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International Council for the Exploration of the Sea

C.M. 1983/B:3
Fish Capture Committee
Ref: Hydrography Committee

# Effects of near-bottom currents on the distribution of olfactory stimuli (smell) from baits

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## Abstract

Olfactory stimuli (smell) leaching from the bait and distributed by currents near the bottom, is the main attractant of fish to the baited hooks. The emission of smell from baits decreases rapidly with time and, therefore, the strength of smell field would vary with currents. A numerical model was designed to study the distribution of smell in different current conditions; some results are presented in this paper. Among other finds, it became apparent that the setting time of the line of hooks in relation to rotary tidal current may exercise considerable influence on fish atttraction and on subsequent catch. Further experimental verification is necessary. There is also a need to measure current speed close to the bottom (e.g., a few cm's to tens of cm's above bottom).

Effets des courants pres du fond
sur la distribution des stimulants olfactifs
(odeurs) des appâts

## Résumé

Les stimulants olfactifs (odeurs) qui filtrent à travers les appâts et sont distribués par les courants près du fond de la mer sont les attirants principaux des poissons aux hameçons amorcés. L'émission d'odeur par les appâts se diminue rapidement avec le temps, ainsi la force du champs olfactif variera-t-elle avec les courants. Un modèle numérique a été dessiné pour étudier la distribution d'odeur dans des conditions variables des courants; quelques resultats sont presentés dans l'ouvrage present. Entre autres conclusions, c'était apparent que l'heure de placement de la ligne d'hamecons par rapport au courant circulaire de la marée pouvait porter une influence considérable sur l'attirance de poissons, et par consequent, sur le taux de capture. Il reste à verifier cette conclusion au cours d'experimentation additionnelle. Il faut aussi calculer la vitesse des courants près du fond, c'est-à-dire, à distance de 5 à 100 cm au dessus du fond.

## Introduction

Research in the last few decades has confirmed that most fish locate bait by olfactory stimuli (smell) (Atema 1980, Kleerekoper 1969). The long line catches are known to be affected by currents, which distribute the smell emitted by baits. The rate of emission of smell from baits decreases rapidly (Solemdal and Tilseth 1983), thus the interaction of currents with changing rate of smell emission creates smell fields where the intensity of smell varies spatially and temporally. The distribution of smell with different currents was investigated numerically, using an abbreviated Hydrodynamical Numerical model. This paper summarizes the essential results of the study, which is described in detail in a technical report (Olsen and Laevastu 1983).

## The numerical model

A 75 x 80 grid with mesh sizes of 1 to 4 meters was used in the model. The current was prescribed with u and v components and horizontal turbulence was simulated with minor periodic fluctuations of these components. In some experiments the vertical turbulence was simulated by increasing the thickness of the layer in which the smell was distributed as a function of distance from the baits.

The rotary tidal current was simulated with Formula 1.

$$U - U_b \cos(\alpha t+\kappa) \qquad (1)$$

The formula for the v component is analogous to Formula 1, except $\kappa$ was 90° higher. $U_b$ is the selected (prescribed) initial speed, $\alpha$ is 0.008 degrees per second, t is time in seconds, and $\kappa$ is "phase lag" (90°).

The smell was advected with currents, using an "upcurrent differentiation" method.

$$S_{n,m} = S_{n,m} - (t_d|U|S_u) - (t_d|V|S_v) \qquad (2)$$

where S is concentration, n and m are grid coordinates, $t_d$ is length of time step (30 and 60 seconds used), U and V are absolute values of the current components and $S_u$ is:

U positive:

$$S_u = (S_{n,m} - S_{n,m-1})/d \tag{3}$$

U negative

$$S_u = S_{n,m} - S_{n,m+1})/d \tag{4}$$

where d is mesh size in cm. $S_v$ is analogous to $S_u$.

The decrease of the emission of smell from the baits was simulated with Formula 5.

$$S_t = \frac{1}{at+1} S_o \tag{5}$$

where $S_t$ is the emission strength of the smell at the source at time t, $S_o$ is the strength at time 0, and a is a decay constant (see Figure 1).

The change of current speed with height above the bottom is not well known. It is expected to vary with the current speed in the water mass some distance above the bottom as well as with bottom roughness (see Figure 2). Current measurements a small distance above the bottom (e.g., 5, 10, 20, 40 cm) are highly desirable. The model was run with different prescribed current speeds to study their effects on the distribution of smell. Different computer runs were made with a single bait and baits in line with different hook spacings. In this paper we report some computed results of smell distribution from a line of baits in a rotary (tidal) current, where the current speed was 0.65 cm/sec and the rotation period was 12 hours.

The relative strength of the smell field from a line of 6 baits two hours after setting, is shown in Figure 3. At the time of setting (of the line), the current was running perpendicular to the line and turning to the right. After about an hour, a "secondary high intensity smell field" forms at some distance from the baits. In Figure 3 the center of this secondary high intensity field is about 34 meters from the baits. This high intensity field originates from

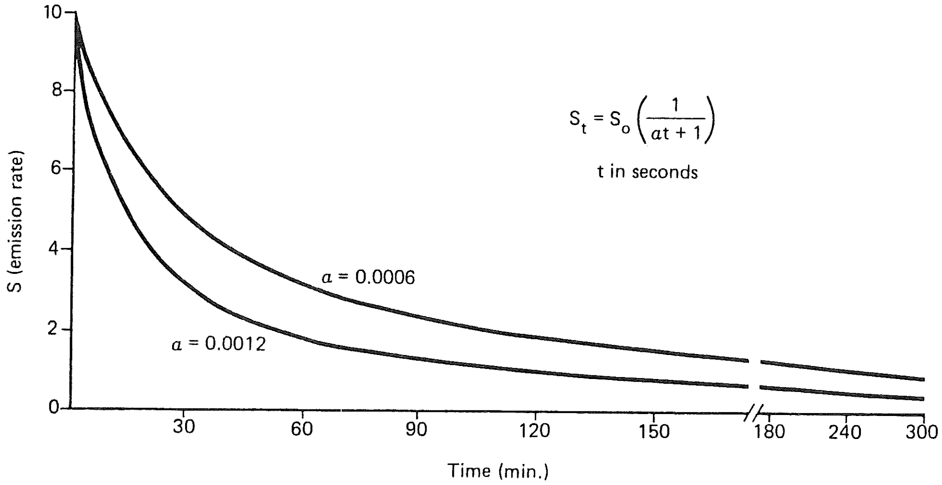


Figure 1.--Simulated decrease of smell emission from bait with two different decay constants.

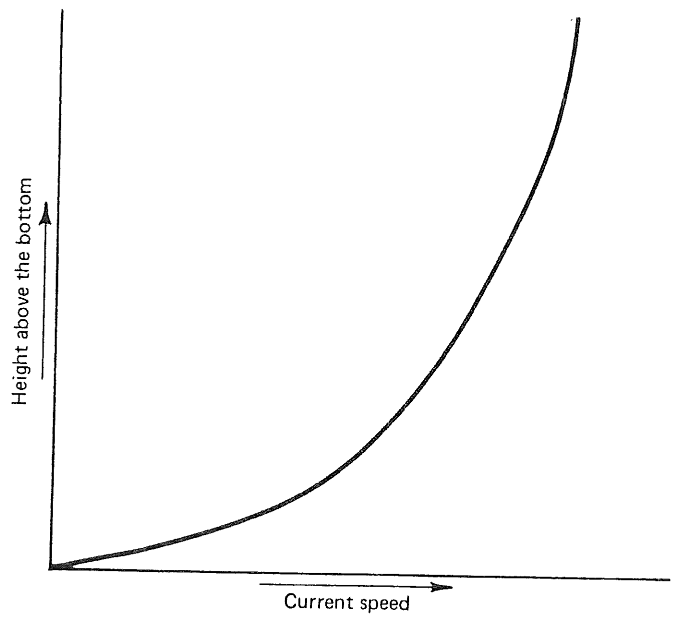


Figure 2.--Schematic profile of current speed near bottom.

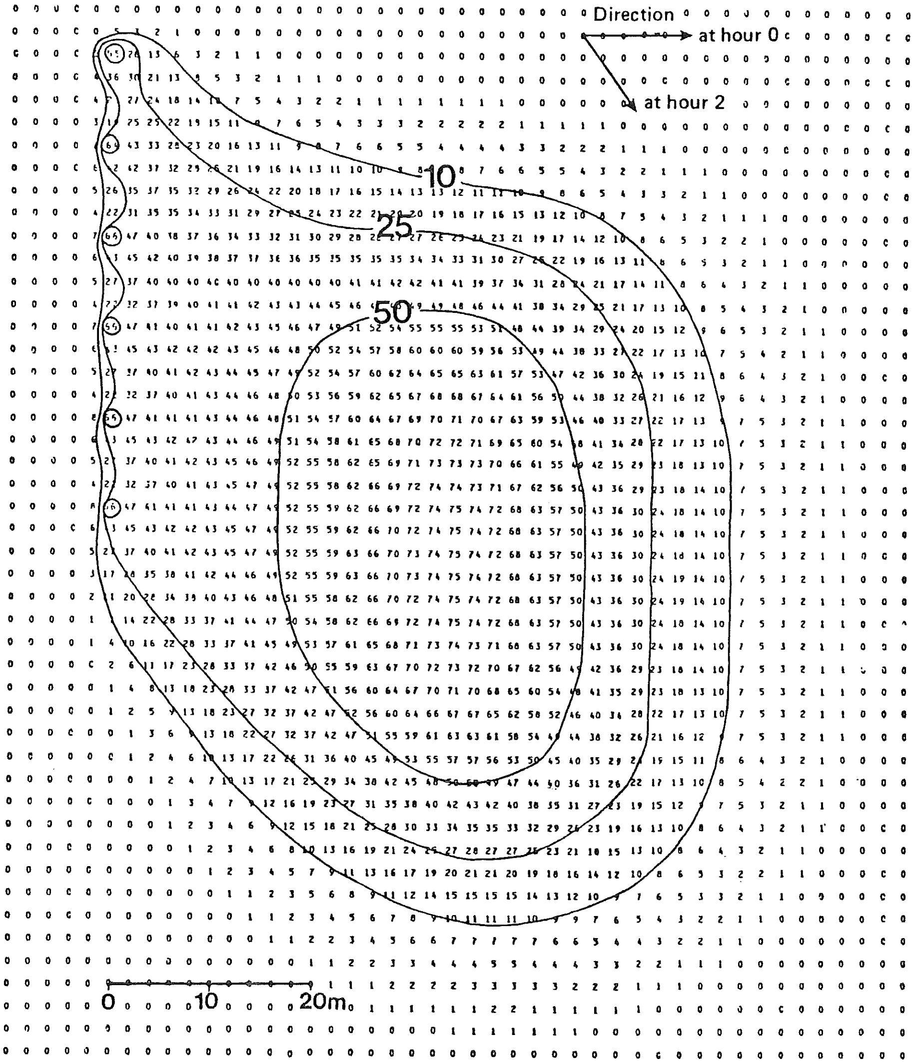


Figure 3.--Smell field from a line of 6 baited hooks, 4 meters apart, in a rotary current, after 2 hours, (initial current perpendicular to the line, 0.65 cm/sec turning clockwise).

the early emission of smell from the baits when the emission rate was high. The later decreasing emission of smell causes a lower intensity field near the baits.

After an additional hour (at hour 3 after setting), the center of the maximum intensity field is about 40 meters from the baits. As current is now parallel to the line of baits, a higher intensity field starts to build up along the baited line due to overlap with that of the smell previously emitted from the baits (Figure 4).

If the line is set in the direction of the current, a high intensity smell field is initially created along the line of baits. This field drifts away from the line when the current changes direction (clockwise in Figure 5). After 2 hours, the center of this field is about 20 meters from the line of baits and is of considerably higher strength although narrower than in the example in Figure 3. After an additional hour, the maximum intensity field has moved further from the line of baits with the center now being about 40 meters away from the line (Figure 6). The intensity is about one-third higher than in Figure 4 and no continuous maximum forms closer to the baits.

Properly designed, experimental fishing is required to determine which of the setting times in respect to tidal currents (i.e., initial current perpendicular or longitudinal to the line) is more beneficial for attracting the fish to the bait and influencing the catch. In the first case, where the current was initially perpendicular to the current, the secondary maximum smell field at some distance from the line is weaker than in the second case where the current was in the same direction as the line of baits during the setting. However, in the first case, another higher concentration of smell formed after about three hours of setting along the baited line when the tidal current had become parallel to it. This higher smell concentration in the immediate vicinity of the baits might be beneficial in helping the fish find the bait.

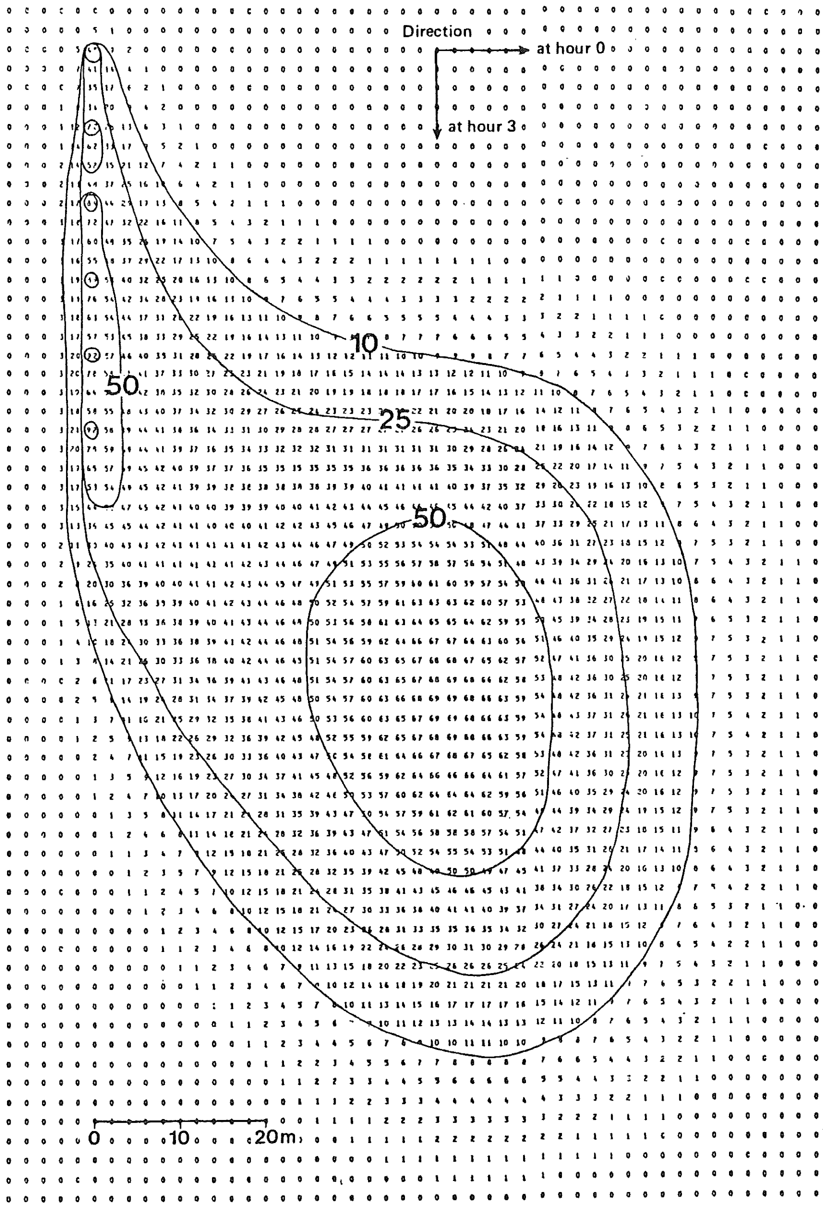


Figure 4.--Smell field in a rotary current (as in Fig. 3) after 3 hours.

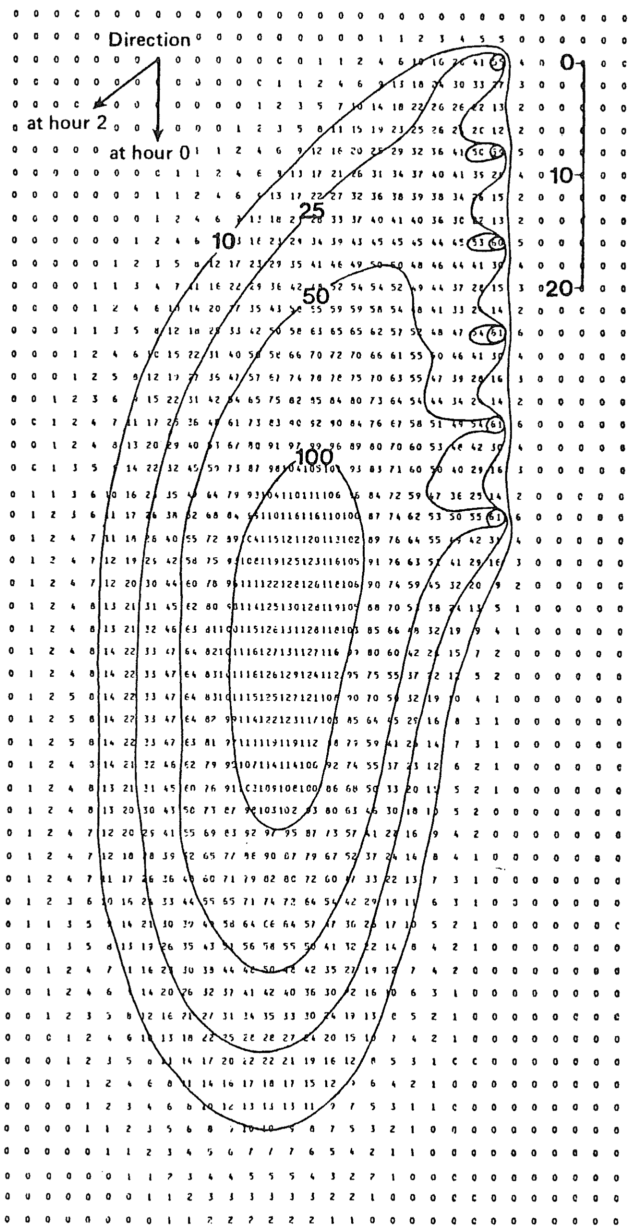


Figure 5.--Smell field from a line of 6 baited hooks, 4 meters apart, in a rotary current, after 2 hours, (initial current longitudinal to the line, 0.65 cm/sec, turning clockwise).

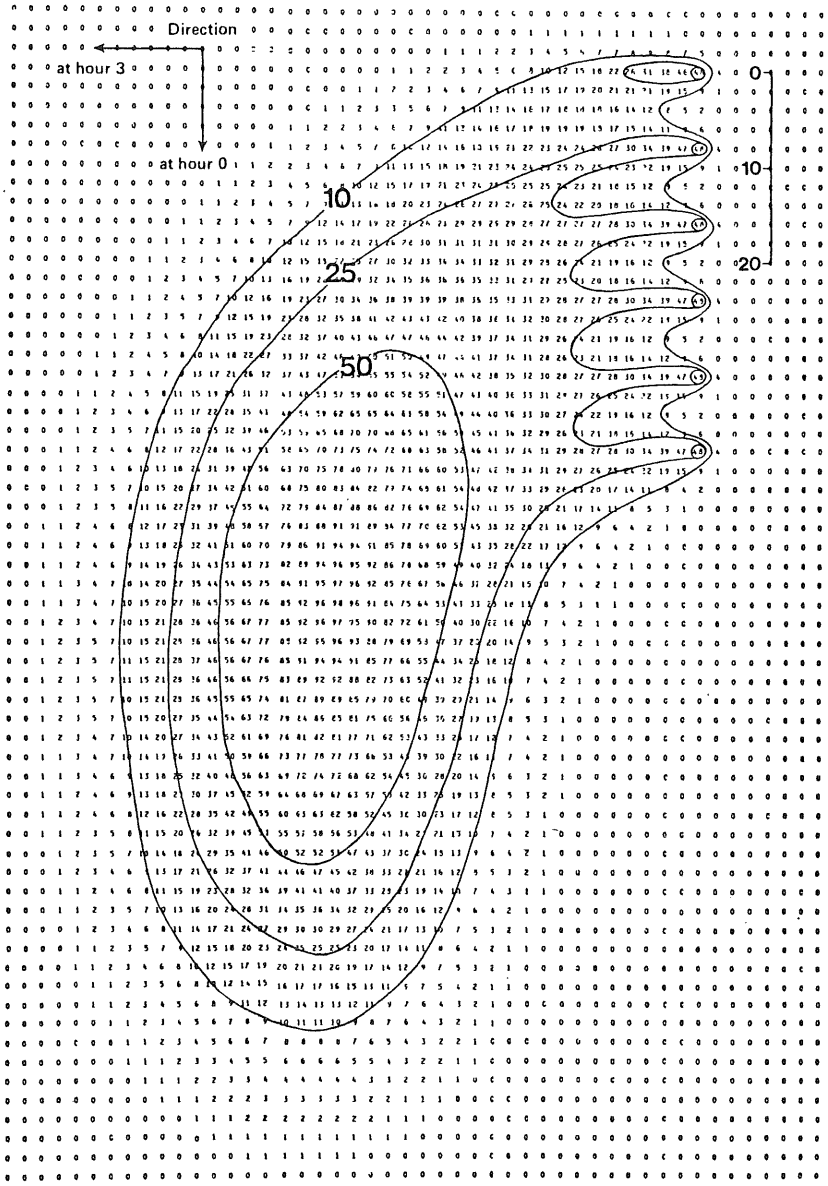


Figure 6.--Smell field in a rotary current (as in Figure 5) after 3 hours.

Conclusions and suggestions for experimental verifications

The conclusions and suggestions refer to the cases reported in this paper only.

Considerable differences occur in the strength of the smell field and in the distance of the smell field maximum from the line in a rotary (tidal) current, depending on the direction of the current in relation to the direction of the line during the setting of the line. The strongest smell field is created when the current runs parallel to the line during the setting. On the other hand, when the line is set across the current, relatively high stimuli intensities near the line are maintained for a longer period.

These numerical simulations indicate the need for several empirical studies: First, there is a need to measure current speeds at close distances above the bottom. Second, we need to know the approximate strength of smell from different baits at which it excites fish to actively search for the bait under varying conditions, i.e., the attraction threshold values of bait smell, and how this is modified by other environmental smell stimuli from natural food (e.g., from benthic animals).

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