

## A PRELIMINARY STUDY OF THE GROWTH RATE OF BLUEFIN TUNA FROM ADRIATIC WHEN REARED IN THE FLOATING CAGES

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### SUMMARY

*The objective of this paper was to estimate growth increment of bluefin tuna (Thunnus thynnus L.) while they were reared in the floating cages placed in the middle part of the eastern Adriatic Sea. In accordance with recommendations of Bluefin Program (BYP) about research activities, and aiming to provide more accurate methods in estimating the increase in both length and weight of cultured fish after being captured, were tagged by means of conventional tags. All fish (FL = 60-120 cm) were tagged immediately upon their transfer from the fishing grounds to the cage sites where they were reared for 516 days period. Losses during handling procedures applied for tagging and mortality during rearing period were recorded. Individual length and weight increment of surviving fish after being tagged and reared in floating cages were measured and calculated. In addition to length-weight data, gilled and gutted weight were recorded, thus providing a conversion factor to convert weights of GG fish into respective round weights.*

### RÉSUMÉ

*Le présent document a pour but d'estimer le poids acquis par le thon rouge (Thunnus thynnus L.) pendant son séjour dans les cages flottantes situées au milieu de la mer Adriatique orientale. Conformément aux recommandations du Programme d'année thon rouge (BYP) sur les activités de recherche, et en vue de fournir des méthodes plus précises d'estimation des gains de taille comme de poids des poissons engraisés après leur capture, des marques conventionnelles leur ont été apposées. Tous les poissons (FL = 60-120 cm) ont été marqués juste après leur transfert du lieu de pêche à l'enclos, où ils ont été engraisés pendant 516 jours. Les pertes dues à la manipulation du marquage et à la mortalité pendant la période d'engraissement ont été enregistrées. L'augmentation de la taille et du poids des poissons survivants après leur marquage et leur engraisement dans les cages flottantes a été mesurée et calculée. Outre les données de longueur-poids, le poids éviscéré et sans branchies a été enregistré, apportant ainsi un facteur pour la conversion du poids des poissons éviscérés et sans branchies en poids vif.*

### RESUMEN

*El objetivo de este documento es estimar el incremento del crecimiento del atún rojo (Thunnus thynnus L.) cuando se cría en jaulas flotantes situadas en la zona media del mar Adriático este. De conformidad con las recomendaciones del Programa Año del Atún Rojo (BYP) sobre actividades de investigación, y con el objetivo de proporcionar métodos más rigurosos para estimar el incremento tanto en longitud como en peso de los peces de cría tras ser capturados, se marcaron los peces con marcas convencionales. Todos los peces (FL = 60-120 cm) se marcaron inmediatamente después de su transferencia de los caladeros a las jaulas donde fueron criados durante un período de 516 días. Se registraron las pérdidas durante los procedimientos de manipulación para el marcado y la mortalidad durante el período de cría. Se midieron los incrementos individuales de talla y peso de los peces supervivientes después de ser marcados y criados en jaulas flotantes. Además de los datos de talla-peso, se registraron los pesos de los peces eviscerados y sin agallas, obteniéndose así un factor de conversión para convertir los pesos de peces eviscerados y sin agallas en sus respectivos pesos en canal.*

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## KEYWORDS

*Aquaculture systems, bluefin tuna, floating structures, tagging, Adriatic Sea*

### 1. INTRODUCTION

Since 1997, a new activities in aquaculture concerning the bluefin tuna (*Thunnus thynnus*) rearing in the floating cages, took place on the eastern part of the Adriatic Sea. In the last few years, the rapid development of this practice of the bluefin tuna farming in the Adriatic has been noticed.

Generally, after being caught by purse seine in the off shore waters, tunas have been transferred into a floating cage. After being filled up with certain quantity of tunas, the floating cage has been tugged by tugboat toward near shore waters, and anchored. The tunas in the cages have been fed for a couple of months with small pelagic fish species, such as sardine, anchovy, sprat and herring. The tunas are usually reared from summer to winter, when they have been sold to Japan (TIEINA, 1999). The smallest specimens usually remain in the cages to grow for the whole next year period. It should be considered that this practice could cause difficulties in terms of the catch statistics and concurrence of catch data with trade data. Therefore, the aim of this preliminary research was to give some indications about a growth rate of bluefin tuna when reared in the floating cages.

### 2. MATERIAL AND METHODS

In total, 36 bluefin tunas (FL = 60-120 cm) were tagged immediately upon their transfer from the fishing grounds to the cage site. The fish were measured in fork lengths and live weights when tagged, and reared for 516 days period in average. After being recaptured, fork lengths and live weights and also gilled and gutted weights of surviving fish were recorded. Based on the differences in length and weight, daily increment rates were calculated. Also, length-weight relation that describes the growth of the tunas in the floating cages was estimated using the formula given by Pauly (1983). In addition to length-weight data, gilled and gutted weight were recorded, thus providing a conversion factor to convert weights of gilled and gutted fish into respective round weights.

### 3. RESULTS AND DISCUSSION

In this preliminary research the fish from two different size classes, were tagged by conventional tags in the July of 1999. The first size class comprised the fish ranged 60-65 cm (3.5-5.0 kg), while the second size class comprised the fish ranged 85-120 cm (10-25 kg) in fork length (FL). The smallest fish measured 60 cm in fork length and 3.5 kg in live weight, and the biggest specimen measured 120 cm in fork length and 25 kg in live weight. They were reared in the floating cages for an average period of 516 days, and fed daily with small pelagic fishes. Initially, probably caused by handling procedures applied for tagging, mortality was very high (50.00%) while during rearing period lower mortality of these fish (5.56%) was noticed. All survived fishes were recaptured in December of 2000. The results on differences in lengths and weights, and also differences between round weights (RWT) and gilled and gutted weights (GWT) are shown in Table 1.

If we assumed a constant growth rate (non-seasonal growth) throughout whole period, between tagging and recapture, it can be calculated that average increment in the fork length of the fish in the 1<sup>st</sup> size class was 2.73 cm/month/fish, and average increment in the weight was 1.31 kg/month/fish. Furthermore, in the 2<sup>nd</sup> size class increment in fork length was 2.16 cm/month/fish, and average increment in the weight was 2.42 kg/month/fish.

According to the growth description concerning the young bluefin tuna in the Ligurian Sea, daily growth increment is 0.71-2.00 mm (ORSI-RELINI et al., 1996). SINOVEIÆ et al. (1998) found that this daily increment, when converted into weight, according to length-weight relation, is 0.8 kg/month. The same authors, on the basis of the successive catch analyses of the bluefin tuna from the Adriatic Sea, are found that average growth rate concerning the specimens of bluefin tuna is approximately 0.7 kg/month.

As it could be expected, according to our results, the growth rates in weight of the fish reared in the floating cages were considerably higher than these estimated by SINOVEIÆ et al. (1998), but increment in length was within the range given by ORSI-RELINI et al. (1996).

Length-weight relation that describe the growth of the bluefin tuna, caught by purse seine during the summer period, in the Adriatic Sea (TIÈINA, 1994) was estimated as:

$$W_{(kg)} = 3.44 \times 10^{-5} \times FL_{(cm)}^{2.87} \quad (r = 0.9987).$$

However, we plotted the initial lengths and weights of fish when tagged, and lengths and weights data of same specimens after a 516 days period of rearing, and estimated a new length-weight relations. The new estimated length-weight relations that describe the growth of tuna during the rearing period in the floating cage were as follow:

|   |   |               |
|---|---|---------------|
| - 1 <sup>st</sup> size class (60-65 cm):  | $W_{(kg)} = 3 \times 10^{-6} \times FL_{(cm)}^{3.37}$ | (r = 0.9884); |
| - 2 <sup>nd</sup> size class (85-120 cm): | $W_{(kg)} = 3 \times 10^{-6} \times FL_{(cm)}^{3.38}$ | (r = 0.9916); |
| - all fish (60-120 cm):                   | $W_{(kg)} = 5 \times 10^{-6} \times FL_{(cm)}^{3.29}$ | (r = 0.9913). |

The significant differences between length-weight relations concerned the wild tuna (TIÈINA, 1994) and tuna reared in the floating cages on the eastern part of the Adriatic Sea are shown on the Figure 1.

Furthermore, it was noticed that these fish, after being gilled and gutted, loss in average 10.23% of its round weight, but it varied in the wide range from 4.69% to 17.70% (Table 2.). Based on these preliminary data, the conversion factor, concerning the weights in kg, is estimated to be 1.109066. Consequently, the formula for conversion of gilled and gutted weight (GWT) into round weight (RWT) of the bluefin tuna reared in the floating cages in the Adriatic Sea would be:

$$RWT = GWT \times 1.109066 \text{ (kg)}$$

#### 4. CONCLUSION

This preliminary research gives us some very important indices concerning the tuna farming in the Adriatic Sea. Large differences in quantity and size composition of the fish before and after rearing period were noticed. Also, it should be pointed out that due to the different growth patterns of the tuna in the captivity (floating cages) compared with free tuna, probably specific (new) conversion formulas to the tuna products originated from cages should be applied. Also, based on these preliminary results, could be concluded that due to the rapid development of the practice of bluefin tuna farming, difficulties in terms of the catch statistics and concurrence of catch data with trade data, will increase. Furthermore, recognising this as a very important issue in the future, and with aim to gain more knowledge about tuna farming and improve the Bluefin Tuna Statistical Document (BTSD), the authors suggest that more effort within Bluefin Program (BYP) should be allocated to the studies concerning the tuna farming.

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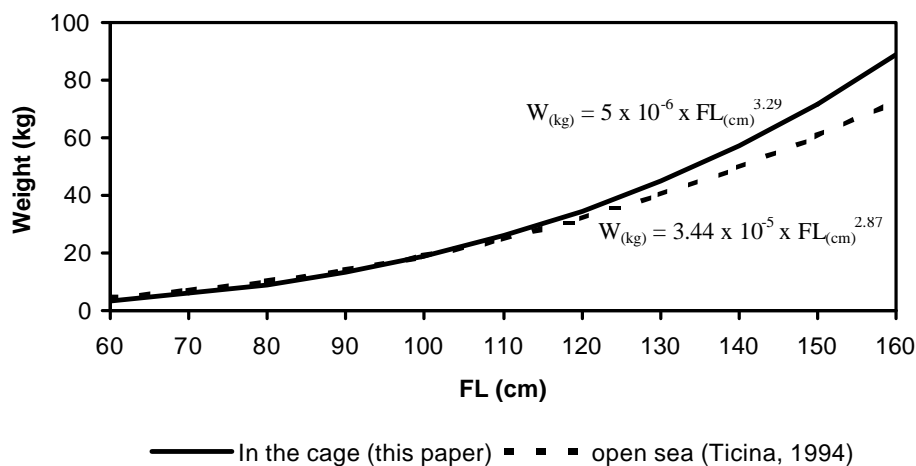
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**Table 1.** Some preliminary results on growth increment in fork length (FL) and round weight (RWT) of bluefin tuna reared for 516 days in floating cages in the Adriatic Sea, based on tag-recapture data (Source: KALI-TUNA d.o.o.).

|                                  | FL <sub>1</sub> (cm) | RWT <sub>1</sub> (kg) | FL <sub>2</sub> (cm) | RWT <sub>2</sub> (kg) |
|----------------------------------|----------------------|-----------------------|----------------------|-----------------------|
| <i>1<sup>st</sup> size class</i> |                      |                       |                      |                       |
| Size range:                      | 60-65                | 3.5-5.0               | 101-120              | 20.0-32.6             |
| Average:                         | 64.38                | 4.13                  | 111.38               | 26.70                 |
| STD:                             | 1.7678               | 0.6597                | 7.0698               | 4.1983                |
| CI 95%(+/-):                     | 1.22                 | 0.46                  | 4.90                 | 2.91                  |
| <i>2<sup>nd</sup> size class</i> |                      |                       |                      |                       |
| Size range:                      | 85-120               | 10-25                 | 122-158              | 38.4-81.0             |
| Average:                         | 96.25                | 14.50                 | 137.88               | 51.63                 |
| STD:                             | 11.2599              | 4.7809                | 10.1902              | 12.9677               |
| CI 95%(+/-):                     | 7.80                 | 3.31                  | 7.06                 | 8.99                  |
| <b>Total</b>                     |                      |                       |                      |                       |
| Size range:                      | 60-120               | 3.5-25                | 101-158              | 20.0-81.0             |
| Average:                         | 80.31                | 9.31                  | 124.60               | 39.20                 |
| STD:                             | 18.2089              | 6.2903                | 16.0950              | 15.8861               |
| CI 95%(+/-):                     | 8.92                 | 3.08                  | 7.89                 | 7.78                  |

**Table 2.** Preliminary results on differences between round weight (RWT) and gilled and gutted weight (GWT) of the bluefin tuna reared in the floating cages (Source: KALI-TUNA d.o.o.).

|              | FL (cm)  | RWT (kg)    | GWT (kg)    | Differences (%) |
|--------------|----------|-------------|-------------|-----------------|
| Range:       | 60 – 120 | 24.3 – 81.0 | 20.0 – 73.0 | 4.69 – 17.70    |
| Average:     | 130.38   | 43.57       | 39.28       | -10.23%         |
| STD:         | 15.053   | 16.187      | 15.089      | 0.028           |
| CI 95%(+/-): | 8.18     | 8.80        | 8.20        | 1.50%           |



**Figure 1.** Comparison of alometric growth between wild bluefin tunas from the open sea and bluefin tunas reared in the floating cage.