

Updated review table of vital rates and life history
parameters for striped marlin, swordfish, and blue marlin in
the North Pacific Ocean¹

James H. Uchiyama and Robert L. Humphreys, Jr.
Pacific Islands Fisheries Science Center
National Marine Fisheries Service, NOAA
Honolulu, Hawaii



¹Working document submitted to the ISC Marlin Working Group Workshop, November 8-15, 2006, Shimizu, Shizuoka, Japan. Document not to be cited without authors' written permission.

**UPDATED REVIEW TABLE OF VITAL RATES AND LIFE HISTORY
PARAMETERS FOR STRIPED MARLIN, SWORDFISH, AND BLUE MARLIN
IN THE NORTH PACIFIC OCEAN¹**

James H. Uchiyama and Robert L. Humphreys, Jr.

Pacific Islands Fisheries Science Center
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822 U.S.A.

The intent of this working paper is to compile available vital rates and life history parameters for striped marlin, swordfish, and blue marlin and present them in a tabular format for stock assessment scientists. Information is presented concerning length-on-weight relationships (Table 1), weight-on-length relationships (Table 2), age-growth parameters (Table 3), reproduction (Table 4) and distribution (Table 5). As this information is typically widely scattered in peer-reviewed articles and gray literature, compiling this information into an accessible format is important. Furthermore, we hope this format will also allow researchers to more easily determine where gaps exist in our knowledge of important vital rates and life history parameters. Information provided in each table has been footnoted and the literature source cited.

This report updates information presented at the August 2005 Joint Meeting of the ISC MARWG and SWOWG in Shimizu. In this updated report, the weight-on-length relationships for eastern North Pacific striped marlin and blue marlin have been corrected (Table 2) and the standard von Bertalanffy growth model parameters for central North Pacific swordfish, by sex, have been updated (Table 3). Also, several references previously incorrectly listed in support of vital rates in tables of the August 2005 working paper have been corrected.

Since the authors are based in the central North Pacific region, the information provided here on billfish vital rates and life history parameters is more complete for this region than the western and eastern North Pacific regions. We have undoubtedly overlooked information from the latter two regions and caution that this review is not complete or comprehensive. It is our desire that during the course of this joint intersessional meeting, our colleagues will call to our attention other data and literature sources that we have overlooked.

¹ PIFSC Working Paper WP-06-011. Issued 27 October 2006.

Table 1.--Length (cm) on weight (kg) relationships; includes available sex-specific values.							
SPECIES	Length on Weight Relationship	Sex	r ²	s.e.	n	Min weight	Max weight
North Pacific striped marlin							
central North Pacific	^a EFL = 51.3506W^{0.300417}	pooled	0.840	6.365	1427	8.1	99.8
	^a EFL = 50.9618W^{0.301733}	females	0.846	6.253	630	6.8	99.8
	^a EFL = 52.8873W^{0.293434}	males	0.721	6.534	671	8.1	80.3
North Pacific swordfish							
central North Pacific	^b EFL = 47.2751DW^{0.29451}	pooled	0.940	6.010	1550	22.8	262.6
	(Results not available)	females					
	(Results not available)	males					
Pacific blue marlin							
central North Pacific	^a EFL = 52.0203W^{0.283377}	pooled	0.929	8.182	154	10.4	381.1
Striped marlin were measured for eye-fork length (EFL , cm) and whole weight (W , kg) at the fish auction in Honolulu, Hawaii, USA.							
Pacific blue marlin were measured for eyefork length (EFL ,cm) and whole weight (W , kg) at the fish auction in Honolulu, Hawaii, USA.							
Swordfish were measured for eye-fork length (EFL , cm) at sea and dressed weight (DW , kg) at the fish auction in Honolulu, Hawaii, USA.							
Literature References							
^a Uchiyama, J. H. and T. K. Kazama. 2003. Updated weight-on-length relationships for pelagic fishes caught in the central North Pacific Ocean and bottomfishes from the Northwestern Hawaiian Islands. National Marine Fisheries Service, Pacific Islands Fisheries Science Center, NOAA. Administrative Report H-03-01, p. 34, p A-6.							
^b Uchiyama, J. H., E. E. DeMartini, and H. A. Williams. 1999. Length-weight interrelationships for swordfish, <i>Xiphias gladius</i> L., caught in the central North Pacific. U.S. Dep. Commer. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-284, 82pp.							

Table 2.--Weight (kg) on length (cm) relationships; includes sex-specific values when available.							
SPECIES	Weight on Length Relationships	Sex	r ²	s.e.	n	Min length	Max length
North Pacific Striped Marlin							
central North Pacific	^a W = (-6.02372) - 0.0647304EFL + 0.0021165EFL ^{2.01602}	pooled	0.802	4.7532	1427	100.3	198.0
	(Results not available)	female					
	(Results not available)	male					
eastern North Pacific	^c log ₁₀ W = -5.005 + 2.999(log ₁₀ EFL)	male	0.7691		975	119.6	202.6
	^c log ₁₀ W = -5.116 + 2.903(log ₁₀ LJFL)	male	0.6084		220	172.0	261.0
	^c log ₁₀ W = -5.243 + 3.113(log ₁₀ EFL)	female	0.7293		1007	110.0	215.1
	^c log ₁₀ W = -5.267 + 2.950(log ₁₀ LJFL)	female	0.6053		315	153.0	271.0
	^c log ₁₀ W = -5.157 + 3.071(log ₁₀ EFL)	pooled	0.7465		1982	110.0	215.1
	^c log ₁₀ W = -5.340 + 2.982(log ₁₀ LJFL)	pooled	0.6147		535	153.0	271.0
eastern North Pacific	^d W = 0.00009727EFL ^{2.5682}	pooled	0.53		1748	107.5	225.5
North Pacific Swordfish							
western North Pacific	^e W = 0.0000013528LJFL ^{3.4297}	pooled	0.9664		227		
central North Pacific	^f W = 0.000012988EFL ^{3.0738}	pooled	0.967	7.9396	166	69.9	228.8
	(Results not available)	female					
	(Results not available)	male					
	^f DW = 0.00000796012EFL ^{3.1307}	pooled	0.931	9.3	1550	112.0	249.0
	(Results not available)	female					
	(Results not available)	male					
eastern North Pacific	^g W = 0.0000137EFL ^{3.04}	female	0.96		77		
	^g W = 0.00000662EFL ^{3.19}	male	0.97		29		
Pacific Blue Marlin							
central North Pacific	^a W = 0.00000272228EFL ^{3.30967}	pooled	0.932	13.446	154	109.2	269.3
central North Pacific	^h W = 0.0000708LJFL ^{2.60}	male			102	127.0	274.0
	^h W = 0.0000001LJFL ^{3.81}	female			55	141.0	342.0
eastern North Pacific	^c log ₁₀ W = -5.690 + 3.318(log ₁₀ EFL)	female	0.8987		57	154.0	265.1
	^c log ₁₀ W = -7.543 + 3.905(log ₁₀ LJFL)	female	0.9101		20	221.1	347.3
For the central North Pacific:							
Striped marlin measured for eye-fork length (EFL, cm), lower jaw fork length (LJFL, cm), and whole weight (W, kg) at the fish auction in Honolulu.							
Swordfish measured for eye-fork length (EFL, cm) on ship and dressed weight (DW, kg) at the fish auctions in Honolulu.							
Pacific blue marlin measured for eye-fork length (EFL, cm), lower jaw fork length (LJFL, cm) and whole weight (W, kg) at the fish auction in Honolulu.							
Literature References							
^a Uchiyama, JH and TK Kazama. 2003. Updated weight-on-length relationships for pelagic fishes caught in the central North Pacific Ocean and bottomfishes from the Northwestern Hawaiian Islands. NMFS, PIFSC, NOAA. Adm Rpt H-03-01 pp34, ppA-6.							
^b Wares PG and GT Sakagawa. 1974. Some morphometrics of billfishes from the eastern Pacific Ocean. In Shomura, RS and FW Williams (eds) Proc of the Int Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972 Part 2 Review and contributed papers. NOAA Tech. Rep. NMFS-SSRF-675, pp107-125.							
^c Ponce Dias G and PG Gonzalez Ramirez. 1991. Analysis of sizes and weight-length relation of the striped marlin, <i>Tetrapturus audax</i> (Philippi, 1887) in Baja California Sur Mexico. Ciencias Marinas, 17(4):69-82.							
^d Sun CL, SP Wang, and SZ Yeh. 2003. Age and growth of the swordfish (<i>Xiphias gladius</i> L.) in the waters around Taiwan determined from anal-fin rays. Fish. Bull. U.S. 100(4): 822-835.							
^e Uchiyama JH, EE DeMartini, and HA Williams. 1999. Length-weight interrelationships for swordfish, <i>Xiphias gladius</i> L., caught in the central North Pacific. U.S. Dep. Commer. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-284. pp82.							
^f Castro-Longoria, R. 1995. Analisis de edad, crecimiento y madurez del recurso pesquero del pez espada, <i>Xiphias gladius</i> , en el pacifico Mexicano. Tesis que para cubrir parcialmente los requisitos necesarios para obtener el grado en Doctor en Ciencias presenta. Division de Oceanologia, Departamento de Ecologia. Centro de Investigacion Cientifica y de Educacion Superior de Ensnada, p114 pp.							
^g Wilson CA, JM Dean, ED Prince, and DE Lee. 1991. An examination of sexual dimorphism in Atlantic and Pacific blue marlin using body weight, sagittae weight, and age estimates. J Exp Mar Biol Ecol, 151(1991):209-225.							

Table 3.--Age & growth and natural mortality estimates; includes sex-specific values when available.						
SPECIES	VB Growth Rate Model	Sex	Maximum Age	Maximum Length	Longevity	Natural Mortality Rates
North Pacific Striped Marlin						
western North Pacific						
central North Pacific	^b FL _t = 277.4(1-e ^{-0.417(t+0.521)})	male	4 yr			^j 0.79; ^k 0.569
	^b FL _t = 251.0(1-e ^{-0.696(t+0.136)})	female	5 yr			^j 1.33; ^k 0.818
eastern North Pacific	^c LJFL _t = 221(1-e ^{-0.23(t + 1.6)})	pooled	11 yr			
North Pacific Swordfish						
western North Pacific	^d LJFL _t = 267.44(1-e ^{-0.13(t+2.302)}) [standard vonB, model II]	female	12 yr	^h 290cm LJFL	^h 21 yr	
western North Pacific	^d LJFL _t = 207.52(1-e ^{-0.198(t+1.955)}) [standard vonB, model II]	male	10 yr	^h 206 cm LJFL	^h 13 yr	
central North Pacific	^f EFL _t = 230.5(1-e ^{-0.246(t+1.24)})	female	12 yr	259 cm EFL		
central North Pacific	^f EFL _t = 208.9(1-e ^{-0.271(t+1.37)})	male	11 yr	229 cm EFL		
eastern North Pacific	^g EFL _t = 263.7(1-e ^{-0.1162(t+4.05)})	female	9+ yr			
eastern North Pacific	^g EFL _t = 273.2(1-e ^{-0.077(t+3.20)})	male	7+ yr			
Pacific Blue Marlin					>15yr	
western North Pacific						
central North Pacific	^b FL _t = 371.1(1-e ^{-0.285(t+0.106)})	male	5 yr			
	^b FL _t = 659.1(1-e ^{-0.116(t+0.161)})	female	8 yr			
eastern North Pacific						
EFL = Eye-to-fork length in cm measured from back of orbit to middle fork of tail.						
LJFL = Lower jaw-to-fork length in cm measured from tip of lower jaw to middle fork of tail.						
FL = Fork length in cm measured from tip of bill to middle fork of tail.						
Literature References						
^b Skillman RA and MYY Yong. 1976. Von Bertalanffy growth curves for striped marlin, <i>Tetrapturus audax</i> , and blue marlin, <i>Makaira nigricans</i> , in the central North Pacific Ocean. Fish. Bull. U.S. 74(2):553-566.						
^c Melo Barrera FN, R Felix Uruga, C Quinonez Velazquez. 2003. Growth and length-weight relationship of the striped marlin, <i>Tetrapturus audax</i> (Pisces: Istiophoridae), in Cabo San Lucas, Baha California Sur, Mexico. Ciencias marinas 29(3):305-313						
^d Sun CL, SP Wang and SZ Yeh. 2003. Age and growth of the swordfish <i>Xiphias gladius</i> L. in the waters around Taiwan determined from anal-fin rays. Fish Bull U.S. 100(4): 822-835						
^e Wang SP, CL Sun, AE Punt and SZ Yeh. 2005. Evaluation of a sex-specific age-structured assessment method for the swordfish, <i>Xiphias gladius</i> , in the North Pacific Ocean. Fisheries Research 73:79-97.						
^f Demartini ED, JH Uchiyama, RL Humphreys Jr., JD Sampaga, and HA Williams. 2006. Age and growth of swordfish, <i>Xiphias gladius</i> , caught by the Hawaii-based pelagic longline fishery Submitted to Fish. Res.						
^g Castro-Longoria, R. 1995. Analisis de edad, crecimiento y madurez del recurso pesquero del pez espada, <i>Xiphias gladius</i> , en el pacifico Mexicano. Tesis que para cubrir parcialmente los requisitos necesarios para obtener el grado de Doctor en Ciencias presenta. Division de Oceanologia, Departamento de Ecologia. Centro de Investigacion Cientifica y de Educacion Superior de Ensenada. 114 pp.						
^h Sun CL, SP Wang, CE Porch, and SZ Yeh. 2005. Sex-specific yield per recruit and spawning stock biomass per recruit for the swordfish <i>Xiphias gladius</i> , in the waters around Taiwan. Fisheries Research 71:61-69.						
ⁱ De Sylva DP. 1974. Life history of the Atlantic blue marlin, <i>Makaira nigricans</i> , with special reference to Jamaican waters. Proc. of the International Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972. Part 2. Review and contributed papers. 80p.						
^j Boggs CH. 1989. Vital rate statistics for billfish stock assessment. In: R. H. Stroud (editor), Planning the future of billfishes: Research and management in the 90s and beyond. Proceedings of the Second International Billfish Symposium, Kailua-Kona, Hawaii, August 1-5, 1988. Part I: Fishery and Stock Synopses, Data Needs and Management. Marine Recreational Fisheries 13:225-234.						
^k Pauly D. 1989. On the inrelationships between natural mortality, growth parameters, and mean environmental temperatures in 175 fishes. Cons. Inter. Explor. Mer, Jour. 39(2):175-192.						

Table 4.--Information on sexual maturity, fecundity, and spawning season; includes sex-specific values when available.					
SPECIES	Age at 1st / 50% Maturity	Size at 1st / 50% Maturity	Sex	Fecundity	Spawning Season
North Pacific Striped Marlin					
western North Pacific					
central North Pacific					April-May rare
eastern North Pacific		^a 168.16 cm LJFL	female		April-September
		^b between 155-165 cm EFL	female	^b 11-29 x 10 ⁶ (total)	
North Pacific Swordfish					
western North Pacific		^c 168.2 cm LJFL	female		not in Taiwan fishery Feb-Mar to Jul-Aug
central North Pacific		^d 144.0 cm EFL	female	^e 3.0-6.2 x 10 ⁶ /batch	^d April-July
central North Pacific		^d 102.0 cm EFL	male		
eastern North Pacific			female		
Pacific Blue Marlin					
western North Pacific					
central North Pacific					^g May-September
eastern North Pacific					
Literature References					
^a Klette Traulsen, A. and S. Rodriques Rodriguez. [?] Contribution to study of the striped marlin gonadic development <i>Tetrapturus audax</i> (Philippi, 1887).					
^b Eldridge, MB and PG Wares. 1974. Some biological observations of billfishes taken in the eastern Pacific Ocean. <i>In</i> Shomura, RS and FW Williams (eds) Proc of the Int Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972, Part 2: Review and contributed papers. NOAA Tech. Rep. NMFS-SSRF-675, pp. 89-101.					
^c Wang, SP, CL Sun, CE Porch, SZ Yeh. 2003. Sex ratios and sexual maturity of swordfish (<i>Xiphias gladius</i> L.) in the waters of Taiwan. <i>Zoological Studies</i> 42(4):529-539.					
^d DeMartini, EE, JH Uchiyama and HA Williams. 2000. Sexual maturity, sex ratio, and size composition of swordfish, <i>Xiphias gladius</i> , caught by the Hawaii-based pelagic longline fishery. <i>Fish. Bull. U.S.</i> 98:489-506					
^e Uchiyama JH, and RS Shomura. 1974. Maturation and fecundity of swordfish, <i>Xiphias gladius</i> , from Hawaiian waters. <i>In</i> Shomura, RS and FW Williams (eds) Proc of the Int Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972, Part 2: Review and contributed papers. NOAA Tech Rep. NMFS-SSRF-675, pp. 89-101.					
^f Yabe H, S Ueyanagi, S Kikawa, and H Watanabe. 1959. Studies on the life history of the swordfish, <i>Xiphias gladius</i> Linnaeus. <i>Nankai-Ku Siusam Kenkyusho Hokoku</i> 10:106-151. [Translated by the Translation Bureau, Multilingual Services Division, Dept. of the Secretary of State of Canada (1975), 103pp.]					
^g Hopper CN. 1989. Patterns of Pacific blue marlin reproduction in Hawaiian waters. <i>In</i> Stroud, RH (ed) Planning the future of billfishes. Research and management in the 90s and beyond. Proceedings of the 2nd International Billfish Symposium, Kailua-Kona, Hawaii, August 1-5, 1988. <i>Marine Recreational Fisheries</i> 13, Part 2: Contributed papers, pp. 29-39.					

Table 5.--Distribution by life stage and documented movements.				
SPECIES	Early Life Stage Distribution	Adult Geographic Range	Adult Vertical Distribution	Documented Movements
North Pacific Striped Marlin				
western North Pacific	^{a, b, c} up to 31°N in the southern Kuroshio Current	^{c, h} up to southern Kuril Isles		
central North Pacific	^e Hawaiian Islands	^c up to 30°N	^b >85% in mixed layer; max depth down to depth related to 8°C<SST	^d 100 miles difference between release and recapture positions after about 1 yr.
eastern North Pacific	^e mouth Gulf of California	^{c, i} 10-40°N	^f down to thermocline depth	^g general trend south and southwest from tip of Baha California NW to California and one to SW of Hawaii
	^f Marias Islands (Mexico/Pacific)			^g Eight from Southern California to Hawaii
North Pacific Swordfish				
western North Pacific	^{b, g} up to 31°N 132°E	^{b, h, i} southern Kuril Isles	^p 0-900m; 3-27°C	
central North Pacific	^d Hawaiian Islands; Northwestern Hawaiian Is.	^{j, k, l} 11-40°N	^d diurnal pattern; deep in day, >720m max; shallow at night -- <160m	^d mostly N-S within fishing ground; few went east within fishing ground; one went to Los Angeles Bite
	^g Musician Seamounts			
eastern North Pacific	none	^{j, m} 0-40°N	^f 100m max due to oxycline	
Pacific Blue Marlin				
western North Pacific	^a wide spread <29°N	^h southern Kuril Isles		
		^{n, o} 10-43°N		
central North Pacific	^d Hawaiian Islands	^{n, o} 10-40°N	^q Most <200m, half <10m ≥17°C (tern @209m)	^d Kona to tip of Baha California Mexico (3); Kona to 1000m S (1); many local movements
			^q >85% in mixed layer; max depth down to depth related to 8°C<SST	
eastern North Pacific	none	^{n, o} 0-42°N		
Literature References				
^a Ueyanagi S. 1959. Larvae of the striped marlin, <i>Makaira mitsukurii</i> (Jordan et Snyder). Nankai Regional Fisheries Laboratory 11:130-146, 2 plates.				
^b Yabe H, S Ueyanagi, S Kikawa and H Watanabe. 1959. Mekajiki (<i>Xiphias gladius</i> L) no Seikatsushi no Kenkyu. 10:106-151. English trans. Studies on the life history of the swordfish, <i>Xiphias gladius</i> Linnaeus. Translation Bureau, Multilingual Services Division, Dept. of the Secretary of State of Canada, 103pp.				
^c Nakamura I. 1983. Systematics of billfishes (Xiphiidae and Istiophoridae). Publications of the Seto Marine Biological Laboratory. 8:255-396.				
^d PIFSC, unpublished data.				
^e Gonzales-Armas R, O Sosa-Nishizaki, R Funes-Rodriguez, VA Levy-Perez. 1999. Confirmation of the spawning area of the striped marlin, <i>Tetrapturus aduax</i> , in the so-called core area of the eastern tropical Pacific off Mexico. Fisheries Oceanography 8(3):238-242.				
^f Gonzalez-Armas R, R Funes-Rodriguez, and VA Levy-Perez. 1993. First record of <i>Tetrapturus audax</i> larvae (Scombroidei: Ostiophoridae) in the coast of Jalisco, eastern Pacific of Mexico. Revista de biologia tropical. San Jose 41(3-B):919-920.				
^g Nishikawa Y, S Ueyyanagi. 1974. The distribution of the larvae of swordfish, <i>Xiphias gladius</i> , in the Indian and Pacific Oceans. In Shomura, RS and FW Williams (eds) Proc of the Int Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972, Part 2: Review and contributed papers. NOAA Tech. Rep. NMFS-SSRF-675, pp.261-264.				
^h Savinykh, VF, GA Shevtsov, KA Karyakin, EV Slobodskoi, and Yu V Novikov. 2003. Yearly variability of migrations in nekton fishes and squids in the Pacific waters of the South Kuril Isles. J. of Ichthyology 43(9):729-740.				
ⁱ Hinton MG and WH Bayliff. 2002. Status of striped marlin in the eastern Pacific Ocean in 2001 and outlook for 2002. Stock Assessment Report. IATTC 3:328-364.				
^j Uozumi Y, and K Uosaki. 1996. Review of the Japanese Swordfish, <i>Xiphias gladius</i> , fisheries in the Pacific Ocean. In Barrett I, O. Sosa-Nishizaki, and N. Bartoo (eds). Biology and Fisheries of Swordfish, <i>Xiphias gladius</i> . NOAA Tech. Rep. NMFS 142:133-146.				
^k Bigelow KA, CH Boggs, and Xi He. 1999. Environmental effects on swordfish and blue shark catch rates in the US North Pacific longline fishery. Fisheries Oceanography. 8(3):178-198.				
^l Seki, MP, JJ Polovina, DR Kobayashi, RR Bidigare, and GT Mitchum. 2002. An oceanographic characterization of swordfish (<i>Xiphias gladius</i>) longline fishing grounds in the springtime subtropical North Pacific. Fisheries Oceanography 11(5):251-266.				
^m Hinton, MG; Deriso, RB. 1998. Distribution and Stock Assessment of Swordfish, <i>Xiphias gladius</i> , in the Eastern Pacific Ocean from Catch and Effort Data Standardized on Biological and Environmental Parameters. In Barrett I, O. Sosa-Nishizaki, and N. Bartoo (eds). Biology and Fisheries of Swordfish, <i>Xiphias gladius</i> . NOAA Tech. Rept. NMFS 142:161-180.				
ⁿ Hinton MG, and H Nakano. 1996. Standardizing catch and effort statistics using physiological, ecological, or behavioral constraints and environmental data, with an application to blue marlin (<i>Makaira nigricans</i>) catch and effort data from Japanese longline fisheries in the Pacific. Bull. Inter-Amer. Trop. Tuna Comm. 21(4):171-200.				
^o Hinton MG. 2001. Status of blue marlin in the Pacific Ocean. Stock Assessment Report 1. pp.284-319.				
^p Takahashi M, H Okamura, K Yokawa, and M Okazaki. 2003. Swimming behavior and migration of a swordfish recorded by an archival tag. Marine and Freshwater Review 2003, 54:527-534.				
^q Brill RW, DW Hollis, RKC Chang, S Sullivan, H Dewar, FG Carey. 1993. Vertical and horizontal movements of striped marlin (<i>Tetrapturus aduax</i>) near the Hawaiian Islands, determined by ultrasonic telemetry, with simultaneous measurement of oceanic currents. Marine Biology, Berlin, Heidelberg 117(4):567-576.				
^r Carey FG and BH Robinson. 1981. Daily patterns in the activities of swordfish, <i>Xiphias gladius</i> , observed by acoustic telemetry. Fish. Bull. U.S. 79(2):277-292.				
^s Block BA, DT Booth and FC Carey. 1992. Depth and temperature of the blue marlin, <i>Makaira nigricans</i> , observed by acoustic telemetry. Marine Biology, Berlin, Heidelberg 114(2):175-183.				
^t Squires JL Jr. 1974. Migration patterns of Istiophoridae in the Pacific Ocean as determined by cooperative tagging programs. Proceedings of the International Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972. Part 2. Review and contributed papers, pp.226-237.				
^u Squires JL Jr. 1987. Striped marlin, <i>Tetrapturus audax</i> , migration patterns and rates in the Northwest Pacific Ocean as determined by a cooperative tagging program: Its relation to resource management. Marine Fisheries Review 49(2):26-43.				