Col.Vol.Sci.Pap. ICCAT, 24 : 143-148 (1986)

CATCH-AT-AGE AND ESTIMATES OF GROWTH OF CANADIAN BLUEFIN TUNA

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SUMMARY

Aging of bluefin tuna based on thin otolith sections has been carried out since 1974. The growth assessed from annuli on otoliths shows a high degree of variability for the older ages making up the Canadian fishery. This makes the length-age relationship of little value but is useful in assigning catch at age to this portion of the west Atlantic bluefin stock.

The catch-at-age matrix derived from this aging material ranges from ages 14 to 39 and indicates a slight increasing trend in mean age since 1979.

Seasonal growth in weight results in significant differences between monthly length-weight relationships. The fish continue to increase in weight at length for the entire time they are subject to the Canadian inshore fishery.

RESUME

La détermination de l'âge du thon rouge à partir de sections transversales fines d'otolithes est effectuée depuis 1974. La croissance estimée à partir des anneaux de croissance sur les otolithes montre un degré élevé de variabilité pour les âges les plus avancés dans la pêcherie canadienne. Ceci fait que le rapport longueur-âge soit de peu d'intérêt, mais est utile pour assigner une prise à un âge donné à ce segment du stock de thon rouge ouest-atlantique.

La matrice de prise à un âge donné qui découle de ces éléments d'étude sur la détermination de l'âge va des âges 14 à 39, et montre depuis 1979 une légère tendance à la hausse de l'âge moyen.

La croissance saisonnière en poids entraîne des différences saisonnières significatives entre les rapports longueur-poids mensuels. Le poids du poisson à une taille donnée continue d'augmenter pendant toute la période où il est soumis à à la pêche côtière canadienne.

RESUMEN

Desde 1974 se determina la edad del atún rojo en base a secciones finas de otolitos. El crecimiento evaluado estudiando los anillos en los otolitos muestra un alto grado de variabilidad en lo que respecta a los peces más viejos que son componente de la pesquería canadiense. Esto hace que la relación talla/edad sea de escaso valor, siendo, sin embargo, útil para asignar una captura por edad a esta sección de la población de atún rojo del Atlántico Oeste.

La matriz de captura por edad derivada de este método para determinar la edad, se extiende desde los 14 a los 39 años e indica una tendencia ligeramente decreciente en las edades, a partir de 1979.

El crecimiento estacional en peso da como resultado importantes diferencias entre las relaciones talla/peso mensuales. Los peces siguen aumentando de peso por talla durante todo el tiempo de su permanencia en la pesquería litoral canadiense.

INTRODUCTION

Biological sampling of bluefin tuna (Thunnus thynnus, L.) from Canadian inshore fishing areas has taken place since 1974. A time series of the following statistics have been accumulated:- caliper fork length, tape flank length, girth measurements, round weight, sex and otolith age. This age and growth data set spans the decade 1975 to 1984.

Age estimates have been produced for this fishery on many occasions (Caddy et al. 1976, Hurley and Iles 1980, Hurlbut et al. 1984). The most recent of these indicated a very weak relationship between age and length for ages over 15 years. Current aging of bluefin is being conducted for the purpose of estimating catch-at-age rather than an age-length relationship. The techniques used to collect, section, and interpret the ages from the otoliths were those described by Caddy et al. (1976).

Although annual growth, measured by length and age, tends to be poorly defined, the intra-seasonal growth, measured by length and weight, has a definite pattern. This strong intra-seasonal growth in these northern regions makes it necessary to use length-weight relationships from smaller time intervals than have been done in the past.

AGE AND GROWTH

The datasets for 1983 and 1984 contain 352 and 121 age estimates respectively - males making up 73% and 74%. The ages ranged from 14 to 36 in 1983 and 16 to 39 in 1984. The mean age of tuna in the fishery has continued to increase and in 1984 stands at 25.7 for males and 28.2 for females.

The high degree of variability of age-at-length for the older ages was presented graphically by Hurlbut et al. (1984). Without the younger age groups to 'lengthen' the age-length curve, the coefficients of variation for 1983 and 1984 were less than 0.05 (Fig 1 and 2). The high age of fish now present in this fishery (total catch is now composed of fish over the age of 14 years) results in a very poor relationship between age and length.

CATCH-AT-AGE MATRIX

The catch-at-age matrices were developed from this length-at-age data (Tables 1, 2 and 3). In recent years the Canadian fishery for bluefin tuna has been exploiting fish ranging in age from 20 to 35 years. Since 1979 there appears to be a trend toward increasing mean age ranging from approximately 21 to 25 years for males and 21 to 28 years for females. To date (including preliminary observations from the 1985 fishery) the apparently strong 1973 year class (Anon 1985) has not yet made the appearance that was expected.

CATCH SAMPLING and INTRA-SEASONAL GROWTH

The Canadian bluefin tuna fishery has traditionally been small in terms of numbers of fish landed, however, it is of great local importance due to the high market value of large bluefin. This fishery is sampled in two ways: first random port sampling is carried out to obtain biological data such as sex, length, weight, and age; second the round weight is collected as part of the Canadian quota management system. This latter dataset, a total measurement of the catch, comprises the data utilized by ICCAT in the annual assessment of the west Atlantic bluefin. Clay et al. (1985) pointed out that using a single length-weight relationship to convert these data to length frequency may introduce significant errors due to intra-seasonal growth.

In order to remove any effect of trap fed fish, only length and weight data from wild caught fish in the Prince Edward Island fishery were used. These data cover only a limited range of bluefin lengths, they are however representative of the majority of fish caught in Canadian waters by the inshore fishery. An analysis of variance indicated these data were heterogeneous with regards monthly length-weight relationships ($P < 0.005$). The monthly length weight relationships are:-

MONTH	EQUATION	N	r^2	LENGTH RANGE cm
JULY	$W = 0.00005262\ L^{2.808}$	57	0.83	233 - 283
AUG	$W = 0.001572\ L^{2.219}$	769	0.59	220 - 300
SEPT	$W = 0.0006377\ L^{2.392}$	1174	0.65	226 - 303
OCT	$W = 0.00004617\ L^{2.871}$	764	0.83	195 - 303
NOV	$W = 0.00001166\ L^{3.121}$	285	0.99	205 - 295

where W is the round weight in kg and L is the fork length in cm. For the length range of fish in the Canadian fishery there is a large increase in weight-at-length between July and August, and progressively smaller changes in the subsequent months. These data indicate northern tuna are increasing in weight at length during the entire time they are available to the Canadian inshore fishery.

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Table 1. Catch at age matrix for male Atlantic bluefin tuna from Canadian waters (thus excluding the Canadian purse seine fishery off New England). The asterix indicate the mean age of the population.

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
<=10				4		35	2			
11	6		7	4	8	6	17			
12						6	8			
13	6		7		16	6				
14	6	10	7	4	8	6	25		3	
15	17	20	15	4	8	36	8		3	
16	51	47	22	12			17		9	5
17	62	91	52	20		6	17		18	15
18	17	111	104	43	23	30	17		27	
19	90	124	215	106	70	42	8		18	20
20	73	77	201*	78	39	36			35	5
21	107*	104	141	78*	31*	36	25		27	
22	129	161*	112	90	16	77*	42*		32	25
23	90	138	119	63		65	42		53	25
24	39	54	156	67	16	12	25		62	10
25	11	40	60	31	8	36	66		118*	50
26	17	23	30	12		36			109	80*
27			7	4	8	42	25		74	70
28		3				18			32	60
29						6	8		56	25
30	6					6	8		27	15
30+									35	30

Table 2. Catch at age matrix for female Atlantic bluefin tuna from Canadian waters (thus excluding the Canadian purse seine fishery off New England). The asterix indicate the mean age of the population.

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
<=10		7	7			12				
11					8		8			
12					8					
13					8		8			
14		3		4						
15	6	3				6	8			
16	6	3		8			8		3	
17	34	27	22	12	16				3	5
18	11	34	22	12	47	6			3	5
19	17	37	60	47	31	6				5
20	34*	34	22	27	62	18	17			5
21	67	20*	22	71	8*	42	17		6	
22	51	40	67*	71	31	36	42		3	
23	11	37	74	39*	16	12*	25		6	
24	11	30	67	59	39	30	25		27	5
25	11	34	37	16	39	12	50*		21	5
26		13	22	35	16	12	42		30	15
27		7	15	4		24	33		18*	20*
28				4		12	17		32	5
29			7				33		30	10
30				4			33		6	10
30+						12	25		72	65

Table 3. Catch at age matrix for Atlantic bluefin tuna (sexes combined) from Canadian waters (thus excluding the Canadian purse seine fishery off New England).

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
<=10		7	7	4		47				
11	6		7	4	16	6	25			
12					8	6	8			
13	6		7		24	6	8			
14	6	13	7	8	8	6	25		3	
15	23	23	15	4	8	42	16		3	
16	57	50	22	20			25		12	5
17	96	118	74	32	16	6	17		21	20
18	28	145	126	55	70	36	17		30	5
19	107	161	275	153	101	48	8		18	25
20	107	111	223	105	101	54	17		35	10
21	174	124	163	149	39	78	42		33	
22	180	201	179	161	47	113	84		35	25
23	101	175	193	102	16	77	67		59	25
24	50	84	223	126	55	42	50		89	15
25	22	74	97	47	47	48	116		139	55
26	17	36	52	47	16	48	42		139	95
27		7	22	8	8	66	58		92	90
28		3		4		30	17		64	65
29			7			6	41		86	35
30	6			4		6	41		33	25
30+						12	25		107	95
SUM	986	1332	1699	1033	580	783	749		998	590

Table 4. Monthly weight-at-length of west Atlantic bluefin tuna sexes and years combined (1974 to 1984) calculated from regression analysis. Data range indicated by asterix.

length cm	.....mean weight at length kg..... JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
155	74	113	110	89	80
160	81	122	119	98	88
165	88	130	128	107	97
170	96	139	137	116	106
175	104	149	147	126	116
180	113	158	158	137	127
185	122	168	168	148	138
190	131	178	179	160	151
195	141	189	191	173	163
200	152	200	203	186	177
205	163	211	215	199*	191
210	174	223	228	214	206*
215	186	235	241	229	222
220	199	247*	255	244	238
225	212	260	269*	260	256
230	225	273	284	277	274
235	239*	286	299	295	293
240	254	300	314	314	313
245	269	314	330	333	333
250	285	328	347	353	355
255	301	343	363	373	378
260	318	358	381	395	402
265	335	374	398	417	426
270	353	389	417	440	452
275	372	406	435	464	478
280	392	422	455	488	506
285	411*	439	474	514	535
290	432	456	494	540	565
295	453	474	515	567	596*
300	475	492*	536*	596*	628

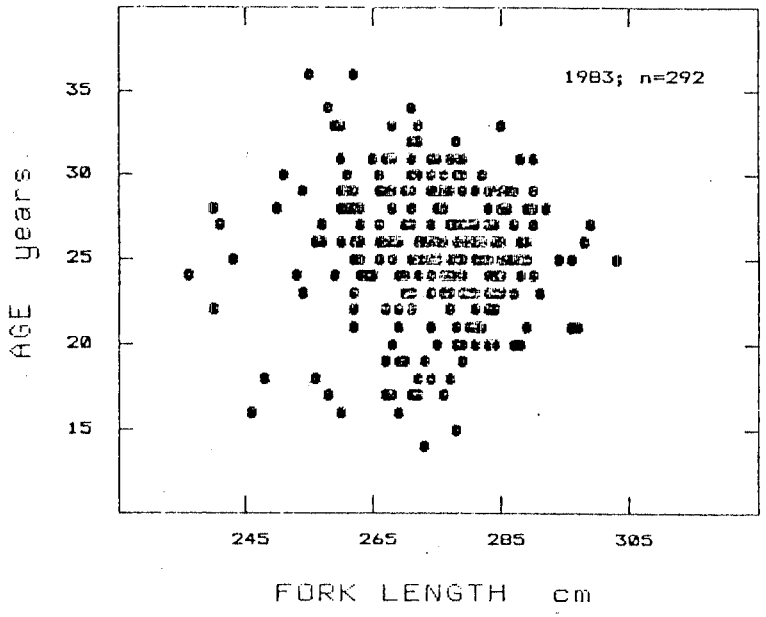

Figure 1. Length-at-age of bluefin tuna (sexes combined) as read from 292 otoliths sampled in 1983 from the Canadian inshore fishery.

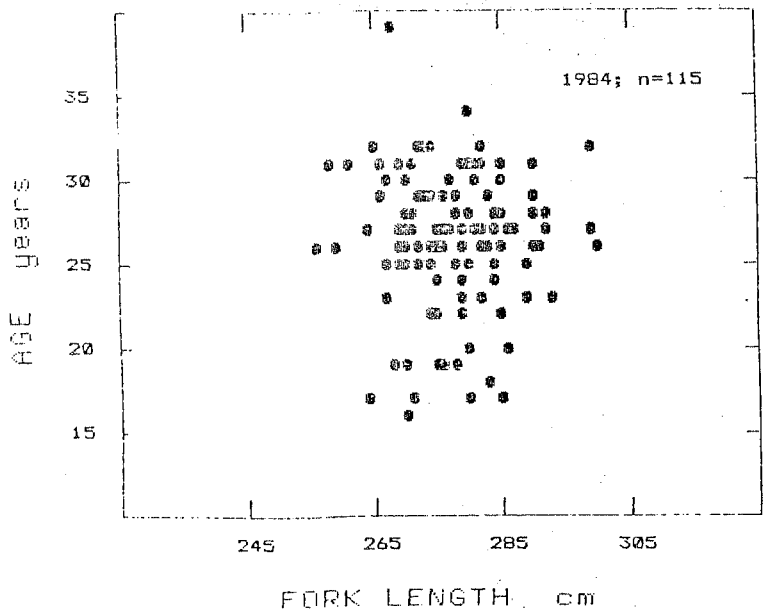

Figure 2. Length-at-age of bluefin tuna (sexes combined) as read from 115 otoliths sampled in 1984 from the Canadian inshore fishery.

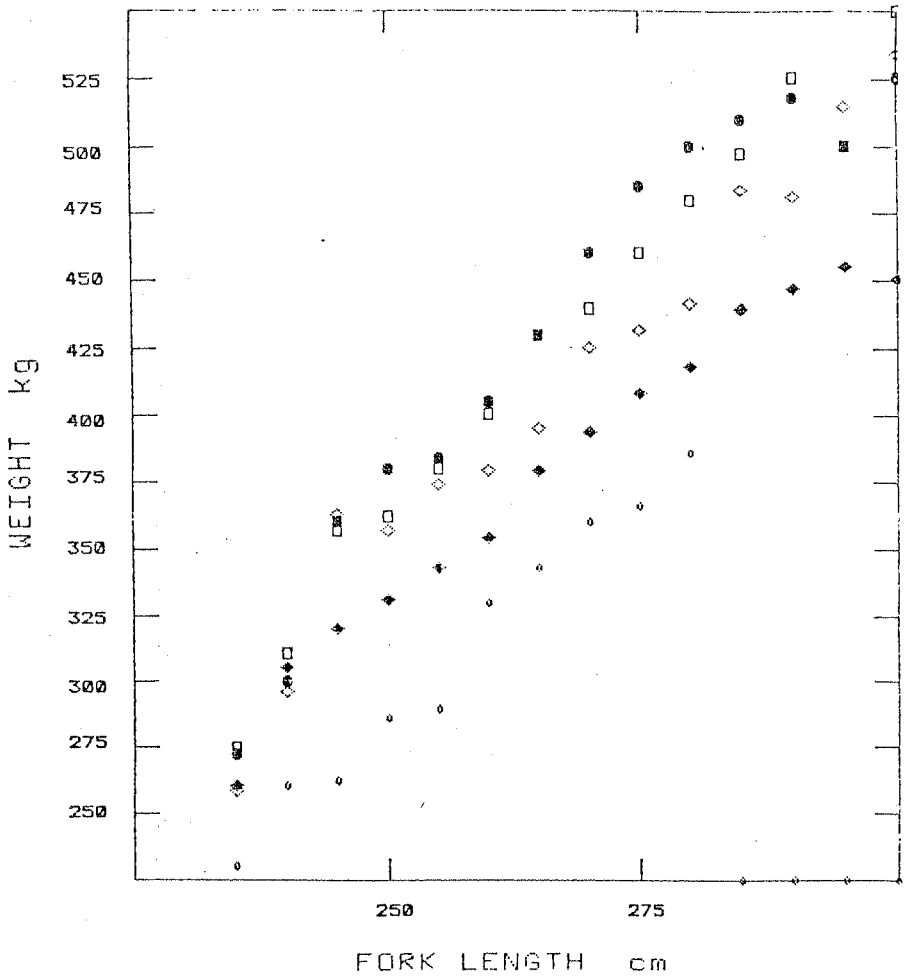

Figure 3. Bluefin tuna monthly length weight relationships for July (°), August (♦), September (◊), October (□), and November (■) for sexes and years (1974 to 1984) combined.