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On fluctuations of the annual cod yield on the

southern Grand Bank

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The year-to-year variations in size-age composition and

catch per fishing effort,total fishing effort,instantaneous

fishing mortality are usually taken as a basis of estimati-

ons of maximum sustained yield. Constancy of annual recru-

itment to fishing stock with the young fishes (recruits) is

assumed.

Meanwhile,since the time of publications of classical

papers by Johan Hjort (Hjort,1914,1926) an important role

of natural fluctuations of the year-classes strength in

the formation of the commercial fishes stocks is well known.

The experience of modern oceanic fishery again and again

makes sure that namely fluctuations exert a paramount de-

cisive influence upon the stocks value.

Therefore,the assessment on future sustained yield

with ignore of the real value of recruitment is very often

to be an erroneous. Thus,Pinhorn and Wells (Pinhorn and

Wells,1970) write about the cod in Divisions 3N and 3O

the following: "In this area recruitment can be quite va-

riable,the survival rate of cod in one year being many

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times greater or lesser than in an adjacent year. Maximum
sustained yield as estimated by Assessments Subcommittee of
ICNAF in 1968 was 75 thousand tons and as estimated in this
paper for 1963-66 data was 92-102 thousand tons. However,
in 1967 the catch increased drastically to 220.000 tons and
in 1968 was still 160.000 tons compared with about 80.000
tons in 1963-66. Associated with this was a sharp increase
in effort. This resulted from increased effort on the excep-
tionally good 1964 year-class of cod when these fish were
3- and 4-year-old,respectively".

Since 1962 the ichthyologists of PINRO undertake an an-
nual determination on young cod in the Newfoundland area
(Bulatova,1973). The most complete,carefully corrected to-
tal data were included in "Review on the USSR investigati-
ons in 1975". From the table given there it is quite seen
how the cod fluctuations are sharply expressed in Divisi-
ons 3N and 3O. It will be shown further,that annual cod
yield of this stock can be predicted with higher accuracy,
basing on data of the young fishes determination.

Pinhorn and Wells (Pinhorn and Wells,1975) stated that
in recent years in commercial catches of cod in Divisions
3N and 3O the specimens at the age of 4,sometimes also of
3 years had been prevailed. An actual fishing value of cod
at the age of 3 years is probably even higher,than that
from the paper by Pinhorn and Wells. Consequently,for pre-
diction of the annual cod yield it is necessary to accept
the abundance of two year classes,born three and four

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years earlier than that calendar year,for which the pre-
diction had been compiled,for initial prerequisite. Regu-
lar determination on young cod,in particular,yearlings is
provided us with necessary data.

It is quite seen from Figs.1 and 2,that there is a clo-
se relationship between the abundance of yearlings and sub-
sequent yield of cod in Divisions 3N and 3O. It can be
expressed by equation:

$$Y_i = 1.258 \ (n_{i-3} + n_{i-2}) + 68.8 \qquad (1)$$

where
$\qquad$ i - calendar year,

$\qquad$ n - average number of yearlings per hour trawling

$\qquad\qquad$ taken with fish counting trawl in Divisions

$\qquad\qquad$ 3N and 3O (in total),

$\qquad$ Y - total yield of cod taken by all the countries

$\qquad\qquad$ (thou.t) in Divisions 3N and 3O (in total).

The coefficient of correlation (r) between the abundance
of yearlings taken into account and subsequent yield of cod
is equal to 0.895. Hence,there is a very close relationship
between the compared indexes,that is quite naturally beca-
use the cod stocks on the southern Grand Bank are exploi-
ted very intensively and their each new recruitment   in-
fluences upon the catches immediately. A mass migration
of cod into Divisions 3N and 3O from adjacent divisions
(or,on the contrary,a mass leaving of cod from Divisions
3N and 3O) is never observed,that is evidenced,in parti-
cular,by tagging data (Danke,1967; Konstantinov,1967,
1970; Templeman,1974).

An example of pre-estimation of cod yield due to

the formula (I).

To predict the total cod yield,for instant,for 1976,it

is necessary to take into account the abundance of the

1972 and 1973 year classes; the cod of these year classes

in 1976 will be at the age of 4 and 3 years,respectively.

A number of yearlings per hour trawling taken with the

fish counting trawl in 1973 and 1974 are accepted for
                      pre/
initial requisites. A number of yearlings of the 1972

year class (determined in 1973) is equal to 9 specimens,

of the 1973 year class (determined in 1974) - to 4 spe-

cimens.Consequently,from equation (1) we obtain the ex-

pected yield (thou.t):

$$Y = 1.258 \ (9+4) + 68.8 = 85.1$$

In Fig.2 there are shown not only actual cod catches

(for 1965-1974),but the pre-estimated ones (for 1975-1977)

also. The latters are below the average level for the

last decade (1965-1974),which constituted 117 thou.t.

However,there is no expected any tendency to further de-

crease of the annual cod yield; it can be probably stated

the stability of the stocks,that is also confirmed by the

results of the total trawl survey in 1971-1975 ("Review

on the USSR investigations in 1975").

If in Divisions 3N and 3O new very abundant year clas-

ses of cod appear,then the stock and annual yield will sharp-

ly increase as in 1967-1968.The appearance of abundant year

classes will take place as soon as the favourable conditions
of abiotic and biotic environment are observed. But the
abundance of the spawners and the eggs spawned by them
does not practically influence upon the strength of new
yearlings.

Average number of yearlings of cod per hour trawling
taken with the fish counting trawl in Divisions 3N and 3O

Year class	Year of determination	Number of yearlings Div.3N	Div.3O
1961	1962	2	2
1962	1963	2	10
1963	1964	1	1
1964	1965	57	37
1965	1966	0	0
1966	1967	2	21
1967	1968	0	2
1968	1969	8	24
1969	1970	4	6
1970	1971	9	2
1971	1972	6	2
1972	1973	6	3
1973	1974	1	3
1974	1975	2	4

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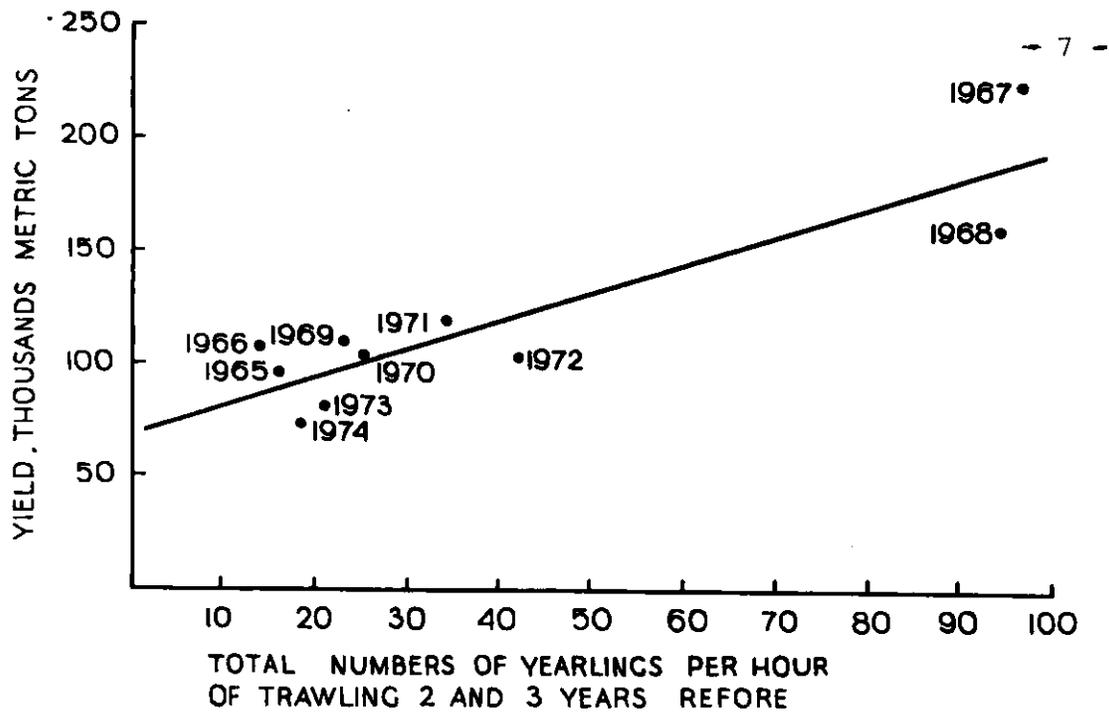
Fig. 1. Relationship between the number of yearlings per hour trawling taken with the fish counting trawl and subsequent cod yield taken by all the countries in Divisions 3N and 3O.
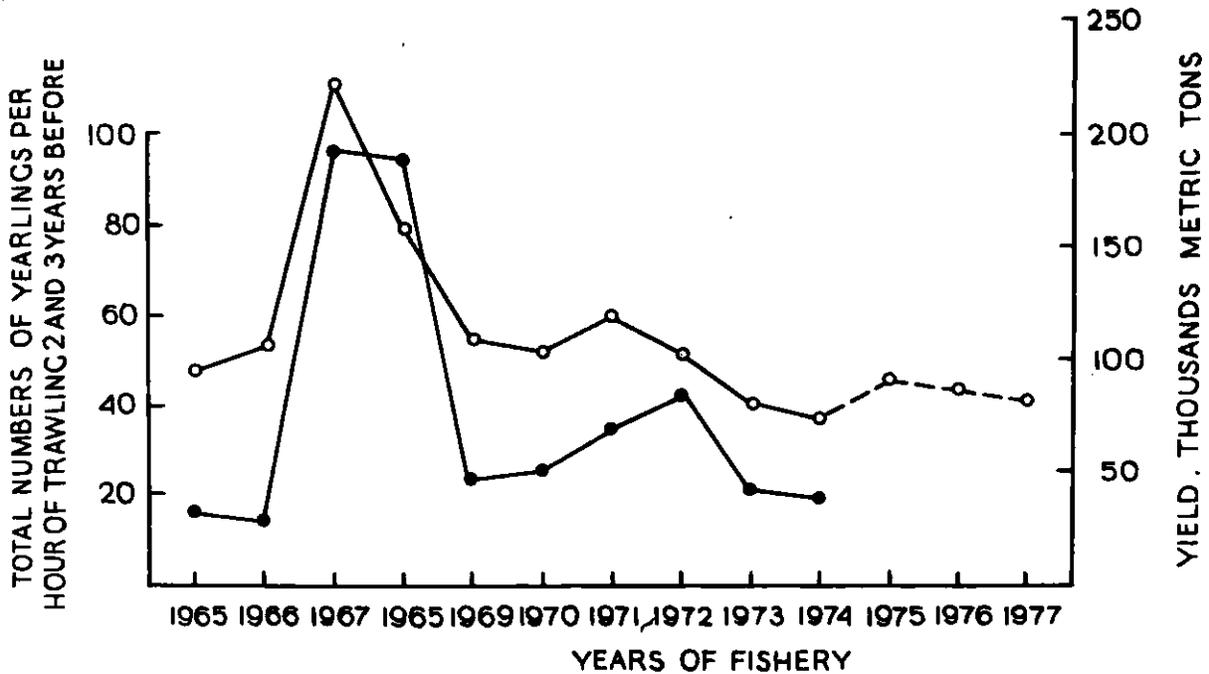

Fig. 2. Annual cod yield taken by all the countries (white circles) and number of cod yearlings per hour trawling taken with the fish counting trawl (black circles) in Divisions 3N and 3O.