



Wash Fishery Order 1992

COCKLE FISHERY MANAGEMENT PLAN

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INTRODUCTION

The intertidal cockle stocks in the Wash have traditionally provided a valuable resource for the local fishing industry. These stocks are also an essential food resource for the internationally important communities of birds that reside or over-winter in the Wash, while the sandbanks and mudflats on which they are situated are an important habitat for invertebrate communities. It is important, therefore, that the fishery is managed in a manner whereby it does not have an adverse impact on the site's features.

Management of the Wash cockle fishery has evolved and strengthened over time. At first this was primarily aimed at making the fishery sustainable, while more recently greater emphasis has been given to protecting the environmental features from adverse impacts. Management needs to be adaptive in order to deal with advances in new technology and changing environmental conditions. When hydraulic suction dredges were introduced into the Wash for harvesting cockles in 1986, the legislation in place at the time was not sufficient to manage the efficiency of this new equipment and method of fishing. As a result, over-fishing occurred and the cockle stocks rapidly declined. The management of Wash shellfisheries was strengthened in 1993 with the introduction of the Wash Fishery Order 1992, but cockle stocks remained low through most of the 1990s. In 1998 the concept of using an annual Total Allowable Catch (TAC) quota for the cockle fishery was introduced to limit exploitation to sustainable levels. This, together with the subsequent evolution of other management measures, helped to stabilise the fishery and facilitate a stock recovery through the 2000s. This period also saw a growing environmental awareness introduced into the management of the fisheries, whereby the fisheries are not just managed to ensure their sustainability, but to protect designated environmental features. To ensure sufficient protection is being given, there is now a requirement to submit detailed Habitat Regulations Assessments to Natural England for approval before fisheries can be consented. To date, these have been conducted annually, but to make the hand-worked cockle fishery consistent with other fisheries requiring assessment, a long term (25 year) Habitat Regulations Assessment will be introduced for this fishery.

Because the management of the Wash shellfisheries had adapted and evolved over time in response to required needs, the management of the cockle fishery needed to take into consideration the legislation from a number of byelaws and regulations, plus a range of non-legislative measures that had been introduced when required. Although these latter measures were broadly recognised and accepted by the industry, they tended to be disseminated, with little auditing of when or why they had been introduced. To ease this potential confusion the suite of fisheries management measures were developed into a single document. Following lengthy consultation, the Eastern Sea Fisheries Joint Committee Fisheries Management Policies were formally agreed between ESFJC, Natural England and the fishing industry in 2008. The formal agreement of these policies enabled Natural England to change the conservation status of many parts of the Wash Site of Special Scientific Interest from Unfavourable Declining to Unfavourable Recovering. Natural England also accepted that by following the policies, the fisheries would not inhibit the Conservation Objectives for the Wash and North Norfolk Coast European Sites being achieved. Since their introduction, the 23 management measures listed

in the policy for the cockle fishery have formed the framework around which the fishery has been managed. This has helped bring relative stability to the fishery and kept disturbance to the site's environmental features within accepted thresholds

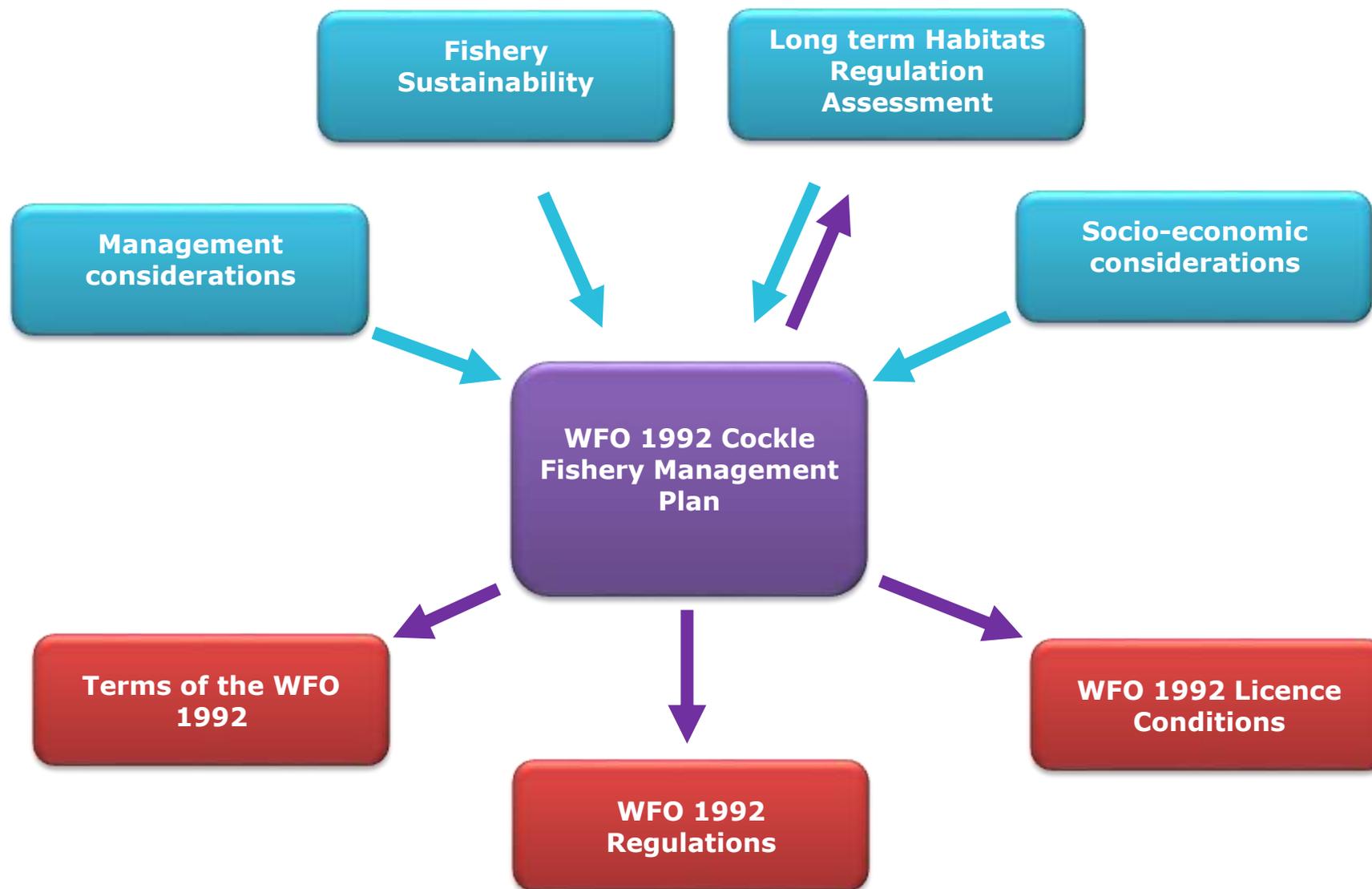
It is accepted by fishers and conservationists alike that shellfish stocks will fluctuate in response to environmental parameters that are outside the control of fisheries managers. Since the introduction of the policies, the cockle stocks in the Wash have been severely impacted by high levels of annual natural mortality that have far exceeded fishery-associated mortality. Although the causal factors for these die-offs have yet to be determined, mortality studies combined with analysis of the annual stock survey data have provided the Authority with a good understanding of trends and environmental conditions associated with the die-offs. In recent years the Authority has used this understanding to target the fisheries where the cockle stocks have been predicted to be most vulnerable to being lost. By doing this, the fishery has been able to harvest stocks that would otherwise have been lost, rather than causing an additional in-combination effect to the natural mortalities. On occasions, when the data has predicted natural losses in an area will greatly exceed the annual quota for the fishery, "contingency" fisheries have been implemented, allowing a larger fishery than would otherwise be possible if the policies were strictly adhered to. The departure from the policies, however, has required additional Habitats Regulations Assessments to be submitted for Natural England's approval. On occasions, when die-offs are predicted to be imminent, this delay can result in opportunities being lost. It has been determined, therefore, that the current review of the shellfish management policies will be more thorough and conducted in conjunction with the development of the long term (25 year) Habitats Regulations Assessment, a review of the Wash Fishery Order 1992 and the development of a Monitoring and Control Plan for the Wash and North Norfolk Special Area of Conservation European Marine Site. The shellfish management policies will form the backbone of this Wash Cockle Fishery Management Plan and the forthcoming Wash Mussel Fishery Management Plan. It is hoped that being underpinned by the existing policies, these plans will provide greater flexibility for managers to respond to natural fluctuations in the stocks, while offering good protection to the site's environmental features.

RELATIONSHIP BETWEEN THE DRIVERS AND OUTPUTS OF THE PLAN

The various management measures described within this plan are broadly derived from four main drivers:

- **Environmental conservation** – The cockle fisheries must not have an adverse impact on the site features. Risks to conservation features and mitigation are detailed in the Long Term (25 year) Habitats Regulation Assessment.
- **Fishery sustainability** – Present fisheries must not threaten the sustainability of future fisheries.
- **Socio-economic considerations** – The fisheries need to be viable and fair to those involved in them.
- **Management considerations** – Measures need to be manageable and enforceable.

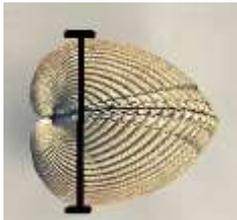
In turn, the measures within the plan inform the requirement for legislation in the form of the terms of the Wash Fishery Order 1992 and the associated regulations and licence conditions. These relationships can be seen in the figure below.



DEFINITIONS OF COCKLE SIZES AND AGE

“Adult” and “juvenile” cockles

In various Authority management papers and reports cockles are frequently referred to as being “adult” or “juvenile”. For management purposes, the differentiation between the two has been size – cockles less than 14mm width have been termed “juvenile” while those that have attained 14mm width have been termed “adult”. While the surveys and management measures differentiate between <14mm width and ≥14mm width cockles, the descriptions of “adult” and “juvenile” for these ranges are not strictly correct. Technically the terms “adult” and “juvenile” refer to the maturity of an individual, not its size. This is quite pertinent, for several factors can affect the growth rates of cockles and in some cases cockles in the Wash may take five years to attain a size of 14mm while on other beds they might only take one or two years. In more recent papers and reports there has been a shift to describe these groups more accurately as <14mm width and ≥14mm width cockles. The diagrams below show the dimensions used by the Authority to define “width” and “length” when measuring cockles.



Width



Length

Year - 0 cockles

Year-0 cockles are juvenile cockles that are less than a year old. Because cockles spawn in late spring/early summer and first become noticeable on the beds during the summer, this is the time they are aged from. Cockles defined as being Year-0 during the spring surveys are those individuals that have settled the previous summer.

COCKLE FISHERIES – HAND-WORKED AND/OR DREDGED

Prior to the introduction of hydraulic suction dredges in 1986 the cockle fisheries were entirely hand-worked, albeit facilitated with the practice of “blowing-out” (an intense form of “prop-washing” utilising heavy anchors to facilitate the “blowing” of several concentric rings). Because of the efficiency that dredges could harvest stocks and quickly reduce cockle densities below levels in which they could be feasibly hand-worked on a commercial scale, it was difficult for a hand-worked fishery to operate alongside a dredge fishery. As such, hand-worked cockle fisheries virtually ceased to operate in the Wash until 2004. Then, disenchanted with short, intense fishing seasons that typified dredge fisheries, a growing number of fishermen requested a renewed emphasis to support the hand-work fishery and in many cases, potentially a total ban on dredges. Between 2004 and 2008 dredging was restricted to limited sands, mainly within the bombing ranges in which it was difficult to operate hand-worked fisheries. This allowed the hand-worked fisheries the opportunity to fish beds that had not had their stock densities reduced by dredges. Following the success of these hand-worked fisheries, the dominance of those opposed to dredging grew to an extent that there have not been any cockle dredge fisheries in the Regulated fishery since 2008.

The absence of a dredge fishery since then has not been based solely on stock availability or environmental considerations, but also because of opposition among a majority of fishermen. This is an emotive subject, in which the majority of fishermen are strongly opposed to dredge fisheries, while a smaller number are equally strong in their support for them. The difficulties of effectively managing and enforcing dredge fisheries have also been raised recently. Taking into consideration the mobility and efficiency of dredges, any lack of compliance could quickly threaten stock sustainability and the environmental features. Where the stocks would support a dredge fishery, officers have continued to present these as options to the Authority alongside options for hand-worked fisheries, but decisions have consistently been for hand-worked fisheries only. This is time consuming and costly on resources, particularly given, the minority support for dredging.

This situation was raised at an EIFCA Full Authority meeting on 27th April 2016. After discussion, the members decided that although hydraulic suction dredges should not be totally banned, future cockle fisheries should **default to being hand-worked, with dredges retained only as a contingency option if exceptional circumstances required their use.**

Taking this decision into account, whilst the measures on the following pages apply to both the hand-worked and dredge fisheries the long term (25 year) Habitats Regulations Assessment only applies to the hand-worked fishery.

MANAGEMENT MEASURES FOR THE WASH COCKLE FISHERY

The following tables describe the management measures for the Wash Fishery Order 1992 cockle fishery. These have been grouped topically into technical measures, cockle stock sustainability measures, environmental conservation measures, measures for assessing stocks and monitoring fishery and additional measures that are specific for managing dredge fisheries.

TECHNICAL MEASURES	
Maximum vessel length	No vessel over 14m in length can participate in the Regulated cockle fisheries, unless subject to a derogation.
Approved design of fishing gear	All equipment used in the fishery must be of a design approved by the Authority.
Limiting vessels to a single method of fishing	Only one fishery (either dredged or hand worked) may be targeted by a fishing vessel in one calendar day. No hydraulic suction dredging equipment shall be on board any vessel participating in the hand worked cockle fishery.
Limiting vessels to a single fishery	Vessels must not fish cockles from within the Regulated fishery on the same calendar day that they have fished other species from within the Regulated fishery or fished cockles from outside of the Regulated fishery.
Requirement for IVMS	Vessels participating in the Wash Regulated cockle fisheries must have an Inshore Vessel Monitoring System of an approved design on board and working.
Limited licence entitlement	The Authority may limit the maximum number of entitlements to a Wash Fishery Order licence, which is required to fish the Regulated cockle fishery. The Order stipulates the conditions under which entitlement holders may purchase a dredging or hand worked licence.

COCKLE STOCK SUSTAINABILITY MEASURES

<p>Minimum landing size for cockles</p>	<p>There is no legal minimum landing size stipulated for cockles fished from the Wash. However, the Authority's management measures are based on a differentiation between "juvenile" and "adult" cockles, the latter having achieved a minimum size of 14mm width (approx. 19-21mm length).</p>
<p>Selection of cockle beds to be opened to the fishery to protect Yr-0 juvenile cockles and/or to reduce in-combination impacts from predicted mortalities.</p>	<p>Areas supporting high densities (>1,000/m²) of Year-0 juvenile cockles will remain closed to cockle fisheries unless EIFCA survey data shows it would be more beneficial to open them (e.g. widespread ridding-out is predicted).</p> <p>On occasions, when cockle mortality is predicted to be high on specific beds, fishers may be directed to harvest these stocks in preference to other beds to reduce potential in-combination effects the mortalities would otherwise cause.</p> <p>Prior to the opening of the fishery, the Authority will provide Entitlement holders with charts showing areas that are open and closed to the fishery.</p>
<p>Protection of juvenile cockles</p>	<p>When Year-0 juvenile cockles are present in significant densities on a bed being fished, fishermen must use either a cockle net or a riddle to allow these juveniles to be discarded. Stocks containing Year-0 cockles must not be shovelled directly into bulk bags without being riddled.</p>
<p>Minimum total stock biomass</p>	<p>It is one of the site's Conservation Objectives targets to achieve a minimum total cockle stock of 11,000 tonnes in The Wash (including le Strange) at the time of the Authority's annual spring stock surveys and prior to the opening of the public fishery.</p> <p>A fishery can proceed below the Conservation Objective stated level, provided the Authority's annual cockle survey demonstrates that the proposed fishery will not prevent stocks returning to the minimum level as assessed by the following year's stock assessment. This can be demonstrated by providing information on recent trends in spatfall and recruitment to the cockle stock (analysis of size class distribution of stock), related to recent fishing activities (and other activities that may reduce stock levels – through the in-combination assessment).</p>

	Overall, the site will be in favourable condition for this attribute if the 6-year mean achieves or exceeds 11,000t total stock.
Minimum spawning stock biomass	The fishery will not be opened unless a minimum of 3,000 tonnes “adult” cockle ($\geq 14\text{mm}$ width) is identified in the Authority’s surveys.
Minimum shellfish biomass threshold	The fishery will not be permitted to reduce the combined mussel and cockle stocks below a minimum threshold calculated to support the over-wintering oystercatcher population (as defined in the Conservation Objective targets). See Appendix 1 for details.
Total Allowable Catch (TAC) quota	<p>Provided the stocks do not go below the various thresholds stated in the plan, the baseline annual quota (TAC) for the intertidal cockle fishery can be up to 33.3% of the total adult cockle stock ($\geq 14\text{mm}$ width) identified in the Authority’s surveys. See Appendix 2 for details.</p> <p>Where there is evidence from the Authority’s spring surveys or on-going monitoring of the beds predicting large-scale mortalities are imminent or predicted to cause long-term problems, at the Authority’s discretion the TAC may be increased or stocks on specific beds ring-fenced outside of the TAC in order to harvest cockles that are expected to die. See Appendix 3 for details.</p>
Daily vessel quota for hand-worked fishery	<p>Vessels participating in the hand-worked fishery may fish for, take or remove from the Regulated fishery a maximum of two tonnes of cockles in any one calendar day.</p> <p>The daily quotas may be increased at the Authority’s discretion if the annual quota is too large to achieve during the course of a normal fishing season or scientific advice predicts widespread mortalities will occur before the TAC is achieved.</p>

ENVIRONMENTAL CONSERVATION MEASURES

<p>Habitats Regulation Assessment of cockle fishery proposals</p>	<p>Proposed hand-worked cockle fisheries are subject to a detailed Long Term (25 years) Habitats Regulation Assessments by EIFCA, under advice from Natural England, to ascertain their likely impact on conservation features of the Wash and North Norfolk Coast European Marine Site (EMS).</p>
<p>Protection of seal haul-out sites during sensitive periods</p>	<p>Seals are particularly sensitive to human disturbance during periods in which they are pupping, moulting and breeding. Cockle fisheries will not be opened within 600m of seal haul-out sites during these periods, unless there is a ridge on the sand that prevents the fishing activity from being seen from the haul-out site. The Authority will provide charts showing closed areas around haul-out sites prior to the fishery starting.</p> <p>Best available and most up to date data – such as that provided by the provided by the Sea Mammal Research Unit - shall be used to identify the location of seal haul-out sites.</p>
<p>Buffer zone around mussel beds</p>	<p>Cockle fisheries will not occur within the boundaries of identified mussel beds.</p> <p>Prior to the start of the fishery, the Authority will provide entitlement holders with charts showing the positions of mussel beds and potential buffer zones around them.</p>
<p>Prohibition of “blowing out”</p>	<p>Fishermen participating in the hand-worked cockle fishery generally prepare the ground they are going to fish by disturbing the sediment with the wash from their propellers prior to drying out. The practice known as “blowing out”, whereby vessels are anchored to the seabed while circling in concentric rings is prohibited.</p>
<p>“Prop-washing” limitations</p>	<p>“Prop-washing”, whereby the vessel is manoeuvred in circles without being anchored, is allowed if conducted in a responsible manner. Fishermen conducting “prop-washing” activities must follow the guidance provided in the Code of Best Practice as agreed with Natural England.</p>

	<p>Only one ring may be created by a vessel each day and care should be taken to avoid unnecessary disturbance of the seabed.</p> <p>To facilitate circling, a single 1-tonne bag may be suspended in the water column while conducting “prop-washing”.</p>
Spreading unharvested cockles	Any unharvested cockles that remain piled within the “prop-wash” rings after the daily quota has been achieved must be spread out to prevent them from smothering.
Protection of seabed habitats from vessels	Cockle fishers must minimise the disturbance they cause to the seabed with their keels when steaming on/off the cockle beds, while “prop-washing” and when laying on the sands. After fishing, fishermen must ensure their vessels are properly afloat before attempting to steam off the sands.
Closure of fishery if fishing activity is found to be damaging	The Chief Executive Officer or their nominated deputy can close the cockle fishery if it is found that fishing activities are damaging the site.
Limiting duration of fishery by using specified opening date/stated days	The level of disturbance created by the hand-worked cockle fishery is not thought sufficient to require a short-term recovery. As such the hand-worked fishery could potentially operate seven days per week. Usually, however, due to industry preference this fishery operates 4 days/week. The preference is for the fishery to occur on week days, but also to include consideration for tidal heights and times. The fishery is only opened on days when the tide exceeds 6.2m height.

MEASURES FOR ASSESSING STOCKS AND MONITORING FISHERIES

Extensive cockle stock assessment surveys	The Authority conducts extensive surveys in spring to evaluate the distribution, abundance and stock composition characteristics of the Wash cockle population prior to the fishing season. This enables the total fishable stock to be quantified, suitable fishing areas to be identified and spatfall and recruitment levels to be assessed. Survey data can also be analysed to determine mortality, although it may be difficult to separate fishery-associated mortality from natural mortality.
Monitoring of sediment characteristics within cockle beds	The Authority collects some additional environmental data during the cockle surveys. At each survey station an assessment of the sediment type is recorded, from which sediment charts can be produced. The presence of two indicator species <i>Macoma balthica</i> (Baltic tellin) and <i>Lanice conchigela</i> (Sand mason) are recorded.
On-going monitoring of cockle stocks	EIFCA officers monitor the cockle beds during the fishery to identify any environmental factors that might require a change to the management measures in place for the fishery.
Monitoring and enforcement of quota	EIFCOs conduct frequent quayside inspections to inspect and record cockle landings. Licence holders are also required to provide weekly catch returns detailing their activities and catch.
Monitoring and enforcement of fishing activities	IFCOs conduct monitoring at sea to ensure the fishing activities are being conducted in a compliant manner and are not causing excessive disturbance to the site features. IVMS data from vessels participating in the cockle fishery is monitored.

ADDITIONAL SPECIFIC MEASURES FOR MANAGING DREDGE FISHERIES

Occurrence of dredge fisheries	By default, cockle fisheries will be hand-worked. Dredge fisheries will only occur in exceptional circumstances that indicate that it is necessary to optimise the socio-economic benefits of the fishery. The decision to authorise a dredge fishery will be at the discretion of the Authority.
Maximum dredge head width	Hydraulic suction dredge head inside opening (horizontal) must not exceed 76cm.
Maximum number of dredges	No vessel may deploy more than one dredge when engaged in cockle fishing.
Smash rate limit	Studies have found that very few discarded cockles survive if they have been visibly damaged. No more than 10% (by weight) of cockles may be visibly damaged during the dredge fishing operation. A Certificate of Approval, issued by the Authority, is required by each vessel wishing to participate in the dredge fishery, and can only be issued once that vessel has demonstrated a breakage rate of <10%.
Mandatory riddling of catch <i>in situ</i>	Cockles fished by dredge must be riddled where they are fished, to return juvenile and small adult cockles to the substratum. ESFJC research demonstrated that a high proportion of undersized cockles returned to the sea will survive and re-enter the cockle population.
Specified bar spacing	<p>The bar spacing on the riddle and dredge head will be specified by the Authority. ESFJC discard studies found cockles <12mm survive significantly better than larger cockles but do still have associated mortality. Cockles discarded from the dredge head were found to have significantly improved survival rates to those discarded from the riddle. Bar spacing for riddles will usually be 12mm, but may be increased if local stock composition characteristics indicate this will be beneficial to the fishery.</p> <p>Bar spacing on dredge heads may be up to 14mm</p>
Allocation of Total Allowable Catch (TAC) quota between fisheries	In the case that a dredge fishery is to occur, the annual quota (TAC) will be sub-divided into separate allocations for the dredged and hand worked fisheries prior to either fishery opening. Allocations will be determined at the Authority's discretion according to stock and socio-economic conditions following consultation with licence holders.

Habitats Regulation Assessment of cockle fishery proposals	Proposed dredged cockle fisheries will be subject to detailed Habitats Regulation Assessments by EIFCA, under advice from Natural England, to ascertain their likely impact on conservation features of the Wash and North Norfolk Coast European Marine Site (EMS).
Buffer zone around mussel beds	<p>Dredge cockle fisheries will not occur within 100m of the boundaries of identified mussel beds.</p> <p>Prior to the start of the fishery, the Authority will provide licence holders with charts showing the positions of mussel beds and the buffer zones around them.</p>
Protection of seabed habitats from hydraulic suction dredges	Hydraulic suction dredge fisheries will only be allowed to take place on beds where the survey data has identified the sediment across the area of the bed is predominantly mobile sands.
Limiting duration of fishery by using specified opening date/stated days	To provide periods in which the cockle stocks and site features can gain short-term recovery from fishing disturbance, the dredged cockle fishery is limited to four days per week, from an agreed opening date.
Selection of cockle beds to be opened to the fishery to protect small (<14mm width) cockles	<p>To protect small cockles, dredge fisheries may only operate on beds that contain at least 70% (by weight) "adult" (≥14mm width) stock. Areas supporting high densities (>1,000/m²) of Yr-0 juvenile cockles will remain closed</p> <p>The Authority will provide Entitlement holders with charts showing areas that are open and closed to the fishery.</p>
Daily vessel quota for dredge fishery	<p>In any one calendar day, a vessel may fish for, take or remove from the Regulated fishery a maximum of four tonnes of cockles per vessel if participating in the dredged fishery.</p> <p>The daily quotas may be increased at the Authority's discretion if the annual quota is too large to achieve during a normal fishing season or scientific advice predicts widespread mortalities will occur before the TAC is achieved.</p>

PROCEDURE FOR OPENING AND CLOSING THE WASH COCKLE FISHERY

The Authority follows several steps during the process of opening and closing the cockle fishery. These include using survey evidence to develop sound management measures and engaging with the industry, Natural England and the Authority members. The table below details each of the steps that are taken.

PROCEDURE FOR OPENING AND CLOSING THE WASH COCKLE FISHERY	
Step 1	Letter sent to Entitlement holders and Fishermen's Associations prior to conducting surveys, seeking comment on timing of the fishery and inviting fishermen to attend surveys
Step 2	Inter-tidal cockle survey conducted.
Step 3	Analysis of survey results and production of cockle distribution charts. TAC determined and potential management options (including daily quota) developed.
Step 4	Letter sent to Entitlement holders and Fishermen's Associations detailing: <ul style="list-style-type: none"> • Survey Data/TAC • Management proposals • Proposed opening dates based upon four days per calendar week between Mon-Fri on tides over 6.2m • Dates of Industry meeting • What licence is likely to be needed
Step 5	Meet with representative industry groups to discuss proposed management measures. Seek industry preferences for management measures that are discretionary.
Step 6	CEO determines management measures, including daily quota, in consultation with the Chair and Vice-Chair
Step 7	Inform Natural England of survey results and management measures.

Step 8	<p>CEO writes to Entitlement Holders and Fishermen’s Associations to inform them of the opening of the fishery. Ordinarily a minimum of seven calendar days’ notice of fishery opening date will be provided. The letter will provide the following information:</p> <ul style="list-style-type: none"> • TAC • Daily quota • Charts showing the adult and juvenile cockle distributions, overlaid with open and/or closed areas • Open days and tides • Other appropriate information
Step 9	CEO reports on the cockle surveys, management measures and the opening of the fishery at the next Authority meeting
Step 10	<p>Fishermen provide accurate weekly landings returns. The Authority monitors landings data Landings data figures used to estimate when TAC will be exhausted.</p>
Step 11	CEO to close the fishery when the TAC is judged to be exhausted. Ordinarily a minimum of seven calendar days’ notice of the closure will be provided.
Note	<p>The CEO, in consultation with the Chair and Vice-Chair, is empowered to open and close the fishery or parts of the fishery and to introduce, vary or revoke management measures/licence conditions (including the TAC) for the cockle fishery as required for the purposes of fisheries management, including meeting the conservation objectives of the Wash and North Norfolk Coast European Marine Site (EMS) and supporting a sustainable and viable fishery.</p> <p>Ordinarily a minimum of seven calendar days’ notice will be given unless a shorter period is judged necessary to meet the conservation objectives of the Wash and North Norfolk Coast European Marine Site or for the sustainability or the viability of the fishery.</p>

Appendix 1 - Minimum Shellfish Biomass Threshold

When determining the TAC for the Wash cockle fishery, consideration must be given to maintaining shellfish stocks above a minimum threshold required to support the overwintering bird populations. This threshold is calculated using a model that determines the food requirements for the birds in terms of Ash Free Dry Mass (AFDM). Because the over-wintering birds prey on both cockles and mussels, both these species are taken into consideration in the calculations. Although the birds also feed on private mussel lays in the Several fishery and those stocks in the private Le Strange Estate area of The Wash, because these areas do not fall within the Authority's management, they are not included in the model.

The threshold model applies the following values:

- The SSSI Conservation Objective target requires sufficient shellfish to support the oystercatchers¹ over-wintering in the site. Information on the number of over-wintering oystercatchers will be updated regularly following conservation advice (at time of writing this figure is 19,602 oystercatchers)
- Each oystercatcher requires 40kg Ash Free Dry Mass of cockles ($\geq 15\text{mm}$ length²) and/or mussels ($\geq 25\text{mm}$ length)
- 1kg of live mussels = 0.058kg AFDM
- 1kg of live cockles = 0.030kg AFDW

Using the stock values from the spring cockle surveys and the previous autumn's mussel surveys, the combined AFDM of the cockle stocks $\geq 15\text{mm}$ length and mussel stocks $\geq 25\text{mm}$ length is calculated.

Using the most recent conservation advice for the numbers of oystercatchers, their AFDM food requirement is calculated.

The proposed TAC's for the cockle and mussel fisheries are applied to the model to ensure they do not reduce the AFDM food value of the stocks below the required threshold target. If the proposed fisheries would reduce stocks below the threshold limit, the quotas for the two fisheries need to be adjusted accordingly.

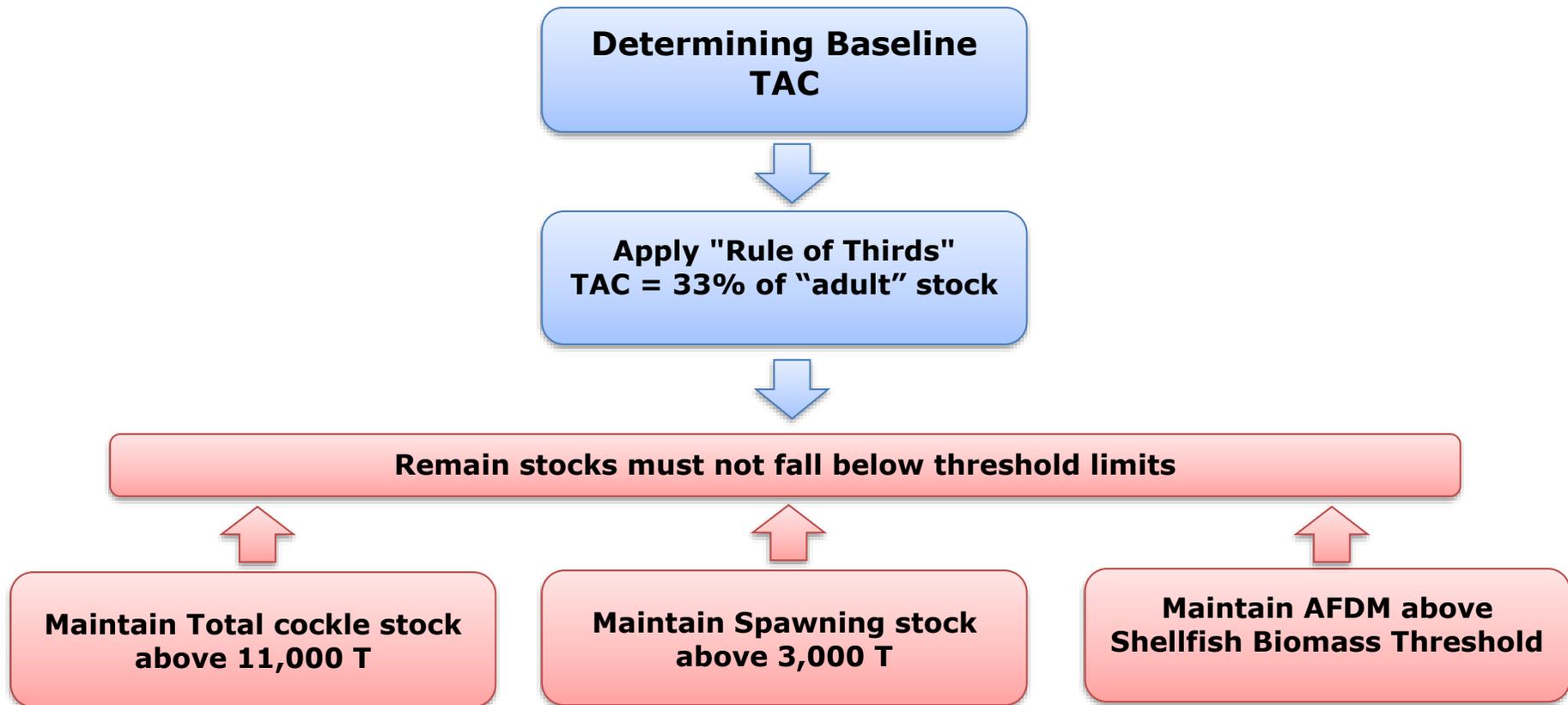
¹ The term "oystercatchers" in this model refers to "oystercatchers and equivalents". The model, therefore, accounts for the requirements of a range of wader species utilising the Wash shellfish stocks.

² A $\geq 15\text{mm}$ length cockle equates to one of approximately $\geq 9\text{mm}$ width. The Authority does not use this size range when differentiating cockles, so the biomass of Year-0 cockles is used as a proxy to represent cockles $< 9\text{mm}$ width/ $< 15\text{mm}$ length.

Appendix 2 – Calculation of Total Allowable Catch (TAC)

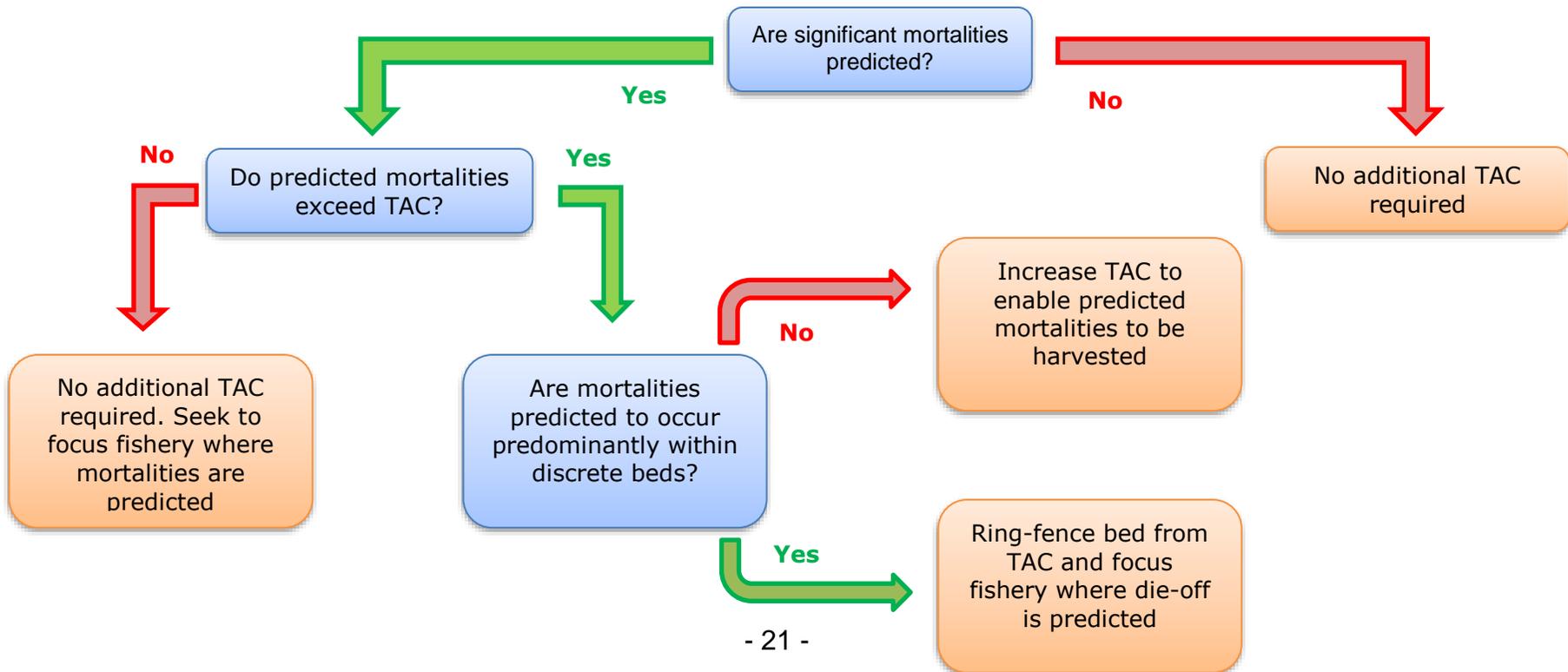
Since its introduction in 1998, the TAC has been calculated using a “Rule of Thirds” principle, in which the TAC is calculated as being one third (33%) of the “adult” ($\geq 14\text{mm}$ width) cockle stock. Various minimum thresholds have then been applied to ensure the fisheries do not deplete the stocks below threshold limits. These thresholds include:

- Minimum Total cockle stock biomass – 11,000 T
- Minimum spawning stock biomass – 3,000 T
- Minimum Shellfish Biomass – See appendix 1



Appendix 3 - Minimising potential “in-combination” effects from natural mortality

Natural mortalities among the cockle stocks are frequently high. Over-crowding in high density patches can cause high levels of localised mortality if the cockles “ridge out”. Since 2008 the cockles in the Wash have also suffered high mortalities from “atypical mortality”, a phenomenon that causes widespread die-offs among cockles that have attained spawning size. Frequently, the combination of “ridging-out” and “atypical mortality” results in annual mortalities that greatly exceed the mortality associated with fishing activities. If these mortalities occur before winter, they provide no benefit to the over-wintering bird populations. While these mortalities can pose a significant in-combination effect with the fishery, if die-offs can be predicted with sufficient confidence to target the fisheries into areas of anticipated losses, the in-combination effect can be reduced. Further, when there is strong evidence predicting stocks will be lost before winter, there is an opportunity to increase fishing effort in those areas. At the Authority’s discretion, this could include increasing the TAC or ring-fencing some areas from the TAC, but such measures will be exceptional as opposed to routine. Under no circumstances, however, should such measures allow stocks to decline below the minimum thresholds described above.



Appendix 4 – Determining daily vessel quota for hand-worked fishery

Applying daily vessel quotas is a common management measure used in many fisheries to maintain exploitation within sustainable limits. This not only helps to protect the targeted stocks, but in environmentally sensitive areas, can help to keep disturbance within acceptable limits. From a purely stock sustainability perspective, it could be argued that the application of an annual Total Allowable Catch for the Wash cockle fishery, as well as a number of minimum thresholds, negates the requirement for a daily vessel quota. There are strong environmental and socio-economic reasons for enforcing one, however. If there was no daily quota, or it was set too high, there would be incentive for the fishers to apply more fishing effort in order to increase their harvest. This could result in unacceptable disturbance to the seabed features or encourage poor behaviours. From a socio-economic perspective, smaller daily quotas mean the finite annual TAC lasts longer. While some fishermen do prefer a short intense cockle fishery, of the type typified by dredge fisheries, currently the majority of fishermen are in favour of extending the cockle season as long as possible. In addition to providing a steady income, it also helps to prevent large-scale displacement to other fisheries that tend to occur during short cockle seasons. As these other fisheries are now coming under scrutiny themselves to be targeted in environmentally-friendly manners, possibly with seasonal closures and/or effort limitation, it is important not to displace effort from the cockle fishery too quickly.

There are, however, counter-arguments why the daily quota should not be too low. Socio-economically, it must be sufficient to cover overheads and be profitable. Also, in years when the TAC is high, the quota needs to be high enough to achieve the TAC during the year. Over the past decade, fishermen have requested the hand-worked daily quota to be reduced from 4 tonnes/day to 2 tonnes/day. For most, this has offered a satisfactory income over a relatively long season. In exceptional years, however, when the TAC is high, 2 tonnes/day is insufficient to achieve the TAC without increasing effort some other way (eg. increasing the number of fishing days per week). Then, it would be prudent to increase the daily quota. From an environmental perspective, this can be important, too. In addition to the physical disturbance the fishery has on the seabed habitats, the disturbance the fishery causes to the feeding birds also needs to be considered. This is particularly important during the winter months when large numbers of waders migrate to the Wash to feed. As disturbance at this time of the year can be particularly damaging, it is important such disturbance is minimised during the winter months. This tends to be self-regulating. Because the meat yields (and, therefore, the value) of cockles declines when the water cools, most fishers tend to stop cockling before winter even if some of the TAC remains.

Landings figures indicate that >90% of the harvested cockles are generally landed before the end of October each year. Managers should, therefore, set an appropriate daily quota each year that would allow 90% of the TAC to be achieved before the end of October. Calculating this figure is not easy, however, because the rate of exploitation is effected by several factors including: number of vessels targeting the stocks, impacts of weather and vessel breakdowns on assigned fishing days and individual catch rates. As these factors cannot realistically be determined at the start of a season the following guide will be applied when setting the daily quota:

Available TAC (tonnes)	Daily Quota (Tonnes)
Up to 4,000	2
4,000 to 10,000	3
Over 10,000	4