# POPULATION FECUNDITY OF WESTERN AND EASTERN NORTH ATLANTIC BLUEFIN TUNA (THUNNUS THYNNUS)

by

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## SUMMARY

This study presents fecundity estimates by age for the western and eastern Atlantic pre-1967 and 1975 spawning populations. The western and eastern Atlantic spawning populations differ in age structure and in the western Atlantic, older fish contribute more to the total population fecundity when compared with the eastern Atlantic. In the western Atlantic pre-1967 population, over 70% of the total fecundity was contributed by 11 to 14-year-old fish, and in the eastern Atlantic pre-1967 population 8 to 11-year-old fish contributed approximately 74% of the total fecundity. In the western Atlantic 1975 population, 13 to 18+-year-old fish contributed over 85% of the total fecundity and in the eastern Atlantic 1975 population 10 to 15-year-old fish contributed over 81% of the total fecundity. Apparently, total fecundity for both the western and eastern Atlantic 1975 populations has become more dependent on older fish.

## RESUME

Le présent document présente des estimations de la fécondité selon l'âge pour les populations reproductrices de l'Atlantique Ouest et Est d'avant 1967 et de 1975. Ces populations diffèrent quant à leur structure démographique, et les poissons plus âgés contribuent plus à la fécondité totale de la population à l'ouest qu'à l'est. Plus de 70% de la fécondité totale de la population ouest-atlantique d'avant 1967 provenait des poissons de 11 à 14 ans, alors que cette correspondance était à l'est d'environ 74% pour les poissons de 8 à 11 ans. Pour ce qui est de la population de 1975, les poissons de 13 à 18 ans représentaient plus de 85% de la fécondité totale dans la partie occidentale, et ceux de 10 à 15 ans plus de 81% dans la partie orientale. La fécondité totale des populations de l'est comme de l'ouest atlantique en 1975 était apparemment devenue plus dépendante des poissons plus âgés.

## RESUMEN

Presenta estimaciones de fecundidad por edad del stock reproductor anterior a 1967 y del de 1975, al Este y Oeste del Atlántico. La estructura demográfica de ambas poblaciones es diferente, y en el Atlántico occidental, los peces de edad más avanzada contribuyen en forma más importante a la fecundidad total de la población, en comparación con los del Atlántico oriental. Más del 70% de la fecundidad total de la población anterior a 1967, al Oeste del Atlántico, corresponde a peces de 11 a 14 años de edad, mientras que al Este la proporción fue del 74% y correspondiente a peces de 8 a 11 años. Respecto a la población de 1975 en el Atlántico occidental, la proporción fue más del 85% por peces de 13 a 18 años y +, y en el Atlántico oriental más del 81% por peces de 10 a 15 años. Aparentemente el total de fecundidad de las poblaciones de 1975 en ambas zonas del Atlántico, ha llegado a depender en gran parte de los peces de edad avanzada.

## INTRODUCTION

There has been a large reduction in catch of Atlantic bluefin tuna, from 38,500 metric tons in 1964 to 12,500 metric tons in 1973 (ICCAT, 1974) To formulate a rational management program, knowledge of the bluefin's reproductive potential is necessary.

Rivas (1977a) presented evidence that bluefin tuna stocks changed from a "stable" condition to an "unstable" condition about 1967. This latter condition has continued to the present,and data from 1975 was selected to represent it. This paper estimates fecundity by age for the western and eastern Atlantic spawning populations before 1967 and for 1975, pointing out the differences.

Age compositions for the pre-1967 and 1975 populations were taken from Rivas (1977b, tables 1 and 2). Since no sex distinction was made by Rivas, we are assuming a one-to-one sex ratio. The numbers in our tables 2 through 5, therefore, represent one half of those given in Rivas' tables. Fecundity data are derived from 10 bluefin from the eastern Atlantic (Rodriguez-Roda, 1967); 6 bluefin from the western Atlantic (Baglin, 1976); and from a fecundity estimate by us from the western Atlantic in 1976. Age was estimated according to the method of Rivas (1977a), and a fecundity-age regression was calculated.

We assumed there was equal fishing pressure on all age groups considered, so the numbers adequately represent the true age structure of the populations. We also assumed that the fecundity of fish of a given age has not changed during the time period under consideration, and that there are no differences in age specific fecundity between western and eastern Atlantic fish.

## RESULTS

The individual fecundity data (table 1) were used to calculate the following fecundity-age regression:

$$F = -19.09 + 3.75\ A\ (R^2 + 0.88)$$

where F is fecundity in millions of eggs and A is age in years.

Table 2 shows the age specific population fecundity ranges from less than 1% for 18+-year-olds to almost 23% for 13-year-olds in the pre-1967 western Atlantic population. Age groups 11 to 14 contribute over 70% to the total population fecundity.

Table 3 shows that the pre-1967 eastern Atlantic age-specific population fecundity ranges from about 1% for 15-year-olds to about 23% for 9-year-olds. Age groups 8 to 11 contribute almost 74% to total population fecundity.

The 1975 western Atlantic age-specific population fecundity ranges from less than 1% for 6 to 8-year-olds to over 15% for 15-year-olds (table 4). Age groups 13 to 18+ contribute over 85% to total population fecundity. As shown in Table 5, the 1975 eastern Atlantic age specific population fecundity ranges from about 1% for 6-year-olds to almost 18% for 12-year-olds. Age groups 10 to 15 contribute over 81% to total population fecundity.

## DISCUSSION

The 8 to 11-year-old fish from the eastern Atlantic pre-1967 population were the greatest contributors (approximately 74%) to total population fecundity. This agrees with the findings of Saila (1975, MS.) for an unexploited stock of bluefin. The western Atlantic total population fecundity was most dependent (over 70%) on 11 to 14-year-old fish. The various age groups showed a wide range in percentage contribution to total fecundity. Saila (1975, MS.), however, found the percentage contribution of each age group to be more uniform.

Therefore, a difference in age structures of the eastern and western pre-1967 spawning populations is indicated (tables 2 and 3). In the western Atlantic, older fish contribute more to total population fecundity compared with the eastern Atlantic.

The oldest fish (ages 13 to 18+) contribute most (over 85%) to total population fecundity in the western Atlantic 1975 population. The eastern Atlantic 1975 population total fecundity is most dependent (over 81%) on 10 to 15-year-olds. Saila (1975, MS.)*found that exploited stocks were more heavily dependent upon younger age groups at the time when they reach maturity.

Also, for the 1975 populations there was a difference in the age structure of the spawning populations, with the western Atlantic population more dependent on older fish (tables 4 and 5).

It is also apparent that the total population fecundity for the western and eastern Atlantic has become more dependent on older fish and this should be taken into consideration when managing the fisheries.

## LITERATURE CITED

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Table 1. Weight, estimated age, and fecundity estimates for bluefin tuna for the combined western and eastern Atlantic.

| Weight[1] kg | Estimated[2] Age | Fecundity (millions) |
|---|---|---|
| 54 | 5 | 5.4[3] |
| 96 | 8 | 10.0[3] |
| 110 | 8 | 12.2[3] |
| 140 | 10 | 17.9[3] |
| 144 | 10 | 17.3[3] |
| 180 | 11 | 21.3[3] |
| 188 | 11 | 16.7 |
| 189 | 12 | 29.6 |
| 191 | 12 | 24.0[3] |
| 194 | 12 | 22.7[3] |
| 197 | 12 | 28.4 |
| 210 | 12 | 28.0[3] |
| 232 | 13 | 24.3 |
| 235 | 13 | 29.9[3] |
| 247 | 14 | 33.0 |
| 272 | 15 | 31.4 |
| 324 | 18 | 57.6 |

[1]Weights of individual fish studied.

[2]Estimated age according to Rivas (1976a MS.).

[3]Data from eastern Atlantic, Rodriguez-Roda (1967).

Table 2. Bluefin tuna age-specific fecundity for the western Atlantic population before 1967. Number of fish in each age group represents one half of fish in Rivas (1977b, tables 1 and 2) because of the assumed one-to-one sex ratio.

| Age | Number | Estimated Fecundity at Age (millions) | Age Specific Fecundity (millions) | Age Specific Fecundity (percent) |
|---|---|---|---|---|
| 6 | 972.0 | 3.4 | 3,304.8 | 2.6 |
| 7 | 529.0 | 7.1 | 3,755.9 | 2.9 |
| 8 | 368.0 | 10.9 | 4,011.2 | 3.1 |
| 9 | 395.0 | 14.6 | 5,767.0 | 4.5 |
| 10 | 487.5 | 18.4 | 8,970.0 | 7.0 |
| 11 | 711.0 | 22.1 | 15,713.1 | 12.3 |
| 12 | 1,065.0 | 25.9 | 27,583.5 | 21.6 |
| 13 | 978.0 | 29.6 | 28,948.8 | 22.7 |
| 14 | 543.0 | 33.4 | 18,136.2 | 14.2 |
| 15 | 200.0 | 37.1 | 7,420.0 | 5.8 |
| 16 | 59.5 | 40.8 | 2,427.6 | 1.9 |
| 17 | 18.5 | 44.6 | 825.1 | 0.6 |
| 18+ | 14.5 | 48.3 | 700.4 | 0.5 |
| | | | 127,563.6 | |

Table 3. Bluefin tuna age-specific fecundity for the eastern Atlantic population before 1967. Number of fish in each age group represents one half of fish in Rivas (1977b, tables 1 and 2) because of the assumed one-to-one sex ratio.

| Age | Number | Estimated Fecundity at Age (millions) | Age Specific Fecundity (millions) | Age Specific Fecundity (percent) |
|---|---|---|---|---|
| 6 | 55.0 | 3.4 | 187.0 | 2.3 |
| 7 | 83.5 | 7.1 | 592.8 | 7.2 |
| 8 | 118.0 | 10.9 | 1,286.2 | 15.6 |
| 9 | 131.0 | 14.6 | 1,912.6 | 23.2 |
| 10 | 94.5 | 18.4 | 1,738.8 | 21.1 |
| 11 | 51.5 | 22.1 | 1,138.2 | 13.8 |
| 12 | 27.5 | 25.9 | 712.2 | 8.6 |
| 13 | 10.5 | 29.6 | 310.8 | 3.8 |
| 14 | 8.5 | 33.4 | 283.9 | 3.4 |
| 15 | 2.5 | 37.1 | 92.8 | 1.1 |
| | | | 8,255.3 | |

Table 4. Bluefin tuna age-specific fecundity for the western Atlantic population in 1975. Number of fish in each age group represents one half of fish in Rivas (1977b, tables 1 and 2) because of the assumed one-to-one sex ratio.

| Age | Number | Estimated Fecundity at Age (millions) | Age Specific Fecundity (millions) | Age Specific Fecundity (percent) |
|---|---|---|---|---|
| 6 | 2.5 | 3.4 | 8.5 | 0.03 |
| 7 | 3.5 | 7.1 | 24.8 | 0.08 |
| 8 | 17.5 | 10.9 | 190.8 | 0.6 |
| 9 | 58.5 | 14.6 | 854.1 | 2.7 |
| 10 | 43.0 | 18.4 | 791.2 | 2.5 |
| 11 | 37.0 | 22.1 | 817.7 | 2.6 |
| 12 | 72.5 | 25.9 | 1,877.8 | 6.0 |
| 13 | 132.5 | 29.6 | 3,922.0 | 12.5 |
| 14 | 161.5 | 33.4 | 5,394.1 | 17.2 |
| 15 | 152.5 | 37.1 | 5,657.8 | 18.1 |
| 16 | 89.5 | 40.8 | 3,651.6 | 11.6 |
| 17 | 70.5 | 44.6 | 3,144.3 | 10.0 |
| 18+ | 103.5 | 48.3 | 4,999.0 | 16.0 |
| | | | 31,333.7 | |

Table 5. Bluefin tuna age-specific fecundity for the eastern Atlantic population in 1975. Number of fish in each age group represents one half of fish in Rivas (1977b, tables 1 and 2) because of the assumed one-to-one sex ratio.

| Age | Number | Estimated Fecundity at Age (millions) | Age Specific Fecundity (millions) | Age Specific Fecundity (percent) |
|---|---|---|---|---|
| 6 | 29.0 | 3.4 | 98.6 | 1.3 |
| 7 | 22.0 | 7.1 | 156.2 | 2.0 |
| 8 | 26.5 | 10.9 | 288.8 | 3.8 |
| 9 | 18.0 | 14.6 | 262.8 | 3.4 |
| 10 | 38.0 | 18.4 | 699.2 | 9.1 |
| 11 | 56.5 | 22.1 | 1,248.6 | 16.3 |
| 12 | 53.0 | 25.9 | 1,372.7 | 17.9 |
| 13 | 44.5 | 29.6 | 1,317.2 | 17.2 |
| 14 | 30.0 | 33.4 | 1,002.0 | 13.1 |
| 15 | 15.5 | 37.1 | 575.0 | 7.5 |
| 16 | 6.5 | 40.8 | 265.2 | 3.5 |
| 17 | 4.5 | 44.6 | 200.7 | 2.6 |
| 18+ | 3.5 | 48.3 | 169.0 | 2.2 |
| | | | 7,656.0 | |