Reducing discards of fish at sea: a review of European pilot projects

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Abstract

This paper is about improving the viability of discard-reduction pilot projects. One way to address the problem of wasteful discarding of fish at sea is to initiate pilot projects to trial potential solutions, such as selective gear, area closures, discard bans and data enhancement, which could subsequently be adopted by the fishing industry, either voluntarily or through regulation. However, such pilot projects are often difficult both to set up and to sustain through to completion and implementation. This study reviewed 15 discard-related pilot projects to find out what were the most important determinants of their success or lack of it, and to recommend ways in which the prospects of future pilots could be improved. The review identifies the seven most important factors associated with the viability of the pilot projects - fisheries crises; incentivization; stakeholder participation; funding; expertise; leadership; and enforcement - and shows how fisheries regulators could take steps to reinforce these factors – by faster responses to crises; more incentives and funding; greater use of fishers’ knowledge and leadership; and better enforcement mechanisms.

Keywords

Discarding, fisheries, fishers, pilot study, incentivization

1. Introduction

Discarding is a common practice in commercial fisheries, yet there is widespread agreement that the discarding of fish and other marine organisms by fishers has both a damaging ecological impact (Anon, 2004; Cook, 2001; Kelleher, 2005) and a negative economic effect on commercial fisheries (Pascoe, 1997; Alverson et al., 1996). Many steps have been taken during the past 30 years to lower discard rates, with varying degrees of success (Suuronen and Sarda, 2007; Valdemarsen, 2003; Lart, 2002; Pascoe, 1997; Cappell, 2001). One step has been pilot projects to test discard-reduction techniques, but, disappointingly, few pilots have been initiated, completed and implemented (Kennelly and Broadhurst, 2002). In 2006, in an attempt to promote these projects, the EU funded a study to analyse the ‘difficulties of setting up pilots to reduce or eliminate discards in cooperation with the fishing industry’ (Catchpole, 2008). This paper is a review of the findings of that study.

The study examined 15 discard reduction pilot projects [hereafter referred to as ‘pilots’] (Table 1), three each from England and Ireland, two each from Scotland and France, and one each from Sweden, Germany, the Netherlands, Italy, and the Baltic Sea – all of them involving large-scale fisheries. Nine of the pilots trialled selective gears, including coverless trawls, large diamond meshes, separator panels, square mesh panels, grids, square mesh codends, codend windows, and beam trawl modifications. The other six pilots trialled data enhancement, data self-sampling, data monitoring, real-time closures, and a discard ban. In the paper, reasons why some pilots were more successful than others are identified and discussed, in order to improve the planning of such pilots in future. Section 2 explains the review method used in the paper; section 3 outlines the 15 pilots; section 4 discusses the findings of the review; section 5 presents recommendations for the conduct of future pilots; and section 6 summarizes the paper.

2. Method

To obtain the data necessary for this study, questionnaires were sent to 250 fishing organizations across nine EU Member States, though only 31 returns were received (an 11% return). In addition, 62 interviews were conducted. The total of 93 responses came from 43 industry members, 31 scientists, 17 regulators, and two NGO representatives, located in 13 EU Member States. Also, use was made of documentary material, including scientific papers, technical reports, project reports, project proposals, Regional Advisory Council (RAC) communications, and EU Commission publications.

In interpreting the data, a template was constructed from two sources. The first source was a framework developed out of work conducted in Australia by Kennelly and Broadhurst (1996, 2002) for addressing by-catch problems, which specified “five key steps” for “the successful development and adoption of solutions to improve selection in problematic gears” (Broadhurst et al., 2007: 2). The
second source was work that identified the most important factors affecting the success of marine environmental projects in the Philippines and Indonesia: White et al. (2005) studied 17 integrated coastal management (ICM) projects and listed nine major factors; Pollnac et al. (2001) studied 45 community-based marine protected areas (MPAs) and listed five major, and 27 other, factors; Pomerooy and Carlos (1997) studied 43 community-based coastal management programmes and listed 11 factors; and Pollnac and Pomeroy (2005) studied 11 ICM sites and listed 16 factors. From these sources, seven factors stood out as most important to the rate of success of marine fisheries projects: 1) a perceived crisis in the fishery; 2) economic incentives; 3) stakeholder participation; 4) funding; 5) expert knowledge; 6) leadership; and 7) enforcement. The present review of the levels of success in the pilots is based on the template afforded by these seven factors (Table 2). The definition of ‘success’ is the extent to which a pilot achieves its objectives, which vary in content from one project to another, but which are divisible into four categories: first, initiating the pilot trial; second, completing the pilot; third, validating the trialled technique; and fourth, implementing the validated technique. The contrast between one project and another was often not success versus failure, but different degrees of success in initiation; completion; validation; and implementation. In Table 3, these degrees of success are given an arbitrary score out of 10 (where 1=lowest; and 10 = highest).

3. Outline of pilots

The 15 pilots reviewed are as follows:

3.1 Swedish Nephrops pilot

To allow Nephrops trawling to continue during a Swedish national ban on all cod fishing in 2002, this pilot was initiated by scientists and fishers to find a technical solution to minimize the by-catch of fish. The Nordmore grid was trialled successfully, and it became compulsory in 2004 for Nephrops trawling by Swedish vessels in areas of Swedish waters agreed with the fishing industry, providing near-complete protection for adult round fish to trawl fisheries. Additional incentives to skippers to adopt the grid and square mesh codend included partial financing for the gear; exclusive access to otherwise closed areas for trawling; and unlimited days fishing, which resulted in over 90 vessels (out of 110) using the gear in 2006. But lack of similar incentives in other EU Member States meant that the take-up rate by non-Swedish vessels was very low. For example, no Danish vessel uses this grid today.

3.2 French Nephrops/Hake pilot

To reduce the high level of hake discarding by Nephrops trawlers in the Bay of Biscay, in 2002 the European Commission instituted a hake recovery programme in which the minimum mesh size (MMS) was raised from 70mm to 100mm, but agreed to the French government’s request for a two-year derogation to allow time for the industry to develop alternative solutions. The pilot, which was initiated by the industry, trialled various gears, and found that the most effective device for reducing hake by-catch was the 100mm square mesh panel (SMP). By agreeing to use it, the French Nephrops fleet persuaded the Commission to allow them access to the 100mm closed box for 12 months (annually requestable). Because the National Nephrops Committee (NNC) made the use of the SMP a condition of obtaining a licence, its take-up rate has been high.

3.3 Irish Sea data-enhancement pilot

In 2006, the Commission proposed that where a stock’s spawning stock biomass (SSB) or fishing mortality was poorly known, a 25% default reduction in TACs and (where applicable) fishing effort would be applied. This stimulated the North Western Waters Regional Advisory Council (NWWRAC) to initiate a data collection pilot in 2007 to provide accurate data on catches (both landings and discards) to enhance the existing information, and to pave the way for discard reduction initiatives. However, the pilot was delayed by EU bureaucracy and funding difficulties, while fishers who took part saw it as hijacked by administrators and scientists, and complained about the excessive paperwork involved. The data collected was incomplete, and could not feed into ICES assessments because it lacked a time series of several years. This was the second least successful pilot.

3.4 French Nephrops pilot

Following on from the French Nephrops/hake pilot, which sought to reduce the level of hake by-catch in the French Nephrops fishery, this pilot sought to reduce its discards of undersized Nephrops, estimated at 42% by weight and 61% by number in 2004-2006. This high discard rate, combined with over-quota landings, led to a cut in the 2006 Nephrops quota, which stimulated the industry to initiate a pilot to trial discard reduction gear. Although the trials were inconclusive, the industry decided that in
2008, the receipt of a fishing licence would become conditional on skippers using at least one of three
selective devices.

3.5 Dutch self-sampling pilot
In 2004, the Dutch Fish Product Board (DFPB) began its own plaice (and now cod) sampling
programme, because it was not satisfied with the accuracy of the estimates of discards produced by
scientists at the Institute for Marine Resources & Ecosystem Studies (IMARES), which were used in
stock assessments of North Sea plaice. DFPB’s sampling data for 2005 and 2006 were analysed by
IMARES scientists, who confirmed that they showed significantly lower discard percentages for plaice
than did IMARES’s own estimates (which were 44% higher for 2005, and 55% higher for 2006). The
collection of discard data by the industry led to gear trials of more selective trawl designs with the
support of the industry.

3.6 Scottish real-time closures
In 2007, Scottish fishers in collaboration with the Scottish Government and scientists from Fisheries
Research Services (FRS) initiated a pilot for real-time closures. The pilot was voluntary, involving only
skippers who belong to the Scottish Fishermen’s Federation (SFF), and applied only to fishing in the
North Sea. It prescribed that when three positive counts taken within 48 hours showed that more than
60 fish of >35cm in length have been caught per hour, an area of 15×15 miles would be closed for 21
days, after which it would automatically be re-opened. There was a maximum of nine closures at a
time, and no more than three within a 45×45 mile square, and fishers themselves were responsible for
notifying the authorities of the need for closures, and for leaving the closed areas. It was estimated that
the pilot saved the capture of 300,000 juvenile cod. However, during the pilot, the minimum fish length
was increased from 35cm to 50cm and the pilot’s objective changed to protect spawning cod rather
than juveniles. Although the pilot helped Scottish fishers to obtain extra days-at-sea and an 11% extra
cod quota, it is unclear whether cod discards have been reduced as a result of it.

3.7 English Nephrops pilot
This pilot consisted of two projects initiated and conducted in 2005 and 2006 by the Seafish Industry
Authority (a non-departmental public body supporting the UK’s commercial marine fishing industry)
to reduce discards in the English Nephrops fishery. Both projects trialled the ‘coverless trawl’ designed
to encourage the escape of roundfish, mostly haddock and whiting. The first trial reduced whiting
discards by 70%, and discards of other fish species by 33%, while increasing the catch of the target
species Nephrops by 10%, and producing less damaged animals. The second project, which was more
focused on producing tubed Nephrops for the live market - the skippers were persuaded to take part by
a promise of training in marketing live animals - resulted in less fish caught, mostly whiting and
haddock, and better survival rates for Nephrops. However, the market for live Nephrops dropped
because buyers preferred creel-caught animals, and no skipper adopted the coverless trawl after the
pilot ended.

3.8 German discard ban pilot
There were two fisheries involved in this attempt to trial a ban on discards: the North Sea saithe
fishery, which has a low discard rate; and the cod fishery of the Burg/Fehmarn region in the Baltic Sea,
which has a known discard problem. The pilot was instigated jointly by scientific institutes and the
fishing industry, to improve stock assessment data, reduce the complexity of regulations, and end the
discarding of marketable fish. However, unwillingness by the German government to apply to Brussels
for lifting EU regulations in the Baltic, and a lack of enthusiasm among some German scientists,
initially led to delays and disagreement with the EU Commission over the extent of deregulation of
these fisheries meant that the necessary derogations to proceed were not granted. This was the least
successful pilot – indeed, it was the only one to fail in its initiation.

3.9 Scottish self-sampling pilot
Arising out of the Clyde Fisheries Development Project, a cross-sector partnership formed in 2004
between fishers, processors, scientists, and NGOs to build a sustainable future for the Clyde inshore
fisheries, sought to obtain a comprehensive picture of those fisheries as a first step to tackling issues
such as the high rate of discards in the Nephrops fishery (the most important Clyde fishery). Alienated
from the regulatory and scientific establishment, and faced by quota cuts because of by-catch estimates
that they disagreed with, the industry was keen to collect data that would correct the record. The pilot,
dubbed ‘The Sustainable Supply Chain Project’, generated a snapshot of the Clyde Nephrops fishery
over a 12-month period 2006-07, collecting data on fishing vessels and their crew, gear, catch
composition, discards, and condition of the Nephrops caught. Every vessel in the 100-strong Nephrops fleet was visited, and all fishers were invited to take part in the sampling programme. The resulting data was provided to, and utilized by, scientists, and has encouraged the trial of selective gear. However, adoption of such gear is unlikely to occur until processors are prepared to pay a higher price for Nephrops caught using more selective devices.

3.10 Italian square-mesh codend pilot

Faced with a directive from the European Council to impose in 2007 a 40mm square-mesh or 50mm diamond-mesh on Mediterranean fishing vessels, Italian scientists with the support of fishers initiated a 12-month pilot in 2005-06 to trial a square-mesh codend (SMC) on an Italian commercial vessel. The results showed that for hake, the SMC was much more selective than a traditional diamond-mesh bag, and that the hake that escaped were below the minimum landing mesh size (MLS) of 20cm, and therefore did not represent economic losses. There were some losses of target species, but not at great economic cost to the fishers, and their quality was unaffected by the SMC. Skippers were prepared to adopt the SMC, provided all other skippers did so. In 2007, the General Fisheries Commission for the Mediterranean (GFCM) agreed to implement on a voluntary basis the 40mm SMC in bottom trawling, and to evaluate the results by 2010.

3.11 Northern Irish Nephrops pilot

This pilot comprised four projects initiated by the Anglo-Northern Irish Producers’ Organization (ANIFPO) relating to discarding practices, to find alternative mitigation measures to replace the anticipated restrictions on quota and days-at-sea imposed by the Irish Sea Cod Recovery Programme. First, the ‘Alternative science project’ trialled large diamond meshes inserted in the top sheet, but the results were inconclusive. Second, the ‘Additional science project’ collected data, including age data of fish, to check the accuracy of scientists’ stock assessment calculations, but again the results were inconclusive. Third, the ‘Replacing of trawls by creels project’ examined whether an open sea Nephrops fishery was economically viable using creels rather than trawls, but found by the end of the project in 2007 that although creels could produce returns matching those of trawls, they could only do so with 1,000 or more creels per vessel, which would lead to gear conflict with trawlers. Fourth, the ‘Improving the selectivity of Nephrops trawls project’ (which was slow to get started), following on from the first project, will trial more types of selective gear. This pilot was bedevilled by funding problems, which led to ANIFPO’s declining to apply for more funds, and this, together with the generally inconclusive nature of its results, make it the third least successful of the 15 pilots reviewed.

3.12 English beam trawl pilot

Four related projects were conducted by the UK’s premier fisheries research centre, Cefas (Centre for Environment, Fisheries and Aquaculture Science), under this pilot, aimed at reducing discards in the British beam trawl fishery. First, three kinds of gear modification were trialled – reduced headline height; a large diamond mesh escape panel (both to reduce the capture of roundfish, especially cod); and a large square-mesh ‘benthic release panel’ to reduce the retention of unwanted benthic invertebrates – but only the third modification showed promise. Second, Defra (UK Department for Environment, Food and Rural Affairs) funded a simultaneous trial of the benthic release panel, which confirmed its promise. Third, with FIGF funding, that panel was tested over 12 months by beam trawlers under commercial conditions, incentivized by the offer of keeping the modified net. The results were encouraging, but further finessing of the panel was needed, and in the fourth project, a ‘Clean Fishing Competition’ funded under the FIGF Programme was held to develop it further and use it commercially for six months in 2006-07 (Revill, 2007). The competition winner, Mike Sharp of the Lady T Emiel, showed that his finessing of the panel resulted in reducing discard levels by about 60%, while making record landings of target fish of improved quality (and therefore higher prices), and his design has been adopted by 12 vessels. But other skippers have not used the panel, fearing loss of some fish species such as Dover sole and scallops, which is a disappointing outcome.

3.13 English self-sampling pilot

As part of the UK Fisheries Science Partnership programme, the fishing industry requested that cod fishery skippers collect their own information on cod catches (both landings and discards), because of feelings that the scientists’ estimates of the 2005 year class of cod were too low due to fish escaping beneath the survey ship trawls, and that consequently cod quotas were too small. In this pilot, known as the ‘Codwatch Project’, 12 fishing vessels belonging to the Eastern England Fish Producers’ Organization (EEFPO) were paid £50 per day to record during a 12 month period (April 2007–March 2008) the incidence, distribution, and abundance of the 2005 and 2006 year classes, and of cod in
general, from their commercial catches, as well as data on fishing location, fishing effort, fishing gear, and target species, etc. An interim report (Large et al., 2007) stated that more than 1,000 hauls were sampled between April and July 2007, the data from which was submitted to EEFPO for collation, analysis, and comparison with estimates from the Cefas Discard Observer Scheme, before onward transmission to Cefas scientists and EEFPO members.

3.14 Irish Nephrops/cod pilot

Independently of the Northern Irish Nephrops pilot, the Irish Nephrops/cod pilot was initiated by the industry during the first introduction of closed areas and seasons in the Irish Sea by the EU in 2000 (Rihan and McDonnell, 2003). The aim of the pilot was to test a separator panel designed to release spawning cod, and the panel proved so effective in reducing the capture of spawning cod, that fishing with Nephrops trawls fitted with separator panels was permitted within a defined part of the closure area in 2001. However, although an increasing number of vessels took advantage of this permission (from 5 in 2002 to 14 in 2003), the permitted area was too small and too poorly policed for the gear modification to have much impact on spawning stocks.

3.15 Baltic Sea: BACOMA pilot

The decline of the eastern Baltic cod stock was caused by high fishing pressure combined with poor recruitment. The Baltic fishers’ organizations sought to head off heavy cuts in quotas or large-scale fishing closures by initiating trials of selective gear during 1997-2000 (Suuronen et al., 2007). A total of 465 trawl tows trialled various types of codends, the results suggesting that the best device for reducing cod discards was an escape window in the codend. A square-mesh window (called the BACOMA window) installed in the codend, was chosen by the industry as the preferred design, and when a 120mm version was prescribed for the Baltic cod fishery in 2002, use of the BACOMA window codend was widespread. However, the target catch losses to trawlers using it were considerable – up to 70% - and most skippers rapidly switched to the alternative permitted by the regulations, a 130mm diamond-mesh codend, which resulted in a resumption of high discard rates and the consequent closure of the fishery by the EU in April 2003. The ban was lifted in September 2003 but only for vessels using a 110mm BACOMA-window codend.

4. Discussion

A summary of the findings of the review are set out in Table 3, which shows that 14 pilots were successfully initiated (the German discard pilot did not start); nine pilots were successful in completing their trials; in seven pilots the trialled techniques fully achieved their objectives; and four pilots resulted in implementation of the trialled techniques. In this section, the reasons for these varying outcomes are discussed, focusing on the seven most important factors promoting success in the pilots.

3.1 Perceived crisis in the fishery

The first of these factors was a perceived crisis in the fishery: all but two\(^1\) of the initiated pilots owed their origin to a perceived crisis, which served as a trigger or stimulus to kick-start the pilot. Most crises were regulatory-related - mainly fishery restrictions, imposed or threatened, such as days-at-sea reductions, quota cuts, closed areas or changes to mesh size and mesh shape. Generally, the perceived crisis was responded to by the industry, in that ten of the pilots were initiated by the fishing industry; two by industry together with scientists; one by industry, scientists and conservationists; and two by scientists, though the success of the pilots did not depend on who was the initiator: of the five most successful pilots, only three were initiated by the industry alone. However, the existence of a regulatory trigger was no guarantee that a pilot would be initiated - a trigger may be a necessary condition for initiation, but it is not a sufficient condition. Still less can a trigger guarantee success in completion, validation, and implementation, as the Irish Sea data-enhancement pilot showed.

3.2 Economic incentives

The second factor was economic incentivization for fishers. The sufficiency of economic incentives to, first, take part in a pilot; and, second, to implement its trialled techniques, are given in Table 2. In only one proposed pilot was the economic incentive too small to persuade enough fishers to participate (the Irish Sea data-enhancement pilot), but in eight pilots, the economic incentives were too low to implement the trialled techniques. There were three kinds of economic incentives for fishers to take

\(^1\)The two pilots not originating in a crisis were the English Nephrops pilot, which was initiated by Seafish and supported by the industry in return for marketing training; and the English beam-trawl pilot, which was initiated and conducted by Cefas scientists.
part in, and implement, pilots: direct payments; indirect inducements such as privileged access to
fishing grounds and more permitted days at sea; and higher prices from catches obtained with fewer
discards. Direct payments were made in XXX pilots [Tom, do you know in how many pilots direct
payments were made to fishers? I have counted four explicit references to direct payments being made
(Swedish Nephrops; French Nephrops; English beam-trawl; and English cod watch), but in the others,
does no mention of direct payments necessarily mean they were not paid?] to compensate for catch
losses during fishing gear development, or to pay for new fishing gear, or to fund prize money awarded
to skippers who developed the most environmentally friendly fishing techniques.

Indirect inducements in the form of increased access and days-at-sea were provided in seven of the
pilots..The size of the required inducement depended on the circumstances of the pilot, including the
opinion of skippers: involving the fishing industry in choosing incentives was shown to aid their
effectiveness. However, a problem with some regulatory incentives was their hypothetical nature. For
instance, an inducement for skippers to engage in data-enhancement pilots was a correction of
scientific assessment of fish stock levels, leading to an increased quota. But there is no guarantee of
such an outcome.

Expected higher prices for selectively-caught fish played an explicit part in two pilots, and an implicit
part in several others, though while it persuaded fishers to take part, it was not reliable enough to
persuade them to implement. For example, in the English Nephrops pilot, what motivated the industry
to take part was the prospect that processors would be willing to pay higher prices for Nephrops caught
more selectively, but the subsequent withdrawal of that marketing opportunity proved fatal to the future
uptake of the coverless trawl.

3.3 Stakeholder participation
The third factor, stakeholder participation, was evident in all the pilots. It was particularly clear that
pilots needed wholehearted support from the fishing industry (Broadhurst 2000; Kennelly and
Broadhurst, 2002). In the French Nephrops pilot, the “insights gained through participation in a trial
undertaken in real fishing conditions encouraged the professionals to adopt these devices as their own”
(Guigue, 2007). Similarly, involvement of the whole fleet was seen as a major strength of the highly
successful Scottish self-sampling pilot. Indeed, in the more successful pilots, fishers were the senior
partner, acting as the driving force and the decision-makers, while in the second least successful pilot
(the Irish Sea data-enhancement pilot), after an initial input, at no subsequent point was that pilot
 driven by the industry, reflecting fishers’ perception that the pilot had been taken over by
administrators and scientists.

3.4 Funding
Pilots needed funding. The Swedish Nephrops pilot cost 480,000 Euros, and the French Nephrops pilot
cost 1,400,000 Euros. In ten cases, EU structural funds from the Financial Instrument for Fisheries
Guidance (FIFG) programme partially (up to 50%) funded the pilots; the remaining funding came from
national and regional administrations. Even where the availability of funds was not an obstacle in
initiating a pilot, bureaucratic problems surrounding funding could be harmful, as in the French
Nephrops pilot (Guige, 2007) and the Northern Irish Nephrops pilot..These negative experiences of the
participants of these pilots dissuaded them from applying for more FIFG funds.

3.5 Expert knowledge
Technical and scientific expertise was available in all the more successful projects, and was provided at
each stage. The scientists’ roles included serving as facilitator to the industry, developing solution
concepts which often originated with fishers, allowing skippers to do the fine-tuning. Scientists also
monitored the operation of the pilots, especially at the evaluation stage, in order to confirm (or deny)
claims that the techniques employed in the trials were effective in reducing discards. An important
factor contributing to the relative failure of the Irish Sea data-enhancement pilot was that there was
inadequate thought given to the status of the data that would be collected by the fishers.

3.6 Leadership
Leadership was a factor clearly linked to the level of success of the pilots. In all the more successful
projects, there was entrepreneurial leadership from either an individual or a group, to initiate and
organise the project, and to develop innovative ways to attract and retain support for it. For example,
central to the success of the French Nephrops project (Guigue, 2007) was the strong leadership
provided by the French National Committee of Marine Fisheries and Marine Husbandry (CNPMEM), as well as the National Nephrops Committee (NNC).

3.7 Enforcement

The need for enforcement was obvious in several projects, both for the completion of the pilots and for subsequent implementation of their recommendations. For instance, in the Italian square-mesh codend pilot (Lucchetti et al., 2006) the selective gear had to be enforced on all fishers, because fishers supported the measure only if all fishers adopted it, so that users would not be disadvantaged relative to non-users.

5. Recommendations

Pilots are important, because the constraints faced by fishers during commercial fishing do not generally permit experimenting with more-selective fishing practices. Moreover, pilots provide a framework for industry to develop solutions acceptable to them and so increase the likelihood of uptake and compliance with new measures. However, pilots are unlikely to be initiated, validated, completed and implemented if many of the above seven conditions are not in place. How can these seven conditions best be met?

With regard to a perceived crisis in the fishery, management should not wait for the fishing industry to identify which fisheries are to have pilots, but should proactively identify the fisheries with the highest rates of discarding. To avoid the danger that releasing this information could make fishers defensive and alienate them from the management strategy for pilots, it is proposed that at the same time, regional working groups which include fishers, scientists and managers be established to choose pilots and their objectives. For economic incentives, one way to ensure that they are strong enough is to hold pre-pilot briefings with skippers to determine appropriate rates of reward for taking part in, and completing, pilots, and to provide assurances that if a pilot proves successful, management will respond by changing the rules to benefit skippers who adopt the trialled techniques. In relation to stakeholder participation, managers must involve fishers as a first priority, and other stakeholders also, in the initiation, validation, completion, and implementation of pilots (Kennelly and Broadhurst, 2002). It is particularly important for fishers to be involved in the design of the trialled gear, and for the trials to be carried out on commercial vessels rather than on research vessels (Broadhurst, 2000). With regard to funding, managers have to ensure that projects are adequately financed.

In terms of expert knowledge, managers have to recognize that while there has to be scientific involvement in the initiation of the pilot, its objectives must synchronise with the perceptions of the fishing industry. Moreover, regulators must acknowledge that fishers themselves have expert knowledge to contribute to discard projects, as shown in the French Nephrops pilot. Nevertheless, scientists have a major role in discard pilots, and while data from pilots must be owned by the participants, its analysis must be conducted by a scientific institute. With regard to leadership, managers should encourage the fishing industry to take the lead in pilots. A steering group should represent all affected fishing industry members, and also include scientists, and a manager should be appointed to ensure that the objectives of the pilot are met, within budget.

Finally, in relation to enforcement, managers should ensure that a project produces a discard-reduction strategy that is implemented, either by voluntary compliance, or by legal sanctions. On voluntary compliance, Kennelly and Broadhurst argue that one of the most important tasks is “the promotion of industry acceptance and adoption of the recommended designs”, and they suggest an elaborate strategy of publicity by video documentaries, poster presentations, and the provision of printed summaries of research at fishing port meetings (Broadhurst, 2000). With regard to legal sanctions, implementation arrangements, which should include specific targets for the level of discard reduction for each species concerned, must satisfy fishers that if they adhere to discard-reduction measures, other fishers will be prevented from free-riding.

6. Conclusion

In this review of 15 discard reduction pilots, it has been argued that the main reasons for the success of pilots undertaken, validated, completed, and implemented were perceived crises; economic incentives; stakeholder participation; adequate funding; expert knowledge; strong leadership; and strict enforcement. To increase the number of successful pilots, it has been recommended to fisheries regulators that they take more pro-active action to respond to crises; increase the attractiveness of incentives; ensure that fishers are involved at every stage; guarantee adequate levels of funding;
provide scientific expertise; build leadership capacity in the fishing industry; and secure fisher compliance with trialled gear. If such steps are taken, the scourge of discarding will be much more effectively challenged than at present.

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<td>Mandatory landing of all catches including undersized and non-target fish to motivate more selective fishing</td>
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<td>Interviews with pilot participants; Anon. (2006a)</td>
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Table 2 The seven factors required for a successful pilot; which were largely met (Y) and which were not fully met (N)

<table>
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<tr>
<th>Pilot</th>
<th>1 Perceived crisis in the fishery</th>
<th>2a Economic incentive to take part in pilot</th>
<th>2b Economic incentive to reduce discards</th>
<th>3 Stakeholder participation</th>
<th>4 Funding</th>
<th>5 Expert knowledge</th>
<th>6 Leadership of new legislation</th>
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