# *A YEAR ROUND STUDY ON FISH MIGRATION*

# Sonar in Fisheries Research

Fisheries acoustics has its origin in the marine environment. Only with the development of small elliptical beams has it become possible to apply sonar in shallow freshwater. Since 1992 the Organisation for the Improvement of Inland Fisheries uses sonar for fisheries research, in The Netherlands. The mean application of sonar in freshwater is fish stock assessment by means of a mobile survey. In addition, sonar equipment can be applied at a fixed location to study fish migration. This gives information on the exact timing, direction and relative number of migrating fish over time. To be sure of the absolute number, fish must be forced to pass through a small corridor, completely covered by the sonar beam. As an alternative, we show in this paper how fish migration can be studied by means of a year-round fish stock assessment.

Besides tulips and wooden shoes, Holland is best known for its struggle against the tides. The most extensive sea defence work was carried out after a storm surge on 1 February 1953, when more than 1,800 people were killed and 150,000 hectares of land was flooded. In response to this, most of the River Rein and the River Meuse delta have been shut of from the North Sea by dykes and sluices. But before the so-called â€˜Delta worksâ€™ were finished, man realised the fatal consequences for the brackish water ecosystem. Consequently, some sluices were redesigned to turn the tide only in case of a storm surge. And even for older sluices like the â€˜Haringvlietsluizenâ€™ (1971) the possibility was studied to re-establish a brackish water zone in the riverâ€™s delta. The expectation is that nature will benefit from it in the sense of a higher variability, especially in the fish fauna. In addition, a brackish water zone will prevent freshwater fish from perishing in the North Sea. In the present situation, fish are surprised by the sudden change from fresh to salt water. With a brackish transition zone fish will be warned in time and retreat before they drift into the sea.

## Study Area & Objective

The â€˜Kanaal door Voorneâ€™ is a small tributary of the Haringvliet (Figure 1). Its length is 8.4 km, the average width and depth is 35m and 4.5m. The principal function of this canal is to drain surplus water from the surrounding area, but there is also an important environmental benefit for fish. Every year huge amounts of Bream (Abramis brama L.) leave the Haringvliet and enter the canal to breed in the reed lands along the shore. The spring migration makes this area one of the best fishing opportunities in the Netherlands. But this may not last for much longer.

The loss of this migration may be the consequence of the intended re-establishment of the River Haringvlietâ€™s natural delta, as mentioned before. Although the idea in itself is good, not everybody will benefit from it. In the past 30 years not only has nature adapted to the change in salinity in the delta; agriculture, harbours and drinking water companies in the neighbourhood, have all got used to the freshwater. When the old situation is restored, farmers will need to change to more salt-tolerant crops, harbours will have to adjust their quays to the tides and water intake must be moved upstream.

In this connection, claims can be expected; and so angling clubs have already announced a financial compensation claim for the probable loss of their precious fishing ground at the â€˜Kanaal door Voorneâ€™. However, to be compensated for a future loss, the present situation must be recorded accurately. This brings us back to sonar as a tool for fish stock assessments.

## Fisheries Sonar

As with hydrographic applications, in fisheries sonar distinct sound pulses are transmitted. By analysing individual and clusters of returning echoes, information can be collected from fish while they are in the sonar beam. Echo integration is the technique commonly used for estimating fish abundance in deep water. The frequencies used range from 10kHz to 100kHz. In shallow water and at close range with side-scan observations, individual fish can be studied using higher frequencies from 70 up to 420kHz. This offers a second technique to estimate the fish abundance. By just counting the number of fish echoes in the well defined volume of the sonar beam, a fish density in numbers per unit of volume can be calculated.

Besides the fish density, the strength of the returning echo (target strength) gives us an impression of the size of the fish. Collected in sufficient numbers, a length-frequency distribution can be presented (Figure 2). Unfortunately, not all echoes can be considered to be reflected from fish. Especially in shallow water with horizontally applied beams there is a lot of reverberation from rain and waves (wind), resulting in unwanted reflections. For this reason echoes are judged by their coherence in their position in the echogram. A clear example of how fish traces can be distinguished from noise echoes is presented in Figure 3.

## Fish Stock Assessment

To determine the fish density in the canal a sonar survey was carried out. A 6-metre boat was used with the transducer fixed just in front of it. The sonar beam is aimed in the horizontal plan and perpendicular to the shore. Because the area was relatively small, both sides could be visited in approximately four hours.

Besides fish density and fish length, the speciesâ€™ composition cannot be determined by means of the sonar echoes. Therefore a conventional seine fishery is undertaken. Inherent to the phenomenon of massive fish migration, is the high variability in fish density in time. So it was decided to carry out the survey every month for one year.

Results

As was expected, bream was the most abundant fish species caught during the seine fisheries (Figure 4). Bream is a fish species most common in turbid, shallow water and the population can exceed a biomass of 350kg per hectare. Besides the spawning period bream are not very keen on submerged vegetation. For food they depend on muddy soils from where they filter small invertebrates with their bulging mouth parts. Only in spring are vegetation or other structures needed to deposit the eggs.

At the first survey the biomass was estimated at a low level of 50 kg/ha (Figure 5). The first signs of the migration were noticed in March. In April the fish biomass reaches its peak with some 1,000 kg/ha. It is interesting to know that there is no open connection between the canal and the Haringvliet. To keep a low water level in the canal it is closed by a lift-lock. All fish that enter the canal in spring must be locked through, together with passing ships. With the increase in biomass some 35,000 kg Ã at least half a million fish - must pass this way.

Spawning migration is triggered by some sudden change in temperature, an increasing water flow or a certain length of day. Withdrawal to the feeding grounds is a more diffuse process and may take a much longer period of time. Surprisingly this is not the case in our study area and may be explained by the unusually high fish density resulting in a quick depletion of the food supply .

The study was carried out in 2000, but it will take at least until 2005 before a limited amount of salt water enters the Haringvliet. And even than, the opening of the sluices at high tide, increases very slowly until the year 2020. This gives us plenty of time to monitor any change in the fish density.

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