Stock Assessment of the Edible Mussel (*Mytilus edulis*) Beds on Fenham Flats

2018

Report prepared by: Natalie Wallace

Northumberland Inshore Fisheries and Conservation Authority
8 Ennerdale Road
Blyth
NE24 4RT
Tel: 01670 797676
Email: nifca@nifca.gov.uk
Website: www.nifca.gov.uk

Abstract

The purpose of this report is to assess and continue to monitor the state of the mussel bed on Fenham Flats. The perimeter of the mussel bed was mapped and percentage cover of mussels was estimated using the 'Walker and Nicholson' technique. Biomass, density and total number of mussels at the site were also calculated. Samples of mussels were collected and total shell length and weight were measured.

The mussel bed on Fenham Flats covers an area of 39.7 ha with a percentage cover of 54.76%. The estimated values obtained for density, biomass and total number of mussels have increased compared to the 2017 survey. Mean length of mussels sampled was 50.76 mm in 2018 which is a decrease compared to 2017. The length distribution was bimodal a change from the unimodal distribution in 2017. 82.17% of mussels were larger than the recommended minimum size of 45mm.

This report is intended to provide information relating to the health and distribution of the mussel bed on Fenham Flats in order to inform future management of the site.

Introduction

The edible mussel (*Mytilus edulis*) is widely distributed, occurring in boreal and temperate waters, in both the southern and northern hemispheres (OSPAR, 2010). *M. edulis* is tolerant of a wide range of environmental conditions (Fisheries Agriculture Organisation (USA) no date) including fluctuations in salinity (Andrews *et al.*, 2011), and therefore occurs in both marine and brackish waters (Gardner, 1996). Mussels can form dense beds (Fenton, 1978) using byssus threads to attach to the substratum (Babarro *et al.*, 2008).

M. edulis beds are included in the OSPAR (Annex V) list of threatened and declining species and habitats and are listed as a UK biodiversity action Plan (BAP) Priority Habitat (Maddock, 2008). Threats to mussel beds include bait collection (Maddock, 2008), gathering for human consumption (Fenton, 1978), pollution (Hilgerloh, 1997), coastal development and anchoring (Maddock, 2008). It is currently unknown whether mussel beds are declining because of the aforementioned threats, due to bird predation or a combination of factors (Hilgerloh, 1997).

In 2005 the Northumberland Sea Fisheries Committee (NSFC) (now Northumberland Inshore Fisheries and Conservation Authority (NIFCA)) was approached by Natural England who requested that NSFC conduct a stock assessment survey of the mussel beds at Fenham Flats, Lindisfarne in order to consider reopening the mussel beds to commercial harvesting within the Lindisfarne National Nature Reserve. NIFCA has continued to carry out annual stock assessment surveys at the site, providing a long-term record of the population dynamics of the mussel bed.

Methods

A series of surveys have been conducted on the mussel bed at Fenham Flats annually since March 2005. The 2018 survey was conducted at low water (between 09:00 and 11:30) on a spring tide on the 20th March by NIFCA staff, volunteers from Natural England and Newcastle University Placement Student Emily Henderson.

Study Site

The study site is located on the mussel bed at Fenham Flats, Lindisfarne on the extensive mudflats south of Holy Island, located within the Lindisfarne National Nature Reserve (NNR).

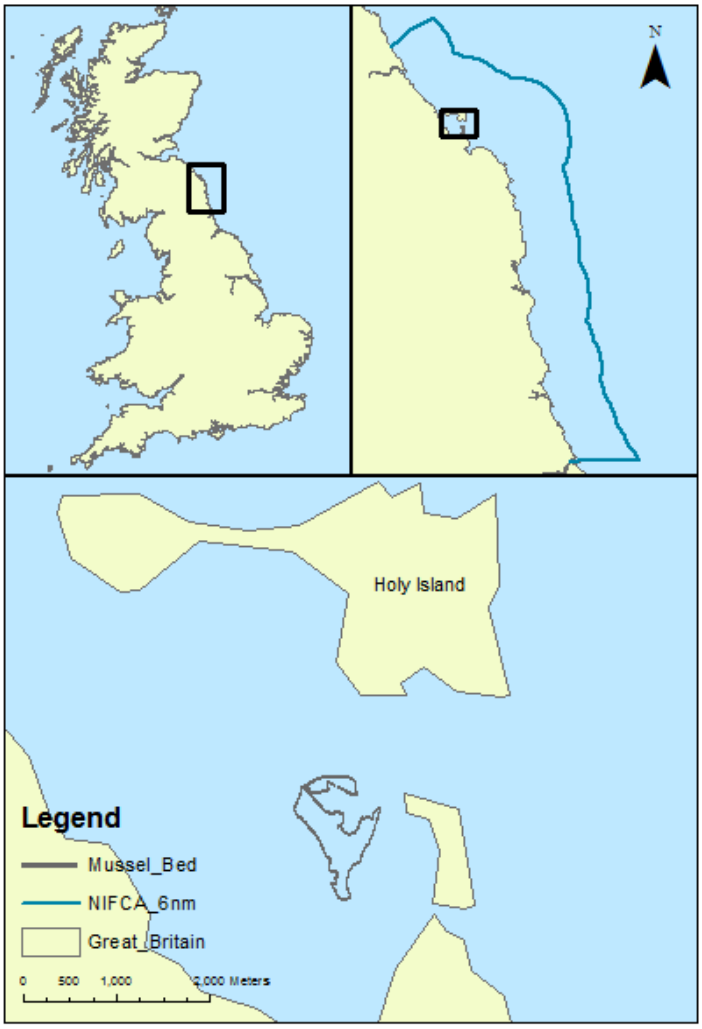

Figure 1. The study area, showing the mussel bed in relation to Holy Island.

Survey Methods

The perimeter of the mussel bed was walked with a handheld GPS. The information was exported into the Garmin GPS software Basecamp to map and calculate the area of the mussel bed.

The percentage cover of mussels on the mussel bed was estimated using the 'Walker and Nicholson' survey technique (Walker and Nicholson, 1986). Surveyors walked in a zigzag pattern across the mussel bed, in a randomly determined direction, recording the proportion of footsteps landing on live mussels. The total number of steps was selected at random at the start of each transect and ranged from 125 to 321. Percentage cover was then calculated using the following equation:

Percentage Cover = (Number of footsteps landing on live mussels / Total number of footsteps) X 100

A mussel sample was taken at the start and end of each transect from within a 0.1m² sampling quadrat. The samples were sieved through a 6mm mesh and cleaned in intertidal pools to remove sediment. 10 quadrat samples were collected from the mussel bed, resulting in a total sample area of 1m².

The samples were processed removing dead shells and debris from the living mussels. Total shell lengths of all the mussels sampled were then measured (to the nearest millimetre) using a vernier caliper and divided into the following size groups: <45mm, 45-54mm and >54mm. The total weight (in grams) of mussels in each size category was also recorded for each sample. The density of mussels

on the mussel bed was then calculated the following equation:

$$\text{Mussel Density} = \frac{\text{Number of mussels per m}^2 \times \text{Percentage Cover}}{100}$$

The total biomass of mussels on the mussel bed was then calculated using the following equation:

$$\text{Mussel Biomass} = \text{Mussel Mass per m}^2 \times \text{Area of Mussel Bed}$$

Results

In March 2018, the mussel bed on Fenham Flats covered an area of 39.7 hectares. A total of 286 mussels were sampled and mean length of the mussels sampled was 50.76mm. Percentage cover, density and biomass are shown in Table 1.

Table 1. Summary of results obtained during the Fenham Flats mussel survey in 2017. Showing Area, Percentage Cover, Biomass per m², Density and Total Biomass.

Area (Ha)	39.7
Percentage cover (%)	54.76
Biomass per square metre (kg/m^2)	7.912
Density (mussels/m^2)	156.61
Total biomass (tonnes)	3141
Total Number of Mussels (millions)	62

Discussion

Annual fluctuations in percentage cover have been observed since the Fenham Flats Mussel Survey began in 2006 (Appendix 1). Despite these fluctuations there has been a downward trend from a maximum percentage cover of 79.81% in 2007 to the minimum of 54.74 recorded during the present study in 2018. Similarly, there has also been a decline in the total area of the mussel bed from 42.9ha in 2017 to 39.7ha in 2018, however the present area of the mussel bed is not particularly low and in fact is average (mean area between 2006 and 2018 = 39.74ha).

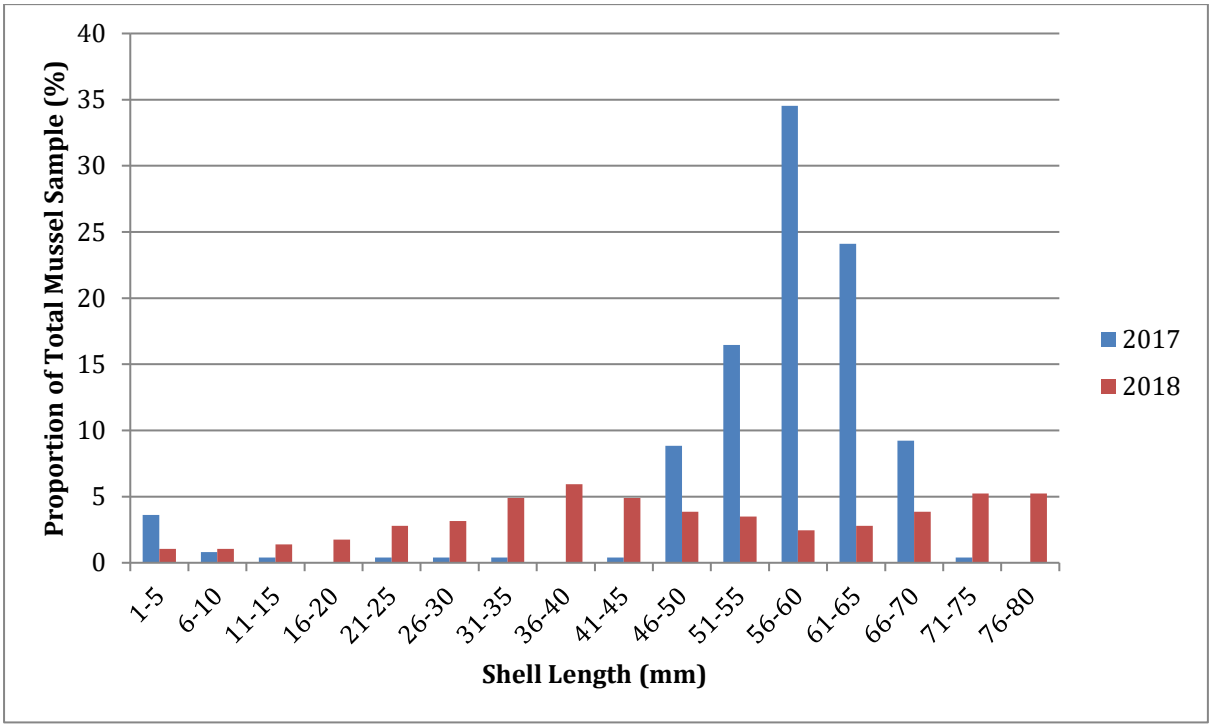

Figure 2. Comparison of the length frequency distribution for the edible mussel (*Mytilus edulis*) sampled during the Fenham Flats surveys in 2017 and 2018.

The lowest values obtained for total estimated number of mussels and density were recorded in 2017 (Appendix 1). The 2018 results show an increase in estimated number of mussels from 58 million mussels (2017) to 62 million mussels (2018) and an increase in density from 145.9 mussels per m² (2017) to 156.6 mussels per m² (2018). Despite this slight increase the values obtained in 2018 are the second lowest values obtained to date for both estimated number of mussels and density.

The 2018 values for biomass per m^2 (7.912) and total biomass (3141 tonnes) were the highest values calculated since 2010 (Appendix 1). It is unclear as to whether this is due to greater flesh content as flesh samples were not collected and weighed.

The length frequency distribution for mussels measured during the 2018 surveys is bimodal, characterised by 2 distinct peaks (figure 2). Several studies have identified bimodal length distributions for mussels (Hilgerloh, 1997; Gray, 2011) one theory for this is the predation of medium sized mussels (between 25 and 38mm) by birds (Gray, 2011). Meire and Ervynck (1986) found that oystercatchers select mussels between 30mm and 45mm in length. Hilgerloh (1997) suggests that dominance by one size class of mussels occurs due to larger mussels growing out of the size range exploited by predators. The length distribution in the 2017 report (Wallace, 2017b) was unimodal, skewed towards the larger sized mussels. This change in distribution could be attributed to i) improved detection of smaller mussels by surveyors or ii) increased recruitment at the site. This change from a unimodal distribution to a bimodal distribution was also observed during NIFCA's Blyth Estuary Mussel Surveys between 2015 and 2016 (Wallace 2016a; Wallace 2017a).

In 2017 the length distribution for mussels was clearly skewed towards larger sized mussels (figure 2), this is still the case for 2018 but not as clear when solely looking at Figure 2. The total shell lengths of 82.17% and 93.57% of mussels sampled in 2018 and 2017 respectively were greater than the recommended minimum size of 45mm. This value has decreased but the high proportions still suggest an ageing population. Mean mussel size has also decreased from 55.50mm to 50.76mm for 2017 and 2018 respectively, despite this slight decrease the 2018 value is still the third highest value

recorded to date. Hilgerloh (1997) suggests that dominance by larger sized mussels occurs due to large mussels growing out of the size range exploited by predators. For example, oystercatchers target mussels between 30mm and 45mm in length (Meire and Ervynck, 1986), therefore individuals above 45mm will exhibit lower mortality due to reduced predation. The number of smaller individuals may be lower than expected as 1) smaller mussels may escape through the 5mm mesh of the sieve (however this does not explain the lack of mussels between 5mm and 44mm) and 2) recruitment may be limited at the site.

Although the results of this survey suggest a decrease in mussel density and total number of mussels at Fenham Flats, the results of previous studies have fluctuated (Appendix 1), therefore this study cannot determine if the trends discussed are as a result of recruitment failure or natural temporal variation. However, it is clear that mean mussel size is increasing and the number of smaller mussels is decreasing over time therefore further study is needed.

Further Study

NIFCA plan to continue annual surveys of the mussel bed, however further study is needed to determine if there is a lack of recruitment at the site. Other future survey options include

1. A future study could also look at the feeding habits of birds at the site to determine 1) how important mussels are to their diet and 2) what size classes are consumed by which species.
2. Surveys of other mussel beds within the area to determine if factors such as increasing mussel size and decreasing percentage cover are site specific due to the oyster bed or a trend for all mussel beds in the region.

Conclusion

The purpose of this report is to provide up to date information to inform future management of the site through monitoring of the mussel bed. This study has mapped the perimeter of the mussel bed, estimated percentage cover, density and biomass, and produced a length frequency distribution of the mussels on Fenham Flats. Whilst the 2018 results suggest that there have been a number of improvements to the status of mussels at the site, the results still indicate a dominance of larger mussels. Further study is needed to determine 1] whether the population is naturally skewed towards larger individuals or whether there is a lack of recruitment at the site, 2] to determine whether these improvements continue or if they are a factor of the survey method used. NIFCA therefore plan to continue annual surveys to monitor the mussel bed.

Acknowledgements

Thank you to all the IFCOs, volunteers from the Natural England and Newcastle University who participated in the 2018 surveys.

References

Andrews, J.W., Brand, A.R., and Maar, M. (2011). MSC Assessment Report for Isefjord and East Jutland Danish Blue Shell Mussel Fishery. Available at: www.msc.org.

Babarro, J. M., Reiriz, M. J. F., & Labarta, U. (2008). Secretion of byssal threads and attachment strength of Mytilus galloprovincialis: the influence of size and food availability. *Journal of the Marine Biological Association of the UK*, *88*(04), 783-791.

Cowden, C., Young, C.M. & Chia, F.S., 1984. Differential predation on marine invertebrate larvae by two benthic predators. Marine Ecology Progress Series, 14, 145^149.

Davenport, J., Smith, R. J., & Packer, M. (2000). Mussels Mytilus edulis: significant consumers and destroyers of mesozooplankton. *Marine Ecology Progress Series*, 131-137.

FAO (n.d.) Mytilus Edulis. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/fishery/culturedspecies/Mytilus_edulis/en [Accessed: 15/02/2016].

Fenton, A. (1978). Shellfish as bait: the interface between domestic and commercial fishing. In: Smout, T.C. (Ed.), Scotland and the Sea, John Donald, Edinburgh, pp. 81–88.

Gardner, J.P.A. (1996). The *Mytilus edulis* species complex in southwest England: effects of hybridization and introgression upon interlocus associations and morphometric variation. *Marine Biology. 125*, 385-399.

Hilgerloh, G. (1997). Predation by birds on blue mussel Mytilus edulis beds of the tidal flats of Spiekeroog (southern North Sea). *Marine Ecology Progress Series*, *146*(1), 61-72.

Kimmerer, W.J., Gartside, E. & Orsi, I.J., 1994. Predation by an introduced clam as the likely cause of substantial declines in zooplankton in San Francisco Bay. Marine Ecology Progress Series, 113, 81^93.

Lehane, C., & Davenport, J. (2002). Ingestion of mesozooplankton by three species of bivalve; Mytilus edulis, Cerastoderma edule and Aequipecten opercularis. *Journal of the Marine Biological Association of the United Kingdom*, *82*(4), 615-619.

Lehane, C., & Davenport, J. (2004). Ingestion of bivalve larvae by Mytilus edulis: experimental and field demonstrations of larviphagy in farmed blue mussels. *Marine Biology*, *145*(1), 101-107.

Maddock, A. (2008). UK biodiversity Action Plan; Priority Habitat Descriptions. BRIG.

Meire, P. M., & Ervynck, A. (1986). Are oystercatchers (Haematopus ostralegus) selecting the most profitable mussels (Mytilus edulis)?. *Animal Behaviour*, *34*(5), 1427-1435.

Nelson, T.C., 1933. On the digestion of animal forms by the oyster. Proceedings of the Society of Experimental Biology and Medicine, 30,1287^1290.

OSPAR (2010). Quality Status Report 2010. Intertidal Mytilus edulis beds on mixed and sandy sediments. Case Reports for the OSPAR List of threatened and/or declining species and habitats. Available at: http://qsr2010.ospar.org/media/assessments/Species/p0010_supplements/CH10_03_ Intertidal_mytilus_edulis.pdf [Accessed:08/02/2016].

Robinson K., Zeldis J. and Ross A. (2002). The (New Zealand) National Institute of Water and Atmospheric Research (NIWA). Water & Atmosphere 10(3) Available at: https://www.niwa.co.nz/publications/ wa/vol10-no3-october-2002/do-mussels-eat-zooplankton. Accessed: 24/07/2017

Ryder, J. A. (1882). *Notes on the breeding, food, and green color of the oyster*. US Government Printing Office.

Savage, R.E., 1925. The food of the oyster. Fishery Investigations, Series 2, 8, 1^50.

Strayer, D.L. and Malcolm H.M,(2012). Causes of recruitment failure in freshwater mussel populations in southeastern New York. *Ecol Appl.* 22(6):1780-90.

Walker, P. and Nicholson, M.D. (1986) The precision of estimates of mussel biomass by zig-zag survey., ICES CM 1986/K:6

Wallace, N.M. (2017a). NIFCA Stock Assessment of the Edible Mussel (*Mytilus edulis*) Beds in Blyth Estuary. 2017 (Data collected 2016). Available at: http://www.nifca.gov.uk/downloads/

Wallace, N.M. (2016). NIFCA Stock Assessment of the Edible Mussel (*Mytilus edulis*) Beds in Blyth Estuary. 2016. Available at: http://www.nifca.gov.uk/downloads/

Wallace, N.M. (2017). NIFCA Stock Assessment of the Edible Mussel (*Mytilus edulis*) Beds on Fenham Flats. 2017. Available at: http://www.nifca.gov.uk/downloads/

Appendices

Appendix 1

Table 2. Summary of results obtained during the Fenham Flats mussel surveys between 2006 and 2018. Showing Area, Percentage Cover, Biomass per m², Density and Total Biomass, Total Number of Mussels and Mean Shell Length.

Year	Area (ha)	% Cover	Total Number of Mussels (millions)	Mean Shell Length (mm)	Density (Mussels per m²)	Biomass (per m²)	Total Biomass (Tonnes)
2006	41.527	60	132	41	321.6	4.48	1861
2007	37.18	79.81	192	45	519.5	8.39	3122
2008	36.72	78.58	339	40	921.7	12.89	4734
2009	34.43	72.1	286	34.5	837.8	9.02	3105
2010	36.28	78.41	381	34.7	1037.3	9.97	3618
2011	45.65	64.91	243	36	533.5	5.49	2510
2012	43.8	67.9	178	43.5	406.7	5.36	2349
2013	41.3	66.5	128	48.2	311.8	5.64	2330
2014	31.82	54.84	95	47.42	300.5	5.77	1838
2015	40.49	69.01	147	49.56	363.6	7.23	2928
2016	44.9	59.95	92	51.2	230.2	5.91	2654
2017	42.9	58.61	58	55.5	145.9	4.821	2068
2018	39.7	54.76	62	50.76	156.61	7.912	3141