Unit 60B, South Nelson Road,
Cramlington,
Northumberland NE23 1WF
T: (01670) 731 399
F: (01670) 731 639
E: nifca@nifca.gov.uk
W: www.nifca.gov.uk

Stock Assessment of the Littoral Mussel (*Mytilus edulis*) Beds on Fenham Flats (Holy Island)

March 2012

Jonathan Green
Deputy Chief Inshore Fisheries & Conservation Officer (Environmental)
Jodie Royle
Environmental Inshore Fishery & Conservation Officer

With thanks to
Claire Carey, European Marine Site Officer
Catherine Scott, Marine Advisor for Natural England
& Dan Skeritt, PhD student Newcastle University
for assisting in the survey of the mussel beds

SUMMARY 2012

INTRODUCTION

The edible mussel (*Mytilus edulis*) is one of the most common shore animals and can be found on most rocky shores in Europe. They also form vast beds on sand and mudflats and in estuaries. Mussels attach themselves to rocks, pebbles and other mussels by secreting silky threads known as byssus threads. They filter feed on plankton and organic matter in the water column.

A survey of the natural population of mussels (*Mytilus edulis*) on the large bed located on Fenham Flats, adjacent to Holy Island, was undertaken in order to estimate the size of the mussel stock. The objective of this stock assessment was to inform fishery managers of the size of the stock in order to allow any potential fishery to be managed in a sustainable way.

METHOD

The mussel bed on Fenham Flats was visited at low water (between 09:00 and 11:30) on a spring tide on 12th March 2012 (previous surveys having been carried out on 8th March 2011, 3rd March 2010, 11th March 2009, 10th March 2008, 22nd March 2007, and 30th March 2006). The outer edges of the bed and the transects were mapped using the tracking facility of a hand-held GPS.

The percentage cover of mussels on the bed (i.e. the proportion of the bed covered by patches of mussels) was estimated using the method developed by DEFRA (Walker and Nicholson, 1986). Percentage cover was determined by pacing over the beds in zigzag lines and recording the proportion of footsteps that landed on mussels as opposed to bare sediment. The length of each transect line was determined and varied from 100 paces to 450 paces. The direction of each transect line was chosen in the field to satisfy three criteria: that the transect should remain within the constraints of the bed, the zigzag pattern should effectively cover all of the bed and within these two constraints the direction should be random.

At the end of each transect a $0.1m^2$ sampling quadrat was placed at random on the nearest patch of mussels. All material within this tenth of a metre patch was gathered and sieved through 5 mm mesh to remove sediment. After sieving and the removal of stones and debris, the contents of each quadrat was transferred to a bag and taken back to the lab for measurement and further analysis. Ten quadrat samples were taken from the mussel bed at Fenham Flats in total.

The samples were processed back at the lab as soon as practical after collection to ensure as little weight loss from the mussel shells as possible. The samples were first sorted to separate any stones, debris or dead shells from the living mussels, before being weighed to the nearest gram. The shell lengths of all the living mussels in each sample were recorded to the nearest millimetre.

The proportion and weight of total commercially sized mussels in each sample were also recorded. At present no minimum landing size exists for mussels on the Northumberland coast. In order to estimate the size of the commercial stock, estimates were based on two different minimum landing sizes; 55 mm and 45 mm. (The minimum landing size being defined as all mussels over 45 mm, or over 55 mm).

The information on the GPS was down loaded onto GPSU software and this software was used to calculate the area of the mussel bed (in hectares and square metres).

The density (number of mussels/m^2) and biomass per square metre (or biomass/m^2 as it will be referred to from hereafter) of all mussels on the bed, and the commercial sized mussels was then calculated by raising the number and weight of mussels in the sample by 10 and then by the mean percentage cover of the bed. The total biomass and commercial biomass (in tonnes) was then calculated by multiplying the biomass/m^2 by the areas covered by the mussel bed.

The maximum sustainable yield (maximum tonnage of mussels that should be removed) or total allowable catch (TAC) was also calculated. The maximum sustainable yield usually chosen is 33% of the exploitable stock (above minimum landing sizes) which is the typical proportion used in most UK bivalve fisheries (CEFAS *per. com*.). The TAC was calculated for a MLS of both 45 mm and 55 mm.

RESULTS

The Fenham Flats mussel bed was found to occupy an area of 43.80 hectares slightly down on the 2011 result of 45.65 hectares (which is the largest size to date) significantly up from previous years with 36.28 hectares recorded in 2010, 34.43 hectares in 2009, 36.72 hectares in 2008, 37.18 hectares in 2007 and even the 41.52 hectares in 2006. Within this mussel bed mussels were found to occupy 67.9% which is slightly up from the 64.91% in 2011 but still down from the 78.41% in 2010, 72.1% in 2009, 78.58% 2008, 79.81% of the ground in 2007 but also above 60.44% in 2006. (Appendix 1 tables 1-7)

The mean biomass per square metre was 7.90kg/m^2 which is a continuing decline from 2011 when 8.47kg/m^2 was recorded and significantly down on recent years, 12.72kg/m^2 in 2010, 12.51kg/m^2 in 2009, 16.41kg/m^2 in 2008, 10.52kg/m^2 in 2007 but again similar to the 7.467 kg/m^2 in 2006. The mean density per square metre was 599 mussels/m^2 which is the lowest since the first survey in 2006, in 2011 822 mussels/m^2 were recorded which in its self was down from the previous years, 1323 mussels/m^2 in 2010, 1162 mussels/m^2 in 2009, 1173 mussels in 2008 but significantly above the 651 mussels/m^2 in 2007 and 536 mussels/m^2 in 2006. (Appendix 1)

From these figures the total tonnage of mussel biomass was calculated to be 3460 tonnes which is the lowest since the first survey in 2006. In 2011 3864 tonnes were recorded, down from the 4614 tonnes in 2010, 4307 tonnes in 2009, 6022 tonnes in 2008, 3911 tonnes in 2007 but above the low of 3101 tonnes in 2006, The total population estimated at 262 million continuing the downward trend from the 375 million in 2011, down from the 486 million in 2010, 396 million in 2009, 431 million in 2008, but up the estimates for 2007 and 2006 being 242 million mussels and 222 million mussels respectively (Appendix 1).

DISCUSSION

This stock assessment has revealed that as at March 2012 there was an estimated 3460 tonnes of mussel biomass within this 43.80 hectare mussel bed. Both comparable with the 2011 results of 45.65 hectares and 3864 tonnes of mussel biomass. The slightly increased size of the beds may well be down to the fact that the survey was organised to ensure that the surveyors arrived on site at least 1.5 hours before low water, thereby ensuring that the full site was surveyed before the

incoming tide started to flow. It is therefore now believed that the site with regards to size is stable and has been for a number of years.

The fact that the biomass is still relatively high would appear to be most related to the increase in the size of individual specimens as the overall numbers of mussels on the beds is significantly down on all previous years. The overall number of mussels estimated on the beds now stands at 262 million, well down on the high in 2010 when there was an estimated 486 million mussels on the beds (appendix 1). The main factor in this reduction would appear to be the absence of juveniles, particularly below 20mm in size; in the survey only 3 individuals were recorded as opposed to previous years when upwards of 200 individuals have been recorded in this size range (appendix 2). This lack of juveniles is of some concern as it suggests that for at least a few years there is likely to be a significant fall in the biomass on the beds. The most likely reason for the reduction in the number of juveniles is down to poor spat production over the last few years. This may very well be linked to the poor condition of the mussels in general that has been observed for some time. The absence of these juveniles has been reported to Natural England who has responsibilities for the management site, (Lindisfarne Nature Reserve).

The poor condition of the mussels has been put down to the generally cold winters of the last few years. If this is so the mild winter of 20011/12 may well allow for a good year class to develop over the coming year. There does appear now to be a healthy year class in the 45-55mm year class of the mussels (appendix 2) and if this is so this should assist in good spat production this year. These mussels are likely to be those that were in the 15-25mm year class in 2011, this being so it assists in estimating the general age structure on the beds and goes a long way to confirm the mussels are reaching a commercial size of 45mm within 3 years. The reduction of the numbers of mussels above 55mm is also of concern but had to some degree been expected as a consequence of the poor condition that the mussels have shown over the last few years. It is now felt that the majority of mussels on the beds account for about 3 year classes which are in the 2, 3, and 4 years of age.

REFERENCES

Lancaster, J Stock Assessment of the Littoral Mussel (*Mytilus edulis*) Beds on Fenham Flats (Holy Island) 2005 & 2006

McGrorty, S., Clarke, R. T., Reading, C. J. and Goss-Custard, J. D. (1990) Population dynamics of the mussel *Mytilus edulis*: density changes and regulation of the population in the Exe estuary, Devon. *Marine Ecology Progress Series* **67**:157-169.

Walker, P. and Nicholson, M. D. (1986) The precision of estimates of mussel biomass by zigzag survey. *International Council for the Exploration of the Sea, Shellfish Committee.* CM 1986/K:6

Appendix 1

Table 1
Physical parameters of the mussel bed

2012

Area (Ha)	43.80
Percentage cover	67.9
Biomass per square metre (kg/m^2)	7.90
Density (mussels/m^2)	599
Total biomass (tonnes)	3460
Number of mussels (millions)	262

2012: The size of the mussels found in the sample ranged from 19mm to 78mm (Figure 1) with a mean length of 43.5mm (Table 4). The length distribution graph (Figure 1) revealed only 1 major peak that is spread over a significant size range from 32mm and 55mm it is likely that this represents more than one year class. The absence of mussels below 19mm is significant and indicates a lack of recruitment.

Table 2
Physical parameters of the mussel bed

2011

Area (Ha)	45.65
Percentage cover	64.91
Biomass per square metre (kg/m^2)	8.47
Density (mussels/m^2)	822
Total biomass (tonnes)	3864
Number of mussels (millions)	375

2011: The size of the mussels found in the sample ranged from 3mm to 6mm (Figure 2) with a mean length of 36mm (Table 8). The length distribution graph (Figure 1) revealed 2 main peaks in size frequency the first between 16 mm and 28mm and the second between 41mm and 51mm. Also notable is the slight peak between 31mm and 41mm.

Table 3
Physical parameters of the mussel bed

2010

Area (Ha)	36.28
Percentage cover	78.41
Biomass per square metre (kg/m^2)	12.72
Density (mussels/m^2)	1323
Total biomass (tonnes)	4614
Number of mussels (millions)	486

2009: The size of the mussels found in the sample ranged from 5mm to 72mm (Figure 3) with a mean length of 34.7mm (Table 10). The length distribution graph (Figure 3) revealed 3 main peaks in size frequency the first between 14mm and 26mm and the second between 32mm and 44mm and the third smaller peak between 51mm and 63mm.

Table 4
Physical parameters of the mussel bed

2009

Area (Ha)	34.43

Percentage cover	72.10
Biomass per square metre (kg/m^2)	12.51
Density (mussels/m^2)	1162
Total biomass (tonnes)	4307
Number of mussels (millions)	396

2009: The size of the mussels found in the sample ranged from 3mm to 76mm (Figure 4) with a mean length of 34.5mm (Table 11). The length distribution graph (Figure 4) revealed 2 main peaks in size frequency the first between 16mm and 32mm and the second between 51mm and 63mm. Also notable is the significant trough between 30mm and 42mm.

Table 5
Physical parameters of the mussel bed

2008

Area (Ha)	36.72
Percentage cover	78.58
Biomass per square metre (kg/m^2)	16.41
Density (mussels/m^2)	1173
Total biomass (tonnes)	6022
Number of mussels (millions)	431

2008: The size of the mussels found in the sample ranged from 3mm to 73mm (Figure 5) with a mean length of 40mm (Table 12). The length distribution graph (Figure 1) revealed 2 main peaks in size frequency the first between 16mm and 26mm and the second between 46mm and 60mm. Each of these peaks also shows some additional peaks. Also notable is the significant trough between 30mm and 42mm.

Table 6
Physical parameters of the mussel bed

2007

Area (Ha)	37.18
Percentage cover	79.81
Biomass per square metre (kg/m^2)	10.52
Density (mussels/m^2)	651
Total biomass (tonnes)	3911
Number of mussels (millions)	242

2007: The size of mussels found in the samples ranged from 11mm to 70mm (Figure 6), with a mean length of 45mm (Table 13). The length distribution graph (Figure 6) revealed several peaks in size frequency, with peaks of mussel shell length at between 12mm and 29mm; 30mm and 41mm; 42mm and 50mm and the final peak between 51mm and 70mm. The majority of mussels were between the sizes of 19mm and 27mm and particularly 42mm and 63mm.

Table 7
Physical parameters of the mussel bed

2006

Area (Ha)	41.52
Percentage cover	60.44
Biomass per square metre (kg/m^2)	7.467
Density (mussels/m^2)	536

Total biomass (tonnes)	3101
Number of mussels (millions)	222

2006: The size of mussels found in the samples ranged from 12mm to 73mm (Figure 7), with a mean length of 41mm (Table 14). The length distribution graph (Figure 7) revealed several peaks in size frequency, with peaks of mussel shell length at between 12mm and 32mm; 33mm and 44mm; 45mm and 55mm and the final peak between 56mm and 73mm. The majority of mussels were between the sizes of 20mm and 28mm, and 39 mm and 63mm.

Appendix 2

Figure 1

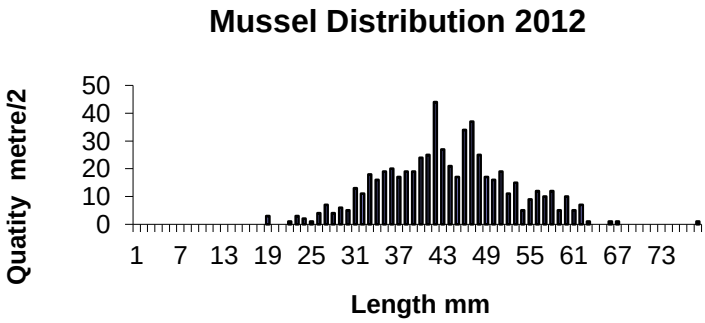


Figure 2

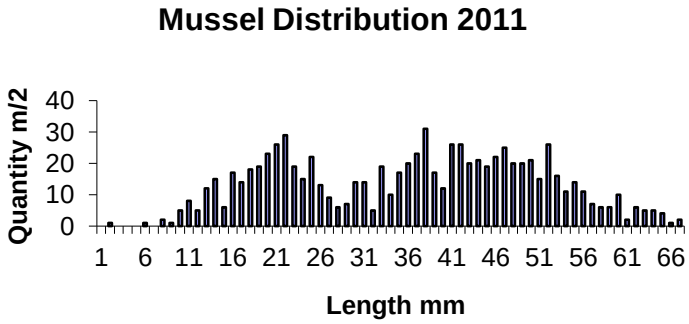


Figure 3

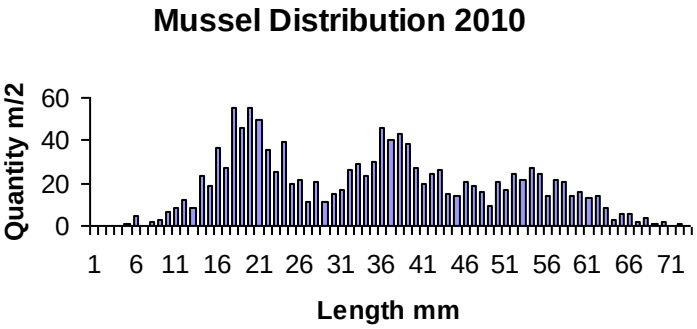


Figure 4

Mussel Distribution 2009

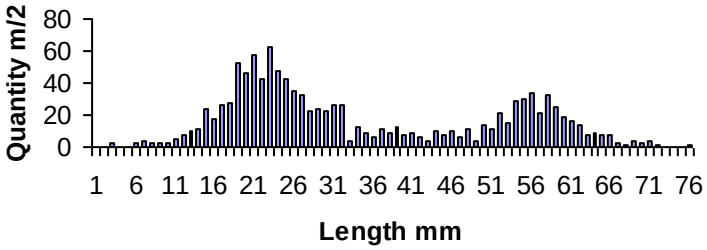


Figure 5

Mussel Distribution 2008

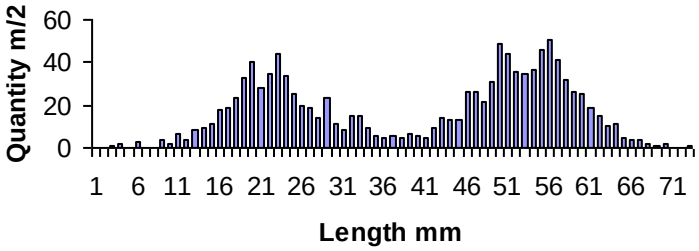


Figure 6

Mussel Distribution 2007

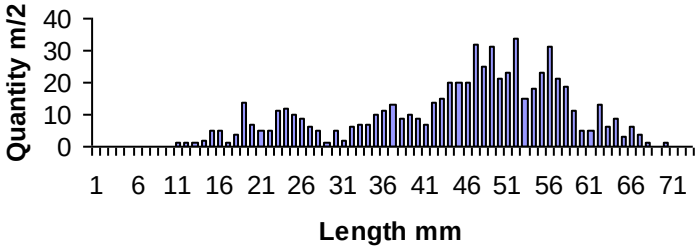
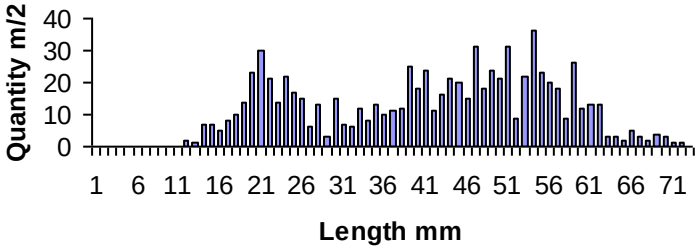


Figure 7

Mussel Distribution 2006



Appendix 3
Table 8

Mean length of mussels and percentage above minimum landing size (MLS) 2012

Parameter	
Mean shell length (mm)	43.5
Percentage of commercial sized mussels using MLS 45 mm	45%
Percentage of commercial sized mussels using MLS 55 mm	12%

Table 9

Mean length of mussels and percentage above minimum landing size (MLS) 2011

Parameter	
Mean shell length (mm)	36
Percentage of commercial sized mussels using MLS 45 mm	32%
Percentage of commercial sized mussels using MLS 55 mm	9%

Table 10

Mean length of mussels and percentage above minimum landing size (MLS) 2010

Parameter	
Mean shell length (mm)	34.7
Percentage of commercial sized mussels using MLS 45 mm	27%
Percentage of commercial sized mussels using MLS 55 mm	12%

Table 11

Mean length of mussels and percentage above minimum landing size (MLS) 2009

Parameter	
Mean shell length (mm)	34.5
Percentage of commercial sized mussels using MLS 45 mm	32%
Percentage of commercial sized mussels using MLS 55 mm	20%

Table 12

Mean length of mussels and percentage above minimum landing size (MLS) 2008

Parameter	
Mean shell length (mm)	40
Percentage of commercial sized mussels using MLS 45 mm	52%
Percentage of commercial sized mussels using MLS 55 mm	25%

Table 13

Mean length of mussels and percentage above minimum landing size (MLS) 2007

Parameter	
Mean shell length (mm)	45
Percentage of commercial sized mussels using MLS 45 mm	61%
Percentage of commercial sized mussels using MLS 55 mm	24%

Table 14

Mean length of mussels and percentage above minimum landing size (MLS) 2006

Parameter	
Mean shell length (mm)	41
Percentage of commercial sized mussels using MLS 45 mm	47%
Percentage of commercial sized mussels using MLS 55 mm	22%

Appendix 4
Physical parameters of the mussel bed

Table 15
Commercial biomass of mussel bed with different minimum landing sizes

2012: By using these two MLS's it was estimated that there were 2349 tonnes or 932 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 310 tonnes or 783 tonnes depending on the minimum landing size used.

2012

Parameter	MLS 45 mm	MLS 55 mm
Commercial biomass (g/m^2)	5364	2130
Commercial density ($mussels/m^2$)	270	74
Commercial tonnage (tonnes)	2349	932
Commercial number (millions of mussels)	118	32
TAC (33% of exploitable stock)	783	310

Table 16
Commercial biomass of mussel bed with different minimum landing sizes

2011: By using these two MLS's it was estimated that there were 2623 tonnes or 1023 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 341 tonnes or 874 tonnes depending on the minimum landing size used.

2011

Parameter	MLS 45 mm	MLS 55 mm
Commercial biomass (g/m^2)	5748	2242
Commercial density ($mussels/m^2$)	265	78
Commercial tonnage (tonnes)	2623	1023
Commercial number (millions of mussels)	120	35
TAC (33% of exploitable stock)	874	341

Table 17
Commercial biomass of mussel bed with different minimum landing sizes

2010: By using these two MLS's it was estimated that there were 3222 tonnes or 2005 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 688 tonnes or 1074 tonnes depending on the minimum landing size used.

2010

Parameter	MLS 45 mm	MLS 55 mm
Commercial biomass (g/m^2)	8883	5449
Commercial density ($mussels/m^2$)	361	171
Commercial tonnage (tonnes)	3222	2005
Commercial number (millions of mussels)	101	62
TAC (33% of exploitable stock)	1074	668

Table 18
Commercial biomass of mussel bed with different minimum landing sizes

2009: By using these two MLS's it was estimated that there were 3546 tonnes or 2466 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 822 tonnes or 1182 tonnes depending on the minimum landing size used.

2009

Parameter	**MLS 45 mm**	**MLS 55 mm**
Commercial biomass (g/m^2)	10302	7162
Commercial density ($mussels/m^2$)	366	238
Commercial tonnage (tonnes)	3546	2466
Commercial number (millions of mussels)	126	82
TAC (33% of exploitable stock)	1182	822

.

Table 19
Commercial biomass of mussel bed with different minimum landing sizes

2008: By using these two MLS's it was estimated that there were 5329 tonnes or 3149 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 1049 tonnes or 1776 tonnes depending on the minimum landing size used

2008

Parameter	**MLS 45 mm**	**MLS 55 mm**
Commercial biomass (g/m^2)	14514	8578
Commercial density ($mussels/m^2$)	614	295
Commercial tonnage (tonnes)	5329	3149
Commercial number (millions of mussels)	225	108
TAC (33% of exploitable stock)	1776	1049

Table 20
Commercial biomass of mussel bed with different minimum landing sizes

2007: By using these two MLS's it was estimated that there were 1546 tonnes or 3318 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 515 tonnes or 1106 tonnes depending on the minimum landing size used

2007

Parameter	**MLS 45 mm**	**MLS 55 mm**
Commercial biomass (g/m^2)	8266	4211
Commercial density ($mussels/m^2$)	398	159
Commercial tonnage (tonnes)	3318	1546
Commercial number (millions of mussels)	148	59
TAC (33% of exploitable stock)	1106	515

Table 21
Commercial biomass of mussel bed with different minimum landing sizes

2006: By using these two MLS's it was estimated that there were 1399 tonnes or 2271 tonnes of commercially sized mussels on this bed. This gives a total allowable catch (TAC) of either 461 tonnes or 749 tonnes depending on the minimum landing size used.

2006

Parameter	**MLS 45 mm**	**MLS 55 mm**
Commercial biomass (g/m^2)	5468	3369
Commercial density ($mussels/m^2$)	263	127
Commercial tonnage (tonnes)	2271	1399
Commercial number (millions of mussels)	109	52
TAC (33% of exploitable stock)	749	461