

**PRELIMINARY RESULTS ON THE REPRODUCTIVE STATUS OF  
ATLANTIC BLUEFIN TUNA SAMPLED IN THE GULF OF MEXICO  
DURING SPAWNING SEASON, 2007-2008**

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**SUMMARY**

*The Atlantic bluefin tuna (Thunnus thynnus) is a highly exploited and economically important fisheries resource. Despite being widely dispersed throughout the year, Atlantic bluefin tuna (ABFT) return to at least two specific areas for spawning. Atlantic bluefin tuna spawning in the Mediterranean reach sexual maturity at 104 cm curved fork length (CFL) and 3 years. It is believed that Atlantic bluefin tuna spawning in the Gulf of Mexico and reach sexual maturity at 190 cm fork length (approximately age 8 using the current growth equation). Atlantic bluefin tuna were sampled from March-July by longline fishing vessels, in 2007 (n=46) and 2008 (n=58). Fish varied in length and weight from 180 cm to 341 cm and 100 kg to 655 kg, respectively. Gonadosomatic Index values ranged from 0.29 to 6.85. The maturity stage of gonads was determined using histology. In May 2007, a 180 cm fish was sampled with gonads containing vitellogenic and atretic oocytes. Under current ICCAT growth curves, this fish is classified as age 7, below the size/age of fish believed to be spawning in the Gulf of Mexico. We suggest that broader sampling is needed to reveal whether the maturity schedule of western origin Atlantic bluefin tuna more closely resembles those of Mediterranean patterns.*

**RÉSUMÉ**

*Le thon rouge de l'Atlantique (Thunnus thynnus) est une ressource halieutique hautement exploitée et d'une grande importance économique. Bien que le thon rouge de l'Atlantique soit très dispersé tout au long de l'année, il retourne au moins à deux zones spécifiques pour s'y reproduire. Le thon rouge de l'Atlantique qui se reproduit en Méditerranée atteint la maturité sexuelle avec une longueur courbée à la fourche de 104 cm et à l'âge de trois ans. Il est estimé que le thon rouge de l'Atlantique qui se reproduit dans le golfe du Mexique atteint la maturité lorsqu'il mesure 190 cm à la fourche (approximativement à l'âge de 8 ans, en utilisant l'équation de croissance actuelle). Des palangriers ont recueilli des échantillons de thon rouge de l'Atlantique de mars à juillet, en 2007 (n=46) et 2008 (n=58). Les poissons présentaient des tailles et des poids variés qui oscillaient entre 180 et 341 cm et entre 100 et 655 kg, respectivement. Les valeurs des indices gonadosomatiques oscillaient entre 0,29 et 6,85. La phase de maturité des gonades a été déterminée au moyen de l'histologie. En mai 2007, un spécimen de 180 cm a été échantillonné avec des gonades qui contenaient des ovocytes vitellogéniques et atrétiques. Conformément aux courbes actuelles de croissance de l'ICCAT, ce thon rouge a été classé comme âge 7, en dessous de la taille/âge des poissons qui se reproduiraient dans le golfe du Mexique. Nous suggérons qu'il est nécessaire d'effectuer un échantillonnage plus vaste pour révéler si le calendrier de maturité du thon rouge de l'Atlantique Ouest présente davantage de similitudes avec les configurations de la Méditerranée.*

**RESUMEN**

*El atún rojo (Thunnus thynnus) del Atlántico es un recurso pesquero altamente explotado y de gran importancia económica. A pesar de hallarse muy disperso a lo largo del año, el atún rojo regresa al menos a dos zonas específicas para reproducirse. El atún rojo del Atlántico que se reproduce en el Mediterráneo alcanza la madurez sexual con un longitud curva a horquilla (CFL) de 104 cm y con tres años. Se cree que el atún rojo del Atlántico que se reproduce en el golfo de México alcanza la madurez con 190 cm de longitud a horquilla (aproximadamente edad 8, utilizando la ecuación de crecimiento actual). Los palangreros recogieron muestras de atún rojo desde marzo a julio en 2007 (n=46) y 2008 (n=58). Los ejemplares presentaban talas y pesos variados que oscilaron entre 180 y 341 cm y 100 y 655 kg, respectivamente. Los valores de los índices gonadosomáticos oscilaron entre 0,29 y 6,85. Se determinó la fase de madurez de las gónadas utilizando la histología. En mayo de 2007, se muestreó un ejemplar de*

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180 cm con gónadas que contenían oocitos atéricos y vitelogénicos. De conformidad con las curvas de crecimiento de ICCAT, el atún rojo se clasificó como edad 7, por debajo de la talla/edad de los peces que se cree que se reproducen en el Golfo de México. Se sugiere que es necesario realizar un muestreo más amplio para revelar si el calendario de madurez del atún rojo atlántico originario del oeste se asemeja más a los patrones del Mediterráneo.

#### KEYWORDS

*Atlantic bluefin tuna, reproductive cycle, sexual maturity, spawning*

### 1. Introduction

Atlantic bluefin tuna (ABFT), *Thunnus thynnus*, are managed as two stocks (Fromentin and Powers, 2005), under an assumption of spawning site fidelity as the predominant reproductive behavior (Mather *et al.*, 1995; Ahlquist, 1998; Corriero *et al.*, 2005; Rooker *et al.*, 2008). The eastern stock spawns from May through July in the Mediterranean Sea with age at first maturity established at 3-4 yrs (Corriero *et al.*, 2005). The western stock is assumed to spawn from April through June in the Gulf of Mexico and the Straits of Florida with an age at first maturity of 8-12 yrs (Baglin, 1976; 1982; Baglin and Rivas, 1977; Diaz and Turner, 2007). This discrepancy in maturation schedules may represent a sampling bias, because comprehensive sampling for maturity status over the spatial and temporal extent of adult ABFT has not been achieved (Mather *et al.*, 1995; Fromentin and Powers, 2005). In addition, ABFT sampled in the Gulf of Maine over a range of size classes show that individuals may mature at a younger age/size than previously believed (Goldstein *et al.*, 2007). Our study objectives are to establish a comprehensive understanding of ABFT maturity status by sampling fish of all size classes in spawning areas as well as feeding areas. Through the NMFS Fisheries Pelagic Observer Program, in 2007-2008 we obtained biological samples for reproductive analysis from ABFT on the Gulf of Mexico spawning grounds and report preliminary results here.

### 2. Methods

Fish sampled in the Gulf of Mexico during the 2007 and 2008 spawning seasons were caught by commercial longline vessels and sampled by Large Pelagics Research Center scientists as well as National Marine Fisheries Service Observers. We determined stage of maturity using histological analysis of gonad tissue according to Schaefer *et al.* (1998). For each ovary, oocytes were classified in stages: (1) unyolked, (2) early yolked, (3) advanced yolked, (4) migratory-nucleus stage, or (5) hydrated. Fish were classified as reproductively active if the oocytes were stage 3 or later and there was little to no atresia present.

### 3. Results and discussion

In the 2007-2008 sampling season, a total of 104 fish were sampled in several size classes (**Figure 1**). Fish varied in length and weight from 180 to 341 cm and 134 to 397 kg, respectively (**Table 1**). Gonadosomatic Index values ranged from 1.1 to 7.5, and varied between months (**Table 2**). In addition to reproductive stage, age was estimated according to the current ICCAT growth equation. While histological classification of samples is ongoing, most of the female fish so far have been classified as reproductively mature (**Figure 2**).

In May 2007, a 180 cm fish was sampled, which under current growth curves would be classified as age 7, below the size/age of fish believed to be spawning in the Gulf of Mexico. This fish contained mature gonads (**Figure 3**) and its histological status was classified as inactive mature. The gonad contained vitellogenic and atretic oocytes indicating maturation had occurred and that spawning was possible. These data are in agreement with previously suggested scenarios indicating younger/smaller fish may be capable of spawning (Baglin, 1982; Goldstein *et al.*, 2007). Other scenarios, however, such as the presence of non-spawners on the spawning grounds (Zupa *et al.*, *in press*) or dummy-run maturation (Holland, *et al.*, 2001) cannot be excluded. With the caveat of an extremely small sample size, these data indicate that broader sampling might better define the presence of younger fish spawning in the Gulf of Mexico or elsewhere. Additional sampling is needed to reveal whether the maturity schedule of western origin ABFT more closely resembles those of Mediterranean patterns. Our comprehensive and comparative approach to sampling multiple size classes from on and off the spawning

grounds combined with forthcoming results on reproductive endocrinology of spawning ABFT will provide a much needed insight into the status of the western spawning stock.

#### 4. Acknowledgements

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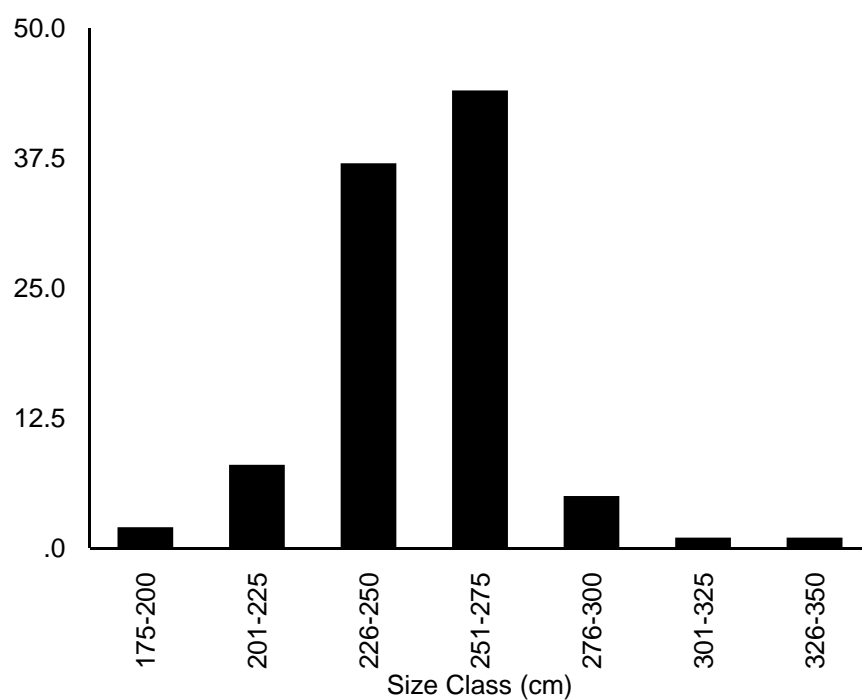
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**Table 1.** Weight and gonad data collected from ABFT during 2007-2008 spawning season in the Gulf of Mexico.

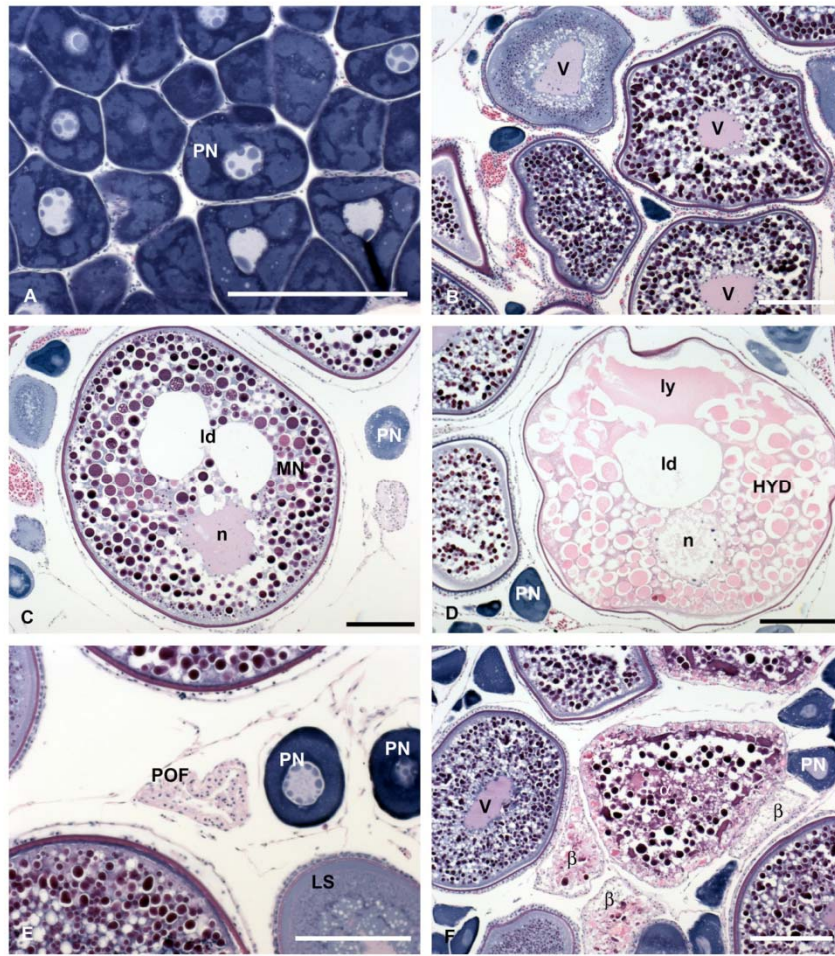
Sex	Dressed weight (kg; n=100)			Gonad weight (kg; n=34)			Gonadosomatic index (n=34)		
	□	SD	Range	□	SD	Range	□	SD	Range
Male	273.8	72.7	137–539	8.8	3.6	0.8–15.2	3.5	1.4	0.29–5.11
Female	269.5	73.0	100–655	6.7	3.0	2.7–13.8	2.8	1.4	0.94–6.85

**Table 2.** Atlantic bluefin tuna Gonadosomatic Index data by month and sex.

Sex	March (n)		April (n)		May (n)		June (n)	
	□	Range (n)	□	Range (n)	□	Range (n)	□	Range (n)
Male	1.00	0.29–1.71 (2)	3.56	1.46–5.46 (9)	4.85	3.79–5.26 (5)	-	5.11 (1)
Female	2.27	1.55–3.54 (5)	3.31	1.33–6.85 (5)	3.04	0.94–4.77 (14)	-	-



**Figure 1.** Histogram of number of sampled bluefin tuna per size class.



**Figure 2.** Micrographs of various stages of oocyte development observed in sampled bluefin tuna. A. immature tuna, B. active nonspawning, C-E. active spawning, F. inactive mature. PN: perinucleolar oocytes, V: vitellogenic oocytes, MN: migratory nucleus oocytes, POF: post-ovulatory follicles, LS: lipid-stage oocytes, HYD: hydrating oocytes,  $\alpha$ :  $\alpha$ -atretic follicles,  $\beta$ :  $\beta$ -atretic follicles, ld: lipid droplet, n: nucleus, ly: liquid yolk, yg: yolk granules.



**Figure 3.** Mature gonads sampled from 180 cm Atlantic bluefin tuna with 4.5 GSI.