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Effect of Shape of Fishing Gear on Moving Behavior of Fish

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The present study used six carps *Cyprinus carpio*, about 11cm in average total length, for investigating fish distribution in a funnel net and fish movement between two mountain-shaped nets which set on upper and lower sides or set on both sides.

The most important effect to fish distribution in a funnel net was a sloped bottom net.

The nets set on upper and lower sides had more great effect on fish movement than that set on both sides.

When disigning, reforming and operating some fishing gears, it is necessary to consider the results mentioned above.

Key words: fish distribution, fish movement, shape of net, fishing gear

In order to investigate the moving behavior of fish in response to a fishing gear, it is necessary to consider the positional relationship between fish school and nets set near them.

Besides, the variable shape of net has a great influence on moving behavior of fish in the net. Set-net, which is said to suffer the influence of tidal current[1], is an example of this.

As to the influence of direction of setting of twine leader on moving behavior of fish, Suzuki[2] pointed out that the preventing effect of fish school was different according to the vertical direction or horizontal direction. The author thinks it probable that the net set in a vertical plane differes from the net set in a horizontal plane about the response of fish toward them.

The present study was performed to investigate fish distribution in a funnel net, and moving behavior of fish in response to a fishing gear which set on upper and lower sides (in a horizontal plane) or set on both sides (in a vertical plane) in the experimental water tank.

Materials and Methods

This study consists of two experiments.

Experiment 1 deals with fish distribution in the closed space which was surrounded with net. Experiment 2 deals with fish movement toward the net which set in a horizontal plane or in a vertical plane.

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Experiment 1: Fish Distribution

Acrylic transparent tank, 200×80×80cm, was used in this experiment. The funnel net, which was quadrangular pyramid-shaped net of 1.2cm stretched mesh size, and dyed with cutch color, was hung in the center of the tank. Six carps *Cyprinus carpio*, about 11cm in average total length, were used in this experiment.

Number of fish in each area divided the net into six was counted by using video camera every thirty seconds during the experiment.

Experiment 2: Fish Movement

Acrylic transparent tank, 117×42×60cm, was used in this experiment. A mountain-shaped net with an incline of 15 degrees was set in the tank.

Fish movement above the net was observed under two conditions; with a roof net on the water surface of the experimental tank and without it.

Subsequently, two mountain-shaped nets were set in a horizontal plane or in a vertical plane.

Six carps were used in these experiments.

The observation of fish movement was conducted in the same way as Experiment 1.

The water temperature in average was 22.0 °C during the period of experiments (from 18 Jun. to 18 Oct. 1985).

For excluding the outside stimulus, these experimental tanks were covered with white plate. But the observational side was not covered with it.

Results and Discussion

1. Fish Distribution

The way of division of the fishing gear into six was shown in Fig. 1. In this experiment, the gear was hung by six kinds of way in the experimental tank. The volume of each area was different, areas C, F, areas B, E and areas A, D were in order of volume.

The percentage of fish distribution in each area, which was the average of 10 measurements, was shown in Fig. 2.

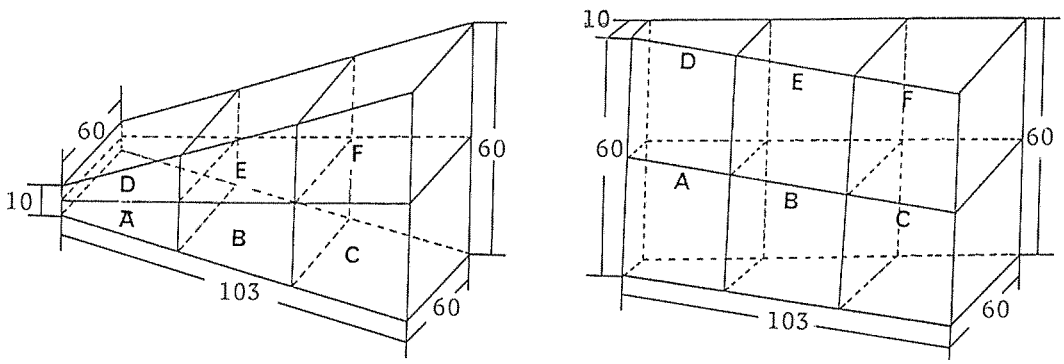

Fig. 1. Fishing gear used in Experiment 1.

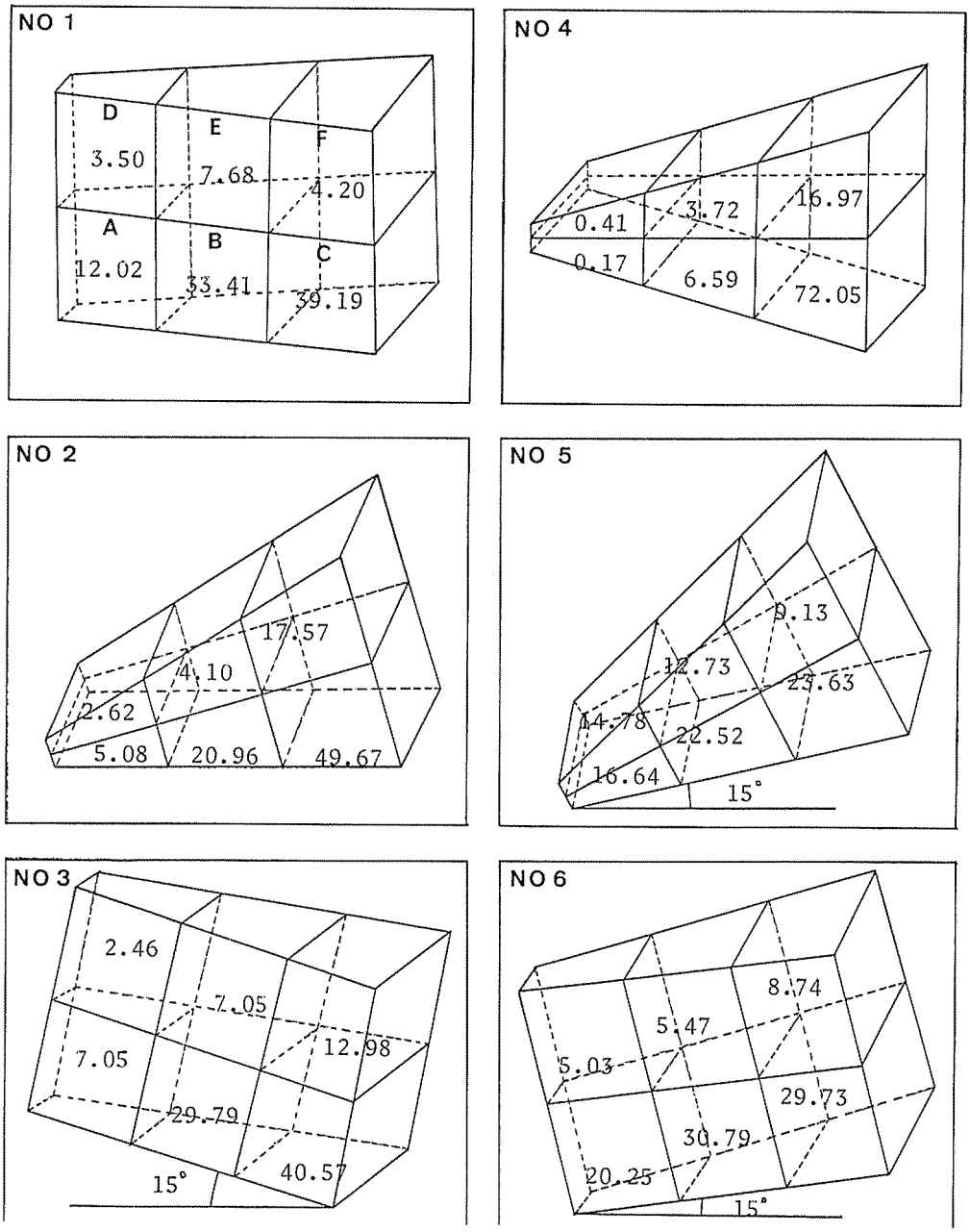

Fig. 2. Rate of fish distribution in experimental fishing gear.

Area C showed the highest rate, except for the case that the fishing gear with wide and narrow sides in a horizontal plane was set (Fig. 2 No. 6), which showed the highest rate in area B.

Besides, the degree of fish distribution in each area was estimated by means of equalizing the volume of each area. That degree was the value divided percentage of fish distribution by volume rate. Each volume

rate was as follows: areas A, D were 0.087, areas B, E were 0.167, areas C, F were 0.246. The results were shown in Fig. 3. Fish distribution did not always incline toward area C as Fig. 2, but the concentration of fish distribution toward lower area was shown.

The results obtained about fish distribution in the closed space surrounded with net were as follows.

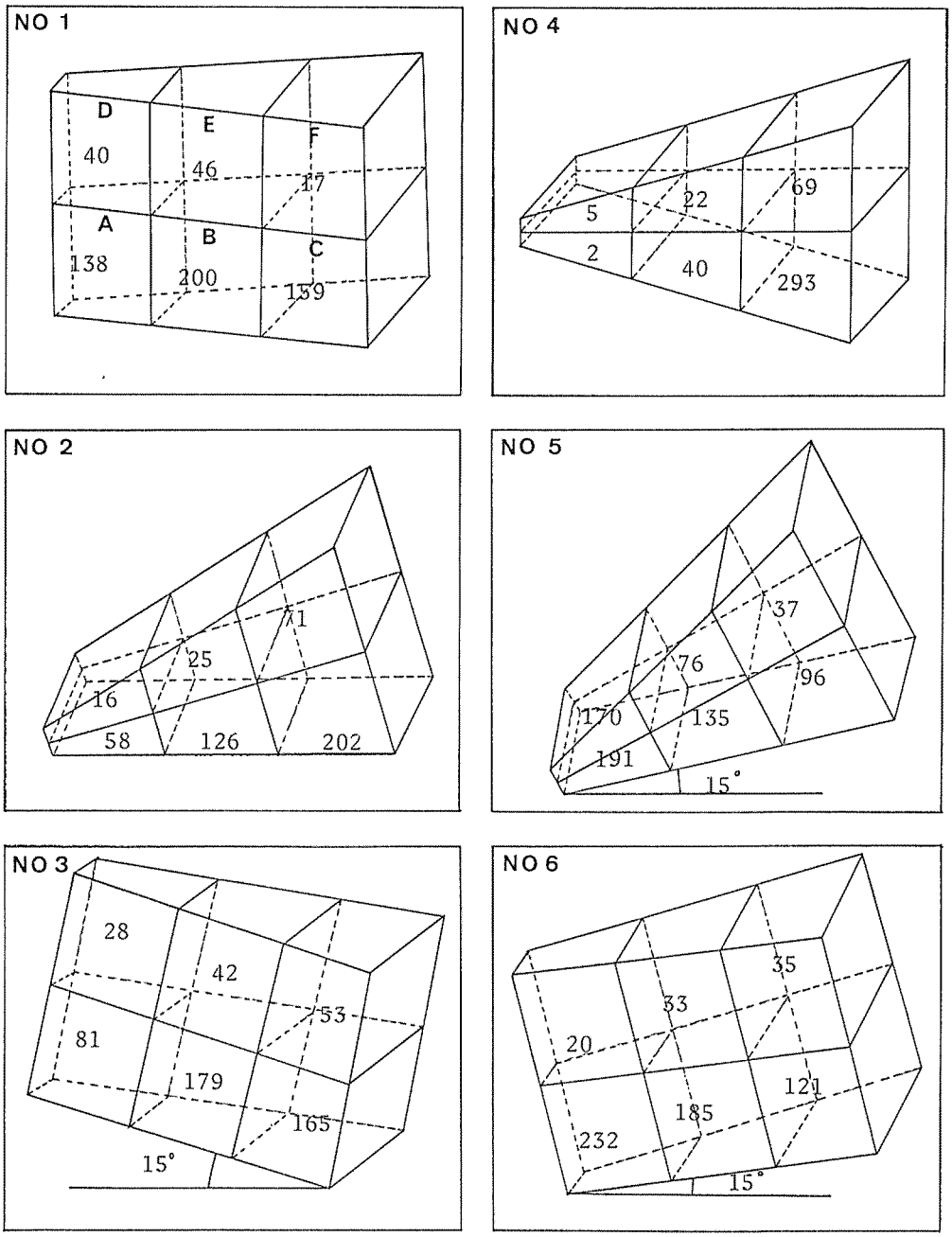

Fig. 3. Degree of fish distribution in experimental fishing gear.

The value of fish distribution tended to indicate high degree in lower area with sloped bottom, even if that area was narrow in vertical or horizontal view (Fig. 3 No. 5, 6).

While in the case of the nets with a level bottom, the value tended to indicate high degree in larger area, and particularly that tendency was shown in the case of the nets with wide and narrow sides in a vertical plane (Fig. 3 No. 2, 4).

Judging from the value of fish distribution in each area of the funnel net which was hung by six kinds of way in the experimental tank, the results obtained were as follows: the most important effect was a inclination of bottom net, a net set in a horizontal plane, especially a roof net set over the fish, followed this, and the effect of the nets set on both sides were little.

2. Fish Movement

The distance between the top of mountain-shaped net and bottom in the tank was 13cm, and that between the top and water surface was 20cm.

When a fish passes over the mountain-shaped net, the moving behavior of fish classified into the following three forms: the passing behaviors which are always parallel to the bottom in the tank, along by the net and over the top of the net and always along by the net, hereinafter called Form 1, Form 2 and Form 3 in order. These forms were shown in Fig. 4.

The changes of these forms were shown in Fig. 5. Under the condition without the roof net, passing frequency of Form 1 was increasing gradually for fifteen minutes after starting the experiment, and then shown the highest frequency among all, indicated 50 to 60 percentages.

Form 2 was decreasing for ten minutes after starting the experiment, and then shown an upward trend. Form 3 showed a downward trend, and was the lowest frequency among all.

While under the condition with the roof net, passing frequency of each form was lower than under the condition without it.

The passing frequency of each form under the condition with the roof net did not show an upward trend, and

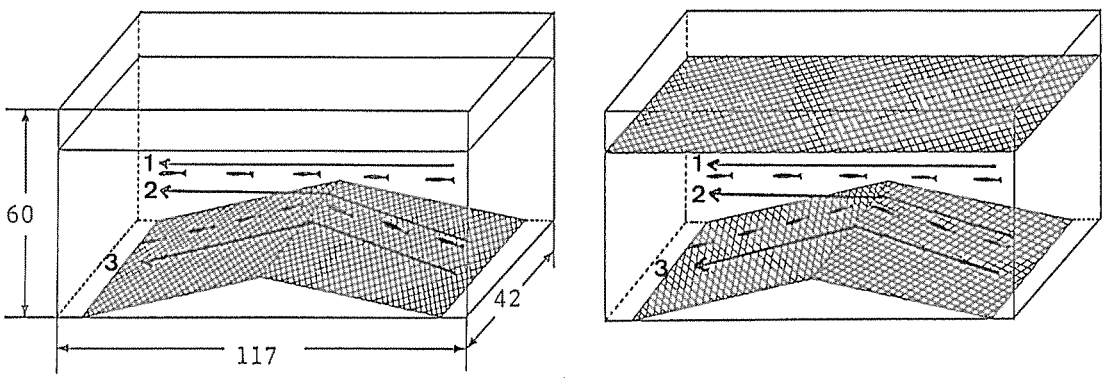

Fig. 4. Forms of fish movement passing over mountain-shaped net.
above: without roof net
under: with roof net
Form 1, Form 2 and Form 3 from above.

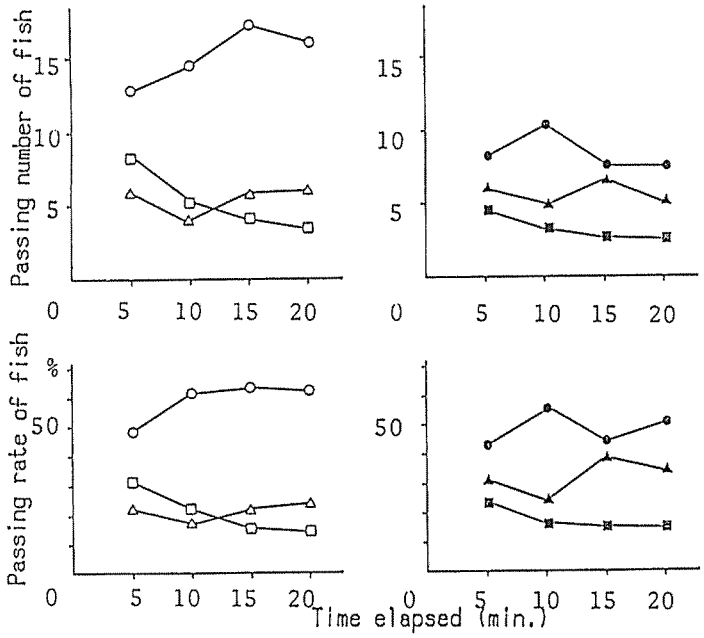

Fig. 5. Change of form of fish movement.
left side: without roof net
right side: with roof net
○, ● Form 1
△, ▲ Form 2
□, ■ Form 3

maintained at constant rate. It was satisfactory to consider that the result was induced by the roof net. Moreover, the average passing number of fish per one minute was 3.8 under the condition with the roof net, while it was 6.2 under the condition without it.

Inoue et al.[3] observed the attractive effect of fish to sloped area in the case of shading it with black roofing board. They measured the difference of light intensity between on the flat area and on the sloped area with that board, and estimated the value which the attractive effect of darkness was equal to the repellent effect of slope.

In this study, the difference of light intensity between the sloped area with the roof net and that without it was little.

In the next experiment, a comparison of fish movement between in the case that two mountain-shaped nets set on upper and lower sides and in the case that two mountain-shaped nets set on both sides was made. The distance between two nets was 16cm in both cases.

When a fish passes through the mountain-shaped nets, the moving behavior of fish were classified into the following three kinds of forms as shown in Fig. 6 and Fig. 7.

When a fish passes through the space between two mountain-shaped nets set on upper and lower sides, the moving behavior of fish classified into the following three forms as the preceding experiment: the passing behaviors which are always parallel to the bottom in the tank, along by the net and over the top of the net and always along by the net, hereinafter called Form 4, Form 5 and Form 6 in order.

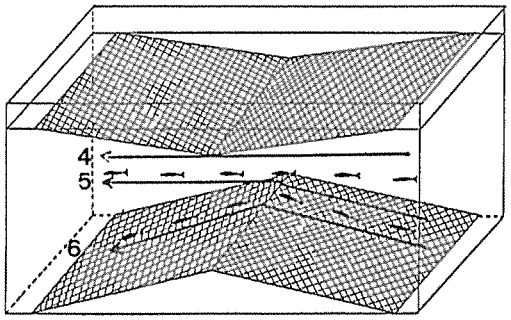

Fig. 6. Forms of fish movement passing through two mountain-shaped nets set horizontally.
Form 4, Form 5 and Form 6 from above.

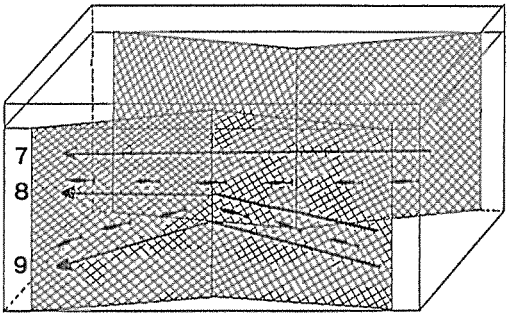

Fig. 7. Forms of fish movement passing through two mountain-shaped nets set vertically.
Form 7, Form 8 and Form 9 from above.

While in the case of the nets set on both sides, the moving behavior of fish classified into the following three forms: the passing behavior which are always parallel to the side in the tank, along the net and through the top of the nets and always along by the net, hereinafter called Form 7, Form 8 and Form 9 in order.

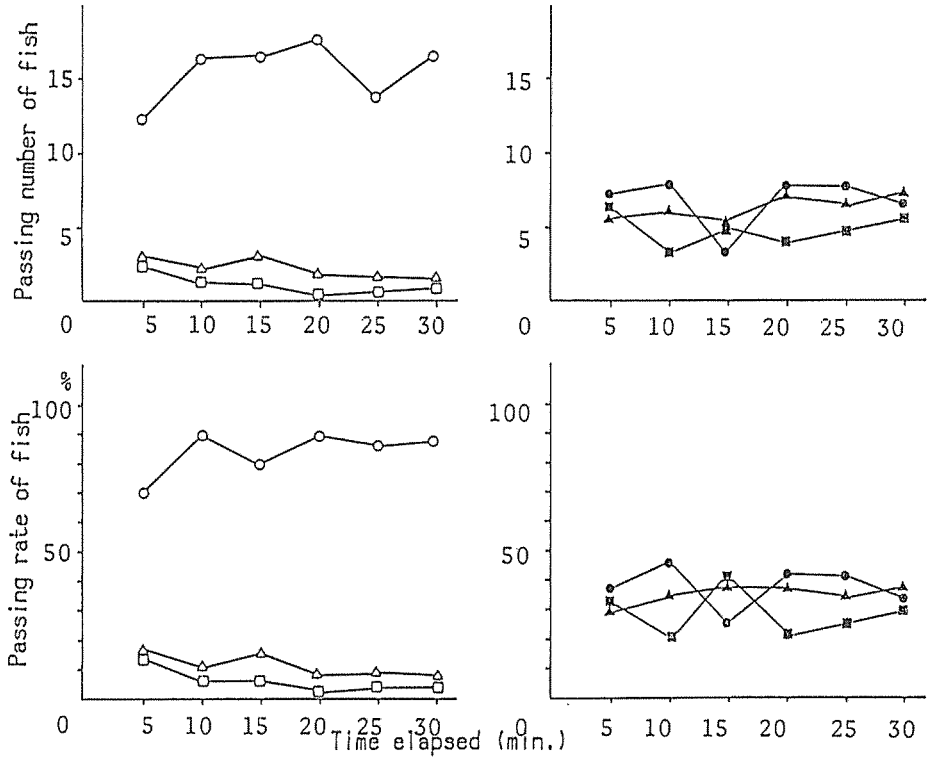

Fig. 8. Change of form of fish movement. left side: nets set horizontally right side: nets set vertically

○ Form 4 ● Form 7
△ Form 5 ▲ Form 8
□ Form 6 ■ Form 9

This observation was conducted for thirty minutes.

The changes of these forms were shown in Fig. 8.

Passing frequency of Form 4 was remarkably high as compared with the other forms, and was increasing gradually with time elapsed. While in the case of the nets set in a vertical plane, the difference among three forms could not be pointed out, and a definite upward trend was not shown.

The average passing number of fish per one minute was 3.9 in the case of the nets set in a horizontal plane, while it was 3.6 in the case of the nets set in a vertical plane.

There were no difference between two cases. However judging by the rate of each form of moving behavior of fish, it was suggested that the nets set in a horizontal plane have an influence on fish movement considerably.

Taylor[4] observed the behavior of herring schools in response to the net during midwater trawl trials. He found out that at least in school lying near the bottom herring apparently did not try to escape by sounding but rather by turning to one side or the other, or to lesser extent by swimming upward. His observation suggests that the effect of the nets set on one side or the other is little when fish escape from the trawl net.

The present study agreed with this.

The author thinks that the same observation will be made on the behavior of fish in response to some other fishing gears, and when designing, reforming and operating those gears, it is necessary to consider these results.

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網漁具の形状が魚群行動に及ぼす影響について

長谷川　英　一

平均体長 11 cm のコイ Cyprinus carpio 6 尾を使用し，漏斗状網内での分布様式および 2 枚の山型網を魚群を挟むように上下に設置した場合と左右に設置した場合とでその間での遊泳行動を調べた。

魚群の分布は周囲の網地に強い影響を受け，その強さは，底面の傾斜，上下の網地の広狭，そして左右の網地の広狭の順であった。

また，遊泳行動は天井網の影響を強く受け，その下方での通過が抑制された。さらに，2枚の山型網間の単位時間当たりの通過尾数は，上下に設置したほうが左右に設置した場合よりも少なくなった。

これらの結果は，各種網漁具の設計，改良，そして操作などを行なう上で考慮されるべきことと考える。