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# On the Separation of catch Projections for a Stock with Seasonal Fisheries in Different Areas: Herring Assessment Unit Division IIIa and Western Baltic Sea

by Otto Rechlin

Institut fuer Hochseefischerei
An der Jaegerbaeck 2
2520 Rostock 5
German Democratic Republic



Abstract

With the present paper it is proposed to split the predicted catches of the herring stock unit Western Baltic/Division IIIa not only according to the areas but also in accordance to the two temporal and spatial different fishing seasons. It is pointed out that for such seasonal fisheries the prediction for the second half of the year has to take into account the fishing mortality during the first season. With examples from the VPA for the stock the difference is shown between predictions based on half yearly and on full year fisheries.

## 1. Introduction

A spring spawning herring population is migrating for feeding and spawning between the Western Baltic Sea and the Skagerak/ Eastern North Sea - area in the course of every year. Its spawning sites are located mainly in the Western Baltic (Subdivisions 24 and 22) and partly along the coast of the Kattegat. Adult herring feed in Division IIIa and off the norwegian southwest coast in summer.

The fishery for this herring is carried out during the prespawning/spawning period in the Western Baltic in the first half of the year and during the time of feeding migrations in Division IIIa/Eastern North Sea in the second half of the year, respectively. Smaller amounts of herring from the same population are caught in both areas also outside the respective main fishery seasons.

With its migration the herring crosses the border between areas under the responsibility of different fishery management bodies who are setting yearly TAC's on the base of scientific advice.

Thus the migration of the herring, resulting in two main fishery seasons, causes the need for a separation of catch predictions.

## 2. Material and Methods

The Working Group on Assessment of Pelagic Stocks in the Baltic tried different ways for assessing stocks size and predicting catch of the combined herring stock in the Western Baltic and Division IIIa. The first assessments were run on half year base. Later the VPA was run on year-base and the prediction was splitted for Western Baltic and Division IIIa on the base of catch in number in both areas and given per year and area.

For the present paper trial runs of predicted catches for the years 1981, 1983 and 1985 have been compared with the results of VPA in the same years by using the data base and results of the Working Group (Anon. 1989). The prediction was carried out according to the following steps:

- prediction of catch in number by age groups separately for Western Baltic and Division IIIa for the first half of the year
- calculation of the stock in number by age groups diminished by the total mortality in both areas in the first half year and left for the second half year
- prediction of catch in number by age groups separately for Western Baltic and Division IIIa for the second half of the year

The highest coincidence of prediction and VPA results for the years mentioned was achieved when for both areas the fishing and the natural mortality rates were taken as 50 % of the total yearly rates for the first and the second half year, respectively. The total fishing mortality for both areas was split according to the catch in number by age group.

For comparison a prediction of catch in number per age group for a non seasonal fishery (step one for the entire year) was carried out.

The following equations have been used for prediction of catch in number per age group:

$$C,SI = NiI * (F,S/2) / (Z,S/2) * 1 - \exp\{ (- Z,S/2) \quad (1)$$

$$NiII = NiI * \exp\{ - [(Z,S/2) + (Z,F/2)] \quad (2)$$

$$C,SII = NiII * (F,S/2) / (Z,S/2) * 1- \exp\{ (- Z,F/2) \quad (3)$$

$$C,FI = NiI * (F,F/2) / (Z,F/2) * 1- \exp\{ (- Z,F/2) \quad (4)$$

$$C,FII = NiII * (F,F/2) / (Z,F/2) * 1- \exp\{ (- Z,F/2) \quad (5)$$

Where (per age group) C,SI is catch in number, Western Baltic, first half year; N1I ist stock in number, first January; F,S is fishing mortality rate, W-Baltic; Z,S is total mortality rate, W-Baltic; N1II is stock in number first July, C,SII is catch in number W-Baltic, second half year; F,F is fishing mortality rate, IIIa; Z,F is total mortality rate IIIa; C,FII is catch in number, IIIa, second half year.

The data base for the test of predictions is shown in table 1.

## 3. Results

Catches in number by age groups predicted according to the database in table 1 for three different years are shown in table 2. A good coincidence of predicted catches with the data in table 1 can be seen when comparing the columns "total catch in number" in table 1 and 2, age group by age group.

On the other hand the comparison of the predicted catch in a non seasonal fishery (table 3, total) shows coincidence with the database only from age 6 onwards.

The main difference between "seasonal" and "non seasonal" prediction is, that the first takes into account the proportion of natural and fishing mortality effective in the first half of the year and starts the second half year with a correspondingly diminished stock size.

It becomes quite obvious from the results, the separation of catch prediction based on a non seasonal fishery increases the prediction of total catches. A split of catches in areal components using this method may raise the TAC's and hence result in an exploitation rate for the stock higher than anticipated.

The prediction of "seasonal" (half yearly) catches as shown with the example in table 2 is not in fact a seasonal prediction. Therefore only the column "total" gives a useful result, whereas the half yearly catches by area do not mirror the seasonal catches. The main reason for this is that the fishing mortality effective to the stock has been splitted according to the areas on the base of yearly catches in number by age. For the same reason the "seasonal" calculation of predicted catch by using the total mortality (Z) divided by two gives the coincidence in column "total".

If there is for both of the areas the catch in numbers available on a half yearly base for splitting the yearly fishing mortality according to area and season it will be possible to predict really seasonal catches.

The main conclusion to be drawn from this exercise is, however, one has to take into account in a prediction the fishing mortality effective to the stock during the first season when there are two fishing seasons for one stock, clearly different in space and time in the course of the year.

A prediction for the second season has to be started with a stock diminished by Z during the first season. Otherwise, a TAC based on the prediction may not have the influence on the stock for what it is aimed for.

## 5. References

Anon. 1989. Report of the Working Group on Assessment of Pelagic Stocks in the Baltic.
ICES, Doc. C.M. 1989/Assess: 14

Table 1 VPA data base for test of prediction

**catches**

| | 1981 | | | 1983 | | | 1985 | | |
|---|---|---|---|---|---|---|---|---|---|
| Ag | C,S | C,F | total | C,S | C,F | total | C,S | C,F | total |
| 2 | 302 | 703 | 1005 | 334 | 516 | 850 | 312 | 537 | 849 |
| 3 | 279 | 188 | 467 | 361 | 124 | 485 | 416 | 428 | 844 |
| 4 | 211 | 66 | 277 | 290 | 58 | 348 | 218 | 135 | 353 |
| 5 | 52 | 6 | 58 | 35 | 4 | 39 | 97 | 11 | 108 |
| 6 | 17 | 1 | 18 | 12 | 2 | 14 | 25 | 10 | 35 |
| 7 | 4 | – | 4 | 2 | – | 2 | 4 | 3 | 7 |
| 8+ | 4 | – | 4 | 3 | – | 3 | 5 | 1 | 6 |

fishing mortalities

| Ag | S | F | total | S | F | total | S | F | total |
|---|---|---|---|---|---|---|---|---|---|
| 2 | .12 | .31 | .43 | .18 | .27 | .45 | .14 | .25 | .39 |
| 3 | .55 | .37 | .92 | .48 | .17 | .65 | .35 | .37 | .72 |
| 4 | .81 | .25 | 1.06 | .68 | .13 | .81 | .56 | .34 | .90 |
| 5 | .99 | .11 | 1.10 | .55 | .06 | .61 | .94 | .11 | 1.05 |
| 6 | 1.21 | .007 | 1.28 | .54 | .009 | .63 | .70 | .28 | .98 |
| 7 | 1.51 | – | 1.51 | .56 | – | .56 | .55 | .41 | .96 |
| 8+ | 1.51 | – | 1.51 | .56 | – | .56 | .80 | .16 | .96 |

stock size

| | 1981 | | 1983 | | 1985 | |
|---|---|---|---|---|---|---|
| Ag | NiI | NiII | NiI | NiII | NiI | NiII |
| 2 | 3159 | 2305 | 2591 | 1863 | 2896 | 2187 |
| 3 | 845 | 483 | 1111 | 723 | 1789 | 1129 |
| 4 | 450 | 245 | 684 | 411 | 647 | 373 |
| 5 | 94 | 49 | 93 | 62 | 180 | 91 |
| 6 | 27 | 13 | 33 | 22 | 61 | 34 |
| 7 | 6 | 3 | 5 | 3 | 12 | 7 |
| 8+ | 6 | 2 | 8 | 5 | 11 | 7 |

Table 2 Prediction, seasonal fishery

1981

| AG | C,SI | C,SII | C,SI+II | C,FI | C,FII | C,FI+II | total |
|---|---|---|---|---|---|---|---|
| 2 | 163 | 119 | 282 | 407 | 316 | 723 | 1005 |
| 3 | 181 | 100 | 281 | 117 | 70 | 187 | 468 |
| 4 | 140 | 73 | 213 | 41 | 25 | 66 | 279 |
| 5 | 34 | 18 | 52 | 3 | 2 | 5 | 57 |
| 6 | 12 | 5 | 17 | 1 | – | 1 | 18 |
| 7 | 3 | 1 | 4 | – | – | – | 4 |
| 8+ | 3 | 1 | 4 | – | – | – | 4 |

1983

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 200 | 143 | 343 | 283 | 222 | 510 | 853 |
| 3 | 218 | 141 | 359 | 73 | 53 | 126 | 485 |
| 4 | 183 | 109 | 292 | 32 | 23 | 55 | 347 |
| 5 | 21 | 14 | 35 | 2 | 2 | 4 | 39 |
| 6 | 7 | 5 | 12 | 1 | 1 | 2 | 14 |
| 7 | 1 | 1 | 2 | – | – | – | 2 |
| 8+ | 2 | 1 | 3 | – | – | – | 3 |

1985

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 176 | 131 | 307 | 302 | 243 | 545 | 847 |
| 3 | 258 | 154 | 412 | 258 | 172 | 430 | 842 |
| 4 | 139 | 80 | 219 | 85 | 49 | 134 | 353 |
| 5 | 63 | 32 | 95 | 7 | 4 | 11 | 106 |
| 6 | 15 | 9 | 24 | 6 | 4 | 10 | 34 |
| 7 | 3 | 1 | 4 | 2 | 1 | 3 | 7 |
| 8+ | 3 | 2 | 5 | 1 | – | 1 | 6 |

Table 3 Prediction for full year fishery

| | 1981 | | | 1983. | | | 1985 | | |
|---|---|---|---|---|---|---|---|---|---|
| AG | C,S | C,F | total | C,S | C,F | total | C,S | C,F | total |
| 2 | 324 | 767 | 1091 | 388 | 585 | 946 | 344 | 583 | 927 |
| 3 | 327 | 238 | 565 | 387 | 158 | 545 | 482 | 504 | 986 |
| 4 | 234 | 93 | 327 | 309 | 76 | 385 | 254 | 170 | 424 |
| 5 | 54 | 9 | 63 | 36 | 5 | 41 | 101 | 17 | 118 |
| 6 | 18 | 2 | 20 | 12 | 2 | 14 | 28 | 14 | 38 |
| 7 | 4 | – | 4 | 2 | – | 2 | 5 | 4 | 8 |
| 8+ | 4 | – | 4 | 3 | – | 3 | 6 | 1 | 7 |