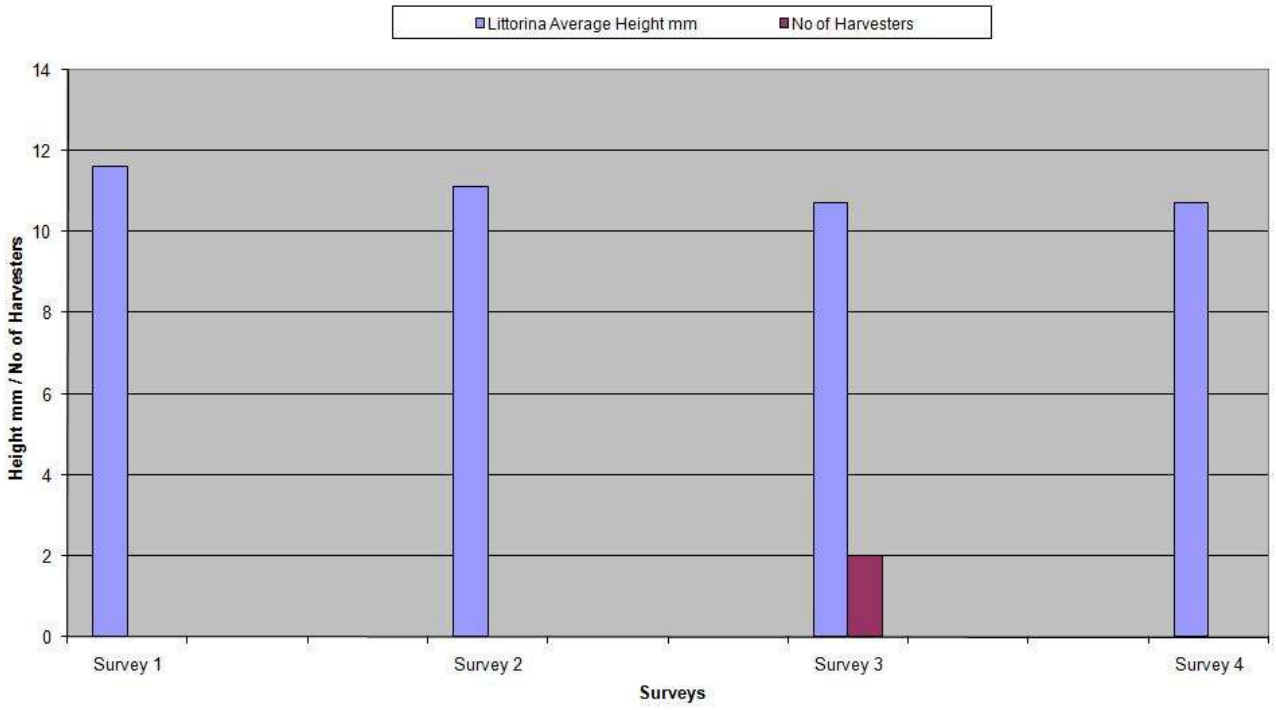

Figure 4.41 Littorina average size / No. of harvesters - Site 11

Fig. 4.42 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

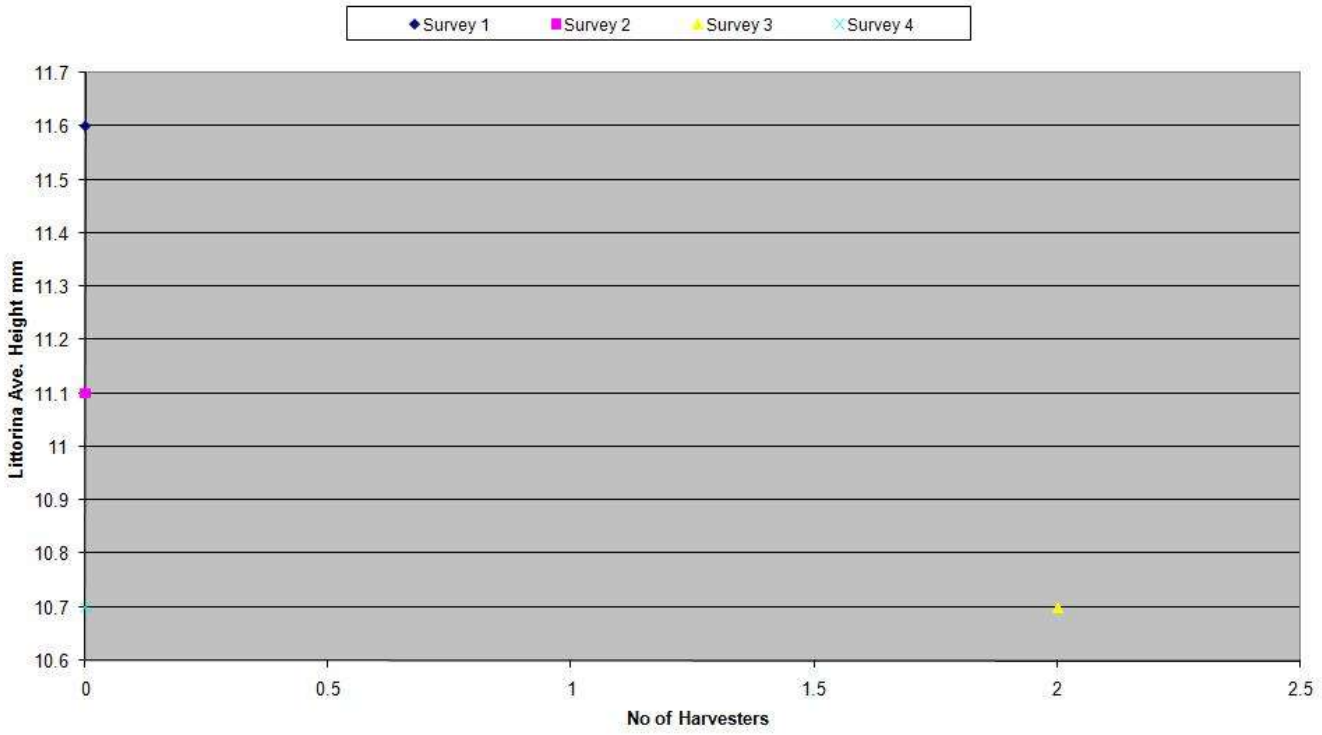

Figure 4.42 Littorina average size / No. of harvesters correlation - Site 11

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1,2 & 4. However, from Fig. 4.41 & Fig. 4.42 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Littorina demography

Site 12 Minnis Bay, Birchington

Fig.3.12 page 12 shows a normal distribution for Littorina population across the 4 survey samples with an overall ◴ site value at 9.9mm. Fig. 4.43 shows the average specimen size for this population taken at each survey against the associated number of harvesters.

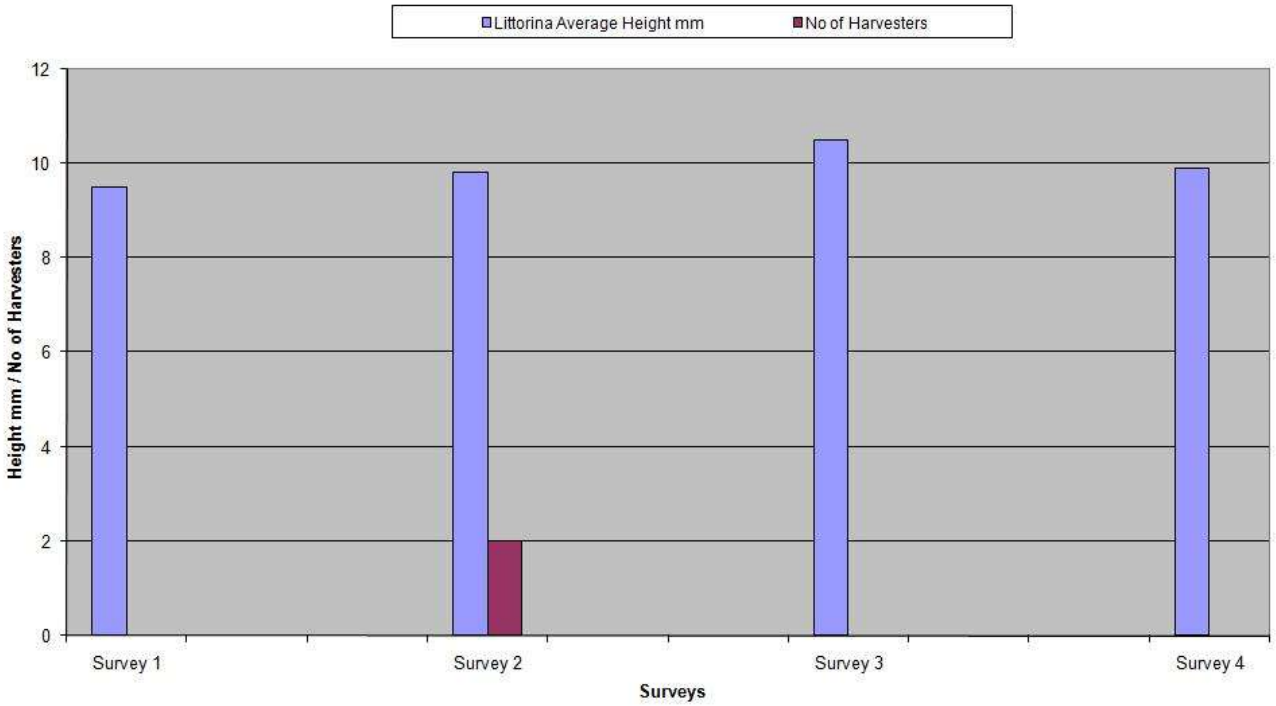

Figure 4.43 Littorina average size / No. of harvesters - Site 12

Fig. 4.44 shows correlation between Littorina average size & harvesters for surveys 1 to 4.

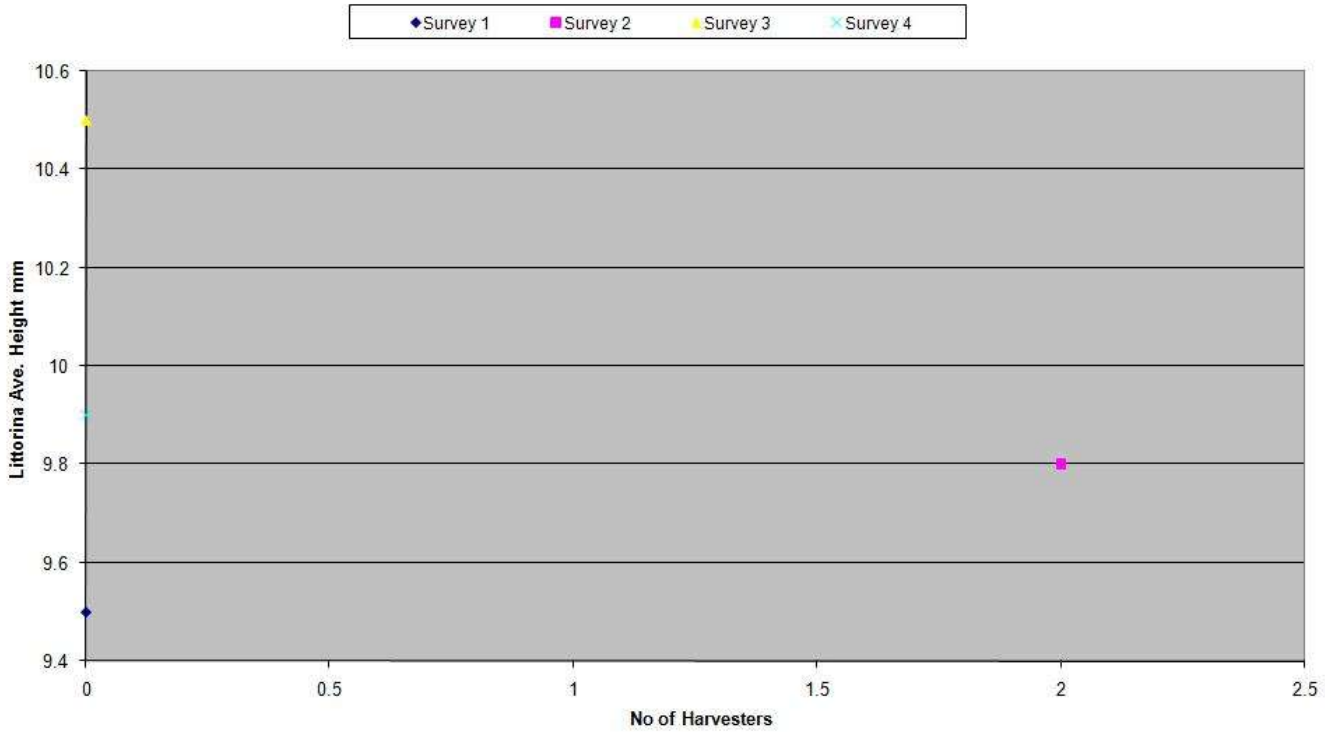

Figure 4.44 Littorina average size / No. of harvesters correlation - Site 12

Correlation co-efficient is not statistically viable given zero number of harvesters observed in surveys 1,3 & 4. However, from Fig. 4.43 & Fig. 4.44 it can be seen that this site experienced a very low level of harvesting over the project period and Littorina average size showed no significant trend.

Selected species summary

Harvesting has been recorded across the expanse of the inter-tidal chalk reef in Thanet. It was not possible, therefore, to pre-select a harvesting free control site. However, site 3 has recorded no observed harvesters during the period of the project and a useful comparison can be made with the most harvested sites 5&6 at Foreness.
For site 3 figures 3.3, 4.5, 4.6, 4.27 and 4.28 show Littorina profile.
For sites 5&6 figures 3.5, 3.6, 4.9, 4.10, 4.31, and 4.32 show Littorina profile.
No significant trend can be seen by site comparison.

Survey and experimental work at Foreness (Margate) between 1994 and 2002 has shown that the removal or depletion of Littorina within controlled areas results in the rapid settlement of the green algae *Enteromorpha intestinalis* succeeded in time by *Fucus vesiculosus.* If Littorina depletion is prolonged, biotope modification from grazed chalk reef to algal dominant chalk reef may occur (Humpheryes 2002).
There was no evidence of biotope modification at any of the Thanet survey sites.

Littorina recruitment was seen at all sites and population demography shows stability including the larger specimens favoured by harvesters. A 2 year study in Victoria, Australia showed consistent variation in size of 3 species of inter-tidal mollusc taken for food which correlated with observed harvesting levels across 8 survey sites. Changes in the mean size of collected species in the range of 10-20% have been recorded (Keough et al 1992).
The average mean size change across the Thanet survey sites was 5.4%.

Natural disturbance

Caution needs to be exercised when analysing Littorina totals. This was highlighted at site 10, Beresford Bay, when on 18/11/08 survey 3 recorded a total of 125 specimens. This count was down from 517 on survey 1 and 996 on survey 2. During survey 3 it was seen that the inter-tidal reef area had acquired a deposit of fine silt which was in places 8cm deep. Plates 4.1 & 4.2 show examples of this deposit.

Plate 4.1 National disturbance - Silt deposit at site 10

Plate 4.2 Natural disturbance - Silt deposit at site 10

In addition to low Littorina numbers, Common Mussel *Mytilus edulis* and Pacific Oyster *Crassostrea gigas* mortalities were evident.

On 24/11/08 approximately 800m east of site 10, thousands of Littorina and Mytilus shells were found on the strandline close to Epple Bay. Plate 4.3 shows these as the dark mass deposited in bands on a section of the affected strandline.

Plate 4.3 Natural disturbance - Littorina & Mytilus mortalities

Although Littorina numbers were reduced during this incident, average specimen size showed no significant change. Fig. 3.10 page 11 shows Littorina demography and table 4.2 shows Littorina totals and average specimen size for site 10 surveys 1 – 4.

Site 10	Survey 1	Survey 2	Survey 3	Survey 4
Littorina Total	517	996	125	214
Littorina Average Height mm	11.5	11.1	10.9	11

Table 4.2 National disturbance - Littorina totals & average size

Physical damage

Evidence of physical damage to the reef habitats was recorded during surveys and by observations byThanet coastal wardens. This included tool damaged chalk, overturned boulders and trampling. Damage was confined to sites 5&6 at Foreness where chalk had been broken by the removal of approximately 50 Pacific oysters *Crassostrea gigas*.

Vehicle access

Fig. 4.45 shows the relationship between the number of harvesters against the distance in meters from the nearest open or public vehicle access for all survey sites. The Y axis scale is logarithmic.

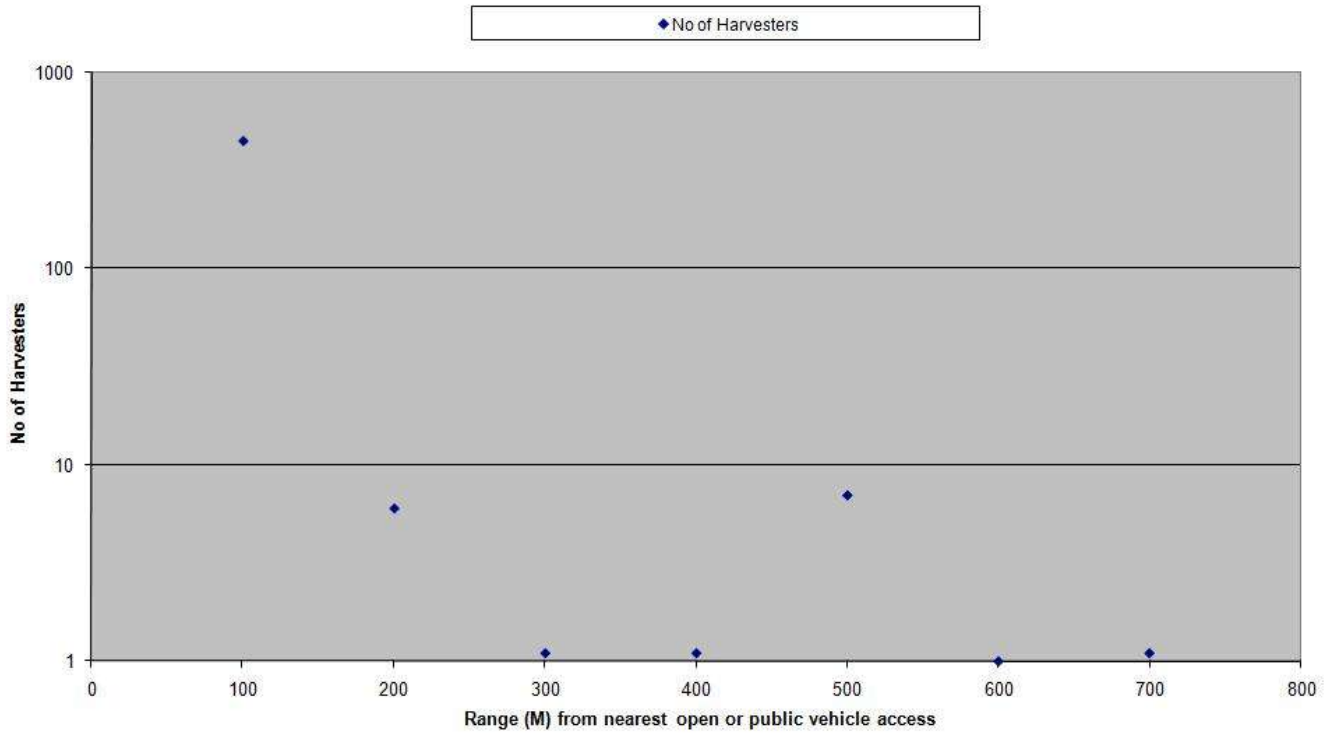

Figure 4.45 No of harvesters per vehicle access

A correlation co-efficient of –0.62 was recorded indicating an association between the number of harvesters and the proximity of vehicle access.

5 Conclusions

Reef habitats

Analysis of project data suggests that the selected species monitored at harvesting sites are stable against the range of observed harvesting intensity. The Edible Periwinkle *Littorina littorea* is the most targetted species. Whilst abundance, demography and average size varied from site to site these factors showed no significant variance between surveys within sites.

There is no evidence of biotope modification attributable to shellfish harvesting.

Of the 12 survey sites, Foreness sustained the highest level of harvesting and was favoured by organised groups of harvesters.

Natural disturbances can have significant effects on shellfish numbers.

Harvesters

Data supplied by Thanet coastal wardens indicate that harvesting is most popular between May and August and at sites within a proximity of 100 meters of vehicle access.

Sustainability

Present levels of harvesting indicate that the species taken, quantity and *modus operandi* of “Casual” and “Local” harvesters is likely to have a negligible impact on reef habitats and can therefore be considered sustainable.

However, for “Organised Groups” the variety of species, quantity and operating methods, particularly the concentration at favoured sites, must raise concern. Natural disturbances, climate change and rising sea levels amplify the unpredictability of the effect that this group of harvesters may produce.

Public concern

The majority of shellfish harvesting reports received by the Thanet Coast Project directly from the public relate to “Organised Groups”. Public perception is that this is harmful to the coastal environment and is unacceptable behaviour. There is a general expectancy that responsible organisations will react and control the situation.

6 Recommendations

Monitoring

Having established a baseline, it would be beneficial to continue monitoring to establish future trends. Locations favoured by “Organised Groups” should be given priority and attention given to the range of species collected.

The Edible Periwinkle *Littorina littorea* as the most targeted species is a useful guide to harvesting levels. Specimen size rather than abundance may give best results since harvesters generally select large periwinkles and, compared with abundance, size is not so affected by natural disturbance.

Thanet coastal wardens should be encouraged to continue reporting observations of shellfish harvesting. This process could be extended to Thanet District Council foreshore staff on a voluntary basis to stimulated additional reports.

The digital images deposited with Natural England are labelled per site/survey/quadrat and could be used as a reference for future coastal morphology tasks.

Vehicle access

Current vehicle control is inadequate and should be improved. 97% of observed harvesters were within 100 meter range of a vehicle parking point. Where barriers exist to the foreshore, they were frequently open, unlocked or vandalised. For some harvesters, lack of vehicle access may simply result in a re-location but no access could resolve the problem of concentration at favoured locations.

Intervention

Organisations with responsibility for the well being of theThanet coast communities and habitats need to establish a tangible threshold at which legal intervention will occur.

Public response

Persistent reports received by the Thanet Coast Project from members of the public would suggest that concern is focussed around the “Organised Group” type of harvesting. In response, public information and reassurance is needed in some format.

7 References

Humpheryes, I 2002. Changes in the near-shore biotope at Foreness Point Margate in relation to harvesting of the common periwinkle *Littorina littorea.* English Nature Research Report 570.

Keough, M.J., Quinn, G.P and King,A 1992. Correlations between Human Collecting and Intertidal Mollusc Populations on Rocky Shores. Conservation Biology Volume 7, No 2, June 1993.

Appendix 1 Typical quadrat distribution showing site 2 : surveys 1-4

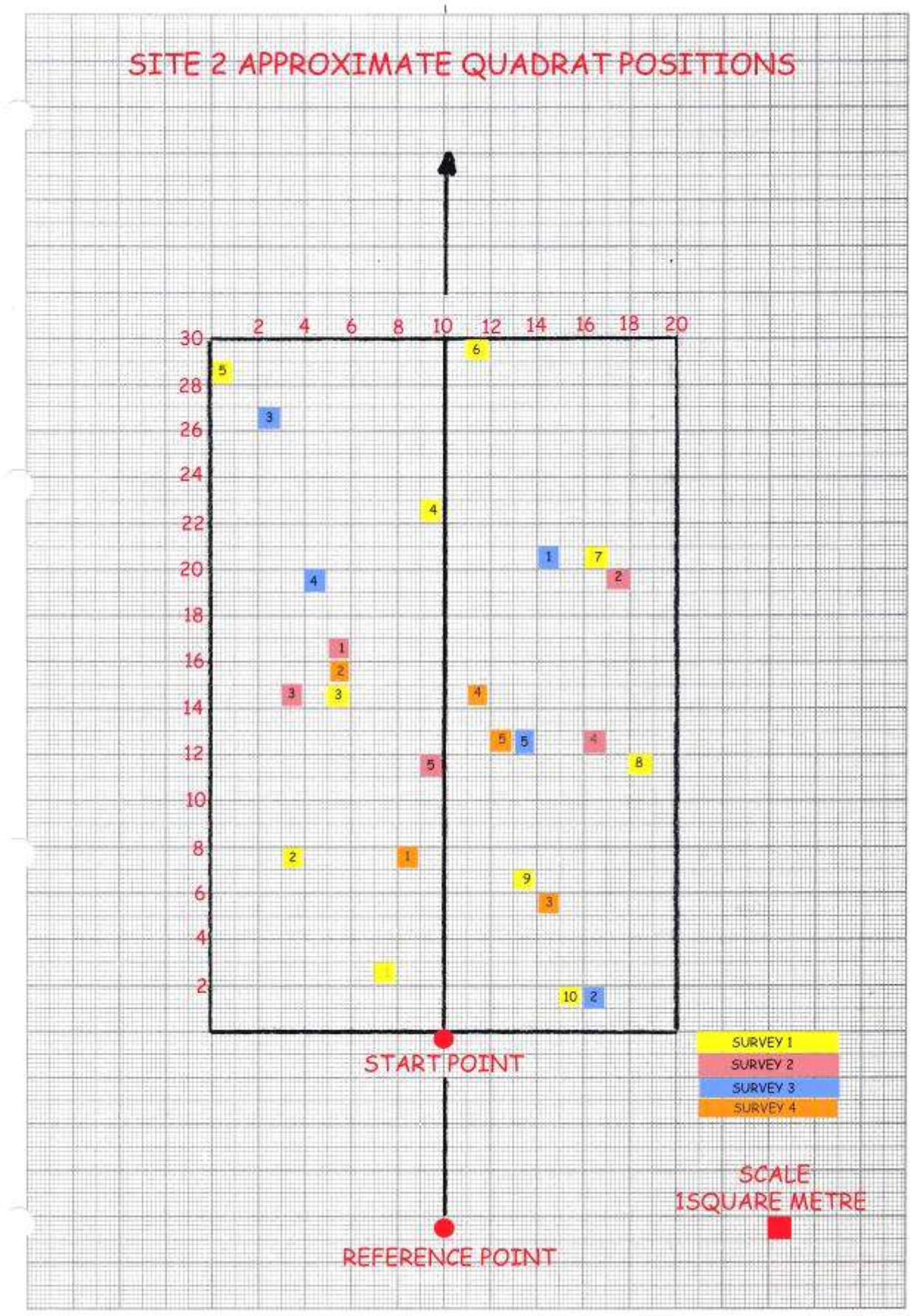

Figure A Typical quadrat distribution showing site 2 : surveys 1-4

Appendix 2 Summary sheet compiled from Thanet coastal warden's individual reports

NATURAL ENGLAND SHELLFISH HARVESTING

Shellfish Harvesting Information

Date	Location	TCP Bay No.	No. of Harv's seen	Observer's Name	Obs's Status (see note)
8/10/07	Minnis Bay East	11a	2	Willie McKnight	Warden
21/10/07	Foreness West	21b	2	Sue Andrews	Warden
1/11/07	Foreness West	21b	2	Sue Andrews	Warden
12/11/07	Western Undercliff	26	1	Willie McKnight	Warden
29/11/07	Foreness West (night time)	21b	?	Sue Andrews	Warden
4/12/07	Westbrook to St Mildred's Bay	16	2	Tony Sykes	Warden
18/12/07	Beresford Gap towards Epple	11c	1	Willie McKnight	Warden
30/12/07	Foreness West	21b	4	Sue Andrews	Warden
14/1/08	Walpole Bay	20c	2	Willie McKnight	Warden
2/1/08	Epple Bay	12a	1	Willie McKnight	Warden
22/1/08	Foreness West (night with torches)	6	2	Sue Andrews	Warden
27/01/08	Western Undercliff		2	Willie McKnight	Warden
10/02/08	Foreness Bay/Point	21b	?	Via Ralph Hanscombe (TH. 293169): DavidBarber-	Local observer
5/3/08	Foreness West. (red van man)	6	2	Sue Andrews	Warden
9/03/08	Foreness East	5	2	Sue Andrews	Warden
20/3/08	Winter Gardens	20a	3	Tony Child	TCP
21/03/08	Foreness West	6	3	Sue Andrews	Warden
21/03/08	Foreness West	6	2	Sue Andrews	Warden
26/3/08	St Mildreds (white Astra van)	16	1	Willie McKnight	Warden
27/3/08	Beresford Gap (white&orange Ford)	11b	1	Willie McKnight	Warden
27/03/08	Foreness West (red van man)	6	2	Sue Andrews	Warden
28/03/08	Foreness West (night with torches)	6	4	Sue Andrews	Warden
1/04/08	Foreness East Parked at point	5	1	Sue Andrews	Warden
3/04/08	Foreness East (Longnose spit) Parked at point.	5	3	Sue Andrews	Warden

Figure B Summary sheet compiled from Thanet coastal warden's individual reports

Appendix 3 Example of selected species raw data

This table represents site 1 survey 1. Similar data are held for all other site surveys.

Quadrat Number	Date Time	Tide Temp Wind	Littorina littorea Total	Patella vulgata Total	Mytilus edulis estimated % cover	Mytilus edulis estimated average size (mm)	Algae estimated % cover	Dominant algae + % cover	Secondary algae + % cover
1	011107 09.00	1.0M +14C SW6	97	1	75	30	0	DRIFT ONLY	
2			256	0	25	30	0	DRIFT ONLY	
3			317	5	40	30	0	DRIFT ONLY	
4			199	2	10	20	0	DRIFT ONLY	
5			267	0	50	30	0	DRIFT ONLY	
6			135	1	60	30	0	DRIFT ONLY	
7			44	1	25	30	0	DRIFT ONLY	
8			120	1	40	40	0	DRIFT ONLY	
9			232	2	5	20	0	DRIFT ONLY	
10			773	1	50	30	0	DRIFT ONLY	
Total			2440	14	38	29	0		

Table A Example of selected species raw data

Appendix 4 Sample of Littorina demography raw data

This table represents 100 specimens per survey collected at random from site 1, surveys 1 to 4. Similar data are held for all other sites.

Littorina littorea count	Height (mm) Site1 Survey1	Height (mm) Site1 Survey2	Height (mm) Site1 Survey3	Height (mm) Site1 Survey4
1	3.4	3.2	3.2	2.8
2	3.7	3.7	3.2	3.3
3	3.9	3.7	3.2	3.4
4	4	3.9	3.3	3.4
5	4.2	3.9	3.6	3.6
6	4.4	3.9	3.7	4.2
7	4.6	4	3.7	4.3
8	4.9	4.1	3.7	4.5
9	5.7	4.2	3.7	4.7
10	5.8	4.9	3.8	4.8
11	5.9	5.2	3.8	4.9
12	6	5.3	3.9	5
13	6.1	5.6	4	5
14	6.1	5.8	4	5.4
15	6.1	5.8	4	5.4
16	6.1	6.1	4	5.5
17	6.3	6.2	4.1	5.6
18	6.4	6.2	4.1	5.6
19	6.5	6.2	4.1	5.7
20	6.5	6.2	4.2	5.8
21	6.5	6.3	4.3	6
22	6.5	6.3	4.5	6
23	6.6	6.4	4.8	6.1
24	6.7	6.4	5.2	6.1
25	6.8	6.4	5.5	6.1
26	6.8	6.5	5.6	6.1
27	6.9	6.5	5.7	6.2
28	6.9	6.5	5.7	6.2
29	7	6.5	5.8	6.2
30	7	6.5	5.8	6.3
31	7	6.6	5.8	6.3
32	7.1	6.6	5.9	6.3
33	7.1	6.7	5.9	6.3
34	7.1	6.8	6	6.3
35	7.1	6.8	6	6.4
36	7.2	6.8	6	6.5
37	7.3	6.9	6	6.5
38	7.5	7	6	6.6
39	7.5	7	6.1	6.6
40	7.5	7	6.1	6.6
41	7.5	7.1	6.1	6.6
42	7.6	7.1	6.2	6.6
43	7.6	7.1	6.2	6.6
44	7.8	7.1	6.2	6.7
45	8	7.1	6.3	6.7
46	8	7.1	6.4	6.8
47	8	7.2	6.4	6.8
48	8	7.3	6.4	6.8
49	8.1	7.3	6.4	6.9
50	8.1	7.3	6.5	6.9
51	8.2	7.4	6.5	7
52	8.2	7.4	6.5	7
53	8.4	7.5	6.6	7

54	8.4	7.5	6.6	7.1
55	8.5	7.6	6.6	7.1
56	8.5	7.7	6.6	7.3
57	8.5	7.7	6.6	7.4
58	8.5	7.8	6.6	7.4
59	8.5	7.8	6.6	7.6
60	8.6	7.9	6.6	7.6
61	8.6	7.9	6.7	7.6
62	8.6	8	6.7	7.7
63	8.6	8	6.7	7.7
64	8.7	8	6.8	7.7
65	8.7	8.1	6.8	7.8
66	8.8	8.2	6.9	8
67	8.8	8.3	6.9	8.1
68	8.9	8.3	7	8.1
69	8.9	8.3	7	8.1
70	9	8.3	7	8.1
71	9	8.4	7.1	8.1
72	9.1	8.4	7.1	8.2
73	9.1	8.5	7.1	8.2
74	9.1	8.5	7.2	8.2
75	9.1	8.7	7.2	8.2
76	9.3	8.7	7.2	8.3
77	9.4	8.8	7.3	8.4
78	9.5	8.8	7.3	8.4
79	9.6	8.8	7.4	8.5
80	9.7	8.8	7.4	8.5
81	9.7	8.8	7.4	8.5
82	9.7	8.8	7.4	8.5
83	9.8	8.9	7.6	8.6
84	9.8	9	7.7	8.6
85	9.8	9	7.8	8.6
86	9.9	9.1		8.6
87	9.9	9.1	8.1	8.6
88	10	9.1	8.1	8.7
89	10	9.2	8.4	8.8
90	10.1	9.2	8.5	9
91	10.2	9.4	8.7	9
92	10.2	9.5	8.8	9
93	10.2	9.5	9.1	9.2
94	10.3	9.8	9.2	9.2
95	10.4	9.9	9.5	9.3
96	10.6	10	9.6	9.6
97	11	10	9.6	9.9
98	11.1	10.2	9.7	10.2
99	11.2	10.2	9.8	10.3
100	11.3	10.5	9.9	10.9

Table B Sample of Littorina demography raw data