Shellfish Fisheries Team, Fisheries Ecosystems Advisory Services, Jan 2021

Version 1.0

Review of the Fishery Natura Plan 2016-2020 for Cockle in Dundalk Bay

Contents

Summary and recommendations

1. Cockle stock biomass was higher during the period 2016-2020 (second Fishery Natura Plan) than in the period 2011-2015 (first FNP). Biomass in 2019 and 2020 was the highest since 2008
2. There was a fishery in each year of the second FNP. In season fishing depletion of the stock was detected in 2016-2018 but not in 2019-2020. Depletion rates were always lower than the 33% harvest control rule and were not detected at all when biomass was over 3000 tonnes. The depletions verify the stock biomass estimates from the mid-summer surveys
3. During 2007-2020 there was evidence that high spat fall translates to higher biomass in the following year.
4. Evidence of a spawning stock recruitment relationship was weak and two years of high biomass had reduced spat fall in the following year suggesting a density dependent effect of high biomass.
5. No relationship was found between spat fall and easterly wind forcing or air or seawater temperatures. East wind forcing is expected to retain larvae in the Bay and increase spatfall.
6. Dominant species of bivalves on the shore were stable during the period 2007-2020. The depth of the sediment redox potential discontinuity layer was stable during 2015-2020. Changes in this index could occur due to eutrophication, reduced bioturbation by infauna or changes in sediment grain size and mobility.
7. The long term (1994-2019) average maximum number of wading birds overwintering in the Bay is stable with a range between 30,000 and 61,000 birds. Year on year declines during the period 2011-2015 were reversed in the period 2015-2019.
8. Recent 5 year averages and longer term 10 year average maximum number of oystercatchers overwintering in the Bay were 5,945 and 7,117 birds, respectively. A year on year decline occurred from 2008/09 to 2014/15. Numbers increased from 2014/15 to 2018/19. Oystercatchers feed on bivalves including cockles.
9. There was a correlation between the number of oystercatchers overwintering in Dundalk and the post fishery biomass of cockles although this was driven by high biomass and high numbers of oystercatchers in 1 year (2008). The estimation of post fishery biomass should be improved.
10. Revisions to the harvest control rules for the fishery are recommended given the observed correlation between cockle biomass and oystercatcher, to stabilise biomass and TACs and to support policy on access of new vessels to the fishery. These are
    a. No fishing at cockle biomass less than 1,200 tonnes. On average this may lead to over 7000 oystercatchers at the site which is higher than the 5yr and 10yr means.
    b. TACs would increase in line with increases in biomass up to 2,000 tonnes giving an 800 tonne TAC at that point. Further stepped increases in TAC could be linked to entry of new vessels.
    c. A maximum TAC, irrespective of high biomass, of 1,200 tonnes is proposed in order to stabilise biomass and TACs in subsequent years. Additional scientific data is need to support this proposal.

Introduction

Two five-year Fishery Natura Plans (FNP) (2011-2015 and 2016-2020) for Cockles (*Cerastoderma edule*) in Dundalk Bay SAC and SPA have been implemented. The Fishery Plans included restrictions and limits on outtakes and in particular a requirement to monitor effects on the environment and the ecological features for which the Bay was designated under the Habitats and Birds Directives. This document reports on the status of cockle stocks, intertidal habitats, wading bird and oystercatcher populations in Dundalk Bay during the period 2010-2020. The findings and recommendations will inform the development of a third 5 year FNP to cover the period 2021-2025.

Harvest Control Rules 2016-2020

The Harvest Control Rules (HCRs) adopted in the FNPs of 2011-2020 were

1. Minimum legal landing size (MLS): The legally binding MLS is 17 mm shell width. Operationally, however, and by agreement, the minimum size in Dundalk Bay was 22 mm shell width. This was implemented on all vessels by grading catch through 22 mm grading devices on board vessels.
2. The annual Total Allowable Catch (TAC) was a percentage of the stock biomass as determined from a mid-summer pre-fishery scientific survey.
    a. where biomass < 750 tonnes the TAC = 0.
    b. where biomass = 750-3,000 tonnes TAC = 33% of biomass
    c. where biomass >3,000 tonnes TAC = 50% of biomass.

    The annual TAC, estimated from annual mid-summer surveys, was included in Fishery Natura Declarations (FND), which gave legal effect to the TAC recommendation in each year. The harvest rules were not based on scientific evidence but have been a rule of thumb in cockle fisheries for a number of years in the UK. The biomass limit for zero TAC is not an estimated limit reference point but approximates to a cockle density of $5m^{-2}$ in Dundalk and was thought to be a limit point for a commercially viable fishery. The exploitation rate is not scaled relative to proximity to the 750 tonne limit and fisheries at biomass between 750-1,120 will deplete the biomass to or below 750 tonnes. The higher exploitation rate at high biomass may be justified for cockles given the high level of density dependence in a number of biological processes that are known to operate in this species. Recruitment, growth and adult survival may all be strongly density dependent at high biomass.

3. The fishery was closed each season if catch rates were <250 kg per vessel per day averaged across vessels for a 5 day period. The first week of fishing was excluded from this rule.
4. The dredge fishery was closed on November 1st to minimise overlap with overwintering waterbirds.
5. The daily catch limit per vessel was 1,000 kgs.
6. Where deemed necessary the plan was to incorporate spatial controls to exclude fishing in areas where seed cockles were concentrated as identified from the pre-fishery survey. In 2011 fishing occurred within 5 discrete areas. In subsequent years these restrictions were thought to be unnecessary and were removed. Water depth in any case restricted fishing to mid and lower shore and voluntary spatial exclusions were adopted in certain years where there was a high spat fall.

7. Fishing occurred on 1 high tide per day and during the hours of 06:00-22:00hrs.
8. Maximum dredge width was 1.0 m in the case of non-suction dredgers and 0.75 m for suction dredgers.

Stock status

From 2007-2010 biomass of cockles ranged from a low of 814 tonnes in 2010 to 3,588 tonnes in 2008. During the first FNP (2011-2015) biomass varied from 972 to 1,532 tonnes (Table 1). During the second FNP (2016-2020) biomass ranged from 1,785 to 3,790 tonnes.

Abundance and density of cockles is spatially variable with patches of high density cockles interspersed with areas of low density. High density patches are dominated by smaller cockles (Figure 1).

Table 1. Trends in biomass, TAC (Total Allowable Catch) and landings of cockles in Dundalk Bay 2007-2020.

Year	Survey Month	Biomass		TAC (tonnes)	Landings	
		Mean	95% CL		Vessels	Hand gatherers
2007	March	2277	172	950	668	Unknown
2008	August	3588	1905	0	0	0
2009	June	2158	721	719	108	0.28
2010	May	814	314	0	0	0
2011	May	1531	94	510	325	0.25
2012	May	1234	87	400	394	9.4
2013	June	1260	99	416	343	0
2014	June	972	188	324	0	0
2015	June	1034	100	345	0	0
2016	July	1878	87	626	626	0
2017	June	2316	95	772	772	0
2018	June	1785	175	542	542	0
2019	July	3790	110	600	594	0
2020	May-June	3420	870	1128	1128	0

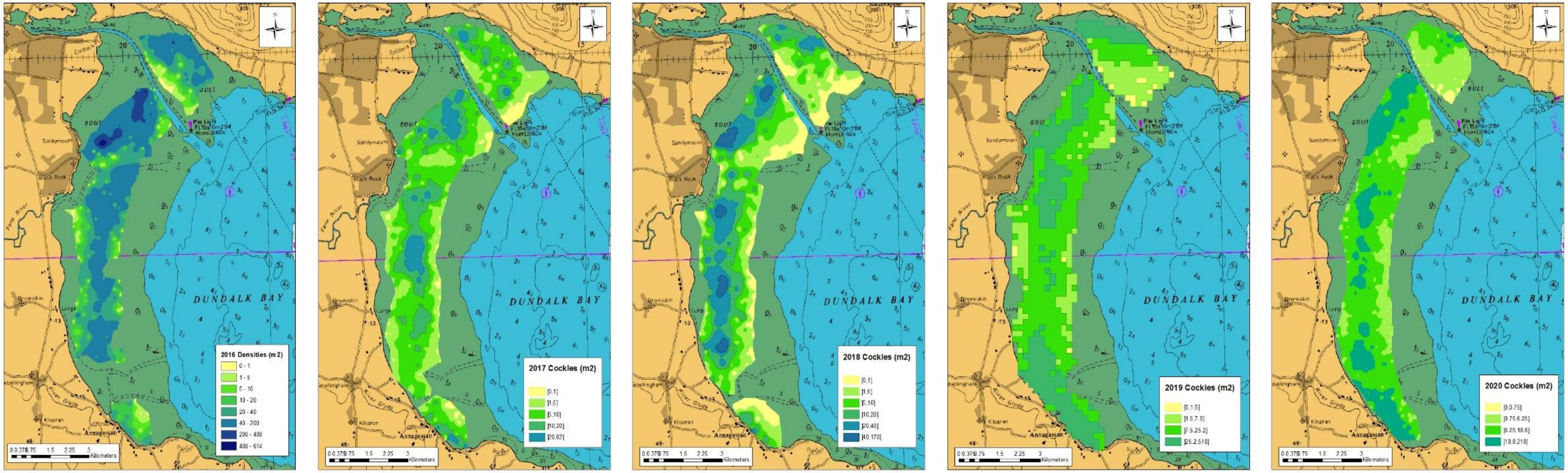

Figure 1. Distribution and abundance of cockle in Dundalk Bay from annual mid summer surveys 2016-2020.

The Fishery

The TAC is based on an advisory 33% exploitation rate provided that the survey biomass is over 750 tonnes. However, no fishery has occurred in any year when the biomass was less than 1,032 tonnes (2015). When the fishery is opened the TAC uptake has varied from 15% (2009) to 100% in all years since 2016. This depends on distribution of biomass and the commercial viability of fishing and market prices.

In the years 2016-2020 in season depletion in catch rates were observed in 2016 (28%), 2017 (21%) and 2018 (31%) (Figure 2). No depletion was observed in 2019 or 2020 where catches remained close to the 1000kg limit throughout the season. The level of observed depletion is negatively correlated with pre-fishery biomass. When biomass is high fishing time is reduced and the fleet can move to different areas to maintain catches. When biomass is lower (1,800-2,300 tonnes in 2016-2018) the fleet is less able to maintain catches. The observed depletions or absence of depletion indicates that in no case was the 33% harvest rule broken (depletions were 21-31%). This also indicates that the pre-fishery survey correctly estimates the biomass which is used to advise the TAC. The survey estimate in fact is likely to underestimate the fishable biomass at the start of the fishing season as there is a significant increase in cockle size between the survey and opening of the fishery even if this is usually only 3-6 weeks. This could explain the less than expected depletion rates.

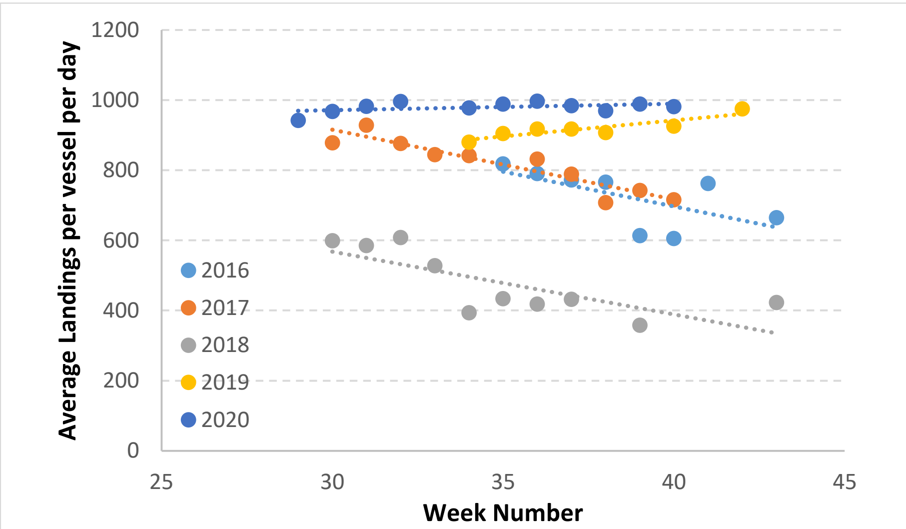

Figure 2. In season changes in average landings per vessel per day grouped by week for each week of the cockle fishery in 2016-2020.

Variability in stock biomass and recruitment

Cockle stocks are known to be highly variable over time. Mortality rates are generally high, even in the absence of fishing. Recruitment and growth are density dependent to the extent that in densely populated areas adult mortality can be high and recruitment can be inhibited. In Dundalk densities of cockles are generally low compared to established cockle fishing areas in the UK. Growth rates of Dundalk cockles are high compared to other populations.

Increases in biomass depend on spat settlement, spat survival and growth rates. Spat settlement may be related to spawning stock biomass but environmental conditions for larvae prior to settlement are likely to be important. Larval supply to settlement areas is likely to be regulated by wind forcing and temperature. Onshore winds may help retain larvae in the system over the adult beds while higher temperatures will reduce the larval life span and thereby lead to an increase in the larval supply. Post settlement survival of spat is regulated by environmental conditions such as storm events which turnover sediment and bird predation in particular from oystercatcher and knot. Two extreme winters with temperatures well below 0^{o}C occurred in Dundalk Bay in 2009/2010 and 2010/2011.

Annual size and age distribution of cockles

The size frequency data indicates that a spring spat settlement occurred every year between 2011-2020. In all years, other than 2014 and 2019, the 0+ cohort was clearly evident (Figure 3).

Although the size distributions suggest the presence of just 2 cohorts the larger component is a mix of ages which overlap because of slower growth rate with age compared to the rapid growth between age 0 and 1 (Figure 3) and (Table 2). Size at age is variable (Figure 4) and in some year's winter growth check rings suggested that autumn settlements also took place. These rings are evident at approximately 5mm from the umbo in the largest cockles classed as 0+. Autumn spawned spat do not grow as fast as spring spawned cockles as their first few months occur during autumn and winter when temperatures are lower.

Length weight relationships have been consistent for the period 2011-2020 (Figure 5).

Table 2. Number and average shell width (mm) of Dundalk Bay cockles in relation to age from 2016-2020.

Age	2016			2017			2018			2019			2020		
	N	Mean	S.d.	N	Mean	S.d.	N	Mean	S.d.	N	Mean	S.d.	N	Mean	S.d.
0	3170	12.75	2.51	1821	11.52	4.41	4307	10.80	2.58	4592	12.85	2.68	1431	12.85	4.08
1	876	20.61	3.18	2210	21.82	2.68	666	22.03	2.99	7079	18.25	3.08	3438	20.75	1.39
2	511	25.35	3.25	709	25.18	3.21	660	26.54	2.81	1013	23.66	3.17	2302	23.68	1.12
3	487	27.19	2.17	221	28.37	2.77	304	28.99	2.79	292	28.68	3.78	648	25.60	1.50
4	126	29.66	2.46	82	30.35	2.67	73	30.70	3.96	67	31.99	2.31	185	26.86	2.36
5	36	32.14	2.43	20	31.95	2.88	8	30.35	9.20	24	36.26	2.20	56	27.19	4.02
6	13	32.80	2.38	5	34.37	8.50	1								

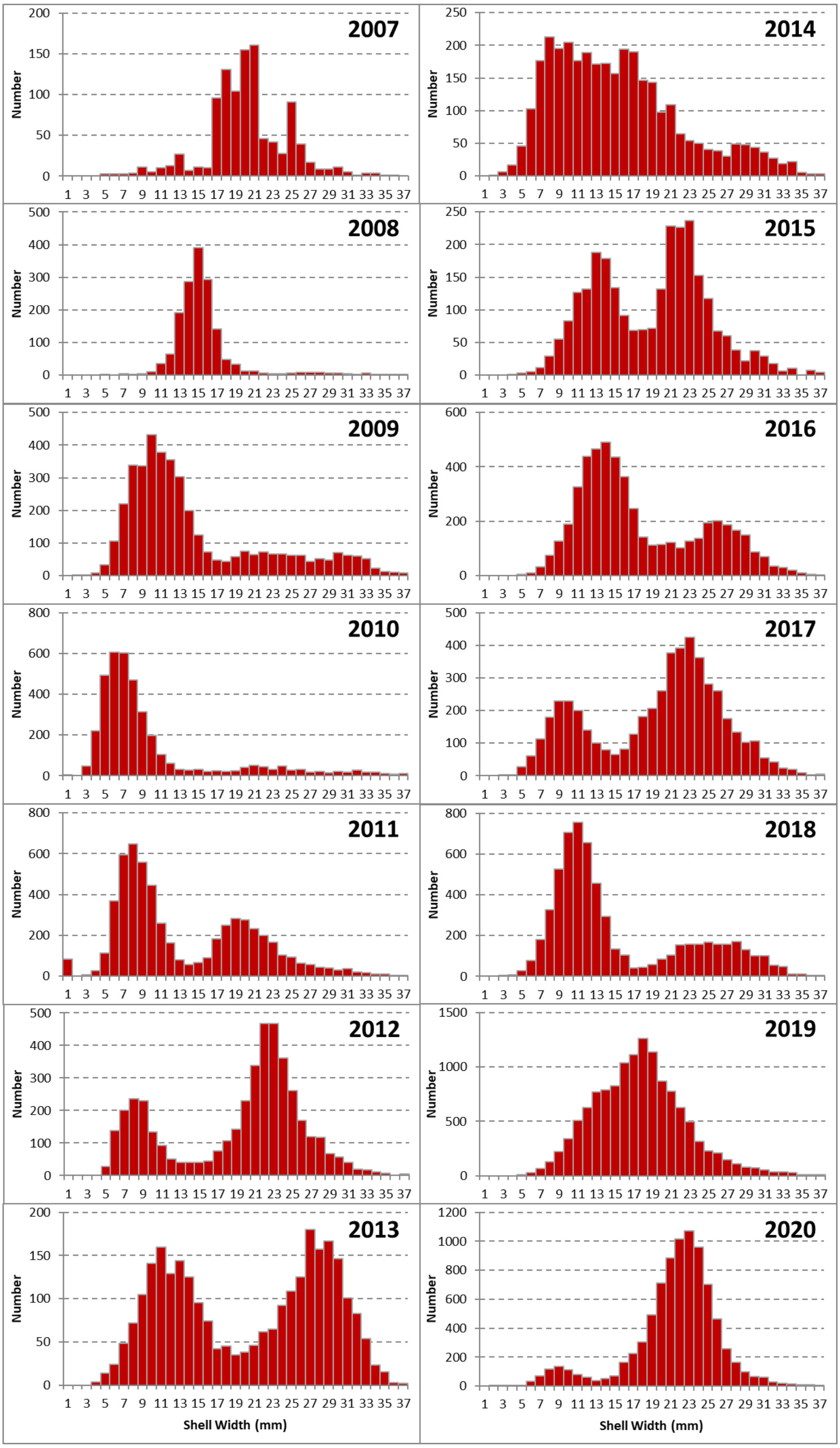

Figure 3. Size (shell width) frequency distributions of cockles from annual mid-summer surveys in Dundalk Bay 2007-2020. The minimum operational landing size in the fishery is 22 mm (shell width).

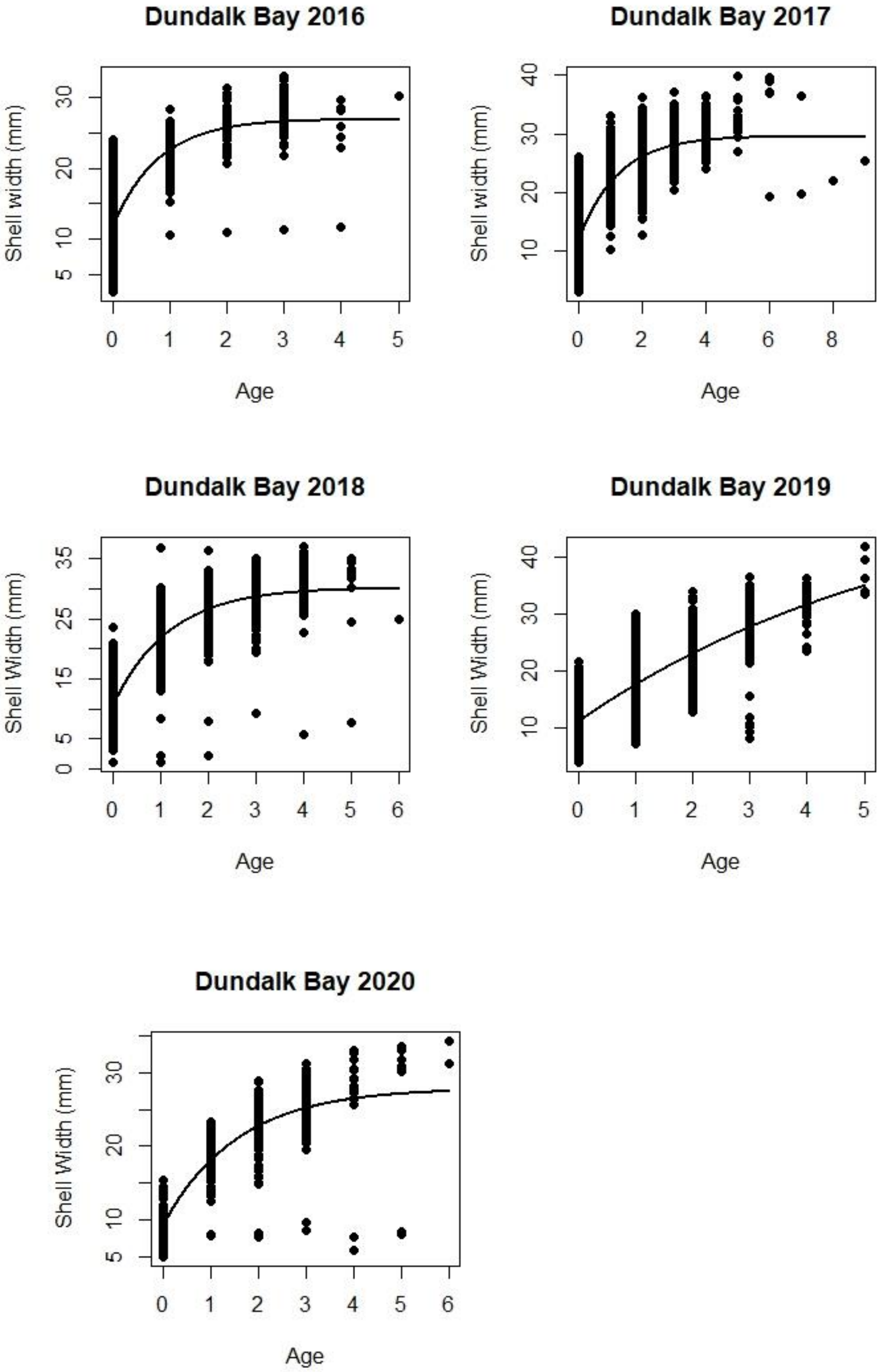

Figure 4. Mean shell width (mm) of Cockles by age for each year class in Dundalk Bay from 2016-2020.

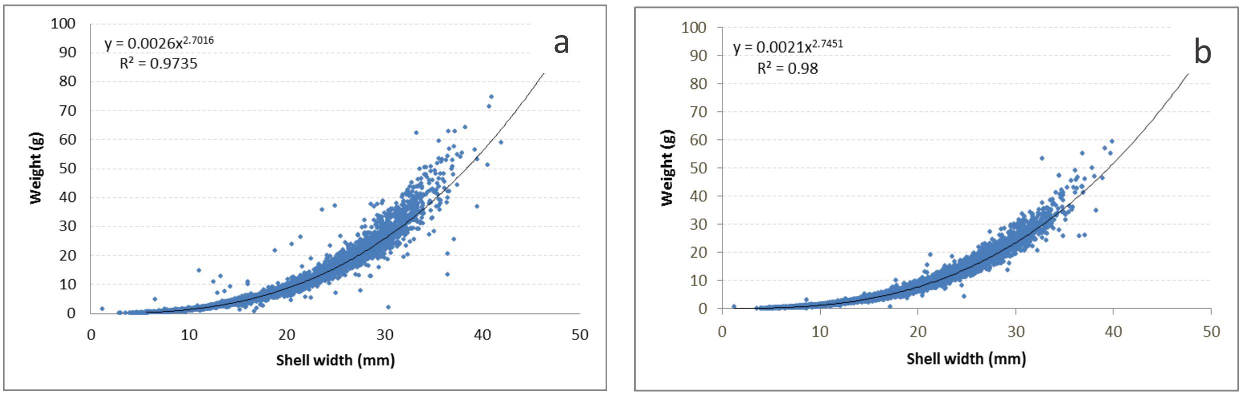

Figure 5. Whole weight shell width relationship for cockles in Dundalk Bay a) 2007-2015 data combined and b) 2016-2020 data combined.

Stock and Recruitment

Spat size and time of survey

Spat size was positively correlated with the week of the year in which the survey took place (Figure 6). The mean size of spat in 2014 and 2019 may be poorly estimated as the 0+ age class could not be clearly separated from older cockles in these year (Figure 3). The positive linear relationship between survey week and mean size of spat suggests that the spat fall occurred at approximately the same time each year. Back calculating to a settlement shell width of less than 0.5mm suggests that settlement occurs in week 8 (end of February).

Table 3. Size and number of 0+ cockles and survey week and sampling effort for Dundalk cockle survey 2007-2020. The 2007 survey was too early to detect the 0+ age class.

Year	0+ Mean shell width	0+ St. Dev	Survey week	Number (0+)	Age (weeks)	Sampling effort (m²)	Spat index
2007			10	87		114.25	
2008	13.8	1.6	34	1540	26	95.5	419
2009	9.5	2.66	24	1223	16	86.5	226
2010	6.05	1.81	21	1112	13	83.5	173
2011	7.5	1.94	21	1058	13	90.25	152
2012	7.5	2.2	21	395	13	75	68
2013	11.03	3.2	26	224	18	93.75	43
2014	7.3	1.89	26	562	18	86	118
2015	12.4	2.43	27	385	19	82.25	89
2016	13.84	3.63	28	645	20	85.3	151
2017	10.03	3.04	21	423	13	96.0	57
2018	10.61	2.69	24	1164	16	98.0	190
2019	11.08	2.90	27	1527	19	94.8	306
2020	10.72	3.94	23	273	15	86.5	47

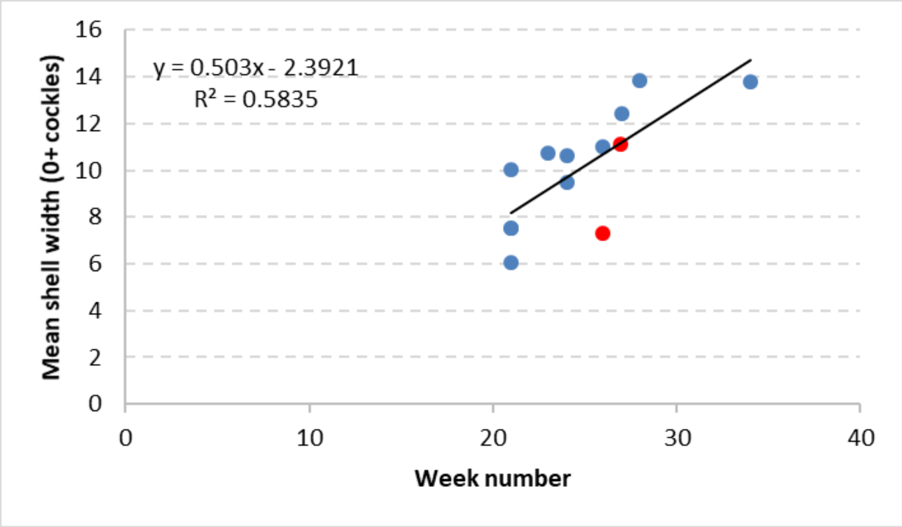

Figure 6. Mean shell width (mm) of 0+ age cockles Dundalk Bay in relation to the week of the year in which the survey took place, 2008-2020 combined (2012, 2013 data points overlapped). Data points for both 2014 and 2019 are highlighted as they may be poorly estimated.

Annual spat index

A spat index was estimated from the abundance of spat identified from the size distributions back calculated to time of settlement. The number of spat recorded in the surveys was raised to account for varying levels of spat mortality that would have resulted between settlement and the survey assuming a constant rate of mortality over time.

The annual spat index declined sharply from 2008 to 2009 and continued to decline from 2009 to 2013 prior to a partial recovery in 2014 and 2015 (Figure 7). The index increased generally from 2013-2019. Although the distribution and extent of the annual survey was similar across years some upper shore stations sampled in early years were discontinued because of difficult access. High densities of spat occurred in some upper shore stations in 2009 which were not sampled in subsequent years. The 2008 survey occurred in August compared to May, June or July in subsequent years.

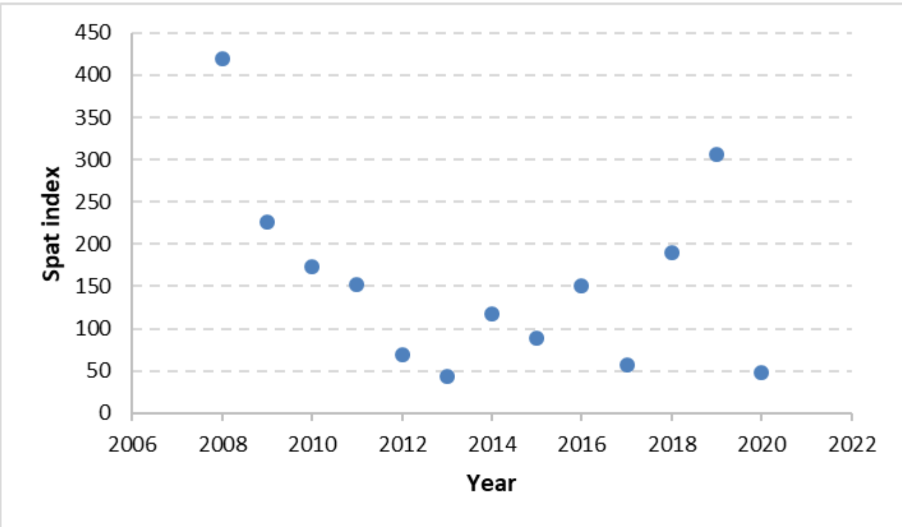

Figure 7. Annual spat index for cockles in Dundalk Bay 2008-2015. The index is standardised for sampling effort and time of year.

Spat index, biomass and landings

Years of high landings were not followed by years of low biomass; in fact high biomass in a given year, leading to high TACs, were generally followed by a year of high biomass. This indicates limited impact of the TAC on biomass in subsequent years (Figure 8).

Years with a strong spat index generally led to higher biomass in the following year although this was not the case for spat index levels less than 180. There is generally therefore successful transfer of spat fall into stock biomass (Figure 9).

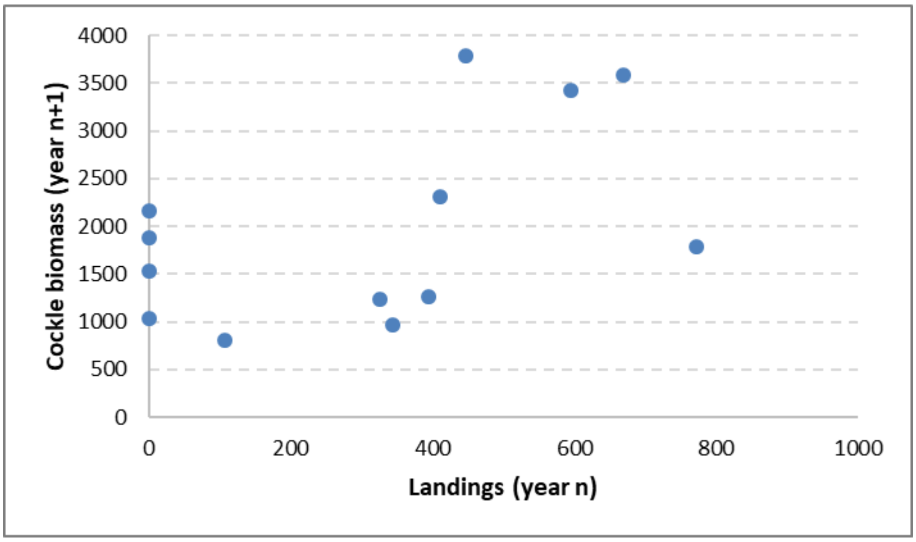

Figure 8. Relationship between cockle landings in a given year with biomass in the subsequent year in Dundalk Bay, 2007-2020.

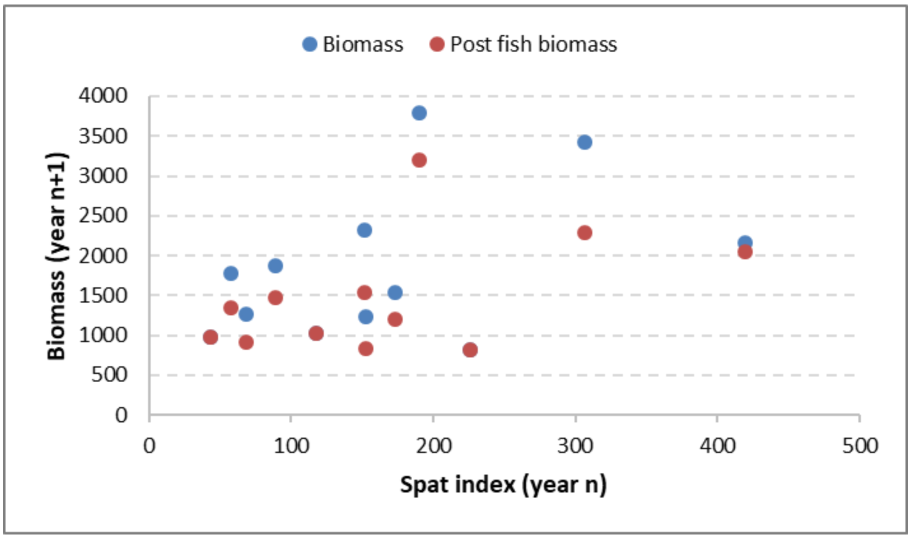

Figure 9. Dependency of cockle biomass on previous year spat index in Dundalk Bay, 2007-2020.

There was some indication of a positive relationship between the post fishery biomass and the spat fall index in the subsequent year (a stock recruitment relationship, Figure 10) when post fishery biomass was less than 2,000 tonnes. When post fishery biomass was greater than 3,000 tonnes spat fall was relatively low. This may indicate a density dependent effect on spat fall.

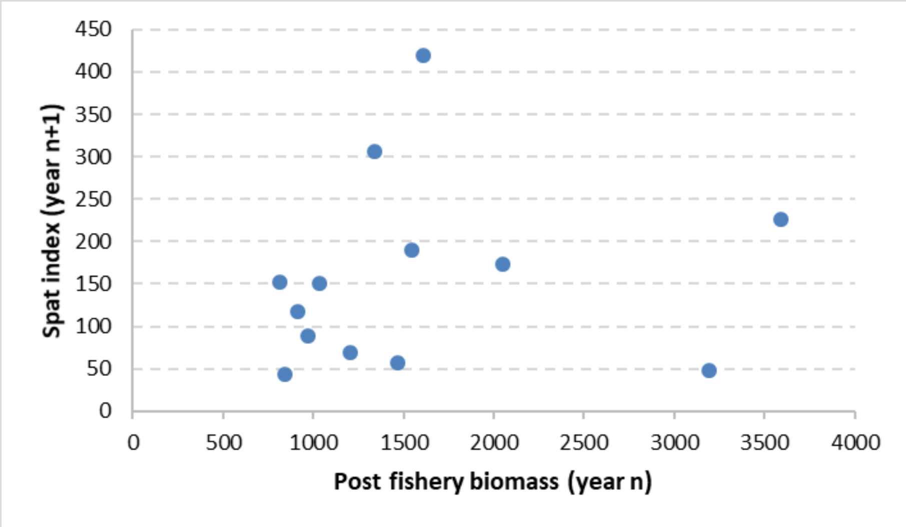

Figure 10. Dependency of the spat index on previous year post fishery biomass in Dundalk Bay 2007-2020.

Spat index and environmental factors

East winds may retain cockle larvae in the Bay while winds with westerly components may disperse larvae away from the intertidal recruitment habitat. On the other hand strong east winds may cause mortality of recently settled spat due to wave exposure and sediment turnover.

During 2007-2020 the strongest east wind forcing occurred in 2010, 2013 and 2018 (Table 4). There was no relationship between this east wind index and the spat index in the same year (Figure 11).

There was no relationship between the spat index and the average sea or air temperatures from January to March of each year (Figure 12).

Table 4. Hours and speed of wind with an easterly component along with Air and Sea Temperatures (C°) from the M2 weather buoy during Jan-Mar, 2007-2020. The east forcing index is East hours x East speed. Air temperatures (C°) from Dublin airport during Jan-Mar, 2018-2020 are indicated by **.

Year	East hours	East speed	East forcing	Air Temp (C°)		Sea Temp (C°)		Air Temp (C°) **	
				Mean	S.d	Mean	S.d.	Mean	S.d
2007	301	12.82	3859						
2008	304	13.65	4151	8.20	1.72	9.17	0.76		
2009	95	13.06	1241	7.29	1.86	9.54	0.25		
2010	725	15.34	11125	6.23	1.65	8.54	0.69		
2011	242	7.41	1793	7.64	1.25	8.15	0.27		
2012	290	9.02	2616	8.27	1.66	8.76	0.48		
2013	971	14.74	14313	6.22	2.14	8.03	0.79		
2014	62	12.94	802	8.14	1.35				
2015	220	10.62	2336	7.30	1.73	8.17	0.81		
2016	344	13.20	4540	7.80	1.64	9.56	0.97		
2017	354	13.55	4797	8.46	1.64	9.51	0.49		
2018	381	19.70	7505	6.28	1.71	10.88	0.03	4.33	0.95
2019	114	12.59	1435	8.30	1.69			6.47	1.19
2020	171	13.95	2385	8.24	1.41	9.03	0.82	5.97	0.29

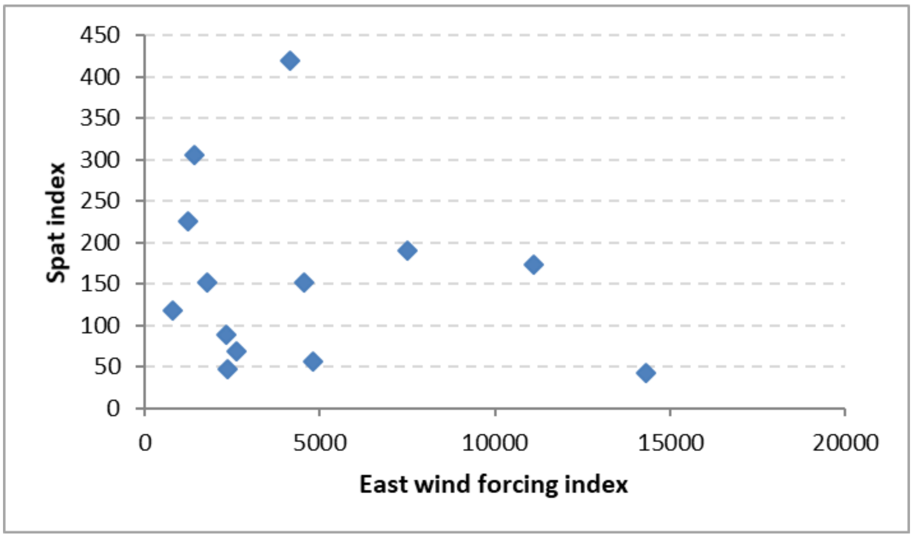

Figure 11. Dependency of the spat index on east wind forcing index during Jan-Mar in Dundalk Bay 2007-2020.

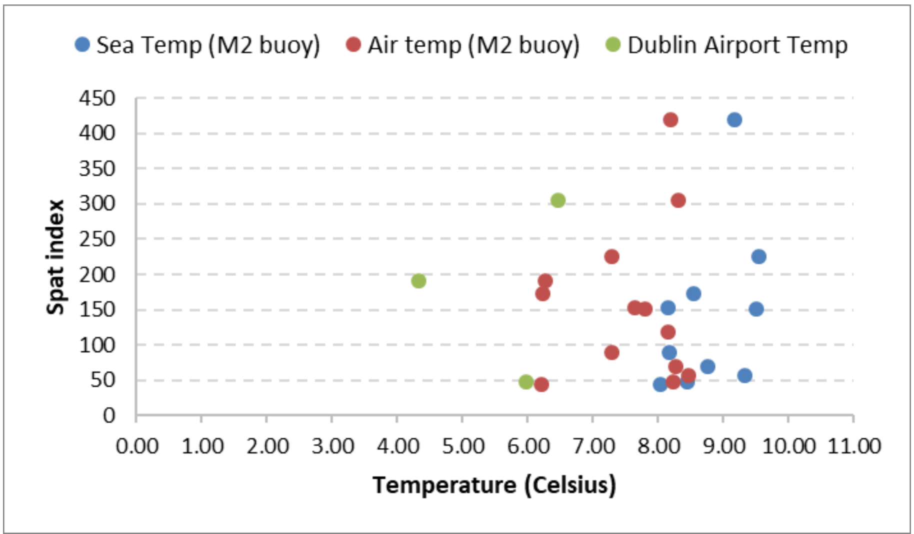

Figure 12. Dependency of the spat index on Sea and Air temperatures (data from the M2 weather buoy) during January-March, 2007-2020. Air temperatures from Dublin airport during January-March, 2018-2020 were also included.

Habitats

Trends in dominant bivalve species

The 3 numerically dominant species of bivalve in the intertidal habitat of Dundalk Bay are cockle (*Cerastoderma edule*), *Angulus tenuis* and *Macoma balthica*. *M. balthica* is more abundant on the upper shore, cockles mainly occur along the mid shore and *A. tenuis* is dominant from the mid to lower shore (Annex II and III). The distribution of all 3 species overlap. Previous studies in Dundalk Bay shows that cockle dredging causes mortality of Angulus in particular as its shell is lighter compared to the other two species. However, its overall sensitivity to abrasion pressure is low given its short life cycle and high recoverability. Macoma is much less exposed to the cockle fishery as it is distributed on the upper shore. Counts of the casts of the polychaete worm, *Arenciola marina* have been recorded since 2013.

The distribution of these species is estimated during annual summer surveys 2007-2020. Both *A. tenuis* and *M. balthica* can occur in high densities (Table 5, Figure 13). The average abundance of both bivalves was stable between 2013-2020. Distribution maps show similar distributions across the time series (Figure 14).

Table 5. Mean density (m^{-2}) of the bivalves *Angulus tenuis*, *Macoma balthica* and the polychaete worm *Arenicola marina*, along with the average Redox potential discontinuity layer in intertidal habitats during the mid summer cockle surveys 2011-2020.

Year	*Angulus tenuis*		*Macoma balthica*		*Arenicola marina*		Redox Potential Discontinuity (RPD) layer	
	Average	S.d.	Average	S.d.	Average	S.d.	Average	S.d.
2011	26.14	38.74	13.98	36.25			9.43	4.63
2012	55.35	62.18	17.74	41.21				
2013	95.43	89.82	28.10	57.49	6.43	8.10	12.74	7.08
2014	91.61	83.19	18.53	42.23	11.62	9.18	18.66	10.8
2015	70.56	76.90	18.80	40.06	6.08	5.33	9.34	6.00
2016	83.33	75.07	19.41	51.29	6.26	4.82	11.21	6.28
2017	67.89	90.11	12.39	30.15	5.58	4.45	10.11	4.43
2018	77.89	88.09	24.64	51.15	4.35	3.10	10.27	6.81
2019	84.66	86.40	22.91	48.60	5.26	3.27	10.43	6.13
2020	87.51	99.59	18.72	42.77	3.49	3.15	9.981	7.29

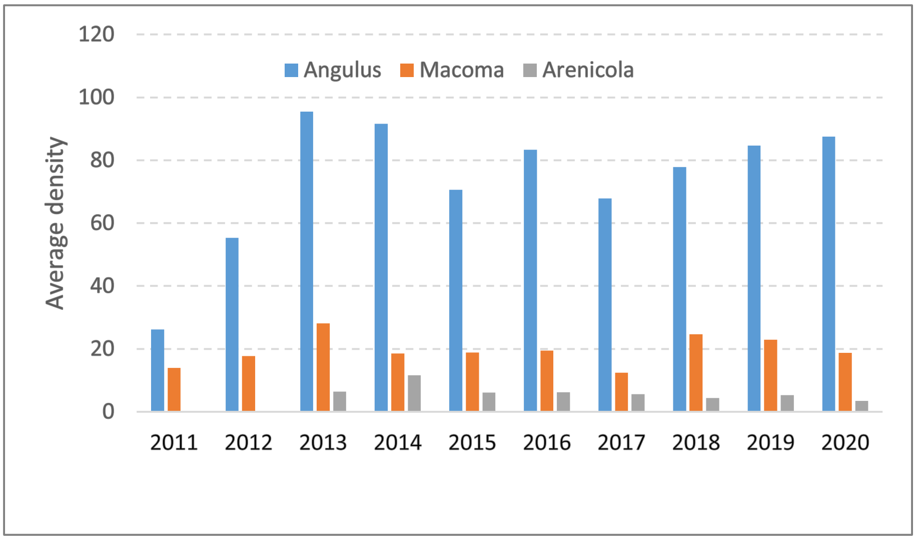

Figure 13. Average densities of *Angulus tenuis*, *Macoma balthica* and *Arenicola marina* in intertidal sediments in Dundalk Bay 2011-2020

The divide between the surface oxygenated and sub-surface anaerobic sediment is known as the redox potential discontinuity (RPD) layer. This divide appears as a grey layer of sediment above the black deoxygenated sediment below. Sediment mobility and biological bioturbation caused by feeding of infaunal deposit feeding increases oxygen supply to sediments and thus makes the oxygenated surface layer of sediment deeper. Eutrophication and increased biological oxygen demand in the sediment reduces oxygen availability and the RPD layer can then occur very close to the sediment surface. Filter feeding bivalves such as cockles occur about the RPD or at least must reach the aerobic layer when feeding.

The depth of the RPD was measured at each station during the summer surveys from 2011 to 2020 (Table 5). It has been consistent at an average depth of about 10 cm since 2015.

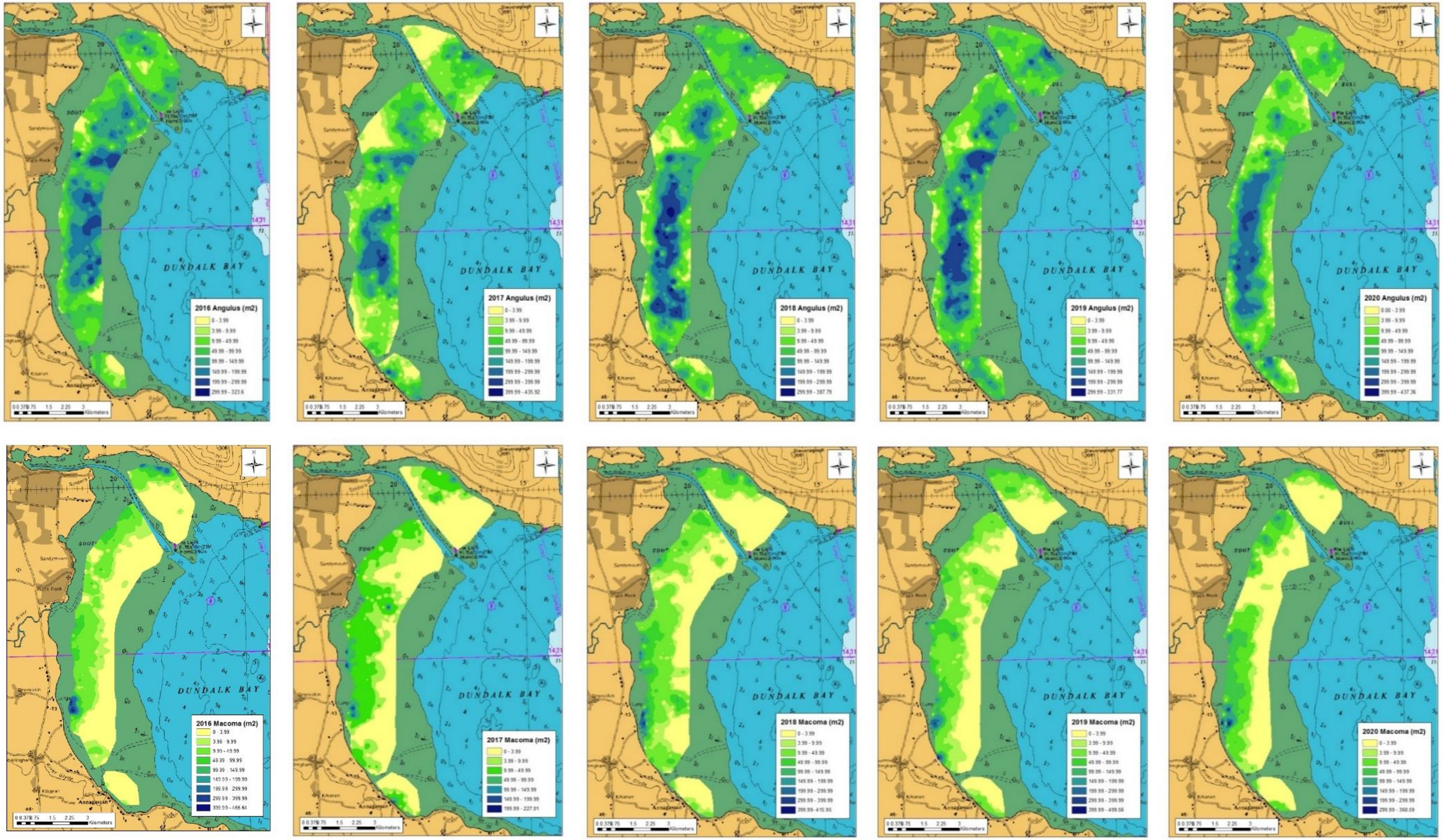

Figure 14. Annual distribution of *Angulus tenuis* (top) and *Macoma balthica* (bottom) during mid summer surveys in Dundalk Bay 2016-2020.

Birds

Overwintering birds in Dundalk Bay have been monitored since the mid-1990s by iWeBs (Irish Wetlands Bird Survey). Counts are taken at key roost locations at high tide.

In 2009-2010 NPWS also commissioned low tide counts when the birds are distributed on the sand flats. These counts were repeated by Atkins, under contract to the Marine Institute, in the 3 years 2012-2015. Low tide count data from Atkins are considered to provide an accurate and precise population estimate; for instance successive monthly counts in autumn have shown very similar total number of birds indicating that the count method had repeatability.

The low tide data suggests that the high tide counts underestimate the number of birds using the bay by about 30%. Nevertheless, the iWeBs data provides a consistent time series given that methods are similar between years even if the absolute number of birds may be underestimated.

Trends in bird populations in Dundalk Bay

The highest numbers of all bird species, 61,255, in Dundalk Bay were recorded in winter 2003/2004 (Figure 15). The long term (1994-2019) average is stable with a range between 30,000 and 61,000 birds. Year on year declines during the period 2011-2015 were reversed in the period 2015-2019.

Data for the most abundant bird species were divided into five feeding groups namely Bivalve feeders, Fish feeders, Generalist feeders, Invertebrate feeders and Vegetation feeders (Figure 16). Bivalve feeders decline in 2012/13 and remained on average at lower levels to 2018/19 compared to earlier years. This decline also occurred in the generalist group with the exception of 2017/18.

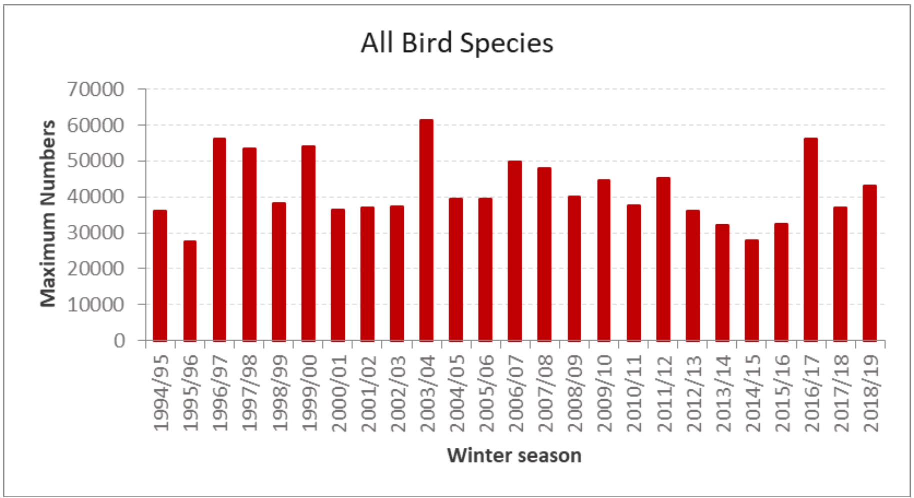

Figure 15. Trends in the number of all bird species from September to February during the winter seasons from 1994/1995 to 2018/2019 in Dundalk Bay.

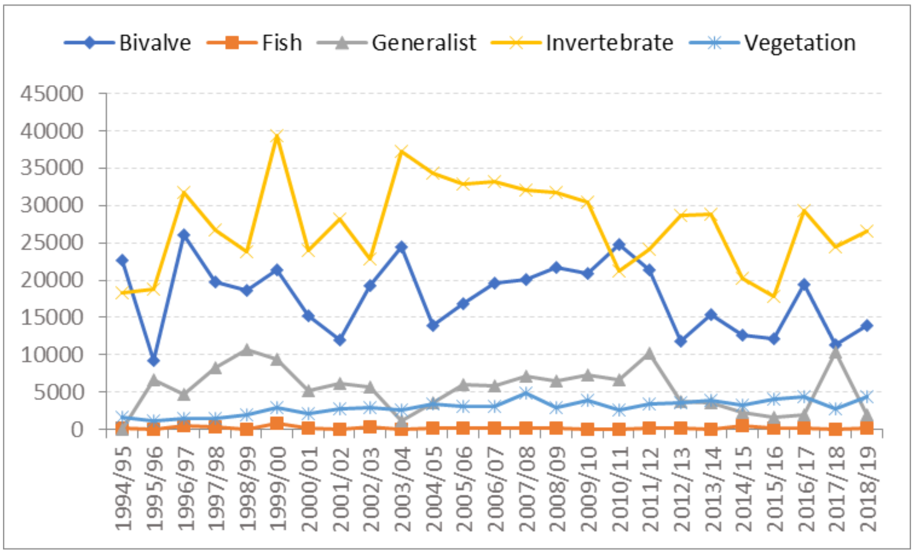

Figure 16. Trends in the number of bird feeding groups from September to February in Dundalk Bay.

Oystercatcher

Oystercatcher feeds on cockles. However, work contracted in recent years by the MI in Dundalk Bay also shows that it feeds on other prey and in particular it feeds extensively in grasslands bordering Dundalk Bay. NPWS report average maximum counts of 8,746 birds in their reference period 1995/96 to 1999/00. iWeBs counts of over 14,000 oystercatchers in 1999/00 and 2006/2007 were the highest counts in 24 years (Figure 17). Recent 5 year averages and longer term 10 year averages were 5,945 and 7,117 birds, respectively. A year on year decline occurred from 2008/09 to 2014/15. Numbers increased from 2014/15 to 2018/19.

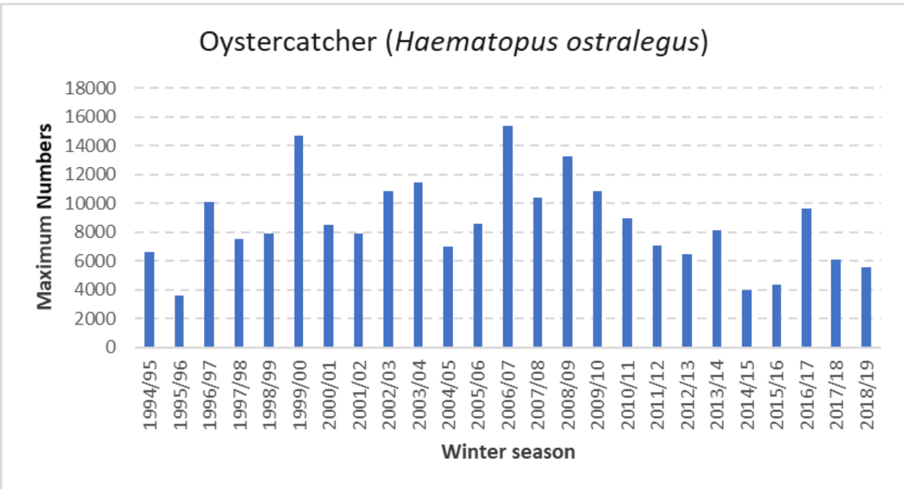

Figure 17. Trends in the number of oystercatcher (*Haematopus ostralegus*) from September-February during the winter seasons from 1994/1995 to 2018/2019 in Dundalk Bay.

East coast trends in Oystercatcher numbers

The number of OC at other east coast sites south of Dundalk Bay hold lower numbers of birds than Dundalk Bay (Figure 18, Table 6). Ten year trends in OC are stable or negative at most of these sites. There is a small upward trend in Dublin Bay. The year on year variation in counts is much higher in Dundalk than in other sites. This is probably due to difficulties in counting this large site and also significant numbers of birds feed inland in fields surrounding the Bay.

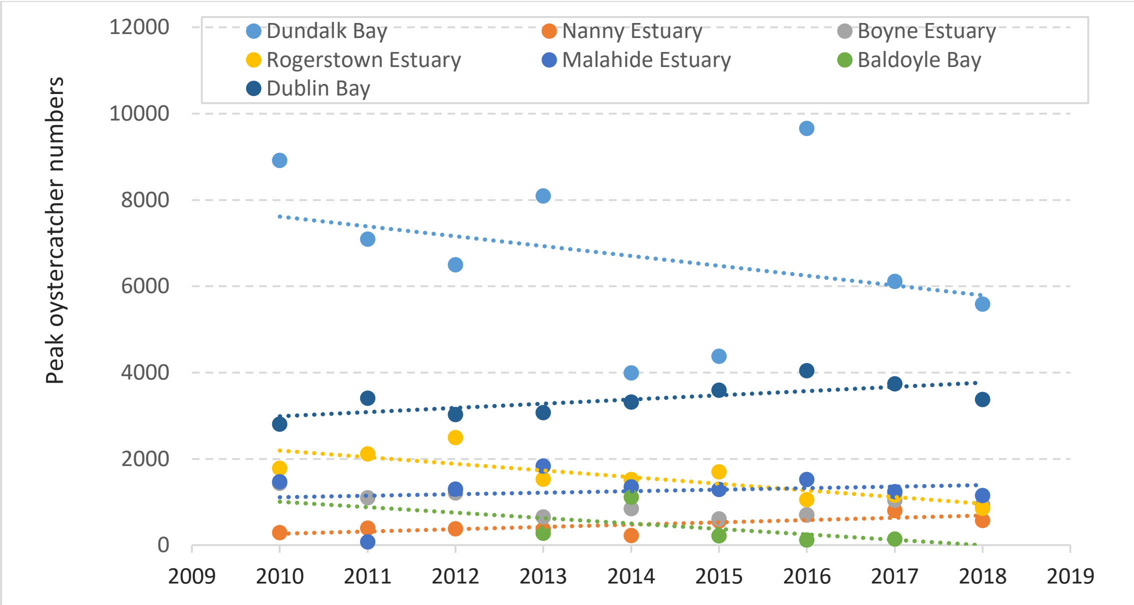

Figure 18. Trends in the number of oystercatcher (*Haematopus ostralegus*) from September-February during the years 2010/2011 to 2018/2019 from several wintering sites along the east coast including Dundalk Bay.

Table 6. Maximum numbers of oystercatcher (*Haematopus ostralegus*) from Winter 2010/2011-2018/19 (September-February) at several sites along the east coast including Dundalk Bay.

Wintering Site	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Dundalk Bay	8920	7095	6502	8094	3993	4377	9660	6113	5586
Nanny Estuary	291	396	378	369	228	560	700	803	575
Boyne Estuary	1435	1099	1211	655	844	610	704	1042	944
Rogerstown Estuary	1781	2116	2491	1531	1519	1697	1057	1161	852
Malahide Estuary	1471	78	1300	1833	1355	1291	1523	1242	1150
Baldoyle Bay				277	1113	219	117	144	
Dublin Bay	2804	3408	3025	3074	3315	3588	4042	3740	3378

Oystercatcher populations, cockle biomass and cockle landings

The number of oystercatchers overwintering in Dundalk Bay is positively correlated with the post fishery cockle biomass (Figure 19). This is the biomass that is available in autumn when the fishery is closed. The relationship is leveraged by the cockle biomass and high OC count in 2008/09. At cockle biomass between 1,000-2,000 tonnes OC numbers are variable. OC data for 2019/20 and 2020/21, years of high cockle biomass, are not yet available from iWeBs.

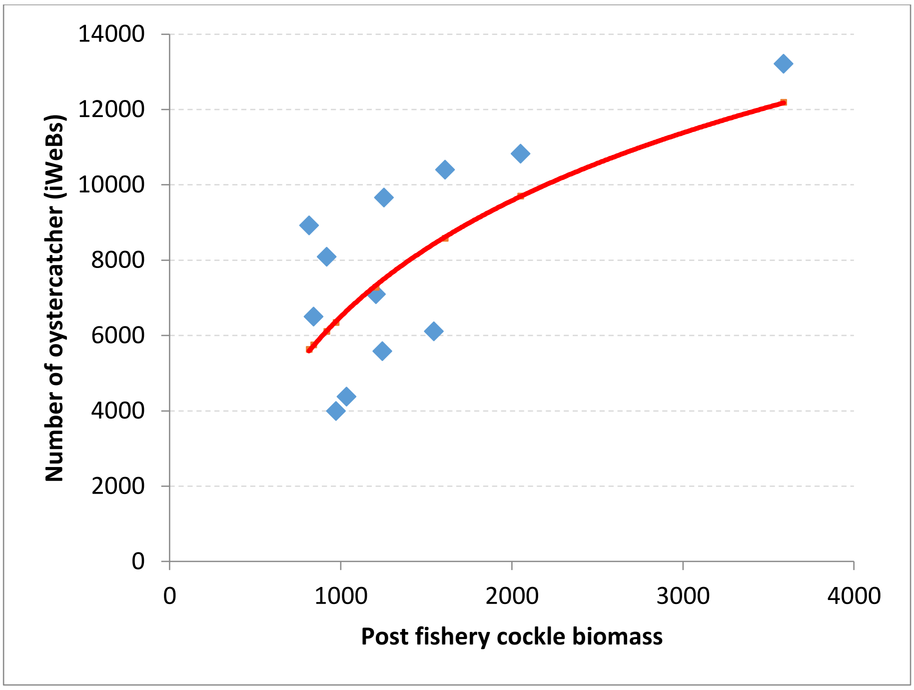

Figure 19. Relationship between oystercatcher numbers (iWeBs data) and post fishery cockle biomass in Dundalk Bay 2007-2018. The fitted curve is a Beverton and Holt stock (cockle) and recruitment (oystercatcher) function R=aS/(b+S), a = 18587 (the asymptote of the curve) and b = 1870 (steepness) or the cockle biomass required to recruit 0.5 of the asymptotic value

Recommended changes in Harvest Control Rules

This review is to inform the development of a third FNP to cover the period 2021-2025. Data reviewed above for the period 2007-2020 suggest some changes to the HCRs would be more precautionary with respect to bird populations and also provide for greater stability in cockle biomass.

Implementation of the Harvest Control Rules 2016-2020

The objectives of the cockle Harvest Control Rules (HCRs) were to protect the food resource for overwintering birds, to limit fishing pressures on benthic habitats and to conserve cockle spawning stock above a level that might limit spat fall and recruitment

The previous FNPs limited harvest rates using a minimum cockle biomass below which there was no fishing but above which a 33% harvest rate was allowed between 750-3,000 tonnes. This could have depleted the biomass well below 750 tonnes. However, even when a TAC was agreed fishing never occurred when the biomass was less than approximately 1,100 tonnes. Furthermore, the rules allowed for a 50% harvest rate above a biomass of 3,000 tonnes. This was to avoid density dependent mortality and recruitment which is known to cause mass die off of cockle stocks in some cases. However, over the period 2007-2020 cockle densities in Dundalk have never reached densities as high as some UK stocks so the likelihood of losing stock to mass die off is low. Nevertheless, spat fall was unexpectedly low in 2 years when biomass exceed 3,000 tonnes.

The data for 2015-2019, when combined with the period of the first FNP, continue to show a relationship between post fishery cockle biomass and the number of oystercatchers at the site overwinter. This relationship indicates that the minimum biomass for fishing should be increased.

In 2019 and 2020 cockle biomass exceeded 3,000 tonnes. However, by proposal from the industry the 50% TAC rule was not implemented and the agreed TAC and landings in these years was lower than allowed for in the FNP. This strategy by industry was to promote stability in landings across years rather than taking one off gains from individual bumper years.

Recommendations for new Harvest Control Rules

The proposed new HCRs are more conservative and precautionary than the rules in the previous FNP

1. The lower biomass limit for fishing is proposed to be 1,200 tonnes (Figure 20).
   Given the relationship between OC and post fishery cockle biomass observed over a 12 year period the number of OC wintering at the site may then be about 7,300. This is higher than the recent 5 year and 10 year means of 5,945 and 7,117, respectively, but lower than during the NPWS reference period (1995-2000) of 8,746. The estimation of post fishery biomass needs to be improved.
2. The TAC will increase with biomass between 1,200-2,000 tonnes and the surplus above the 1,200 tonnes can be harvested.
   Fishing at biomass just above 1,200 tonnes under this rule is unlikely to be economic but would allow some harvest. Experience over the past 10 years shows that viable fishing would occur at 1,500-1,800 tonnes biomass which, under the revised HCRs, would result in a 300-600 tonnes TAC.
3. To allow a limited number of additional vessels to enter the fishery at high biomass as per the policy supporting the previous FNP the TAC would increase in steps of 200 tonnes for every 500 tonnes increase in biomass and up to a maximum TAC of 1200 tonnes. This rule could therefore be linked to access policy. An absolute cap at 1200 tonnes is consistent with industry strategy of favouring long term stable TACs rather than bumper years. Additional scientific data is needed to support this strategy.

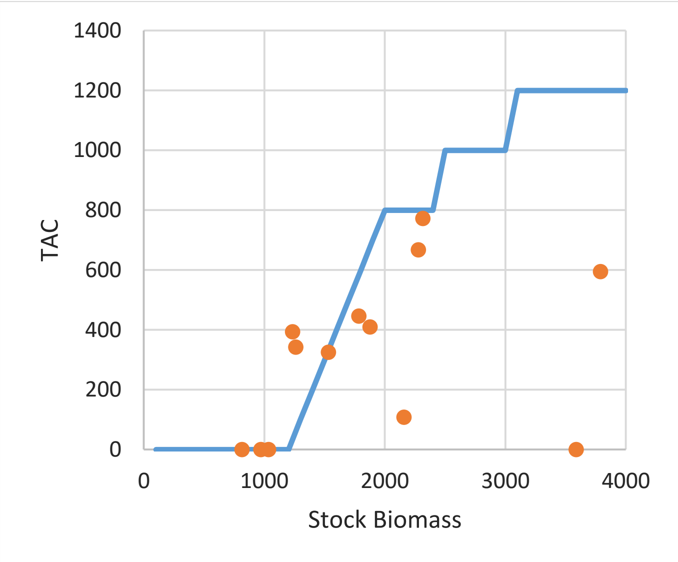

Figure 20. Proposed Harvest Control Rules (HCRs) for cockle 2021-2025. No fishing would occur when stock biomass was less than 1,200 tonnes. TAC would increase in line with biomass up to a TAC of 800 tonnes at biomass of 2,000. Further increases in TAC could be linked to how new vessels were allowed to enter the fishery. The maximum TAC irrespective of biomass would be 1,200 tonnes (similar to 2020) in order to increase the prospect for stable TACs in subsequent years. Annual landings in the period 2007-2020 are shown.

The proposed revisions of the HCRs will affect the landing patterns observed in the previous 10 years (Figure 20). Landings will be lower at biomass of 1,200-1,500 tonnes than previously. There were two years in the previous series where 300-400 tonnes were taken within this biomass range. This is the main effect on the fishery of the proposed revisions.

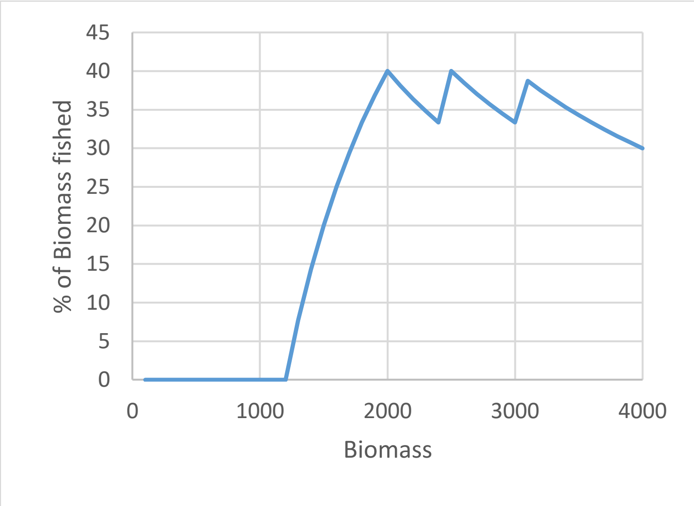

Figure 21. Percentage of biomass that would be fished under the proposed TAC limits in Figure 20.

END