

STANDARDIZED CATCH RATES OF BLUEFIN TUNA FROM THE JAPANESE LONGLINE FISHERY
IN THE EXCLUSIVE ECONOMIC ZONE OF THE UNITED STATES

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SUMMARY

Bluefin tuna data collected by observers aboard Japanese longline vessels fishing in the U.S. exclusive zone were re-analyzed in order to obtain estimates of standard deviation for 1989 age-specific standardized mean catch rates.

RESUME

Les données sur le thon rouge rassemblées par des observateurs à bord de palangriers japonais opérant dans la zone exclusive des Etats-Unis ont été analysées de nouveau pour obtenir les estimations de l'écart standard des taux moyens de prise standardisés spécifiques de l'âge de 1989.

RESUMEN

Se volvieron a analizar datos de atún rojo recopilados por observadores a bordo de barcos palangreros japoneses que faenaban en la ZEE de Estados Unidos, para obtener estimaciones de la desviación estándar de las tasas medias estandarizadas de captura específicas de la edad, para 1989.

Introduction

Age specific standardized catch rates for 3 to 7 year old bluefin tuna within U.S. Exclusive Economic Zone (EEZ) (Figure 1) were developed by Davis (1989) using a general linear model approach. In that analysis 1989 was used as the standard year. Consequently the confidence interval (CI) estimate reported for 1989 was the CI of the intercept which included uncertainty introduced by all variables in the model. In order to obtain a CI specifically for 1989 the analysis was redone using 1984 as the standard year.

Materials and Methods

Data used in this analysis are identical to those used by Davis (1989) (Table 3). Catch and effort data were restricted to December, January, and February, the months of greatest abundance of bluefin tuna in the fishery. December observations were grouped with the next years' January and February data in order to make logical fishing seasons 1984 through 1989.

Observations used in the analyses were single sets. Sets that contained less than 1000 hooks or had missing lengths for more than 67% of the bluefin tuna were not used.

A general linear model was used to calculate standard catch rates and associated model parameter confidence intervals (CI) for each age from 3 to 7 years. Standard catch rates and CI's were also calculated for combined 3 to 5 year old bluefin and 6 and 7 year old bluefin. The models used were the same as those used in the original analysis (Table 1).

Results

Designation of 1984 as the standard year allowed calculation of CI's around the 1989 standardized mean which reflect the variation in the model estimated parameters for that year only (Figures 2-8). As expected the CI's for 1989 were smaller and the 1984 CI's were larger than those reported by Davis (1989). A intercept value of 1 was used in all cases to decrease the between year variation due to inclusion or exclusion of the continuous variable T.

Change of standard year did not affect standardized mean catch rates. However, corrections for temperature parameter effects (ages 3, 4 and 3 to 5) for bias from logarithmic transformation (Brown and Lucy 1990) and intercept standardization (Table 2) changed the estimates of standardized mean catch rates. These corrections rescaled the standardized mean catch rates but did not alter relative levels of the yearly values. (Table 4). Typographical errors in the model descriptions were corrected (Table 1).

Literature Cited

- Brown, C.A. and J.A. Lucy. 1990. Standardized catch rates of bluefin tuna in the Virginia (U.S.) offshore rod and reel fishery. ICCAT Working Document SCRS/90/81
- Davis, K. S. 1989. Standardized catch rates of bluefin tuna from the Japanese longline fishery in the exclusive economic zone of the United States. Int. Comm. Conserv. Atl. Tunas, Col. Vol. Sci. Pap. 32(2):229-239

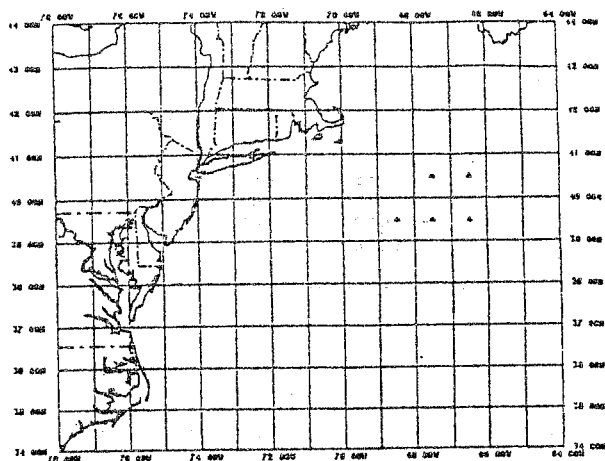


Figure 1. Map of the areas used in developing standardized catch rates for bluefin tuna from the Japanese longline fishery in the U.S. EEZ.

Table 1. Initial and age specific models used in the analysis.

Initial Model:

$$\ln(\text{CPUE} + 1) = Y + M + A + P + N + M*A + M*P + M*N + A*P + A*N + P*N + T$$

CPUE = catch per 1000 hooks
 Y = year
 M = month
 A = area
 P = presence of a warm water body
 N = number of hooks between floats
 * = interaction of 2 class variables
 T = surface water temperature
 LN = natural log

Age Specific Models:

3 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*N + A*P + A*N + T$$

$$R^2 = 33 \text{ square root MSE} = 0.73$$

4 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*A + M*N + A*P + A*N + T$$

$$R^2 = 18 \text{ square root MSE} = 0.77$$

5 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*A + M*N + A*N + A*P + P*N$$

$$R^2 = 30 \text{ square root MSE} = 0.70$$

6 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*A + M*P + M*N + A*P$$

$$R^2 = 41 \text{ square root MSE} = 0.64$$

7 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*A + M*P + M*N + A*P$$

$$R^2 = 40 \text{ square root MSE} = 0.50$$

3 to 5 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*A + M*N + A*P + A*N + T$$

$$R^2 = 27 \text{ square root MSE} = 0.88$$

6 to 7 year old bluefin

$$\ln(\text{CPUE}+1) = Y + M + A + P + N + M*A + M*P + M*N + A*P$$

$$R^2 = 45 \text{ square root MSE} = 0.69$$

Table 2. Logarithmic bias correction:

$$\text{Abundance Index } -10 = \exp\left[\frac{I+Y+T*A+(S^2_I+S^2_Y)/2+(E-S^2_Y)*(DF+1)/2*DF}{DF}\right]$$

- I = intercept parameter
- Y = year parameter
- T = temperature parameter
- A = average temperature
- S^2_I = intercept SE squared
- S^2_Y = temperature SE squared
- E = mean square error
- S^2_Y = year SE squared
- DF = degree of freedom error

Table 3. Age specific mean catch per 1000 hooks of bluefin tuna caught by the Japanese longline fishery in the U.S. EEZ by logical year 1984-1989.

Year	AGE				
	3	4	5	6	7
1984	0.56	1.84	2.36	0.56	0.05
1985	5.66	3.54	3.86	5.28	2.53
1986	0.38	3.90	1.37	0.64	0.40
1987	2.70	5.46	4.00	1.67	0.36
1988	1.98	2.64	2.18	1.65	0.69
1989	2.03	1.68	0.86	1.04	0.37

Table 4. Standardized mean catch per 1000 hooks from the General Linear Model analyses on bluefin tuna from the Japanese longline fishery in the U.S. EEZ for logical year 1984-1989.

Year	AGE						
	3*	4*	5	6	7	3-5*	6-7
1984	0.93	1.04	2.66	2.49	2.16	0.59	2.64
1985	6.97	1.28	1.84	5.78	4.90	1.86	7.06
1986	1.71	0.43	0.52	0.97	2.63	0.00	1.31
1987	2.92	2.40	3.89	4.60	4.00	2.06	5.52
1988	1.87	0.83	2.42	4.75	3.96	0.64	5.78
1989	1.00	0.20	1.87	5.17	4.56	0.02	6.65

* corrected for temperature parameter effect

Figure 2. Standardized mean catch per 1000 hooks (CPUE) +/- 2 standard errors (SE) for 3 year old bluefin tuna.

YEAR	Y	S^2_Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	0.01	0.93	2.69	1.000
1985	1.429	0.145	5.00	6.97	9.60	4.175
1986	0.371	0.246	0.67	1.71	3.40	1.449
1987	0.718	0.142	1.96	2.92	4.18	2.050
1988	0.404	0.127	1.24	1.87	2.68	1.498
1989	0.045	0.140	0.52	1.00	1.63	1.046

- I = 1
- T = -0.0473
- A = 14
- DF = 809
- S^2_I = 0.3303
- S^2_Y = 0.0126
- E = 0.5306

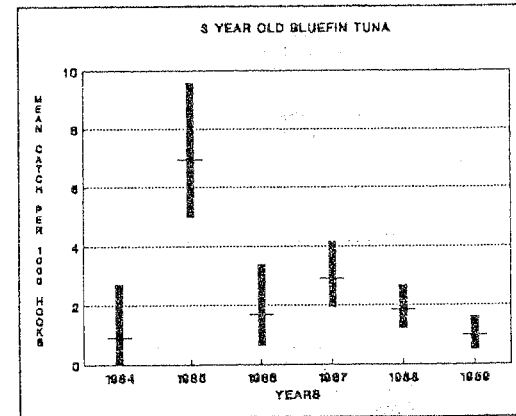


Figure 3. Standardized mean catch per 1000 hooks (CPUE) +/- 2 standard errors (SE) for 4 year old bluefin tuna.

YEAR	Y	S ² _Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	-0.30	1.04	3.29	1.000
1985	0.122	0.163	0.65	1.28	2.13	1.130
1986	-0.324	0.264	-0.15	0.43	1.39	0.723
1987	0.523	0.156	1.51	2.40	3.62	1.687
1988	-0.102	0.141	0.38	1.83	1.41	0.903
1989	-0.519	0.152	-0.11	0.20	1.62	0.595

I = 1 S²_I = 0.3791
 T = -0.0467 S²_T = 0.0137
 A = 14 E = 0.5908
 DF = 801

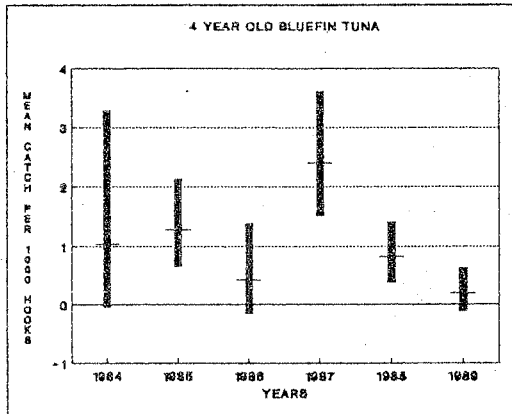


Figure 4. Standardized mean catch per 1000 hooks (CPUE) +/- 2 standard errors (SE) for 5 year old bluefin tuna.

YEAR	Y	S ² _Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	0.94	2.66	5.90	1.000
1985	-0.247	0.126	1.21	1.84	2.63	0.781
1986	-0.847	0.254	-0.08	0.52	1.50	0.429
1987	0.300	0.138	2.73	3.89	5.41	1.350
1988	-0.059	0.129	1.66	2.42	3.40	0.943
1989	-0.232	0.139	1.19	1.87	2.77	0.793

I = 1 S²_I = 0.3240
 DF = 800 E = 0.4883

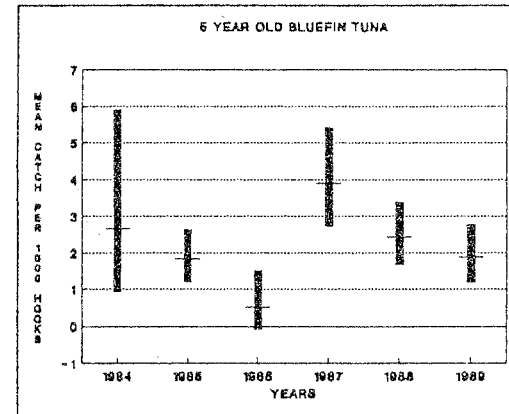


Figure 5. Standardized mean catch per 1000 hooks (CPUE) \pm 2 standard errors (SE) for 6 year old bluefin tuna.

YEAR	Y	S^2_Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	0.95	2.49	5.23	1.000
1985	0.672	1.114	4.42	5.78	7.48	1.958
1986	-0.551	0.211	0.30	0.97	1.97	0.576
1987	0.481	0.126	3.37	4.60	6.16	1.618
1988	0.508	0.117	3.58	4.75	6.23	1.662
1989	0.578	0.125	3.85	5.17	6.88	1.783

I = 1
DF = 808
 $S^2_I = 0.2959$
E = 0.4100

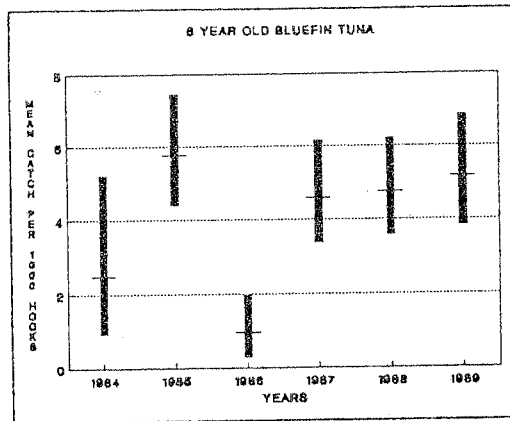


Figure 6. Standardized mean catch per 1000 hooks (CPUE) \pm 2 standard errors (SE) for 7 year old bluefin tuna.

YEAR	Y	S^2_Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	1.01	2.16	3.95	1.000
1985	0.630	0.089	3.96	4.90	6.02	1.878
1986	0.153	0.164	1.64	2.63	4.00	1.165
1987	0.463	0.098	3.13	4.00	5.05	1.589
1988	0.455	0.091	3.15	3.96	4.92	1.576
1989	0.570	0.097	3.59	4.56	5.72	1.768

I = 1
DF = 808
 $S^2_I = 0.2297$
E = 0.2470

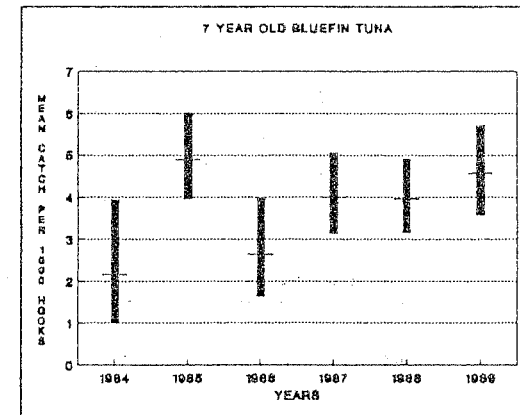


Figure 7. Standardized mean catch per 1000 hooks (CPUE) +/- 2 standard errors (SE) for 3 to 5 year old bluefin tuna.

YEAR	Y	S ² _Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	-0.32	0.59	2.73	1.000
1985	0.603	0.187	0.98	1.86	3.13	1.828
1986	-0.425	0.303	-0.45	0.00	0.80	0.654
1987	0.670	0.178	1.16	2.06	3.35	1.954
1988	0.042	0.162	0.19	0.64	1.25	1.043
1989	-0.431	0.174	-0.28	0.02	0.44	0.650

I =	1	S ² _I =	0.4344
T =	-0.0449	S ² _T =	0.0156
A =	14	E =	0.7760
DF =	801		

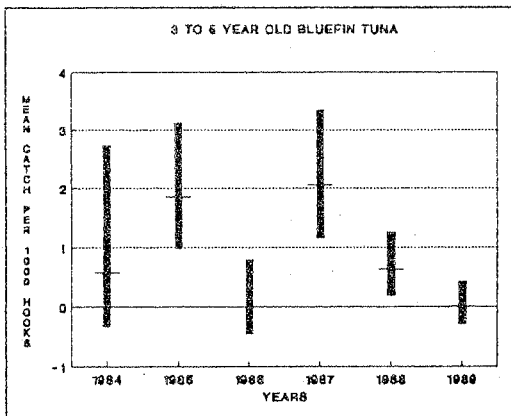


Figure 8. Standardized mean catch per 1000 hooks (CPUE) +/- 2 standard errors (SE) for 6 to 7 year old bluefin tuna.

YEAR	Y	S ² _Y	-2*SE	MEAN	+2*SE	EXP(Y)
1984	0.000	0.000	0.94	2.64	5.83	1.000
1985	0.802	0.124	5.33	7.06	9.27	2.230
1986	-0.429	0.228	0.48	1.31	2.62	0.651
1987	0.592	0.136	3.99	5.52	7.52	1.808
1988	0.630	0.127	4.29	5.78	7.70	1.878
1989	0.752	0.136	4.87	6.65	8.98	2.121

I =	1	S ² _I =	0.3209
DF =	808	E =	0.4821

