Summary

This report summarizes the results of the second phase of the scientific evaluation of the Dutch shellfish fishery policy (EVA II) and relates these findings to the results of other studies on the ecological impacts of shellfish fisheries in the Wadden Sea and elsewhere. The report begins by sketching the history of the problem, and setting out the policy and research questions. This is followed by an overview of results and findings. The most important results are then summarised again in a chapter with conclusions, followed by a chapter with recommendations. A glossary of terms and an overview of research reports are given at the end of this document. All reports are available from the internet site www.eva2.nl.

Four main policy questions are at the heart of the EVA II research program. These policy questions (in bold) were translated into research questions (underlined), and these were answered on the basis of the research carried out as part of the EVA II project as well as other relevant scientific investigations in the Wadden Sea or elsewhere.

1. What are acceptable effects of shellfish fishing on the benthic biotopes of stable mussel beds, intertidal flats, cockle beds and sea grass fields? What are acceptable effects on birds which feed on the shellfish and are dependent on the biotope in the coastal waters?

1a. How and to what extent do the different forms of shellfish fishing impact on the important benthic biotopes?

Cockle fishery on intertidal flats – direct impacts. Cockle fishery by suction dredging removes cockles of one or more years old. In the Wadden Sea, a good spatfall of cockles occurs on average once every six years. During the past ten years, on average 25% of the surface of the cockle beds in the open areas was touched by a cockle dredge each year. More than half of the surface of the beds in the open areas was fished each year, where fished means that at least 2% of the area was actually touched by the cockle dredge. As a result, a larger proportion of the biomass of mature cockles was to be found in the areas closed for shellfish fishing. Suction dredging has a direct negative impact on mussel beds and sea grass beds, when fishing occurs in these habitats. However, fishing plans effectively exclude mussel beds and sea grass beds from cockle fishing, except for one newly established sea grass bed along the Groningen coast, which disappeared after having been fished for several years. Cockle fishery leads to considerable mortality of non-target benthic fauna in the top layer of the sediment on the fished bed, running into dozens of percent and also removes dispersed mussels. Suction dredging also leads to a decrease in the silt content of the top layer of the sediment in the short term.

Cockle fishery on intertidal flats – indirect effects. There are also indications for a long-term effect of cockle fishery on the sediment. Since cockles capture silt through their pseudofaeces, the long-term effect is probably a consequence of the systematic decrease in cockle stock as a result of cockle fishing. There are no

indications that suction dredging reduces the prospects of re-establishment of sea grass beds, but systematic research is lacking. At the scale of the Wadden Sea there is no evidence for a decrease in the recruitment of mussels as a result of cockle fishing, despite the fact that such evidence does exist at small spatial scales. Less cockle spat developed in the open areas than in the closed areas. However, the difference has disappeared since 2000 and recruitment was even slightly higher in the open areas during the last three years. This may be explained by a negative effect of high cockle densities on recruitment and the fact that high densities of cockles occurred in the areas closed for fishing. There are indications that the densities of the ragworm *Nereis diversicolor* have increased as the result of cockle fishery. In a study in the western Wadden Sea, a more general shift towards worms was observed.

Mussel fishery on intertidal flats. Mussel beds enrich the surrounding sediment, so the biological loss that results from removal of a mussel bed is greater than the loss of the mussel bed itself. Mussel fishery on stable mussel beds may lead to a long-term decrease in the coverage of such mussel beds, as was demonstrated in the Wash. In order to restore mussel bed areas the Sea and Coastal Fisheries Policy does not allow mussel fishery on stable mussel beds in intertidal areas. Large scale recruitment of mussels in the intertidal areas occurred on average once every 4 years over the past 50 years. Successful recruitment is the primary condition for the formation of new mussel beds area. Once established other factors become relevant. In the Dutch Wadden Sea relatively unstable seed beds often disappear during winter storms and observations in lower Saxony suggest that high bird predation may also lead to loss of seed beds. The combination of only some good spatfalls since 1990 and considerable losses of young mussel beds led to a relatively slow recovery of the mussel stocks. In the nineties, after the disappearance of the intertidal mussel beds, a good spatfall occurred in part of the area in 1994, but most of these beds disappeared during the subsequent winter and spring. In 1999 and particularly in 2001 large seed bed areas have established, and about 50% of these new beds survived. At present, after 12 years almost without fishery, about 2100 ha of relatively young, but more or less stable beds are present. A controlled fishing experiment on newly established mussel seed beds showed a decrease in the coverage of such mussel beds directly after fishing, but no evidence was found for either a positive or a negative long-term effect on these beds in terms of coverage. The role of mussels that disappeared naturally during winter was not studied, so it is not possible to make a comparison with the yield of the mussels that were fished and transported to the culture lots.

Mussel fishery and mussel culture in subtidal areas. The Sea and Coastal Fisheries Policy does allow fishery on all mussel beds in the subtidal and this could potentially explain why there are hardly any old mussel beds in the subtidal areas of the Wadden Sea and Oosterschelde at present. By transporting mussels from areas with high recruitment but poor growth, to areas with poor recruitment but high growth, mussel culture increases the average standing stock of mussels, despite subsequent harvest. A first attempt to calculate the overall effect of mussel culture on the subtidal mussel stocks during the 1990s points to an increase of the total subtidal stock in Dutch coastal waters by a factor 2. As a considerable part of seed mussels

and half-grown mussels is transplanted to the Oosterschelde, the net increase in the Wadden Sea was tentatively estimated as ca. 15%. We did not observe effects of sublittoral mussel fishing on mussel seed production and fishing for mussel seed does occur in roughly the same areas year after year. However, fishery effects on spatfall in subtidal areas cannot be excluded because available data for analyses of fishery effects on spatfall are limited, and comparison with reference areas is not possible. We did not study effects of sublittoral mussel fishing on epibenthic species. A more detailed and quantitative assessment of the total effect of mussel farming and fishing on biodiversity in the Dutch Wadden Sea is difficult to make because comparative information from untouched mussel beds, fished beds and culture locations are missing.

1b. How and to what extent does shellfish fishing affect the food supply of oystercatchers and eider ducks, which feed on large shellfish, and other wild birds which are dependent on these biotopes?

Cockle fishery. Cockle fishery reduces the food stock of oystercatchers. On the basis of model calculations, it is estimated that this direct effect of cockle fishery amounts to a decrease of the carrying capacity of Wadden Sea and Oosterschelde for oystercatchers with a number in the order 15000 and 3300 birds respectively, during the evaluation period. These model calculations do not take cumulative effects of cockle fishery on stock sizes, recruitment and age distribution of cockles into account. At present, there is no evidence that cockle fishery has had a negative impact on common eiders, which may be due to the fact that cockles are not a preferred prey for common eiders as a result of their thick shells. Cockle fishery may influence the food supply of knots through its influence on stocks of small shellfish. There are indications that the quality of cockles in fished areas is reduced. It is possible that cockle fishery favours some worm species that are an important food source for birds feeding on worms.

Mussel fishery. The primary reason for the decline in the number of oystercatchers wintering in the Wadden Sea from 260000 to 175000 is the disappearance of the intertidal mussel beds. This disappearance was caused by mussel fishery in combination with recruitment failure and possibly winter storms. The numbers of common eiders which winter in and around the Wadden Sea have also decreased. Under the assumption that mussel fishery does not impact recruitment of mussels in the subtidal, mussel culture has, on average, improved the food supply of common eiders during the evaluation period. However, scarcity of sublittoral mussel seed and the lack of mussel seed fishery from intertidal seed stocks resulted in low stocks of mussels on culture plots in a number of years. As a consequence, common eiders have experienced several years with mass mortality related to low stocks of sublittoral mussels. Fluctuations in shellfish stocks are a natural phenomenon. However, due to lack of data, it cannot be excluded that during years of scarcity, transport of mussels from culture lots in the Wadden Sea to culture lots in the Oosterschelde was increased, thereby increasing the food shortage for the common eiders.

2. One measure currently in use is the closure of areas to fishing. The main aim of this is to restore the most important benthic biotopes, specifically the intertidal mussel beds and seagrass fields. Another existing policy measure is that of food reservation. Have these measures produced the desired effect?

2a. Has the area of intertidal mussel beds been restored to the desired level? If not, is that due to shellfish fishing, other human impact or natural factors?
The policy aim is 2000-4000 ha of stable intertidal mussel beds. If 'stable' is equated to 'having survived at least one winter' it can be concluded that the area has been restored to the desired level at the end of the evaluation period. From 1990 to 1994 there were practically no mussel beds in the Wadden Sea. Since 1995, there has been a recovery to 2500 ha in 2002. This recovery was mainly due to natural circumstances, because almost no fishery was carried out since 1992.

2b. Have the seagrass fields recovered to the maximum possible extent? If not, is that due to shellfish fishing, other human impact or natural factors?
Recovery of seagrass fields has occurred, but it was not maximal, since one new establishment disappeared again due to cockle fishery in the period 1999-2002. About 30% of this fished area showed recovery in 2003.

2c. Are the methods previously used to calculate the food requirements of shellfish-eating birds correct?
The method previously used was not correct. The amount of food that must be present per bird at the start of winter (the ecological food requirement) is around 2.5 to 3 times higher than the physiological food requirement, depending on factors like emersion time, distribution of the prey and the efficiency with which the birds can harvest the food. The ecological food requirement for oystercatchers in the Wadden Sea was estimated at around 200 kilos of cockle flesh per bird in the absence of mussel beds. For the Oosterschelde the figure is 150 kilos. There is a margin for error in this ecological food requirement which is difficult to determine accurately, but which could amount to some dozens of kilos. The margin of error in the estimate of the ecological food requirements of the common eider is greater than for oystercatchers, since our knowledge of the feeding ecology of common eiders is crude compared to the details of our knowledge on the feeding ecology of oystercatchers. The risk of increased mortality among eider ducks rises as the stocks of half-grown and mature sublittoral mussels in the Wadden Sea in December fall below the level of 60 million kilos net fresh weight. Food shortage can also have natural causes, like long periods with poor shellfish recruitment, so food reservation policy does not account for periods of natural food shortage.

2d. How do the observed numbers of birds compare with the target or reference numbers?
The numbers of oystercatchers in Wadden Sea and Oosterschelde have declined as a result of food shortages. In the Wadden Sea from 260000 to 175000. In the Oosterschelde from 64000 (of which an estimated 54400 did not feed on mussels) to 35000. In recent years there are indications of a slight recovery in the Oosterschelde and a stabilization of numbers in the Wadden Sea. The numbers of eider ducks

which winter in and around the Wadden Sea have decreased from 130000 to 100000, partly due to several years of mass mortality.

2e. How can any discrepancies in these numbers be explained?
The decrease in the number of common eiders wintering in Dutch coastal waters is most likely due to several years with high mortality as a result of food shortages. The main food stock in short supply were sublittoral mussels, but other food stocks probably also played a role. The decrease in the number of oystercatchers wintering in the Dutch Wadden Sea is primarily due to the disappearance and subsequent slow recovery of the intertidal mussel beds, and to a lesser extent due to the continuing cockle fishery. The decrease in the number of oystercatchers wintering in the Oosterschelde is primarily due to the lowered stocks of cockles to which cockle fishery has contributed.

3. Is the result of effects and measures such that the Netherlands meets its international obligations under the EU Birds Directive and the EU Habitats Directive? What can we learn from the evaluation of current policy and what possible guarantees are there for the future?

3a. Is the current food reservation policy sufficient to prevent shellfish fishing in the long term having a detrimental effect on populations of shellfish-eating birds?
The policy of food reservation was unable to prevent a food shortage due to fisheries for the reference number of shellfish-eating birds. The current food reservation policy is insufficient, because it is not based on the ecological food requirements of the birds. It should be noticed that the food reservation policy does not account for periods of natural food shortage. In addition, the implicit assumption that the ecosystems of the Wadden Sea and Oosterschelde can return to the state they had during the reference period, may be questioned.

3b. Are there indications that numbers of wading birds which do not feed on large shellfish have improved or declined? And are any such developments the result of shellfish fishing, of other human factors or of natural factors?
In the Wadden Sea, the number of knots has increased during the early 1990s. More recently, numbers have decreased. Both increase and decrease seemed primarily to occur in the open areas, but it is difficult to assign knots counted during high tide to low tide feeding areas. The number of several species of waders feeding primarily on worms has increased during the evaluation period. For most of these species, the increase occurred primarily in the areas open to cockle fishery. It cannot be excluded that the increase of worm-feeding waders is related to an increased density of some worm species as a result of cockle fishery.

3c. Are the effects of shellfish fishing 'significant' in terms of the Habitats Directive?
During the course of the investigations, the ministry of LNV decided that this last question will be addressed in the follow-up to EVA II: experts will be asked to judge if the new shellfishing policy complies with the EU directives.

4. If it is established that shellfish fishing has had any adverse effects, what additional measures could be taken to counter these effects?

It was decided by the ministry of LNV that this question should be addressed in the follow-up to EVA II.