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Oil production structures in the North Sea as fish aggregating devices

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Abstract

The paper deals with a study aimed at investigating whether underwater structures from decommissioned oil platforms in the North Sea can be used as artificial fish reefs or protection habitats for fish. The experimental part of the investigation is not yet finished, and the results presented must be regarded as preliminary. An abandoned petroleum platform in the Norwegian North Sea sector was used as case study. The amount of fish aggregated among the underwater steel structures of the platform was quantified by vessel based and platform based hydro-acoustics and UTV, as well as by fishing trials with trawl, gillnets, longlines and traps. The movement and behaviour of fish around the platforms were studied by acoustic tagging technique. The possible potential for the use of steel structures from abandoned oil platforms as management tools is discussed.

Keywords: Acoustic tagging, fish aggregation, artificial reef, habitat protection, petroleum platform, North Sea.

Introduction

A significant number of petroleum and gas production platforms in the North Sea are or will be shut down in the near future. There are several possibilities for disposal of the abandoned platforms, such as continued use in petroleum activities, alternative use, full or partial removal. A number of studies have been initiated in the Norwegian North Sea sector to provide information on what the various disposal categories entail. Based on these studies, and on an evaluation of the environmental, economic and safety related consequences, a recommendation for the future cessation of offshore petroleum production installations has to be decided by the Norwegian authorities.

One suggestion for reuse of abandoned platforms is to leave them on the sea bed as fish aggregation devices (FADs) or «rigs-to-reefs» as done successfully in the Gulf of Mexico (Driessen 1985; Stanley and Wilson 1997; Stanley and Wilson 1991). Depending on the management of the reefs, they can be used as an aid to increase fishing yield for commercial fishermen (Stanley and Wilson 1990), or as a means of protecting habitat and enhancing fish stocks (Pickering and Whitmarsh 1997).

Limited documentation exists on the potential for rigs-to-reefs in the North Sea, where the climatic and ecological conditions are very different from the Gulf of Mexico (Picken and McIntyre 1989; Valdemarsen 1979). More information is required to answer important questions: How much fish will be attracted to the reefs? What will be the benefits to fishermen if the reefs are left open for fishing? Will reefs left as protection zone add significantly to the fish production locally or regionally, and thus in the long run, increase the fish stocks? Will possible gains from the artificial reefs (over)compensate fishermen's loss of trawling grounds?

This paper deals with a project aimed at looking at the impacts on resources and fisheries by leaving petroleum or gas installations in place. The field work has been carried out during the summer season 1998, and is not yet completed. The results discussed in this paper are therefore preliminary, and should be looked upon more as a basis for discussion than of a documentation of facts.

Materials and methods

The experiments were mainly carried out at a «semi-cold» (vacated, production closed, but still illuminated during night) steel-piled petroleum platform (Albuskjell 2/4 F) belonging the Ekofisk complex in the southern part of the Norwegian North Sea sector (Fig. 1). The sea bed in the area is almost flat and sandy with a water depth of 70 m.

Following methods were used to study fish aggregations, distribution and behaviour at the platform site:

- *Acoustic quantification of fish from a research vessel.* The vessel was running in transects with the platform in centre and out to a distance of 5 nautical miles (9,3 km) (Fig. 2). It was equipped with a hull-mounted 38-kHz split-beam transducer and a SIMRAD EK500 echo-sounder connected to the Bergen Integrator System (Knudsen 1990; Foote et al. 1991). To identify the species and length distribution of the acoustically recorded fish, trawling was carried out at three different distances from the platform (Fig. 2) with the standard Norwegian bottom sampling trawl (Engås and Godø 1989). On the basis of the trawl catches and echograms, the acoustic registration was interpreted in accordance with the standard methods used by the Institute of Marine Research (Dalen and Nakken 1983) and split between species.
- *Acoustic quantification of fish from the platform.* Three stationary 120 kHz split-beam transducers were hung down from three sides of the platform deck and anchored 5 m below the sea surface (Fig. 3). The same echo-sounder, integrator and data processing system as described above was used. A multiplexer shifted the recording of data between the three transducers at pre-set intervals. Acoustic registration was done for 10 days in May, 5 days in June and 10 days in September.
- *Fishing trials with gillnets, longline, traps and bottom trawl.* Fishing trials were carried out for 10 days in May and 5 days in September. Very few fish were caught by longline and traps. These gears are therefore excluded from further discussion. The gillnets (mesh size 66 to 90 mm) were set in fleets of 50 nets, each net 28 m long, tied end to end. The inner end of a fleet was anchored as close to the platform as possible (Fig. 4). Trawling was performed as described for acoustic sampling, using a towing time of 15 min at a speed of 3 knots (1.5 m/s). The catch was sorted by species, weighted and length measured. Biological samples (age, individual weight and stomach contents) were taken from a number of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*) at different distances from the platform.
- *Acoustic tagging of fish.* Thirty cod caught by trap close to the platform were tagged with coded acoustic transmitters (VEMCO Co., Canada) operated into the abdominal cavity and released at the catching site. An array of eight ultrasonic receivers (VEMCO VR20-coded Receivers) recording the presence of the transmitters to a distance of approximately 500 m were anchored around the platform. In addition were two receivers anchored at a neighbouring platform located 8

km away. Data on fish distribution and movement were stored in the receiver buoys for a period of 4-5 weeks, whereafter the data stores had to be emptied and batteries recharged.

- *Underwater video* (SIT low light camera with pan and tilt unit) was used to study fish distribution and species composition underneath the platform where hydro-acoustic methods could not be used due to interference with the steel jacket structures.

Results

The acoustic quantification of fish using transducers tied to the platform is not yet completed, and the results can not be presented. The acoustic mapping from a research vessel running in transects around the platform showed a small but significant decrease in acoustic density of bottom dwelling fish close to the platform compared to the average density in the area (Fig. 5).

The fishing trials around the platform are not yet finished. Preliminary analyses of data obtained until now show no increase in trawl catches close to the platform compared to trawl catches taken further away. The gillnet fleets showed a significantly higher catch rate in the four nets closest to the platform than the rest of the fleet (Fig. 6). The main species in the gillnet catches were cod (79%) and saithe (20%) . However, the general catch per unit effort (CPUE) in the investigated area was low (less than 3 kg/net in average) in the reported period (last half of May 1998) and could not sustain a profitable commercial fishery. The CPUE also showed a gradual decreased from day one to the end of the experiment.

The experiments with acoustic tagging technique showed that the cod were tightly associated with the platform at which they were caught (Fig. 7). Of 30 tagged cod, an average of 15 individuals were present at the platform at any time. Two of the fish were recorded visiting the neighbouring platform for a short period. Two cod were reported caught by fishing, but the number of unreported catches is unknown. Ten of the tagged fish were not recorded after the initial days, and may either have left the area, died from tagging stress or been caught. The majority of the cod were present at the platform both day and night, but the standard deviation and the difference between minimum and maximum number of fish recorded at the platform at a certain hour were larger during night, indicating a higher activity level at night than during day (Fig. 8).

Underwater video and hydro-acoustic recordings showed that mackerel and saithe were more loosely tied to the platform than cod. They seem to school around the platform structure periodically at differing depths, and may be looked upon as occasional visitors at the reef site. Cod, however, could be seen positioned in great numbers among the steel jacket structures. The observed activity level was low, only occasional slow swimming among the steel components. Cod was observed to stay very close to the bottom, only up to about 1-2 m above the sea bed. The size distribution was rather narrow. Estimating size from video is difficult, but the majority of fish may have been about 20-35 cm long.

Discussion

Steel jackets from abandoned petroleum or gas platforms aggregate fish and may be used as artificial reefs. However, the fish aggregations are closely tied up to the structure itself. Only few meters off the platform the concentration of fish decreases to the average of the area, or even below. The very tight connection between fish and the platform jackets makes it difficult to measure the quantity of fish tied to the reef, at least by the means of hydro-acoustic methods, even though it has been used with some success in the Gulf of Mexico (Stanley and Wilson 1996). Hydro-acoustics cannot be used directly underneath the platforms where the steel components interfere with the acoustical signals.

Neither vessel based nor platform based measurements could give a reliable estimate of the total fish density at a platform «reef». Observations with UTV gives a visual impression of the amount of fish staying between the jacket structures, but has the disadvantage of being difficult to quantify.

Vessel based hydro-acoustic measurements of the fish density around the platform indicated that the concentration of bottom dwelling fish close to the platform was even lower than the average for the total area. If the platform jackets offer a favourable reef habitat, the fish arriving close enough to the reef to sense it will most probable be attracted and swim towards and underneath it, leaving a low density zone around the platform. The reef may thus act as a vacuum, absorbing fish from the surrounding area.

The total amount of fish staying at one platform site is not large enough to contribute significantly to the fish stocks in the North Sea. The area of increased fish concentrations is strictly tied to the structure itself and not to the surrounding areas, and, at least as far as cod is concerned, also limited to a narrow range (1-2 m) above bottom. Even though the fish concentration in this limited water volume may be high, the amount of fish is negligible compared to regional or even a local fish stocks.

The observed species and size distribution of fish at the platform further limits the potential for the use of platform reefs as a protective area for enhancing fish stocks. As the main fish species present was cod at a size large enough to be aggressive predators, recruits of any fish species entering the protected area for shelter would be met with an increased risk of being eaten.

This investigation has been carried out at one particular abandoned petroleum platform in the North Sea. If political decisions are being made in the future to use abandoned platforms as artificial reefs, the platforms will not be left at site in their present condition. The topsides will be removed, and the jackets toppled on the sea bed (Aabel *et al.* 1997). It is also suggested that a number of jackets will be grouped in a predestined configuration making a reef cluster more complex and of wider extension than the one investigated in this study. How this will effect the fish distribution and its potential as protected area is difficult to predict.

Acknowledgements

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References

Aabel, J.P., Sripps, S.J., jensen, A.C. and Picken, G. 1997. Creating artifical reefs from decommissioned platforms in the North Sea: review of knowledge and proposed programme of research. ISBN: 82-7220-837-7. Report for the Offshore Decommissioning Communications Project (ODCP), 129 p.

Dalen, J., and Nakken, O. 1983. On the application of the echo integration method. ICES C.M. 1983/B:19.

Driessen, P.K. 1985. Oil platforms as reefs: oil and fish can mix. Pp.1417-1438. In: *Coastal Zone Conference.* American Society of Civil Engineers, 2.

Engås, A., and Godø, O.R. 1989. Escape of fish under the fishing line of a Norwegian sampling trawl and its influence on survey results. J. Cons. Cons. Int. Explor mer, 45: 269-276.

Foote, K.G., Knudsen, H.P., Korneliussen, R.J., Nordbø, P.E., and Røang, K. 1991. Postprocessing system for echo-sounder data. J. Acoust. Soc. Am. 90: 37-47.

Knudsen, H.P. 1990. The Bergen Echo Integrator: an introduction. J. Cons. Int. Explor. Mer, 47: 167-174.

Picken, G.B., and McIntyre, A.D. 1989. Rigs to reef in the North Sea. Bull. Mar. Sci. 44: 782-788.

Pickering, H., and Whitmarsh, D. 1997. Artificial reefs and fisheries exploitation: a review of the «attraction versus production» debate, the influence of design and its significance for policy. Fisheries Research 31: 39-59.

Stanley, D.R., and Wilson, C.A. 1997. Seasonal and spatial variation in the abundance and size distribution of fishes associated with a petroleum platform in the northern Gulf of Mexico. Can. J. Aquat. Sci. 54: 1166-1176.

Stanley, D.R., and Wilson, C.A. 1996. Abundance of fishes associated with a petroleum platform as measured with dual-beam hydroacoustics. ICES J. Mar. Sci. 53: 473-475.

Stanley, D.R., and Wilson, C.A. 1991. Factors affecting the abundance of selected fishes near oil and gas platforms in the northern Gulf of Mexico. Fish. Bull. 89: 149-159.

Stanley, D.R., and Wilson, C.A. 1990. A fishery-dependent based study of fish species composition and associated catch rates around oil and gas structures off Louisiana. Fish. Bull. 88: 719-730.

Valdemarsen, J.W. 1979. Behaviour aspects of fish in relation to oil platforms in the North Sea. ICES C.M. 1979/B:27 (Mimeo).

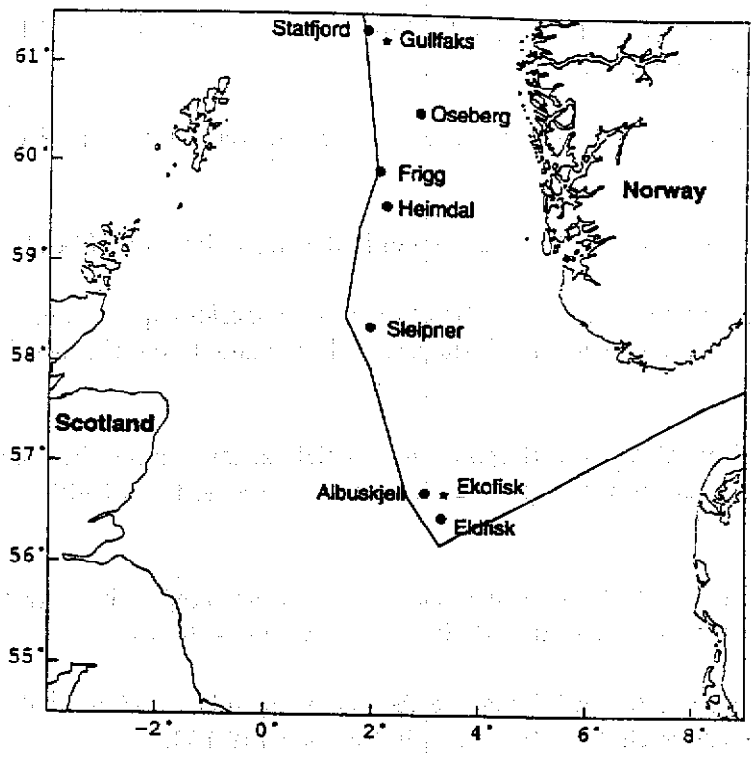

Figure 1. Main oil fields in the Norwegian North Sea sector. The experiments were carried out at the Albuskjell 2/4F platform.

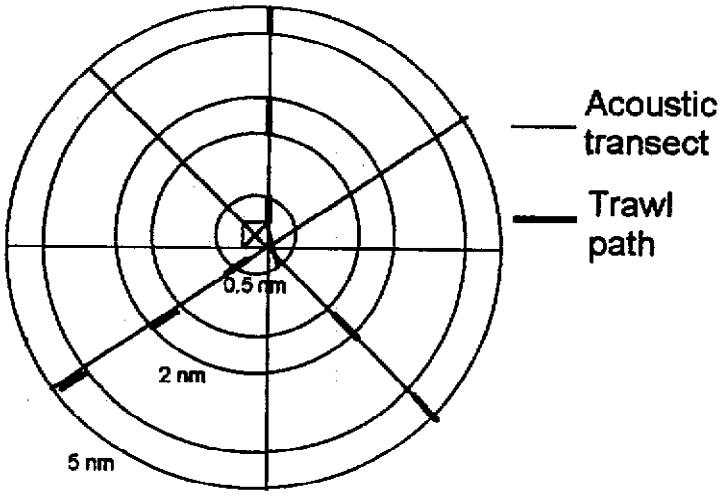

Figure 2. Hydro-acoustic transects (radial lines) and sampling trawl hauls performed by the research vessel.

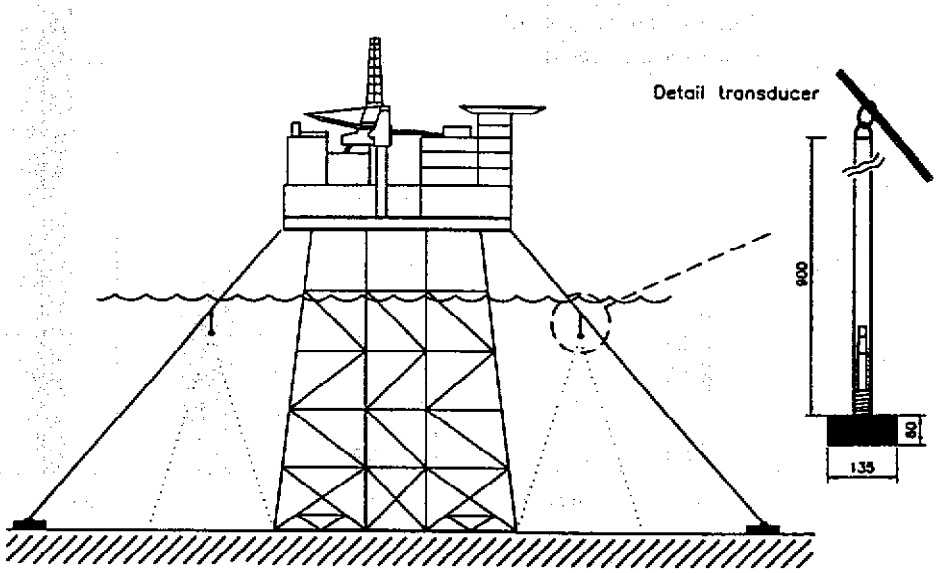

Figure 3. Stationary hydro-acoustic transducers anchored at the platform.

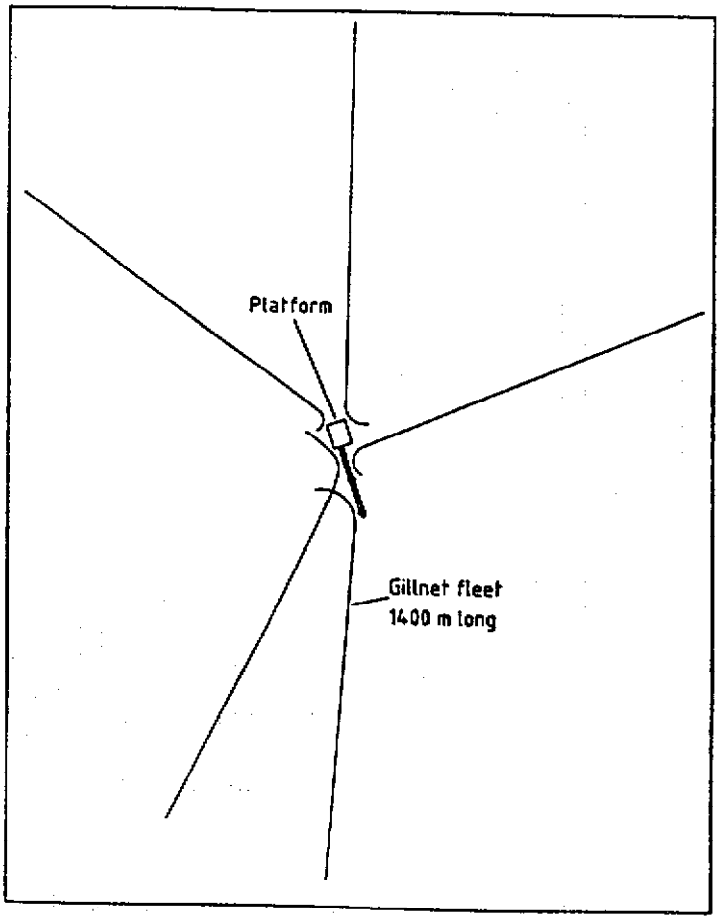

Figure 4. Setting of five gillnet fleets around the 2/4F platform. Each fleet consisted of 50 nets each 28 m long.

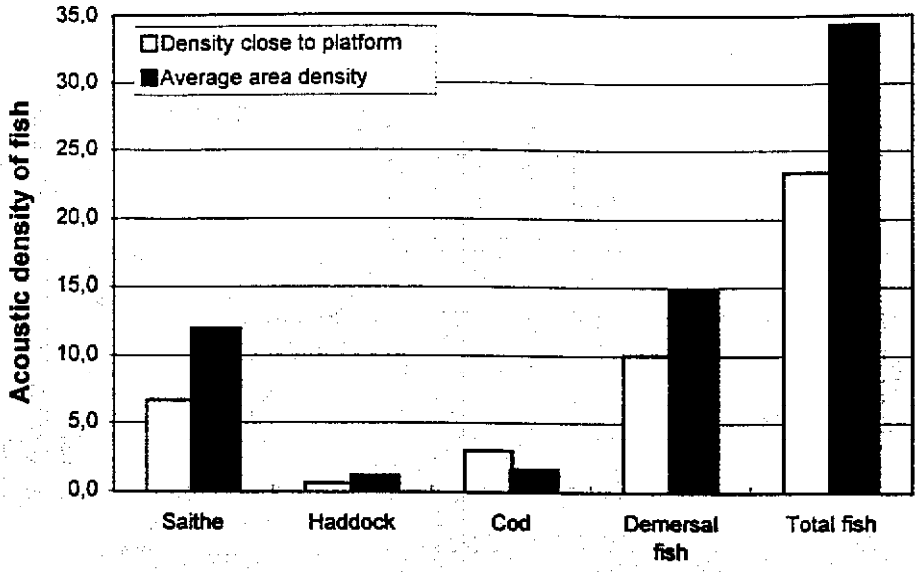

Figure 5. Acoustic density of fish (s_A-value) close to (closer than 900 m) the platform (white columns) compared to the average of the investigated area (black columns).

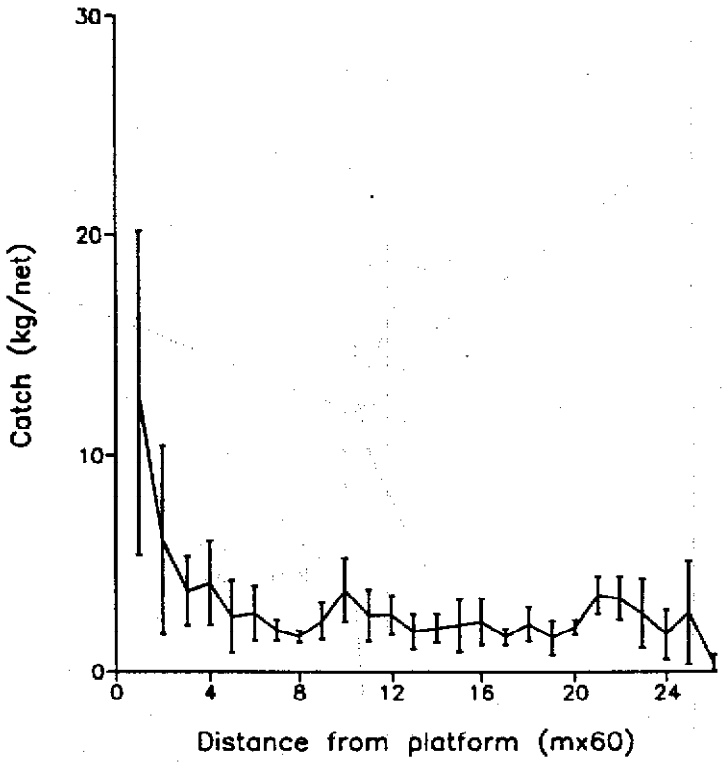

Figure 6. The total catch rates of gillnets at different distances from the platform.

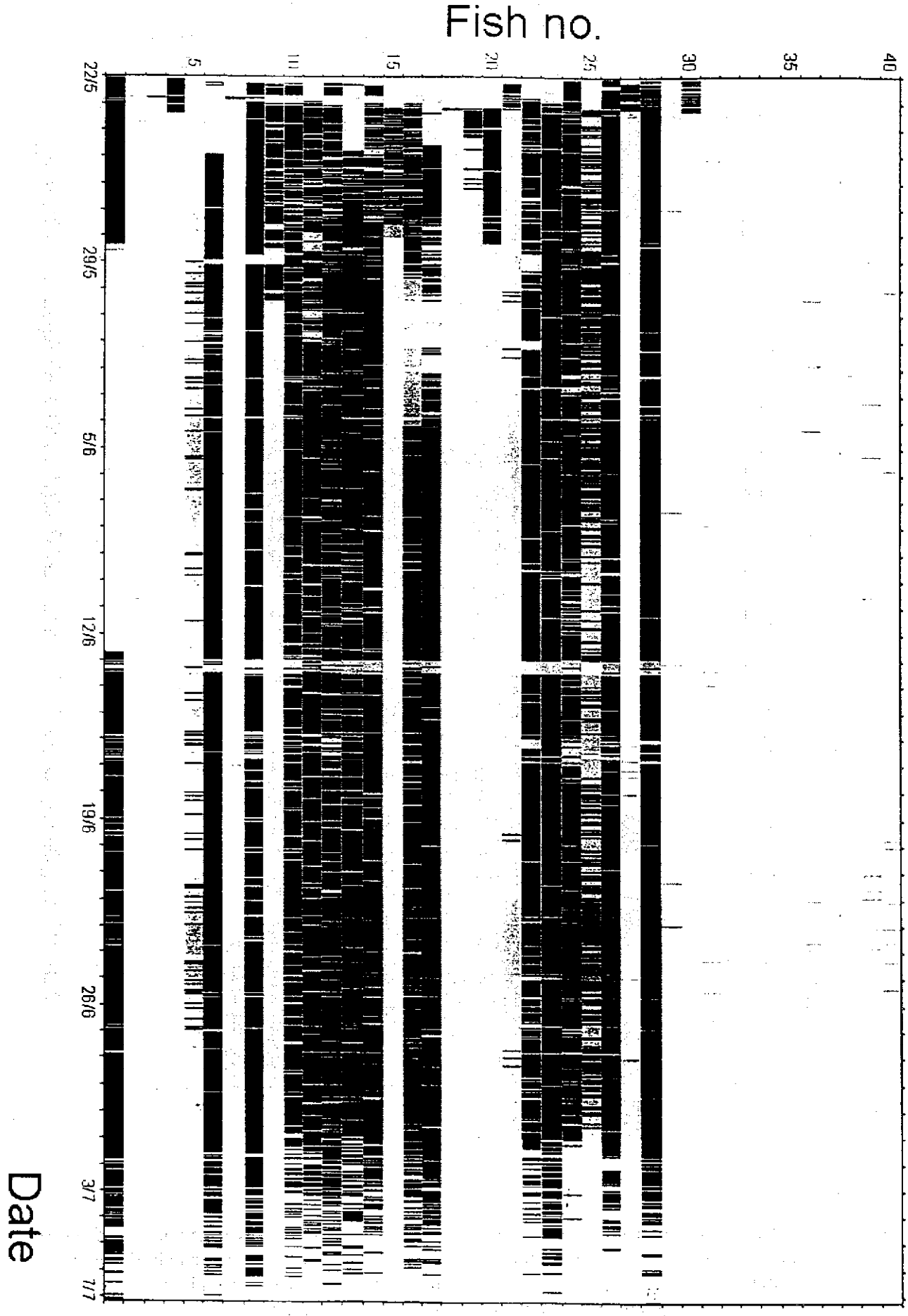

Figure 7. The presence or absence of individual acoustically tagged cod at the platform between 22 May and 5 June. (After 5 June the battery level of the receivers was too low). Black: The fish present in at the platform. Gray: Fish moving in or out of the platform area. White: Fish not present at the platform.

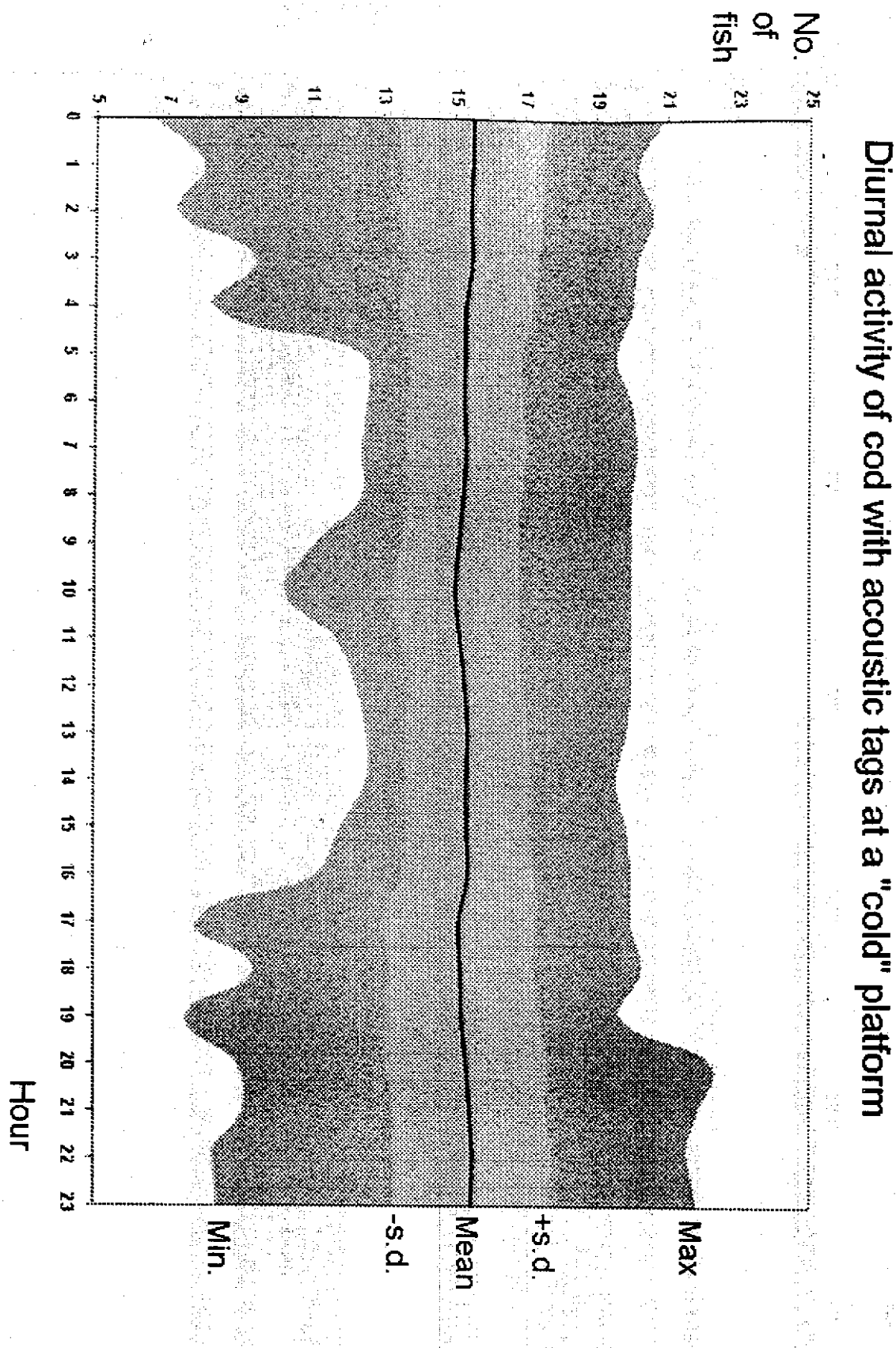

Figure 8. Diurnal activity of acoustically tagged cod. Black line shows the average number of tagged cod recorded by the receivers at a certain time interval. The grey area shows one standard deviation to both sides, and the dark grey area the max and min number recorded. The variability was larger during night than by during day, indicating a higher activity level at night.