International Council for the
Exploration of the Sea

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Pelagic Fish (Northern) Committee

INTERIM REPORT OF THE NORTH SEA HERRING ASSESSMENT WORKING GROUP

x) General Secretary
International Council for the Exploration
of the Sea, Charlottenlund Slot
2920 Charlottenlund, Denmark

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I. Objectives and Participation

At the last meeting of the Working Group in September 1971 new methods were applied in order to achieve answers to the questionnaire of NEAFC. Due to the very restricted facilities and time available to the Group some inconsistencies and miscalculations appeared in the Report (C.M.1971/H:28).

The purpose of the present meeting was to make a critical review of the work carried out at the previous meeting, to update the prognosis and to plan future work.

The meeting was held at ICES headquarters, Charlottenlund, from 24-28 January 1972, and attended by the following members:

Dr H. Ackefors	Sweden
Mr A.C. Burd	U.K.
Mr H. Lassen	Denmark
Mr Ulltang	Norway
Mr K. Popp Madsen	Denmark (Chairman)
Mr K.H. Postuma	Netherlands
Mr A. Saville	U.K.
Mr O.J. Østvedt	Norway
Mr J. Møller Christensen	Secretary of the Liaison Committee

II. The Prognosis

The prognosis of the future development in catch and biomass at different levels of fishing mortality is based on certain assumptions and estimates of the parameters discussed below.

a) Natural mortality

At the previous meeting a least square estimation based upon the total North Sea catches broken down by age groups gave an estimate of $M = 0.1$, being about half the value hitherto assumed.

At the present meeting the same method was applied to each sub-area independently using data from the period 1957-1968 and for total North Sea catches in 1951-1969. The following estimates of M for adult herring were derived:

Area IVa west	0.067
Area IVa east	0.093
Area IVb	0.094
Area IVc	0.073
Total North Sea	0.073

The overall standard deviation for these estimates is about 25% and they are thus not significantly different from 0.1.

It was then decided that in further stock calculations a rounded estimate of $M = 0.1$ should be used.

b) Fishing mortality

In the previous Report estimates of the fishing mortalities in 1969 and 1970 were made from regressions of estimates of F from the virtual population analysis, and the least square method on estimates of fishing mortality derived from catches per effort. A value of 0.70 was obtained for the fishing mortality in 1970.

From data of the 1968-1971 fisheries the following estimates of total mortality have been derived from catch per effort data.

Year	Total Mortality Z			
	IVa Scotland	IVb England	IVb Netherlands	IVc Netherlands
1968/69	0.55	1.27	1.30	2.0
1969/70	1.34	1.30	0.79	1.0
1970/71	0.73	1.30	-	-

It would appear from these data that the total mortality in recent years has been high and it was thought more realistic to run the prognosis with a fishing mortality for adult herring (i.e. 2-ringers and older) of $F = 1.0$ rather than the value of 0.7 used previously.

Using the total North Sea catches and catches from the areas IVb and IVc, F values for the juvenile herring were calculated by a Cohort Analysis using $M = 0.1$. Average values of 0.4 and 0.6 respectively were derived over the period 1964-1969 and a current $F = 0.5$ appears reasonable for 1-ringed herring.

c) Initial age composition and recruitment

The stock composition as at 1 January 1972 was used as a starting point for the prognosis. This was derived from catch in number per age group in 1970 corrected to stock in number as at 1 January 1970 by applying an $M = 0.1$ for all age groups and an $F = 1.0$ to fish older than 1-ringers and $F = 0.5$ to 1-ringers. The 1970 catch figures used were corrected according to new information from German sources by adding 20,000 tons of juvenile herring. The youngest year class (1969) was calculated as being 50% greater than the average recruitment in 1962-69. The relative strength of the 1969 year class was based upon data from 0-group surveys, ICES' young herring surveys and young herring fisheries. A comparison between year classes 1968 and 1969 is shown below (year class 1968 set at unity):

	1968	1969
0-group surveys, English coast	1.00	2.28
ICES Young Herring Surveys, Feb-Mar	1.00	2.54
Young herring fishery, spring 1971	1.00	2.60
Young herring fishery, autumn 1971	1.00	2.23

Those year classes, younger than that of 1969, entering the stock in the period covered by the prognosis were assumed to be of average strength. The average value of 6.5 for the period 1962-1969 was used.

The age composition as at 1 January 1972 was:

Winter Rings

	0	1	2	3	4	5	6	7	8	9
Stock in numbers x 10^{-9}	6.5	5.9	4.9	.7	.4	.16	.02	.009	.01	.001

d) Mean weights per age group

In order to assess the effects of changes in juvenile and adult fishing mortalities on the stock and catch in weight, estimates of the mean weights of each age group as caught have been made. The mean weights of fish older than 2-ringers were calculated from the von Bertalanffy growth equation presented in the previous Report.

For the younger age groups estimates were obtained of their mean weight both in the fishery and as at 1 January. The main growth period of herring is in the early part of the year; most of the adult catch is made after the annual growth has been achieved.

The mean weights used in the computations appear below:-

<table>
<tr><th></th><th colspan="2">Mean weights (gm)</th></tr>
<tr><th>Winter Rings</th><th>Biomass at 1 January</th><th>Catch</th></tr>
<tr><td>0</td><td>17</td><td>17</td></tr>
<tr><td>1</td><td>25</td><td>50</td></tr>
<tr><td>2</td><td>75</td><td>125</td></tr>
<tr><td>3</td><td colspan="2">182</td></tr>
<tr><td>4</td><td colspan="2">207</td></tr>
<tr><td>5</td><td colspan="2">226</td></tr>
<tr><td>6</td><td colspan="2">240</td></tr>
<tr><td>7</td><td colspan="2">249</td></tr>
<tr><td>8</td><td colspan="2">256</td></tr>
<tr><td>9</td><td colspan="2">260</td></tr>
<tr><td>10</td><td colspan="2">264</td></tr>
<tr><td>11</td><td colspan="2">266</td></tr>
</table>

e) Prognosis for different levels of fishing mortality

Using the parameters indicated in the previous sections, computations were made of the expected catches in 1972 under different levels of juvenile and adult fishing mortalities. These are presented in Table 1 and in Figure 1 for all combinations of juvenile fishing mortality from F 0.0-0.7 and adult fishing mortalities from F 0.0-1.5. In addition is shown the expected percentage changes in the 1975 catch and biomass over those in 1972.

The juvenile mortalities are applicable only to the 1-ringers as the 2-ringers mainly are exploited in the adult fisheries. The fishing mortality on 0-group is assumed to be negligible.

In Table 1 the first column indicates the expected changes, if there were no fishing on 1-ringed fish (F = 0.0). Thus at an adult F = 0.1, the expected catch in 1972 would be 79,000 tons, and if this pattern were continued to 1976, then the 1975 catch would be 243% greater and the biomass at 31 December 1975 would be 300% greater. At an adult F = 1.0, the expected catch for 1972 would be 527,000 tons and the catch in 1975 would be increased by 34% and the biomass by 32%.

The first row indicates the effects of stopping all adult fishing and exploiting 1-ringed fish only.

It has been assumed that the recruitment would be of average strength up to 1976. The annual 1972-75 catches would then simply be a proportion of these recruits depending on the fishing rate. There would be no change in catch with time, as the 1-ringed fish after passing through the fishery would join the adult unfished stock. However, the biomass would increase by 359% over the 1972 level at F = 0.1 or 217% at F = 0.7.

The expected changes in catch and biomass in Table 1 differ somewhat from those given in the corrected version of the Report of the North Sea Herring Assessment Working Group (C.M.1971/H:28) as presented by the Liaison Committee of ICES to the North-East Atlantic Fisheries Commission (NC H/1, Table 8). Some examples of the changes are given below and show that the two sets of prognoses are rather similar.

Fishing Mortality		1972 Catch		% increase in biomass 1972-1975	
		Table 8	New Data	Table 8	New Data
Juvenile Adult	0 0	0	0	240	392
Juvenile Adult	0.5 0.0	133	111	149	255
Juvenile Adult	0.5 0.7	472	529	4	16
Juvenile Adult	0 0.7	339	419	45	68

III. The Effect of Closed Seasons

The Working Group estimated the effects of a closure of the fishery on herring in the first half of the year by adapting the average weight per age group in the second half of the year as used in the prognosis for calculating the biomass.

When the fishing on herring is confined to the second half of the year, there will be an increase in average weight of the individual fish caught. Supposing that the annual catch in number is taken in the second half of the year, then in the current range of fishing mortality of juvenile and adult herring the gain in weight of the total catch would be of the order of 20-30%.

Any resulting decrease in the number of 1-ringers caught would increase the expected gain of the overall catch in weight over the period considered.

IV. Preliminary catch figures for 1971

1971 preliminary catch data (metric tons)

	IVaE	IVaW	IVb	IVc + VIID+E	Total North Sea	IIIa	Total North Sea & Skagerak	West of 4 W
Belgium	-	-	1	285	286	-	286	-
Denmark	←	183615	→	-	183615	29188	212803	-
Faroes	←	25070	→	-	25070	4930	30000	27000
France	-	685	6309	5967	12961	-	12961	-
Germany	←	3600	→	148	3748	-	3748	7466
Iceland	←	29503	→	-	29503	5193	38696	?
Netherlands	160	5260	8902	13133	27454	-	27454	?
Norway	10592	89606	6	-	101791	5961	107752	99011
Poland	←	5000	→	-	5000		5000	
Sweden	←	34673	→		34673	12814	47487	-
U.K. England	-	-	4113	-	4113	-	4113	-
U.K. Scotland	-	24711	362	-	25073	-	25073	-
U.S.S.R.	?	?	?	?	?	?	?	?
Total					457287	58086	515373	133477

Danish catches are available only to the end of November. To this were added 4,000 tons for December in the North Sea and 4,000 tons in the Skagerak.

Swedish catches were available only to the end of October. Of herring caught for consumption (46,733 t.) 10% were taken in the North Sea, 21% in the Skagerak and 69% in the Kattegat according to landing statistics from Danish harbours. It was estimated that 30,000 tons of reduction catches were taken in the North Sea; 3,000 in the Skagerak and 3,000 in the Kattegat. The total Swedish catch including the Kattegat up to the end of October was 82,733 tons.

German figures are preliminary ones given by the Institut für Seefischerei.

Polish catches are an estimate given by Professor J. Popiel during the Moscow NEAFC meeting.

Faroese catches were available only to the end of October. In 1970 9% of the catch January-October was taken in November-December and therefore 9% was added to the January-October catches in 1971.

The Icelandic catch figures are those landed in Denmark. No figures are available for the proportion of this taken west of 4°W. By comparison with Norwegian and Faroese catches this may be as much as 50%.

The Dutch data includes January-September. As an estimate 4,000 tons were added to the figures for areas IVc + VIId,e.

It should be pointed out that the preliminary figures presented here are rough estimates only and in some cases likely to undergo considerable amendments.

V. Discussion

Preliminary figures of the total herring catch, taken in the North Sea and Skagerak in 1971, show a reduction of 100,000 tons compared with the figure for 1970. The fisheries on juvenile herring showed an increase in catch from 100,000 to 200,000 tons, whilst the catch of adult herring decreased to about half of that taken in 1970. The increase in the juvenile catch was due to the entry into the fisheries of the good 1969 year class. On the estimated strength of this year class used in the prognosis and on the assumption that the fishing mortality rate in these fisheries is 0.5, it can be forecasted that the catch of this year class would amount to 167,000 tons and 3.3×10^9 fish. The preliminary data on the catch in number of this year class taken in 1971 was 3.5×10^9 fish. The hypothetical catch of the 1968 year class in the juvenile fisheries in 1971 would amount to 40,000 tons, giving a forecast total catch in this fishery of 207,000 tons. This is very close to the preliminary catch figure from these fisheries of 203,000 tons. The correspondence between the forecast and the actual catch would support the assumption that the fishing mortality in the juvenile fisheries in 1971 was close to the estimated average value of 0.5.

An estimate of the catch in 1971 in the adult fisheries, using the stocks size data at 1st Jan. 1970 on which the prognosis is based, and an adult F of 1.0 gives a value of 321,000 tons. The preliminary catch figures point to an adult catch in that year of about 250,000 tons. The lack of age composition data at present from the major fisheries on adult herring makes it impossible to judge the source of this discrepancy between the forecast catch and the catch taken. It might be, however, that the fishing mortality rate in the adult fisheries in 1971 was less than 1.0, but until complete catch data are available it is not possible to assess whether the difference in forecast and observed catches are real.

A reduction in the adult F below the 1970 value could be due to the effect of the closure of the fishery, in May and in the period 20 August - 30 September in 1971. The fact that a high proportion of the Norwegian, Faroese, and Iceland catches were taken to the west of 4°W may also have meant a reduction in the effective fishing effort, and consequently in the fishing mortality rate, in the North Sea.

Because of the changes in the distribution of fishing which took place in 1971 it is not possible to estimate directly the effect of the 1971 closures on the fishing mortality rates in the adult fisheries. They would appear to have had little effect on the fishing mortality in the juvenile fisheries. A closure of the fisheries in the first six months of the year however would be likely to give a measureable increase in total catch even if it resulted in no decrease in the fishing mortality rates. Because of the large increase in weight of juvenile fish over this period even if such a closure resulted in 50% less juvenile fish being caught, there would still be some increase in weight of catch.

VI. Requirements for Effective Future Assessment

The Working Group also considered future work in the light of experience obtained from its recent meetings.

The problems fall into three main categories:-

a) Catch statistics.

The inevitable recommendation for improved catch statistics put forward in all former reports on herring assessments, must be repeated in the present report. Future activities especially in connection with regulations of the herring fisheries depend critically on the reliability and completeness of the data.

The Working Group had to admit that its repeated demands for improvements have not so far brought noteworthy results. The problems of statistics are especially acute in the major herring fisheries and can apparently only be solved through action at a high administrative level.

b) Biological data

The biological data are also far from satisfactory and again the most serious deficiencies occur in the major fisheries. As pointed out in previous reports of the Assessment Working Group, most of the age composition data available to it came from the fisheries which are now of minor importance in relation to the total catch taken.

The application of such age data to the total catch might result in large immeasurable errors in the assessment. More adequate age sampling by those countries with major catches of North Sea herring must be pressed for and given higher priority by the laboratories concerned.

c) Assessment methods

To increase the reliability of the prognoses, further development of assessment methods should be undertaken parallel to the use of those already at hand. The Working Group felt, however, that at present the greatest priority should be given to improving the quality of the basic data.

Table 1. Initial catch levels (1972) and percentage increase in catch and biomass 1972-75

Juvenile mortalities (1-ringers)

Adult mortalities (2-ringers and older)

F	.0	.1	.2	.3	.4	.5	.6	.7
	0	27	51	73	93	111	127	142
.0	–	0	0	0	0	0	0	0
	392	359	329	302	277	255	235	217
	79	105	130	152	172	190	206	221
.1	243	164	120	90	73	59	49	41
	300	272	247	224	203	184	167	152
	150	177	201	223	243	261	277	292
.2	196	148	115	92	74	61	50	41
	231	208	186	166	149	133	118	105
	215	242	266	288	308	326	342	357
.3	158	123	97	77	62	50	40	32
	180	159	141	124	109	95	82	71
	273	300	324	346	366	384	401	416
.4	128	100	78	61	48	37	28	21
	141	123	107	92	79	67	56	46
	327	353	378	400	419	438	453	469
.5	103	80	62	47	35	25	17	10
	110	95	80	68	56	45	36	27
	375	406	426	448	468	486	502	517
.6	83	63	47	34	24	15	7	1
	87	73	60	49	38	29	21	13
	419	445	470	492	511	529	546	561
.7	67	50	35	24	14	6	-1	- 7
	68	56	44	34	25	16	9	2
	458	485	509	531	551	569	586	600
.8	54	38	25	15	6	-2	-8	-14
	54	42	32	23	14	7	0	-7
	494	521	545	567	587	605	622	636
.9	43	29	17	7	-1	-8	-14	-19
	42	31	22	13	6	-1	-8	-13
	527	554	578	600	620	638	654	669
1.0	34	21	10	1	-7	-14	-19	-24
	32	22	14	6	-1	-8	-13	-19
	556	583	607	629	649	667	684	699
1.1	26	14	4	-5	-12	-18	-23	-28
	24	15	7	0	-7	-13	-18	-23
	583	610	634	656	676	694	711	725
1.2	20	8	-1	-9	-16	-22	-27	-31
	17	9	2	-5	-11	-17	-22	-27
	608	634	659	681	701	719	735	750
1.3	14	3	-6	-13	-20	-25	-30	-34
	12	4	-3	-9	-15	-20	-25	-29
	630	657	681	703	723	741	757	772
1.4	10	-1	-9	-16	-23	-28	-33	-36
	7	0	-7	-13	-18	-23	-28	-32
	650	677	701	723	743	761	777	792
1.5	6	-4	-12	-19	-25	-30	-35	-39
	3	-4	-10	-16	-21	-26	-30	-34

Upper fig.: Catch 1972 (1 000 tons)
Middle " : Increase in catch 1972-75 (%)
Lower fig.: Increase in biomass 1972-75 (% in weight)

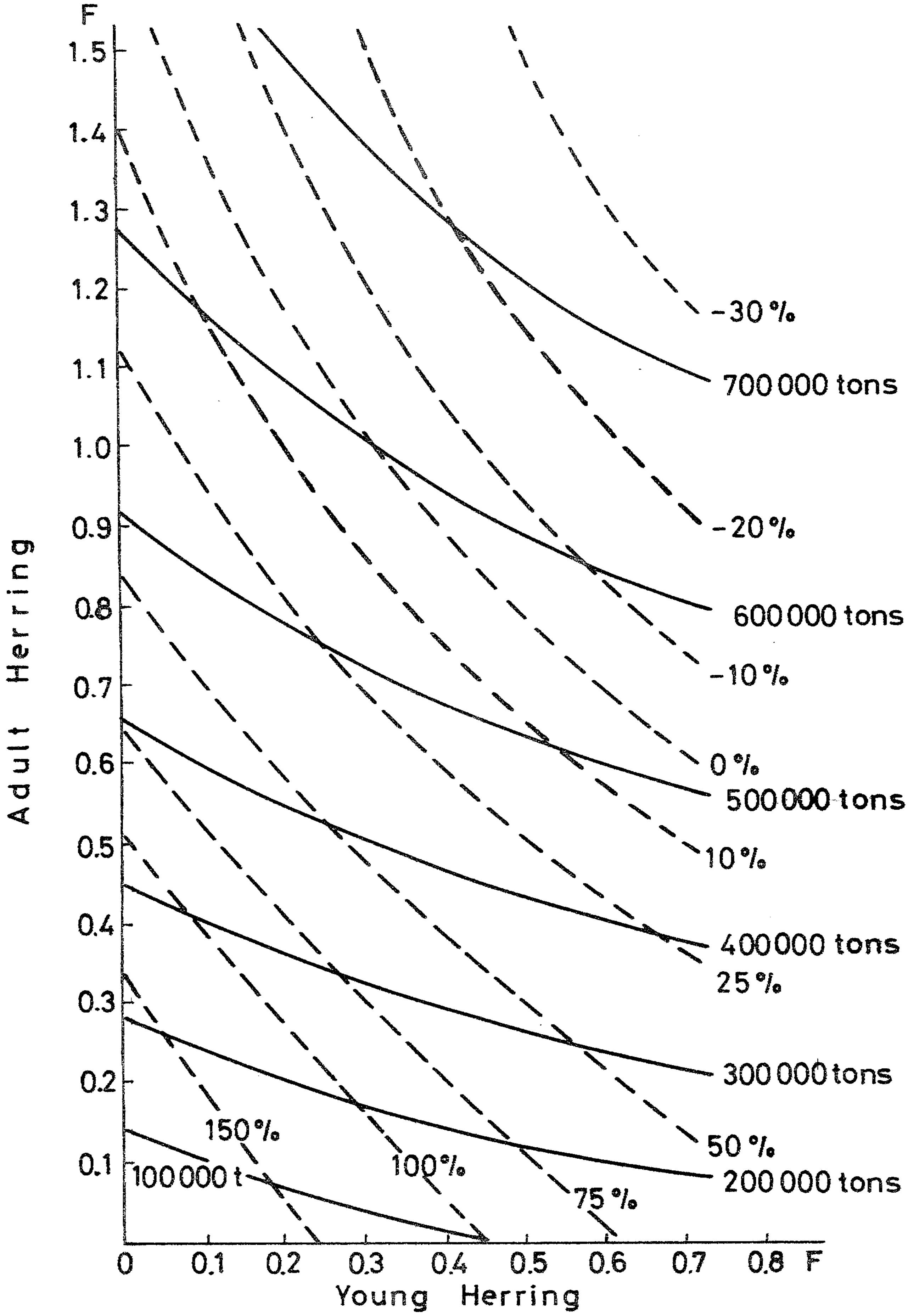

Figure 1 Total catch levels in 1972 (full drawn lines) and percentage increase in total catch from 1972-1975 (broken lines) at various combinations of adult and juvenile fishing mortalities.