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Underwater Television Observations of the Effect of Chafing  
Gear on Escapement of Haddock

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The use of protective coverings or "chafing gear" over the upper surface of cod ends is common among trawlers fishing in the ICMAP area. Chafing gear may be in the form of a second cod end completely encompassing the primary cod end or in the form of a smaller piece of netting attached to the upper surface only. Hides or other material may occasionally be employed for chafing gear, but usually netting in some form is used.

The usual practice of fishermen is to affix the chafing gear very tightly to the cod end allowing little or no slack. This method allows no clearance between the two layers and the cod end meshes are obstructed by the meshes of the overlying netting. If the two layers of netting are equivalent in mesh size it would be possible, of course, to superimpose the two so that the cod end meshes would not be obstructed. This is not feasible in practical circumstances, however, and the obstruction of the meshes results in much reduced escapement of small fish from the cod end. The degree of reduction will depend upon the dimensions and arrangement of the particular chafing gear. A reduction of 11 cm. in 50 percent escapement point was reported by McCracken for typical Canadian chafing gear (Reported to Scientific Advisers to Panel Four, December, 1956).

The Research and Statistics Committee recognized the possible detrimental effects of chafing gear in mesh regulation programs but concluded that the necessity of protection for cod ends justified its use. The committee therefore recommended the following restrictions on the use of chafing gear to prevent obstruction of the cod end meshes (pg. 13, Report of Seventh Annual Meeting):

- a. The chafing gear must be made from one continuous layer of netting and must not be of a mesh size less than that prescribed for the cod end.
- b. Chafing gear shall be attached at the forward end no more than four meshes in advance of the splitting strap.

- c. The width of the chafing gear must be at least one and a half times the number of meshes of the cod end to be covered.
- d. The chafing gear may be attached to the cod end along the lateral edges but not at its rearward edge.
- e. The chafing gear must terminate at least four meshes in advance of the most rearward mesh of the cod end.

The Committee also recommended that further research be conducted on the effects of chafing gear, and the U. S. Fish and Wildlife Service undertook a study of the effect of chafing gear upon escapement of haddock with underwater television equipment. The results of this experiment are reported in the following pages.

The experiment was conducted 3-1/2 miles west of Cape Cod on June 22, 1957, in 18 fathoms depth. A No. 41 Yankee trawl was towed at a speed of about 3-1/2 knots by the 180 foot research trawler, Albatross III. The cod end used was made of 127 mm. mesh (ICNAF gauge measurement) double 50/4 manila twine and was 58 meshes around. The chafing gear was designed and attached in accordance with the recommendation of the Commission and consisted of a piece of netting, identical to that of the cod end, 11 meshes in length and 44 meshes in width. As its lateral edges were fixed to the laceage of the cod end it covered the upper half of the circumference of the cod end (29 meshes) allowing the required 50 percent slack.

The escapement of haddock was viewed from both inside and outside the cod end with the television camera being supported by a four foot diameter iron frame. The arrangement for outside viewing is shown in Figure 1.

Two successful tows were completed with the camera being positioned inside the cod end on the first tow and outside the cod end on the second. The abundance of haddock of the escape size was adequate, with about 400 fish of 30-50 cm. length being taken per hour of towing. Natural illumination was adequate and no lights were used.

The cod end under tow was not different in appearance than cod ends without chafing gear. The cod end appeared to be distended with well opened meshes. The mesh angle varied from 85° at the after end, where the cod end reaches its maximum diameter, to 70° in the proximity of the camera.

The haddock which were observed inside the cod end during the first tow displayed behavior typical to those in cod ends without chafing gear which we have observed under similar conditions (Figure 2). Haddock were seen to escape, but their encounters with the chafing gear could not be observed because of the intervening cod end meshes and the tow was terminated after about two hours. About 800 haddock (1,500 pounds) had been captured.

The camera was positioned atop the cod end to permit better observation of the chafing gear and the second tow was commenced. The chafing gear now could be seen very clearly to flow up away from the cod end, allowing about two feet clearance at its after end. The meshes were not stretched so tautly nor extended so fully as those of the cod end, however, and the whole piece of netting gave the appearance of being much slacker than the cod end netting. Mesh angles varied from 90° at the after end to 60° at the forward end of the chafing gear.

The intervening chafing gear prevented detailed observation of the fish as they were escaping from the cod end meshes, but they could be seen clearly once they completed their escape and were approaching the netting of the chafing gear.

All haddock attempting escape were successful and no fish became permanently meshed or otherwise lodged in the chafing gear. The escape patterns varied considerably:

Some fish avoided contact with the chafing gear entirely, passing down between the two layers of netting and escaping at the rear opening. Other fish swam straight upwards and escaped through the chafing gear meshes. Many fish became meshed and were able to escape only after a prolonged struggle. A few were seen to give up struggling with the mesh, back out of it, and swim out through the rear opening.

Our visual observations were supplemented by moving picture recordings of the television image. Prints taken from the moving picture film shown in Figure 3 illustrate the appearance of the chafing gear and escapement of fish.

The frequency of the various chafing gear escape patterns as determined from analysis of a 3-1/2 minute film sequence is given below:

Total escaping. . . . .	68
Number escaping through mesh:	
After considerable struggle . . . . .	14
With no struggle. . . . .	28
Number escaping through rear opening:	
After struggling with chafing gear mesh . . .	4
Without contacting chafing gear . . . . .	22

This tow was terminated after two hours by a "hang-up" which resulted in severe damage to the net and loss of the entire catch. The quantity of fish in the cod end was estimated to be about the same as for the previous tow; i.e., 800 fish.

It may be concluded from these observations that chafing gear of the type approved by the Commission flows up clear of the cod end under tow and does not obstruct the cod end meshes or interfere with the escapement of haddock through them. It may be further concluded that this type of chafing gear does not prevent haddock from completing their escape once they have emerged from the cod end. Since fish escaped through the meshes as well as through the rearward opening of the chafing gear, it appears desirable to control both mesh size and degree of clearance. No conclusion can be reached as to whether sufficient clearance would be afforded by chafing gear of less than 1-1/2 times the number of meshes in the cod end because experiments were conducted only with this one type.

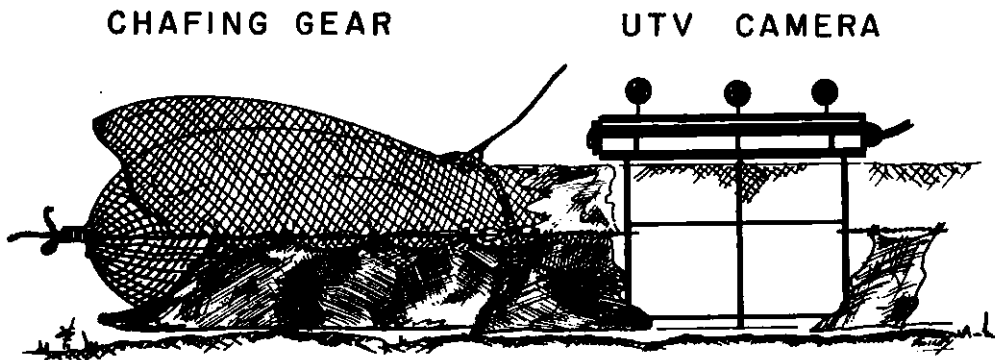


Fig. 1. Television Camera Rigged to Study the Effect of Chafing Gear on Escapement from the Cod End.

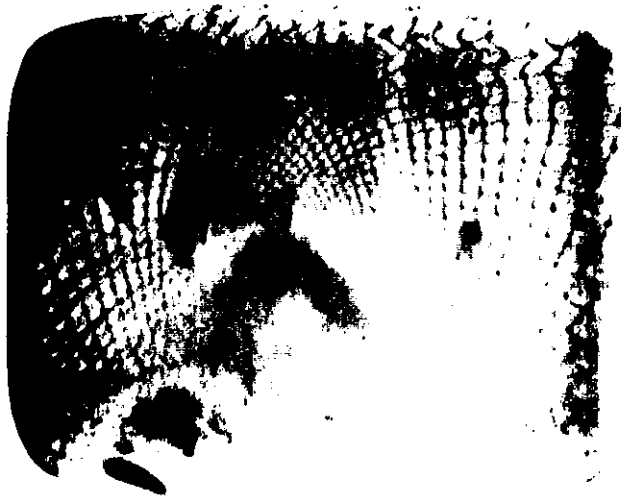


Fig. 2. Internal View of Cod End in Action. The Fish are Haddock.

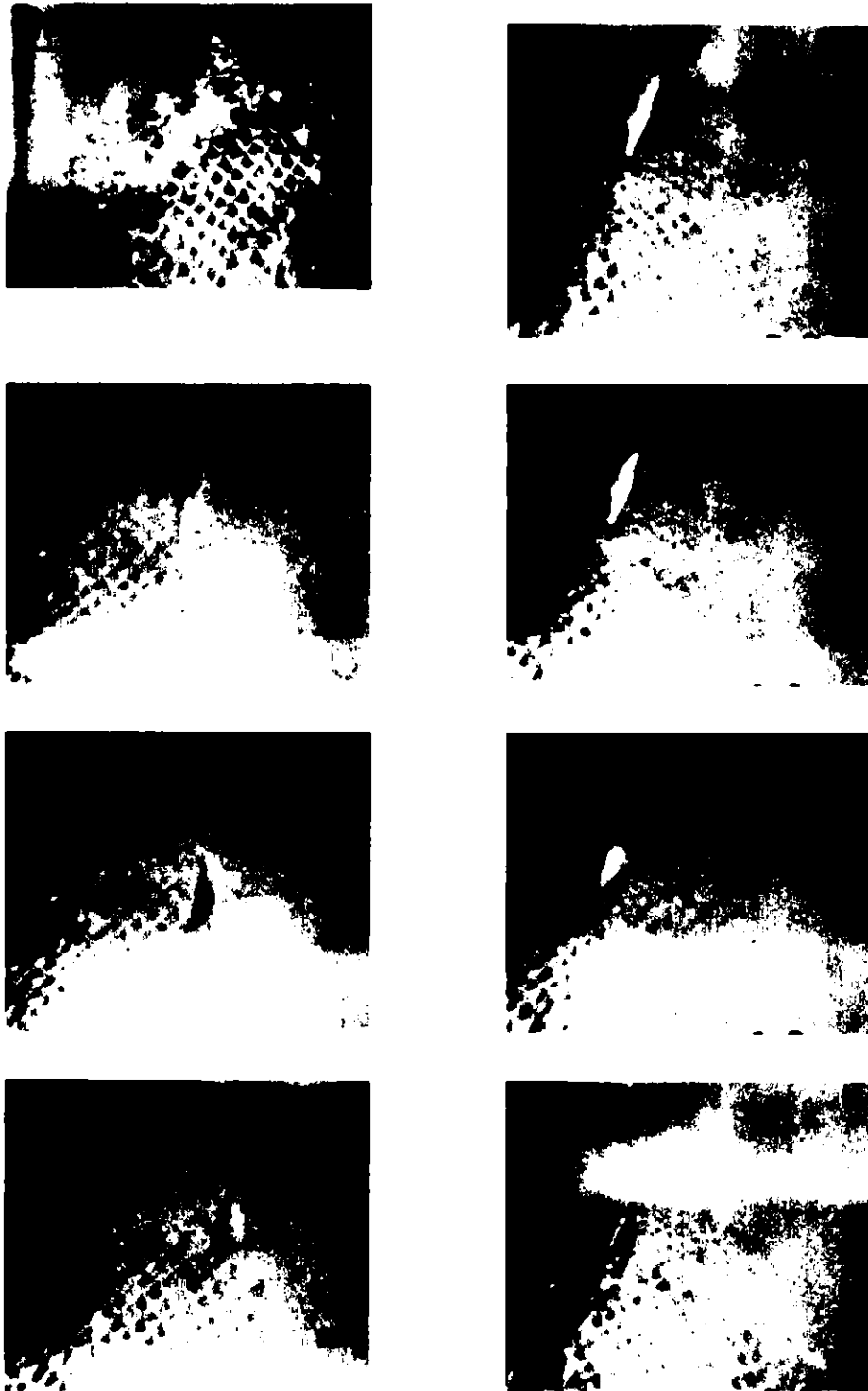


Fig. 3. Chafing gear in action as viewed from above. In frame at upper left the clearance between chafing gear and cod end may be seen. The series of three frames below at left show a haddock escaping. The four frames at right also show an escape sequence.