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TITLE XII

Collaborative Research Support Program

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The University of Rhode Island—International Center for Marine Resource Development
The University of Washington—Center for Quantitative Sciences
The University of Costa Rica—Centro de Investigación en Ciencias del Mar y Limnología
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Working Paper Series

Working Paper No. 14
"Hydroacoustic Observations of
Fish and Behavior
Around An Artificial Reef in Cost Rica"
by

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The Fisheries Stock Assessment CRSP (sponsored in part by USAID Grant No. DAN-4146-G-SS-5071-00) is intended to support collaborative research between U.S. and developing countries' universities and institutions on fisheries stock assessment and management strategies.

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ABSTRACT

Hydroacoustic techniques were used to monitor aspects of the distribution and behavior of fish around an artificial reef in the Gulf of Nicoya, Costa Rica. The reef, constructed of 4-5000 tires, is located 1 km off the beach at Punta Leone.

The study took place during April 1987. Both transecting and stationary hydroacoustic data acquisition modes were used. The echosounder was a Simrad EY-M scientific echosounder. Echogram charts were examined for trends in abundance and distribution.

The transecting mode showed strong association of fish with the reef during day, but widespread dispersion at night. These trends were confirmed by the on- and off-reef stationary transducers. In addition, the stationary, on-reef transducer showed unexpectedly high concentrations of fish which were surface-oriented, but clearly associated with the reef. These concentrations, detected by the non-perturbing stationary transducers, were not detected by either the diver observations or the hydroacoustic transects, apparently due to active avoidance by the fish of both the divers and the boat.

The results indicate that assessment by diver observation alone may seriously underestimate the fish abundance. Additional experiments showed fish in the vicinity of the reef were strongly attracted to lights at night, indicating potential bias in visual observations with lights.

INTRODUCTION

Visual assessment techniques, usually involving diver observations, have been the primary methods for study of fish abundance and behavior around reefs (Brock 1954, 1982, Jones and Thompson 1978, Helfman 1983). These methods have the advantage of being direct, relatively inexpensive and reasonably quantitative. However, they are also subject to potential biases resulting from variability in water clarity, avoidance by fish, and variability in ambient light levels.

There is growing recognition that hydroacoustic techniques have substantial capability for study of fish abundance and behavior (Spigarelli et al. 1973, Thorne et al. 1979, Thorne 1983). The mobile transecting techniques usually used in hydroacoustic surveys have inadequate near boundary resolution for investigation near reefs. However, stationary deployment of transducers allows resolution of targets within 0.1 m of boundaries and can obtain detailed information about fish behavior near structures (Thorne 1980).

The Centro Investigation Ciencias del Mar y Limnologia (CIMAR), University of Costa Rica, has been conducting a long term study on an artificial reef at Punta Leone, Costa Rica

(Campos et al 1987). During April 1987, a field investigation of the utility of hydroacoustic techniques for artisinal fishery management was conducted in the Gulf of Nicoya, Costa Rica (Thorne 1979). This particular study, part of a collaboration between CIMAR and the University of Washington, focuses on fish abundance and behavior in the open water of the Gulf (Thorne et al. 1987). However, the availability of equipment and personel afforded an opportunity to also investigate the capability of hydroacoustic techniques for study of fish abundance and behavior in the vicinity of the artificial reef.

MATERIALS AND METHODS

The research site is located 1 km off the beach at Punta Leone, in a depth ranging from 7-10m. The reef is constructed of 4-5000 tires, tied together and supported by concrete and rebar. The long axis of the reef is 46m and the width is about 25m. Further details of its construction and monitoring are given in Campos et al. 1987.

The data collection effort was conducted on April 24-26,1987. The hydroacoustic equipment consisted of Simrad EY-M echosounders. Both transecting and stationary deployments were used. The transects consisted of several

runs over various portions of the reef (Fig. 1), plus runs offshore of the reef and from the reef to the beach. Three series were run: 1630-1712 and 2042-2108 April 24, and 0825-0853 April 25.

The stationary deployment consisted of a bottom mounted transducer within the reef, oriented toward the surface, and a downward oriented transducer deployed at the surface from a small boat anchored approximately 100 m off the reef (Fig. 1). The data collection in the stationary mode was continuous from noon April 25 to 1035 April 26. The acoustic data were recorded on echogram paper. Trends in abundance and distribution were obtained by visual inspection of the echograms.

RESULTS

The initial transecting, during afternoon, showed a strong correlation of the fish with the reef (Fig. 2). Large concentrations of fish were observed near bottom over the reef. Very few were observed in the upper water column, and very few were seen away from the reef. The situation changed dramatically at night. The nighttime transects showed considerably fewer fish associated with reef, while scattered targets were observed throughout the off-reef transects (Fig. 3). However, the morning transects again showed high

correlation with the reef and few off-reef targets (Fig. 4).

The data from the stationary deployment provided considerably more detail on these trends. High concentrations of fish were observed throughout the day by the on-reef transducer. Two general distributional characteristics were noted: a concentration of fish just off the bottom, and a second concentration which was clearly surface-oriented (Fig. 5). The off-reef transducer, in contrast, rarely observed fish. The few observations were usually in the form of large schools near bottom (Fig. 6).

The stationary transducers observed a rapid breakup and dispersion of the fish targets associated with reef. Within minutes of dusk, the characteristic schooled distribution disappeared and abundance clearly declined rapidly (Fig. 7). At the same time, the off-reef transducer observed a wave of fish, apparently moving off reef, followed by only scattered targets (Fig. 8) Abundance of fish on the reef remained low throughout the night with the few fish mostly near bottom (Fig. 9), while the off-reef condition was low density, scattered targets. However these scattered targets could be concentrated by attraction to light. Several experiments were conducted with a 60 watt light bulb mounted 0.5 m above the water over the off-reef transducer. Each of these experiments attracted large concentrations of fish. Both the attraction to the light and subsequent dispersal when the

light was extiguished occurred rapidly (Fig. 10).

The stationary transducers also documented a rapid recruitment of fish to the reef in the morning. As early as 1627 (dawn was officially 1620 according to the Nautical Almanac for 1987), high concentrations were apparent around the reef (Fig. 11). However, concentrations of fish in the control area were also higher than seen in the afternoon of the previous day, perhaps indicating continuing movement to the reef throughout the early morning (Fig. 12). Indeed, concentrations of fish on reef appeared to continue to build until completion of the data acquisition at 1035 (Fig. 13).

DISCUSSION

While the hydroacoustic transects provided information to place the results of the stationary observations in proper spatial perspective, the stationary deployment provided considerably more detail in time and resolution. In addition to better near-bottom resolution, the stationary transducers were able to document a surface-oriented concentration of fish that avoided the mobile unit. The abundance of these fish is also probably underestimated by the diver operations. Although schools of jacks (*Caranx*) are occasionally seen near the surface by divers, their distance and mobility preclude accurate visual quantification.

While the non-perturbing stationary transducers were able to detect some distributional trends during the day that were not obvious from diver observations, the most novel observations were made at night. Previous diver observations at this site have indicated a major decline in abundance at the reef, but were inconclusive because of the severe limitations of visability at night. The acoustic data clearly show a major nighttime decline, combined with a dramatic wave of off-reef movement at dusk. Both the dispersal at dusk and the recruitment at dawn were surprisingly rapid. In particular, the capability to rapidly reconverge onto the reef after widespread dispersion suggests behavioral mechanisms beyond our current understanding.

The objective of this oportunistic study was to evaluate the potential of acoustics as a supplementary tool for studies of fish abundance and behavior around artificial reefs. The data analysis techniques were limited to the echograms and no attempt was made to accurately quantify the fish abundance. Quantitative analysis techniques are available and could be used to obtain abundance estimates of the various concentrations (Thorne 1983, Johannesson and Mitson 1983).

While this study shows that the non-perturbing hydroacoustic sensors can provide valuable data on the fish abundance and distribution, they are obviously complementary and not a replacement for visual techniques. Species

identification is important and not obtainable from the acoustic data. Further, while the acoustics could more readily observe the near-surface concentrations, there are undoubtably fish distributed within and very close to the tires which are not acoustically detectable with this technology. On the other hand, acoustics are very amenable to automatic, remote data collection (Thorne 1988) and could be useful for long term monitoring at very low costs.

ACKNOWLEDGMENTS

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Figure 1. Schematic showing location of artificial reef and hydroacoustic transects and stationary transducer positions. Actual reef dimensions are approximately 50 by 25 m.

Figure 2. Echogram from two transects across the reef 1643-1649 (above), and transect from offshore to inshore across reef, 1704-1710 (below)

Figure 3. Echogram from night transect across reef and inshore, 2100-2107

Figure 4. Echogram from inshore across reef, 0829-0832 (above) and second crossing of reef (0850-52).

Figure 5. Echogram from the uplooking transducer on the reef, 1310-1340, showing high concentrations of fish associated with the reef.

Figure 6. Selected echograms from the stationary downlooking transducer off the reef showing two of the rarely observed schools.

Figure 7. Echograms from the on-reef transducer, 1750-1800 (above), 1814-1821 (middle) and 1822-1829 (below). Official sunset was 1809.

Figure 8. Echograms from the off-reef transducer, 1801-1809 (above) 1830-1839 (middle) and 1905-1915 (below) showing wave of fish, apparently moving off reef, then only scattered targets.

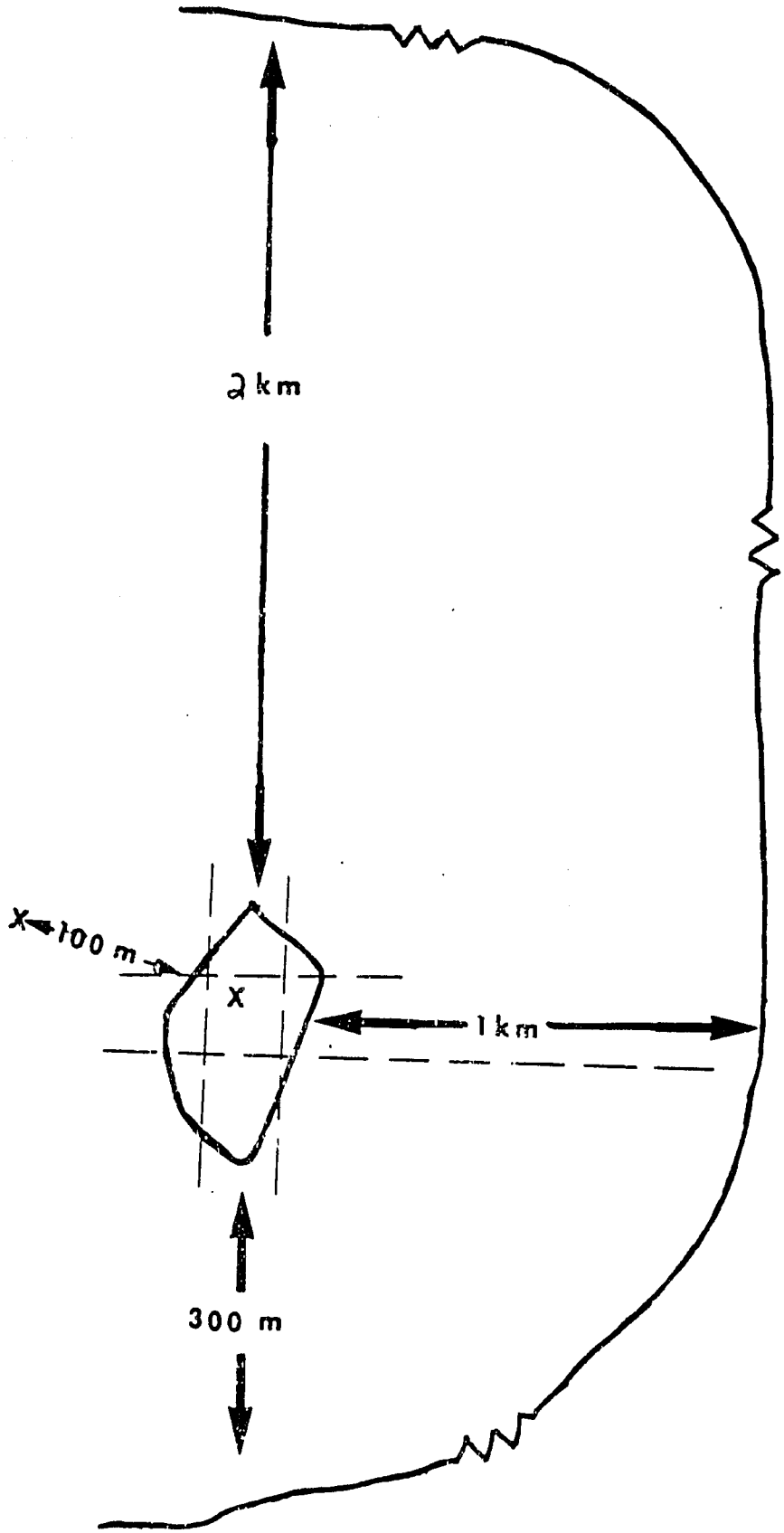
Figure 9. Typical echogram from on-reef transducer at night, shows only a few fish associated with the reef, most near bottom.

Figure 10. Echogram demonstrating attraction of fish to light. Total record length is 15 min.

Figure 11. Echogram from on-reef transducer, 0627 to 0639, showing rapid school formation and aggragation.

Figure 12. Typical echograms from off-reef transducer, 0710-0715 (above) and 0900-0906 (below) showing moderate fish densities.

Figure 13. Echogram from on-reef transducer, 1015-1025, showing return to high concentrations of fish.



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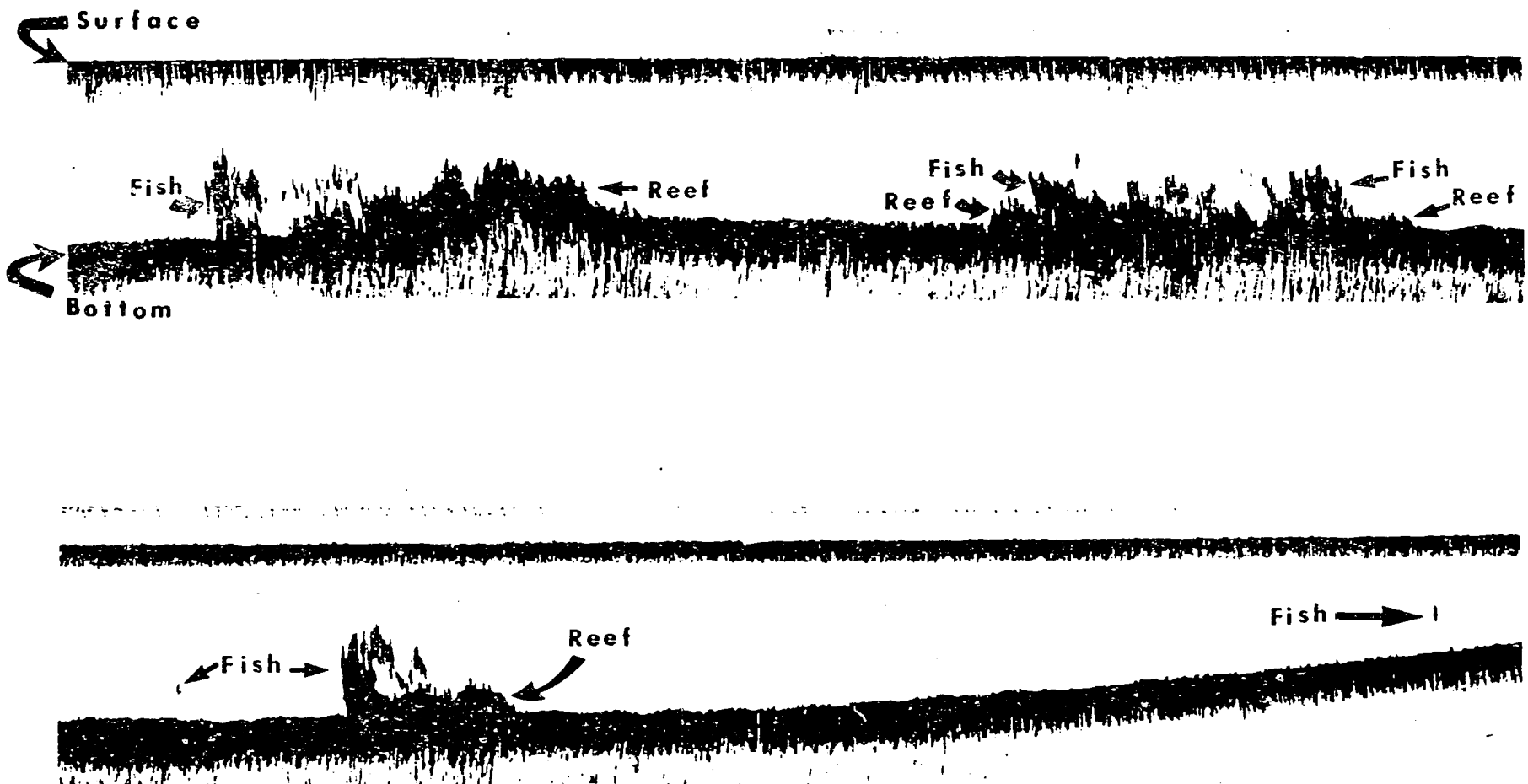

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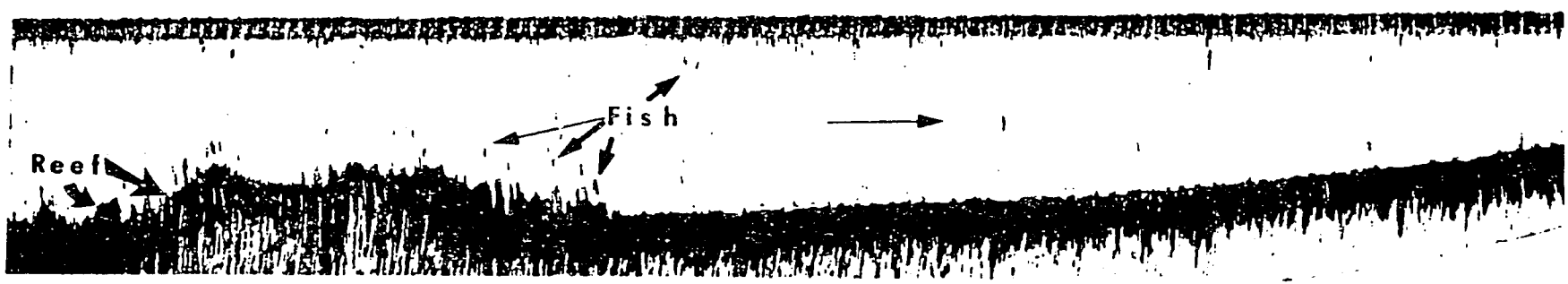

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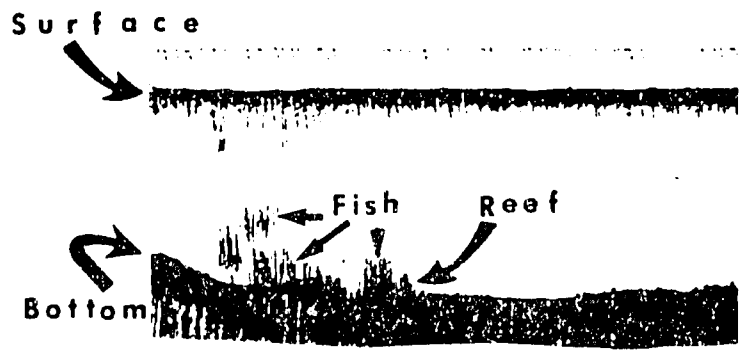

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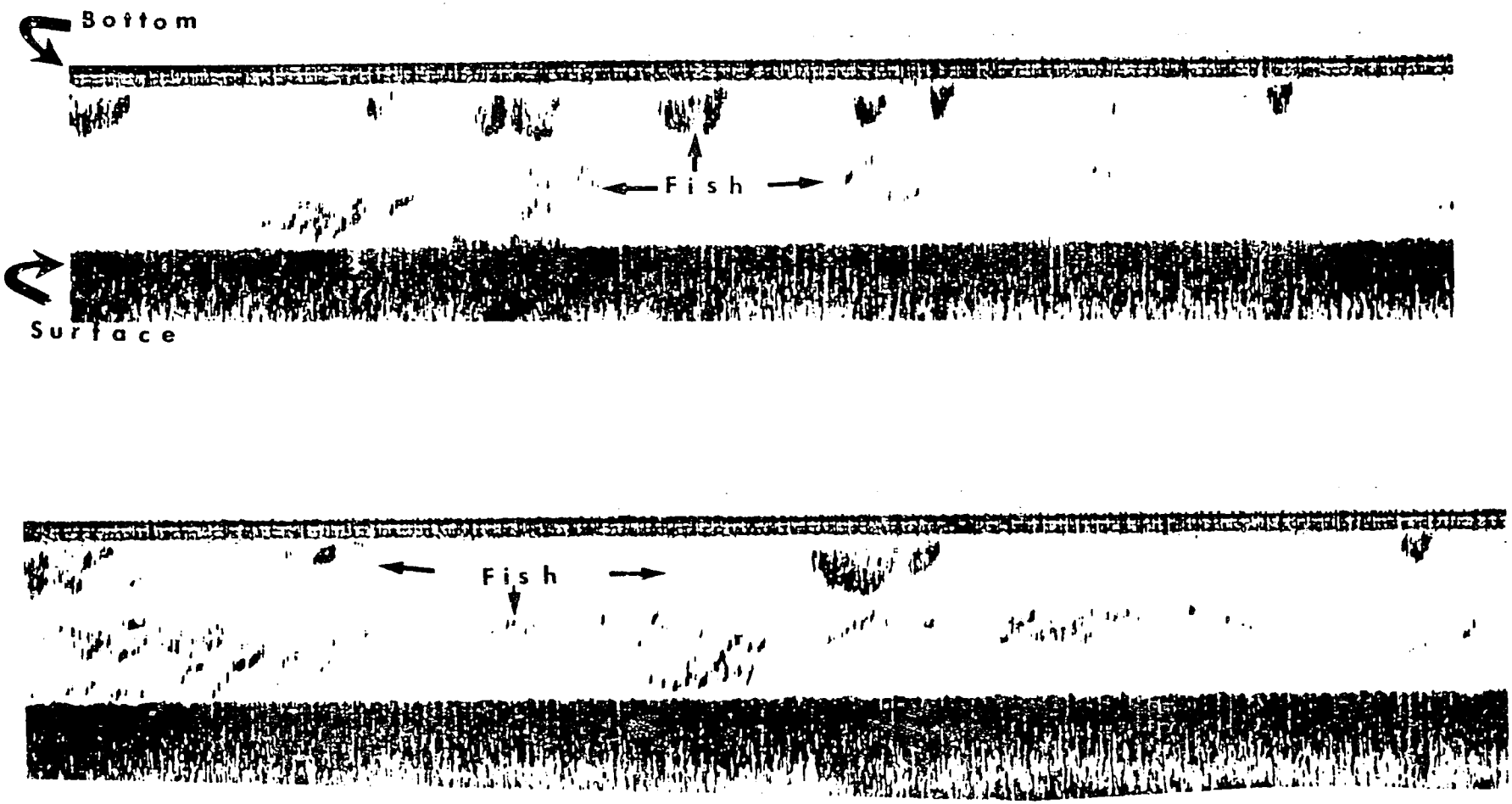

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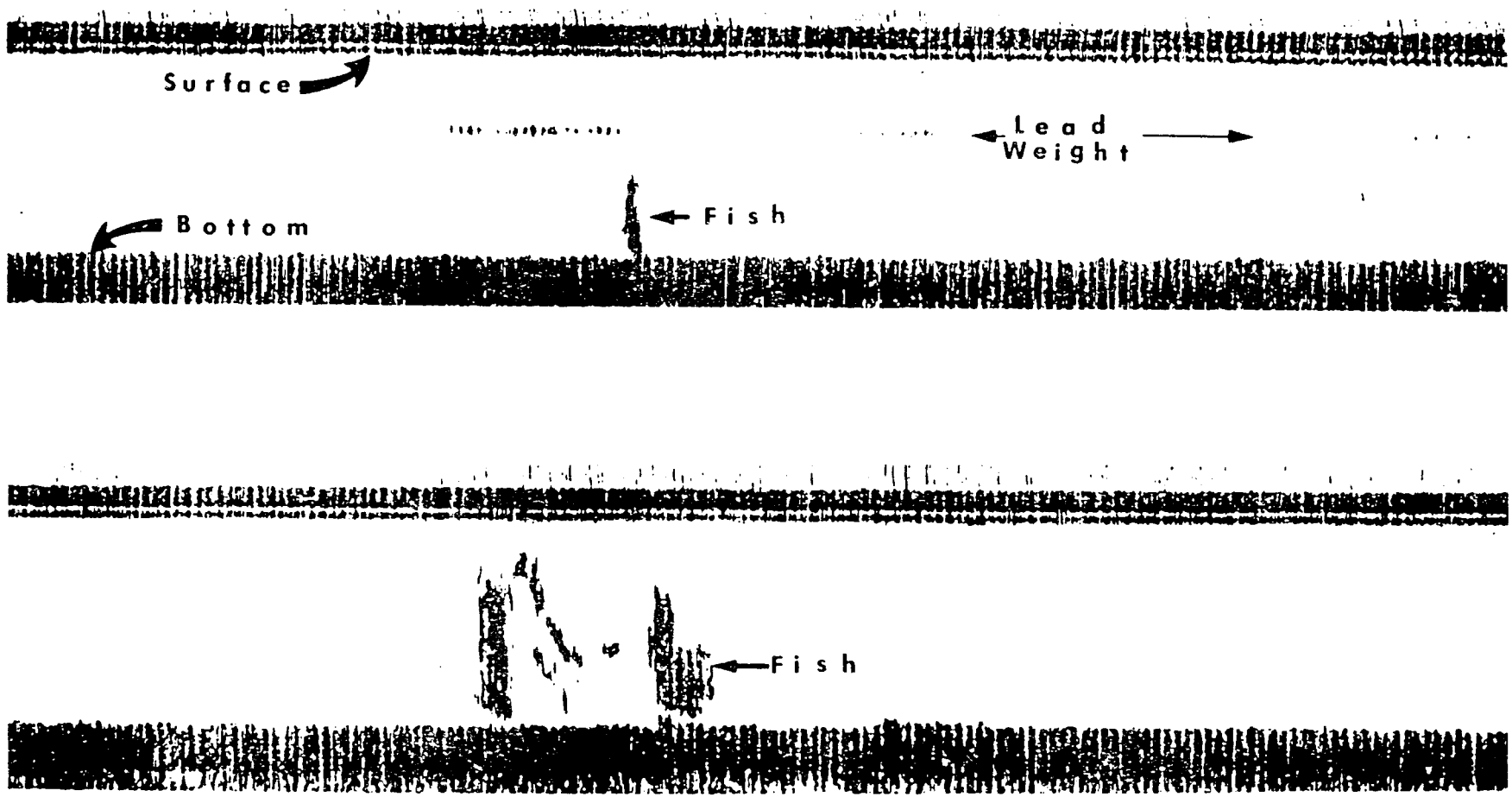

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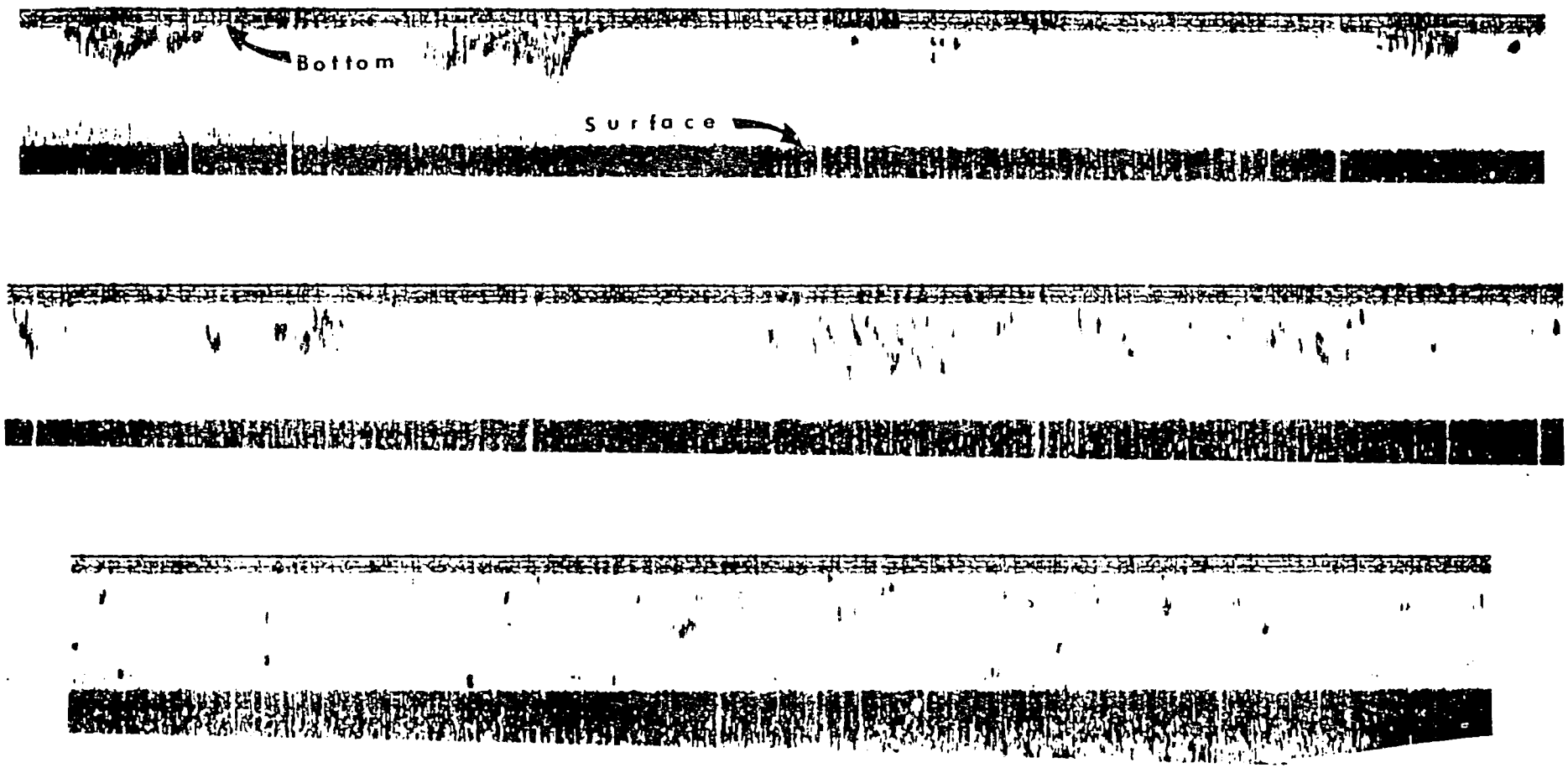

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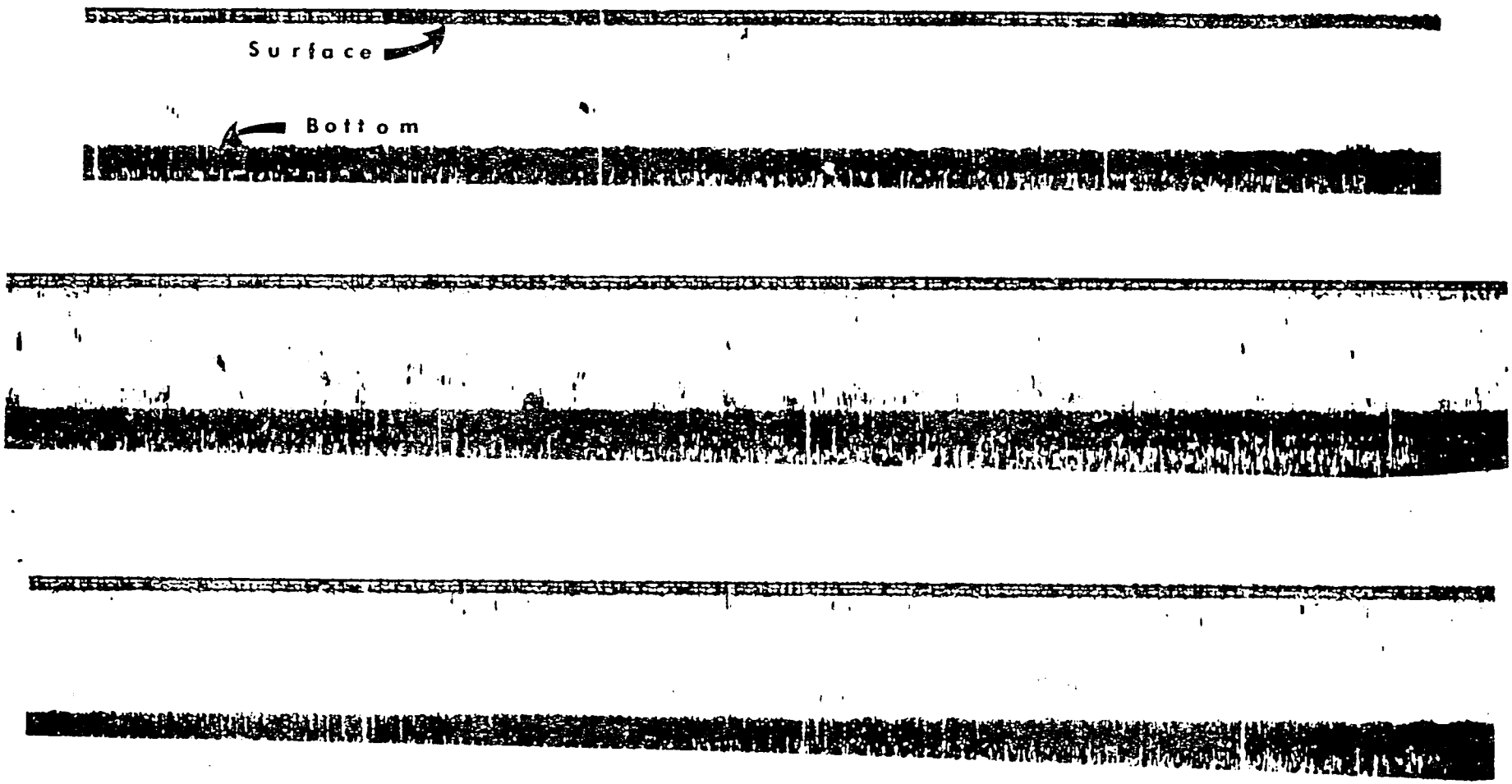

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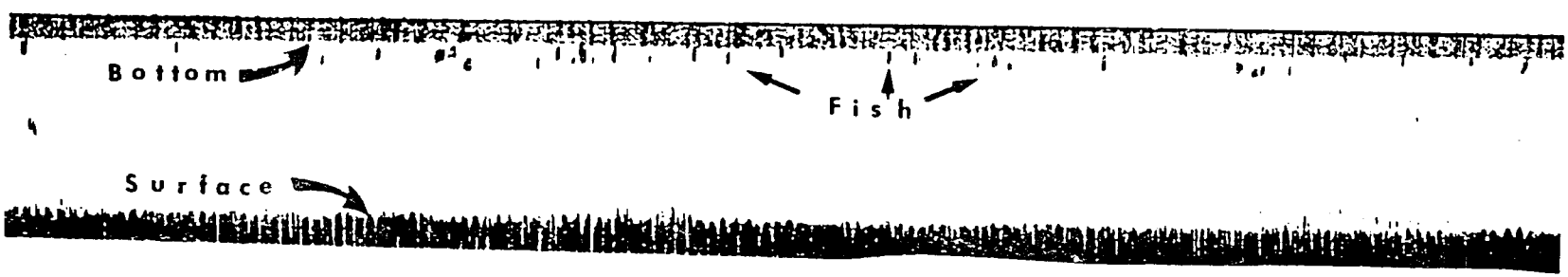

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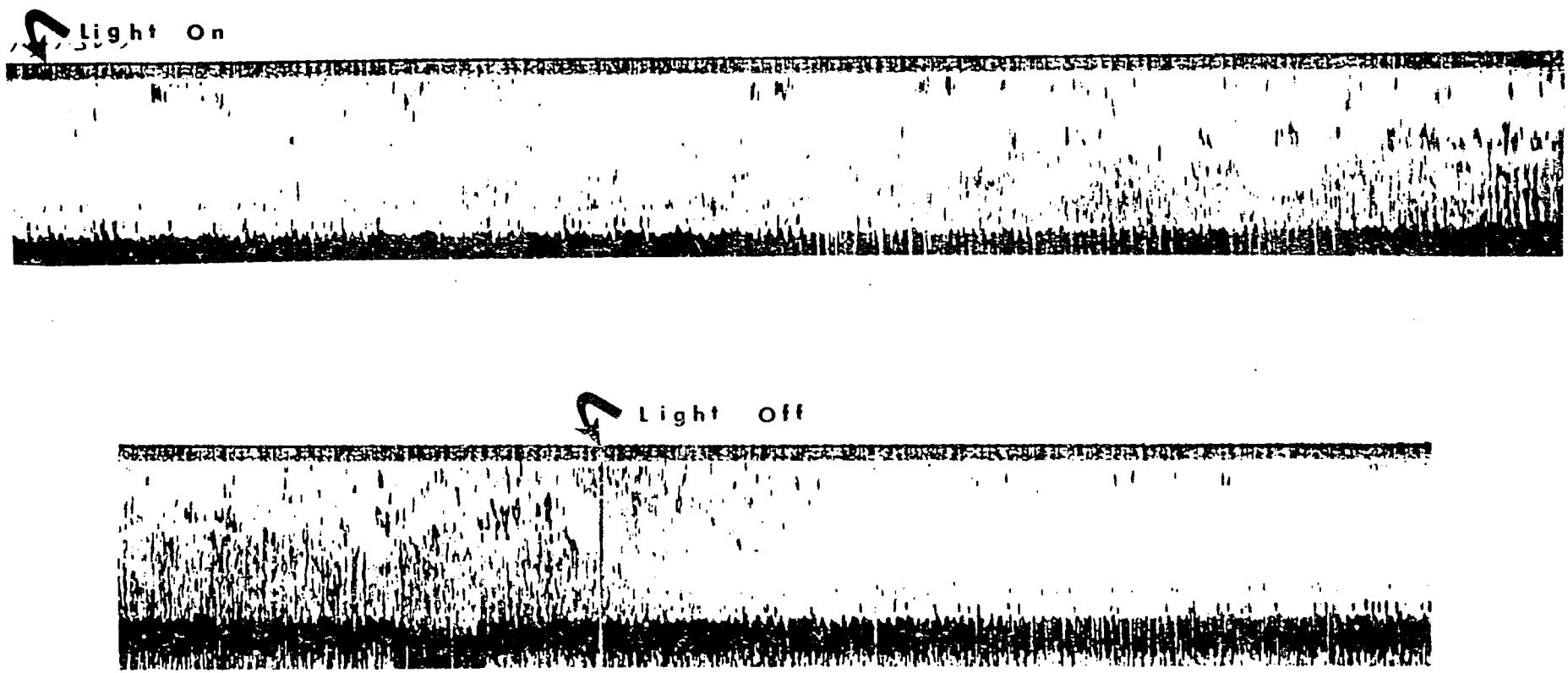

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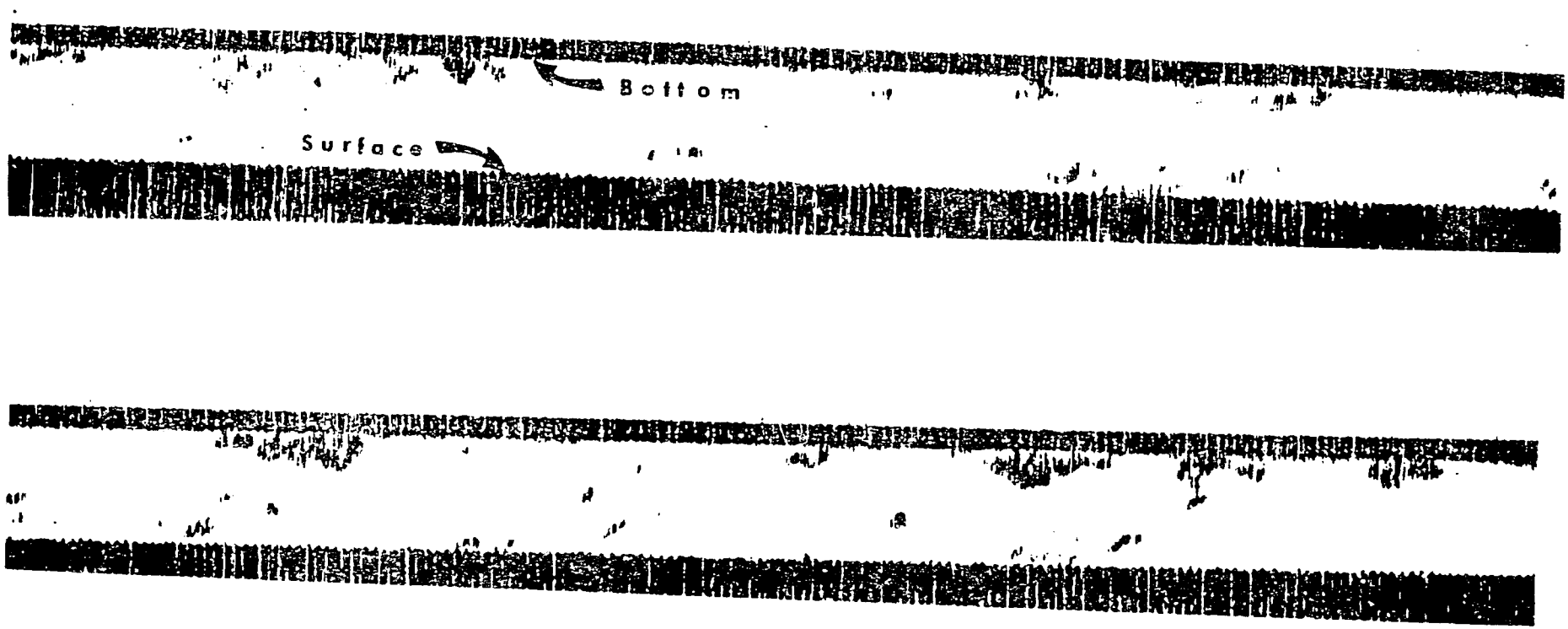

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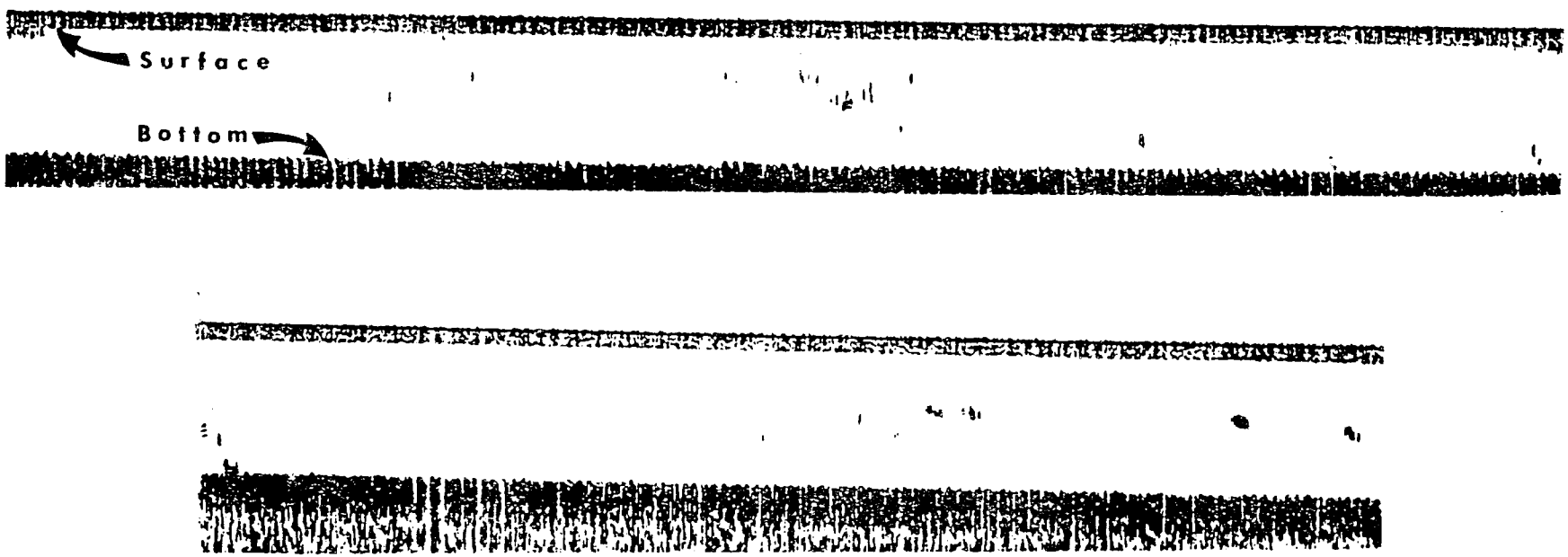

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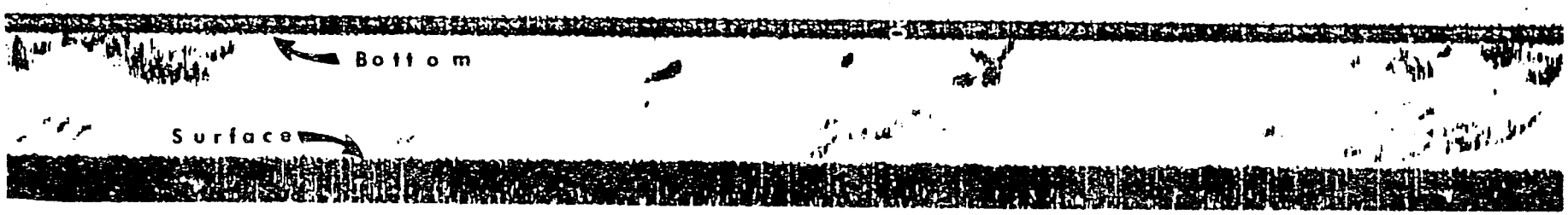

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