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ON SOME PROBLEMS OF SELECTIVITY OF A COMMERCIAL TRAWL

by

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Abstract

Method of experimental estimate of trawl selectivity which is in practice at present time does not allow to have a clear view on actual losses in catches. The viability of fish escaped through a trawl mesh is studied insufficiently.

An alteration of the mesh size in a commercial trawl cod-end appears to be one of the most propagated ways of marine fishery regulation. Numerous experiments (Margets,1957; Cieglevicz, Strzyzewsky, 1959; Bedford, Jones,1960; Jonsson,1960; Longhurst,1960; Clarc,1963; Hodder, May,1965; Anon,1967; Bohl,1967,1969,1971; James,1970; Bohl, Botha, Eck,1971; Yephimov,1976) showed to what extent selective capacity of a trawl (selectivity factor) depends on the mesh size and the net material.

Taking into consideration natural mortality and fish growth rate it is possible to calculate such mesh size which is capable to take maximum catch per recruit. Such calculations show that in a number of cases the increase in mesh size is reasonable as the short-time losses of the catch will be compensated in future by its stable growth (Meyer,1960; Gulland,1964; Pinhorn,1970; Pinhorn,Wells,1971).

True, calculations made in such a way are usually based on experimental trawlings which are not quite identical to commercial ones. In fact for experimental trawlings brand-new trawls with no damaged and mended parts of webbing are sometimes used. As a rule experimental trawlings do not take much time and are carried out on those concentrations in which only one species which is of interest for the experimentators dominates.

Meanwhile commercial trawls used in real conditions of marine fishery have the most different degree of wear. Commercial trawlings are often conducted on fish concentrations of mixed species composition, besides, time of trawling as well as catches are sometimes considerable.

As the exploitation of a commercial trawl goes on it gains more and more new features distinguishing it from experimental trawls.

For example the irregularity of mesh sizes becomes greater because o thread wear, tension and separation into fibres (Longhurst,I960). After a long period of exploitation mesh size in trawl sacks made of polyamide netting decreases. That is why the new sacks are often made with larger mesh than it is required by the conventional fishery rules. Precise measurements showed that even new experimental trawls have inner size of different meshes far from being similar (Bohl,I969). Meanwhile the increase in mesh size irregulariry leads to greater fish escape; the selectivity of a trawl is determined not only by the average mesh size but also by the sizes of the largest meshes.

The trawl selectivity changes considerably depending also on catch size; the more is the catch the less is selectivity (Anon,I96I Bohl, Botha, Eck, I97I). Great number of fish in a cod-end prevents even the smallest fish from escape.

Finally, fluctuations of fish fatness and stomach fullness also influence the selectivity (Margets,I957; Longhurst,I959; Shestov,I96

It is practically impossible to regulate the influence of fishery on the exploited stocks when aggregations being catched are of mixed species composition (James,I970; Anon,I978).

At last, it is necessary to mind the following rather important point: while calculating the trawl selectivity fish amount and size composition are usually compared: I) remained in the cod-end and 2) escaped through the mesh and then stopped by the small-meshed cover net. But one should consider the fact that the small-meshed cover net decreases filtering capacity of the trawl and changes its catchability. This conclusion was confirmed, in particular, by experiments carried out in the Barents Sea under the leadership and direct participation of the author of this paper (Konstantinov, I963). Two trawlers of the same type running parallel courses towed bottom trawls of similar construction, size and rigging but with a different mesh in the cod-end. During 40 trawlings, each lasting for an hour, 26 542 specimens of cod and haddock were caught, each fish being weighed and measured. As it was expected the trawl with a larger mesh yielded lower catches. At the same time another important conclusion was also drawn: the largest cod and haddock specimens always got into a large-meshed trawl in greater quantities then into a small-meshed one. It goes about fish so large that they were unable to escape neither through the first trawl nor through the second trawl mesh. But the absolute number and total weight of the specimens mentioned were constantly higher in a large-meshed trawl due, perhaps, to its better filtering capacity. Of course, a small-mesh cover net affects the amount and size composition of the catch even to a greater extent.

Thus, a traditional scheme of experiments on selectivity (comparison of catches in the cod-end and in the small-mesh cover net) does not provide a true estimation of the selectivity factor.

Due to all circumstances mentioned above the calculations made on the basis of traditional experimental trawlings cannot be regarded as irreproachable. Experimental trawls selectivity to some extent differs from that of commercial ones just like laboratory experiments of an industrial process differ from real indices of large industrial enterprise. Besides, for a correct estimate of the mesh size influence on the exploited stock it is necessary to know the viability of fish escaped through the mesh.

This problem wasn't payed enough attention yet, though the problem itself is very important. For example, in 1957 a joint symposium of ICNAF, ICES and FAO devoted to selectivity of fishing gears took place in Lisbon. Materials of the Symposium were published later on and they touched various aspects of selectivity. But out of 24 articles in the Volume[+)] none deals with the vitality of fish escaped through the mesh.

In 1960 a number of reports on selectivity of fishing gears was made at the ICES annual session. Only two touched the problem of viability of fish escaped. Thus, Vinogradov (1960) noted that Baltic cod escaped through the trawl mesh go down. According to A.I.Treshchev (1974) this may be interpreted as preservation of viability. But the authors mentioned had not any data concerning the further fate of cod left for the sea. Meantime, escaping of cod through the mesh is described in the following manner: "It seems that when a fish manages to push its head into a mesh it makes every effort to push through the whole its body. During this process the fish belly contracts and so to say "pushes back" to the part of body with a lesser girth; after the front part of the body has passed through the mesh it is relatively easy for the rest parts to follow." It can't be excepted that after such a difficult getting over the mesh the fish specimen even having no visible injury may die. Canadian scientists proved experimentally on cod (Templeman, 1963) that "some fish which escaped through the mesh may die from swimming fatigue because lactic acid accumulation in blood appears to be of a very high extent. Bagge (1970) describes quite a number of similar facts in his sapid article.

+) ICNAF Special Publication, No 5, 1963.

Otterlind (I960) showed that Baltic cod juveniles which got into the trawl and passed through the mesh are not viable in most cases. The author relates the lethal effect to the change of outer pressure when taking a fish from bottom layers to the surface. Konstantinov observed from a hydrostatic apparatus the trawl movement along the bottom and noticed that meshes in the cod-end of moving trawl had the form of a very long rhombus (Lagunov,I955). The similar fact was noted by Vinogradov (I960). Thus, it is very difficult for fish to pass through the mesh when escaping from the cod-end. Only when the trawl is winched up to the side (or near the stern slip) of a commercial vessel the mesh widens and fish get the possibility to go out. But its viability decreases considerably as a result of continuous dragging of the catch along the bottom and consequent elevation to the surface.

It concerns especially physoclistic fish to which the most important commercial species of Gadidae, Macruridae, Scorpenidae families are related. Their mass tagging is either impossible at all or connected with extra difficulties such as puncturing of swim bladder swelled after the elevation of fish from deep layers (Beverton, Gulland, Margets,I959; Konstantinov,I965,I977; Reinsch,I969; Kohler,I97I). But even bladderless fishes caught by a trawl and elevated to the deck often die. Thus, according to the rules of fishery, plaice smaller than 27 cm (Einarsson,I956, or 30 cm long (Lux,I969) are thrown overboard in different parts of the ocean; but keeping such specimens in tanks (holding nets) showed that only about 25% of specimens thrown back into the sea survive.

In order to determine the viability of fish passed through the commercial trawl mesh a series of special experiments is necessary. Their scheme was developed in details by ichthyologists working at fish tagging (Kohler,I963,I97I; McCracken,I963; Overko,I964; Birjukov,Shirokova,I966; Lamp, Tiews,I969,I972; Rauck, I974; Kock,I975; Konstantinov,I977). The caught fish are usually placed in reservoirs (holding nets) on deck of a ship, on the shore or even put down on the sea bottom. After a certain considerable period of time (sometimes 2-3 weeks) the survived specimens should be chosen and tagged (usually by tags of several different types in order to compare their return).

In the course of such experiments it was found that fish caught with a trawl and elevated to the surface lose their vitality in quite a number of cases.

Thus, when hake (Merluccius merluccius) were taken from the trawl catch for tagging the return of tagged specimens reached only 0.3-I.4% whereas the return from the Danish seine catches was 6.5% (Fritz,I959). The soviet ichthyologist N.N.Malashkin (I962) having made observations on trawl fishery of whitefish in the Ladoga Lake

came to a conclusion that "increasing a mesh size to 50 mm it is possible to avoid juveniles by-catch into the trawl...but it is impossible to stop juveniles mortality".

If it is really so then the increase of the trawl mesh leading inevitably to catch losses does not contribute to the shortening of fish stocks. And it is really difficult to give examples when the increase in trawl mesh sizes affected favourably the abundance and biomass of any fish stock of the open ocean. Sometimes after the larger mesh introduction a gradual increase in catches is observed but there is no ground to suggest that the first takes place due to the second. Thus, the average annual catch of haddock per one commercial vessel on the Georges Bank increased by 5% in a year after the trawl mesh has become larger (Martin, Jean, I958). But gradually it became obvious that fluctuations of haddock fishery production are not connected with the trawl mesh size (McCracken, I968; Grosslein, Hennemuth, I973; Anon, I978). The mesh change in the barents Sea had no visible positive consequences, did not remove and soften periodic very sharp declines in fishing conditions.

It is reasonable to include the checking up the viability of fish passed through the trawl mesh into the programme of international investigations. The main scheme of the experiments recommended - simultaneous keeping of two fish batches in similar tanks: I) passed through the trawl mesh; 2) remained in the cod-end. Having cleared out the reasons of fishes death in either batches it is possible to estimate quantitatively their viability. It is expedient also to practice mass tagging of fish from both batches for the further comparison of their return.

Much more complicated methods of investigations include separation of cod-end (with a small-mesh cover net) from the bottom trawl after finishing of trawling but without the cod-end elevation to the surface. Provided with a buoy the cod-end with fish must be kept near the bottom[+)] after which both the death of fish passed and not passed through the mesh should be compared. Fish viability may be determined either under water or after the cod-end is elevated to the surface.

It is much more difficult to study those changes which take place in behaviour of fish passed through the mesh and preserved their viability. There are grounds to suggest that these specimens have a sharpened reaction to trawl avoidance and this new feature is transferred to their neighbours in the shoal.

[+)] Of course in this case the cod-end and small-mesh cover net should have special rigid frames which will give the fish caught an opportunity to swim freely inside an original "holding net".

REFERENCES

Anon,I96I. Aus der Arbeit der Deutschen Wissenschaftlichen Kommission für Meeresforschung. "Allgem. Fischwirtschaftszeitung", Bd.I3, Nr.27, S.I3-I4.

Anon,I967. Compilation of selectivity data presented to the commission from I962 to I966. "ICNAF Redbook I967", part3, pp.I0I-II5.

Anon,I978. Some scientific problems of multispecies fisheries. "FAO Fish.Techn.Pap.", No I8I, pp.I-42.

Bagge O.,I970. The reaction of plaice to transplantation and taggings. "Medd.Dan.fisk - og havunders", Bd.6, Nr.5, S.I53-338.

Bedford B.C.,Jones B.W.,I960. Mesh selection experiments in the Irish Sea. "ICES I960 Meeting, Comp.Fish.Comm.", No 58.

Beverton R.J.H.,Gulland J.A.,Margets A.R.,I959.Whiting tagging: how the return rate is affected by the condition of fish when tagged. "J.Conseil perman.internat.explorat.mer.", vol.25, No I, pp.53-57.

Biriukov N.P.,Shirokova M.I.,I966. Some results of cod tagging in the Baltic Sea I962-I964. "Ann.biol.Conseil perman.internat.explorat. mer.,I964", vol.2I, pp.84-89.

Bohl H.,I967. Selection of cod by bottom trawl cod-ends in South-West Greenland waters. "ICNAF Redbook I967", part 3, pp.75-89.

Bohl H.,I969. Trawl mesh selection experiments on cod (Gadus morhua L.) off Bear Island. "Ber.Dtsch.Wiss.Kommiss.Meeresforsch.", Bd.20, H.I, S.84-90.

Bohl H.,I97I. Neue Selectionsexperimente im Nordwestatlantik. "Inform. Fischwirtschaft", Nr.6, S.I95-I99.

Bohl H.,Botha L.,Bok T.H.,I97I. Selection of Cape hake (Merluccius merluccius capensis Castelnau and Merluccius merluccius paradoxus Franca) by bottom-trawl cod-end. "J.Conseil perman.internat.explorat.mer.", vol.33, No 3, pp.438-470.

Cieglewicz W.,Strzyzewsky W.,I959. Selection of Baltic cod by cod-ends of different materials. "Rapp. et procès verbaux réunions. Conseil perman.internat.explorat.mer.", vol.I47, pp.75-80.

Clark J.R.,I963. Size selection of fish by otter trawls results of recent experiments in the Northwest Atlantic. "ICNAF Special Publ.", No 5, pp.24-96.

Yephimov Yu.N.,I976. On some questions of fishing grars selectivity in relation to Pacific redfish. "Rybnoe khozyaistvo", No 2, pp.43-46.

Einarsson H.,I956. Skarkolinn (Pleuronectes platessa L.) i Hamarsfirdi. "Rit Fiskideildar", Bd.2, No 3, S.I-20.

Fritz R.L.,1959. Hake tagging in Europe and the United States,1931-1958. "J.Conseil perman.internat.explorat.mer.", vol.24, No 3, pp.430-485.

Grosslein M.D.,Hennemuth R.C.,1973. Spawning stock and other factors related to recruitment of haddock on Georges Bank. "Rapp. et procès-verbaux réunions. "Conseil perman.internat.explorat.mer.", vol.164, pp.77-88.

Gulland J.A.,1964. A note on the interim effects on catches of changes in gear selectivity. "J.Conseil perman.internat.explorat. mer.", vol.29, No1, pp.61-64.

Hempel G.,1978. Synopsis of the symposium on the North Sea fish stocks - resent changes and their causes. "Rapp. et procès-verbaux réunions. Conseil perman.internat.explorat.mer.", vol.172, pp.445-449.

Hodder V.M.,May A.W.,1965. Ottertrawl selectivity and girth-length relationship for cod in ICNAF Subarea 2. "ICNAF Res.Bull.", No 2, pp.8-18.

James C.D.,1970. Mesh selection studies on flatfish in relation to the Otago trawl fishery. "N.Z.J. Mar. and Freshwater Res. vol.4, No 3, pp.229-240.

Jonsson J.,1960. Selection factor for Icelandic cod and haddock, 1958-1960. "ICES 1960 Meeting, Comp.Fish.Comm.", No 134,

Kohler A.C.,1963. Use of tagging data in Subarea 4 cod growth investigations. "ICNAF Spec.Publ.", No 4, pp.66-70.

Kohler A.C.,1971. Tagging of white hake, Urophycic tenius Mitchill, in the southern Gulf of St.Lowrence. "ICNAF Res.Bull.", No 8, pp.21-25.

Konstantinov K.G.,1963. Advantages of a large-meshed trawl when catching fish of middle and large sizes. "Materialy rybokhoz. issled. Severnogo basseina", Sb.I, Murmansk, s.25-26.

Konstantinov K.G.,1965. Functions of the swimbladder of Teleosts and their change in the course of phylogenesis. "Zhurn.Obshch. Biol.", t.26,95, s.538-545.

Konstantinov K.G.,1977. Modern fish marking technique. "Voprosy ichtiologii", t.17, vyp.6 (107), s.1097-1112.

Lagunov I.I.,1955. The experiment of underwater observations from hydrostate apparatus. "Rybnoe khozyaistvo", No 8, s.54-57.

Lamp F.,Tiews K.,1969. Verleichende Markierungsexperimente am Ostseedorsch (Gadus morhua) im Jahre 1968. "Ber.Dtsch.Wiss.Kommiss. Meeresforsch.", Bd.20, H.1, S.76-79.

Lamp F.,Tiews K.,1972. On the initial survival rates in Baltic cod tagging experiments. "ICES 1972 Meeting, Sea Demersal fish (Northern) Comm.", No F-10.

Longhurst A.R.,1959. Prediction of selection factors in a tropical trawl fishery. "Nature (Engl.)", vol.184, No 4693, pp.1170.

Longhurst A.R.,1960. Mesh selection factors in the trawl fishery off tropical West Africa. "J.Conseil perman.intermat.explorat.mer.", vol. 25, No 3, pp.318-325.

Lux F.E.,1969. Landings per unit of effort, age composition and mortality of yellowtail flounder, Limanda ferruginea (Storer), off New England. "ICNAF Res.Bull.", No 6, pp.47-52.

Malashkin N.N.,1962. Should fishing gears in the fishery rules be limited according to the mesh size and their construction. "Rybnoe khozyaistvo", No 2, s.26-29.

Margets A.R.,1957. The length-girth relationships in whiting and cod and their application to mesh selection. "J.Conseil perman.intern. explorat.mer.", vol.23, No 1, pp.64-71.

Martin W.R.,Jean Y.,1958. First-year effects of mesh regulation on northern New Brunswick dragger fishery. "Progr.Repts Atlant.Coast. Stat.", No 69, pp.33-40.

McCracken F.D.,1963. Comparison of tags and techniques from recoveries of Subarea 4 cod tags. "ICNAF Spec.Publ.", No 4, pp.89-100.

McCracken F.D.,1968. Size, age and recruitment comparisons for haddock of the central Scotian shelf. "ICNAF Res.Bull.", No 5, pp.99-109.

Meyer A.,1960. Internationale Bemühungen zur Erhaltung und bestmögkechen Ausnutzung der arktischen Kabeljau- und Schellfischbestandes. "Inform. Fischwirtschafte", Bd.7, Nr.1, S.8-12.

Otterlind G.,1960. Some observations on the survival of released trawl-caught cod. "ICES 1960 Meeting, Comp.Fish.Comm.", No 204.

Overko S.M.,1964. Experimental fish tagging near north-western African coast. "Trudy Atlantich. in-ta rybn.khoz. i okeanogr.", vyp.11 s.100-103.

Pinhorn A.T.,1970. Assessment of the effects of increases in the mesh sizes of trawls on the southern Grand Bank area (ICNAF Divisions 3N and 3O). "ICNAF Res.Bull.", No 7, pp.32-45.

Rass T.S.,1973. The geographical complex of fisheries of the North Sea and its changes. "Oceanology", vol.13, No 1, pp.173-182.

Rauck G.,1974. Nordseeschollen in der Ostsee markiert und gesetzt. "Inform. Fischwirtschaft", Bd.21, Nr.6, S.147-148.

Reinsch H.H.,1969. Deutsche Markierungsexperimente am Köhler Pollachius virens (L.) in norwegischen Gewässern 1964-1968. "Ber.Dtsch. wiss.Komm.Meeres-forsch.", Bd.20, H.3-4, S.296-301.

Shestov V.P.,1966. Girth-lengkh relations in some species of fish and selectivity of cod-ends in the Barents Sea. "Trudy VNIRO", vol.61, pp.63-72.

Templeman W.,1964. Canadian research report,1963. A. Subareas 2 and 3. "ICNAF Redbook 1964", part 2 and 3, pp.3-21.

Treshchev A.I.,1974. Scientific grounds of selective fishery. M., pp.1-448.

Vinogradov N.N.,1960. Survival of fish escaping from the cod-end of trawls. "ICES 1960 Meeting, Comp.Fish.Comm.", No 172.