

Status for the project entitled:

Investigations on the artificial reef effect on fish from marine windmill parks at Horns Reef.

Contract Ref: Ordre Nr. 69.(11-06-01)

Our ref: 2001/C231/10

Samt rettelser til tidsplan jævnf. brev 18-06-01

1. Purpose of the project

The objectives of this investigation are:

- to study fish attraction relative to single windmill structures and to the windmill park
- to study the potential fish production enhancement of single windmill structures and of the windmill park

2. Methods

The artificial reef impact on fish attraction and potential production from the individual windmill base, as well as from the whole windmill park will be examined by studying fish assemblages prior to and after deployment of the windmills, and from transects from individual windmills in different positions in the park. The following zero hypothesis will be tested:

- a) There are no differences in fish assemblages (composition and occurrence) relative to the distance from the individual windmill
- b) There are no differences in fish assemblages around windmills placed centrally or peripherally in the park.
- c) There are no differences in fish composition and occurrence within and outside the windmill park.
- d) There are no differences in fish composition and occurrence in the area before and after the deployment of the windmill park.
- e) There are no differences in the stomach content of fish caught in the windmill area and outside. There are no similarities between prey found in fish around windmills and fauna growing on the new habitat provided by the windmill foundation structures. Prey found in the fish stomach can be used to examine the foraging behaviour of the resident fish. This assumes that there are clear differences in prey assemblages on the new hard bottom and the surrounding bottom. (Bottom fauna surveys will not be carried out by DFU. Thus, planning and execution of bottom-fauna and fish population studies must be co-ordinated in order to ensure this type of analysis).

BACI (Before/After/Control/Impact) model will be employed. This involves fishing surveys in the windmill park and in the control area and a baseline study. The fishing surveys will be directed towards obtaining a description of the reef attraction impact of the windmill park relative to previous conditions (Before establishment) and relative to the surrounding area (Control area). Further, a description of the fish

population attracted to the windmill foundations or to the windmill park as a whole will be obtained. Stomach analysis will be carried out to examine the extent fish utilise the fauna colonising the windmill foundations (hard-bottom base and rock coaming). These analyses will be carried out on the most frequently occurring species.

Since the windmills are expected to be deployed in 2002, the baseline study can be carried out in 2001 during 2 different seasons. Stomach content analysis may be restricted to the period after deployment to establish the degree of utilisation of prey resources being established on the hard bottom bases of the windmills.

Stomach content for the most frequently occurring species will be analysed. An endeavour to provide data from a representative flatfish and roundfish species will be made.

Fishing surveys will be conducted after the deployment of the marine windmill park twice annually (2 seasons) at 12 stations within the park and 3 stations outside the windmill park, in the control area. In total 15 stations will be established.

3. Fishing surveys.

DFU intends to charter commercial fishing vessels for the fishing surveys. Fishing will be conducted with DFU's KFG 7/9 research gillnets (Eigaard et al., 2000) modified for weather conditions at Horns Reef. Aboard the chartered fishing vessels, DFU's qualified personnel will be in command of the sampling. Gillnet fishery within the park in transects at varying distance from three windmill foundation (<5m, 50m, 100m, 200m) located centrally and peripherally in the park, and outside the park in a further 3 stations in a control area. The 12 windmill stations and 3 control stations give a total of 15 stations. A minimum of 20 gillnet arrays will be set at each station, deploying a minimum of 2 per station per fishing day. Each gillnet will fish for 12 hours during daytime or nighttime. A total of 8-9 fishing days will be required to carry out the fishery in the 15 stations.

The catch will be treated according to internationally recognised standardised methods, which DFU implements routinely. Information on total catch per species in numbers and weight and length distribution will be collected. The most valuable commercial species will be aged, using fish otoliths. Since this process demands the use of microscopes and specially trained personnel, this work will be carried out at DFU's laboratories.

4. Experimental protocol : tasks and (responsible)

Task 1: Fishing surveys.

2001/2002: Baseline study.

Since the KFG research gillnets have not been tested in conditions such as those around Horns Reef, these need to be tested in the area and modified accordingly. As an added security the fishing will be supplemented with fishery with commercial sole and cod nets. Prior to the first survey DFU's KFG research gillnets will be further developed and their fishing effectiveness described.

Due to timing of the start of the project and delay to test the performance of the gillnets in this site prior to the survey, the first survey, which can be conducted is the autumn survey in September. The spring survey will have to be conducted in 2002 before deployment of the windmills, which are scheduled to start on March 18.

The different mesh sized gillnets will be randomly distributed in each gillnet array. KFG7 will measure around 50 m, whereas KFG9 around 65 m. The number of mesh sizes to be employed depends on the results of the developments for the KFG gillnet. Because of the strong currents expected in the site, it may be necessary to remove the smaller mesh sizes during the first days of fishing and to continue with the larger mesh sizes alone.

Survey 1: This will take place during September 2001. A commercial vessel will be chartered for this purpose and two trained HFI personnel will assist with the fishery.

Conditions: A total of 8 fishing days are required. Thus it is preferable to have a ship and crew stand-by for a period of 30 days, to ensure 8 complete fishing days. (2 TAP from HFI- JD)

Requirements: Communication between the responsible TAP and project responsible is required during the fishing survey in order to assess whether the catch obtained will be sufficient to provide adequate data for the statistical analysis, or one should increase the effort.

The bottom fauna sampling should be coincided with the September fishery, i.e. late August, September or early October in order to be able to compare fish stomachs with bottom fauna stomachs.

Fishing: The three windmill stations and three control sites will be fished daily. A total of 24 gillnet arrays will be used daily, together with commercial plaice and cod gillnets, which will fish the same localities.

Samples for the laboratory: Otoliths or frozen fish for aging.

Survey 2: This will take place during February/March 2002, just before the windmills are deployed. Same conditions, requirements and fishing details as for Survey 1.

2003.

Survey 3: This will take place during March 2003 during the same period as survey 2. The station number here is extended to 12 in the windmill site (4 per windmill and 3 windmills) and three control site stations. The number of gill arrays required will be determined from the results of the baseline study.

Samples for laboratory work: Fish from the stomach analysis to be frozen directly on board and transported to the laboratory for analysis. Otoliths/frozen fish for aging of fish.

Conditions: The nearest station (<5 m) may be problematic and it may, for safety reasons, be unwise to have a station so close to the windmill. It may be possible to have a station with fishing on the combing, but this decision needs to be delayed until

more experience with fishing on site is gained. At this point the stations or stratifications around the windmills will be defined and fixed for the rest of the surveys.

Survey 4: This will take place in September 2003 and will be similar to Survey 3.

2004.

Survey 5: This will take place in March 2004 and will be similar to Survey 3.

Survey 6: This will take place in September 2004 and will be similar to Survey 3.

Task 2. Data collection and computing

Data to be collected and computed according to standard DFU protocol for gillnet fishing. (HFI)

Data output will be provided by HFI according to the specifications provided by JGS and EN. EN/BMC will conduct the data analysis and statistical analysis of the data.

Task 3. Stomach analysis and computing.

Stomach analysis according to standard laboratory protocol.

Task 4. Otolith reading.

This will be conducted according to standard protocol by experienced otolith 'readers'. The data will be computed and run together with the fishery data.

Task 5. Data treatment.

Multivariate analyses will be carried out on the collected data to test for the following:

- whether there are significant differences in fish composition with varying distances from the windmill foundation as well as in relation to the windmill position within the windmill park.
- whether there are significant differences in fish composition within and outside the park area.
- whether there are significant differences in fish composition before and after the deployment of the windmill park.

The statistical strength of the analysis lies with the number of samples, and the extent of the temporal variation. The variation will be determined from the replicates at each station.

Furthermore, the stomach content of fish (one representative of flatfish and one for roundfish) will be examined for differences in prey composition in the stomach and these will be compared to prey occurrence on the different bottom substrates in the area.

5. Status.

1. The **contract** covers only 2001- 2003.

2. The project was **commenced** June 1, 2001, and therefore too late for the spring baseline study in 2001 as described under section 2.

The baseline study would therefore take place in September 2001 and in March 2002, just before the windmill deployment as described under section 4.

3. A contract has been drawn up with a local fisherman, subcontracted to help in the fishery.

4. The **gillnets** have been modified and manufactured for this purpose. They were assayed in a two-day survey at the site and the catches analysed. The results indicated that fishing with the modified KFG-gillnet is possible and the catches are relatively consistent. It was therefore decided to go ahead with the baseline study, which is underway although the following modifications have to be made to the survey design to accommodate the physical properties of the gillnets, the fishing conditions in the area and to ensure safety for the crew during fishing under these conditions.

- the number of stations at each of three windmills has been reduced from 4 to 3
- the number of gillnets which can be deployed per day has been reduced from 20 to around 12
- fishery will not take place twice daily as planned, but only once daily and during a specific time period to encourage high catches of fish, and low catches of crab.
- specific conditions for weather during fishery have been specified
- only whole gillnets can be deployed.

5. A **reference area** has been chosen and fishery in this area will be not allowed during the project period to ensure reproducible results. Contact has been made with all relevant institutions and groups to communicate this initiative to as many as possible.

6. **Co-operation** with other teams. Co-operation with BioConsult has been established concerning sampling around the windmills and the reference site. The timing of the operations are being co-operated by the ground team at DFU and BioConsult. DFU notifies BioConsult on embarkation of a new fishing 'expedition'. This cannot be fixed beforehand due to the dependency on weather conditions.

7. Activities in 2002.

As described under section 4, one fishing survey will be conducted in the spring prior to the deployment of the windmills. A mid-year status and full year report will be supplied including fishery data and comparison of reference and non-reference site fishery. This report will comprise the one-year baseline study.

8. Activities in 2003.

As described under section 4, two fishing surveys will be conducted in the spring and autumn of that year. The report will include fishery and stomach data, as well as comparison of before/after impact on the windmills on fish assemblages.

9. Budget

Because the fieldwork has recently been initiated, and the purchase and manufacture of the special gillnets has only recently been completed, it is not possible to provide a noteworthy budget.

Until September 18, the following number of hours have been accounted to the project: AC , TAP .

Thus the budgets for this and the following years remain unchanged according to the letter of 18 June and the total is similar to that specified in the contract.

10. Timeplan.

This also remains unchanged as compared to the project description.

Project Start: 1. June 2001. FD = Fishing days.

2001

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Details							
Project planning	x	x					
Survey 1 plan JGS/JD			x				
Survey 1 JD/CB				8FD			
Data computing					xxx		
Otoliths						xxx	
Data treatment						xxx	xxx
½ year report							xxx

Regarding vibration studies.

Purpose: To examine the effect of vibration on the fish populations.

Conditions. Several criteria must be met before embarking on such a study.

1. Vibrations from the windmill can be measured.
2. Similar vibrations can be generated in the laboratory

Method.

A combination of field and laboratory work will be implemented using a representative of demersal species and one representative of burrowing species.

The field work will comprise abundance estimates at distances from the windmill park.

The laboratory work will examine lethal and sub-lethal impact of vibrations on the feeding and behavioural physiology of fish of different sizes, which occur in the area.

A detailed study will be outlined once the conditions have been examined and met.

Regarding studies on sand eel populations, possible impacts and studies.

A project outline has been handed to Tech Wise at an earlier meeting. This project description includes a budget and is still relevant.