Size Composition Data for Billfishes Caught by the Hawaii-based U.S. Longline Fleet: Data Collection, Sample Sizes, and other Metadata [1]

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Size Composition Data for Billfishes Caught by the Hawaii-based U.S. Longline Fleet: Data Collection, Sample Sizes, and other Metadata[1]

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Purpose

Billfish are an important component of the catch of U.S. longline vessels based in Hawaii. Historically, all Hawaii longliners fished for tunas and caught billfishes incidentally. Today, however, a segment of the fleet deliberately pursues swordfish, primarily in fishing grounds associated with the Subtropical Front, using shallow-set gear. Other longline vessels target tunas in more southerly waters, using gear set deeper in the water column. Besides swordfish, the Hawaii longline billfish catch includes striped marlin, blue marlin, black marlin, shortbill spearfish, and sailfish. The purpose of this note is to describe available data on the size composition of the billfish catch by the Hawaii-based longline fleet. Such metadata should be useful to for planning ISC billfish stock assessments.

Sources of Size Composition Data and Data Collection Protocols

Sampling at the Honolulu fish auction --- In Hawaii, billfishes are valued as food fish and, therefore, are generally retained by local longline vessels and commercial troll vessels and landed for sale in local fresh fish markets or export to the U.S. mainland. Information on the size composition of billfishes and other pelagic species landed by these fleets has been collected from the Honolulu fresh fish auction on an irregular basis by the National Marine Fisheries Service (NMFS) and the State of Hawaii's Division of Aquatic Resources (HDAR). Such sampling began in the late 1940's and ended in June 2002. However, only records available through 2001 have been entered in NMFS databases. The weight of each billfish landed is part of the auction records. Billfish are usually landed whole (without their bill or tail), but sometimes have been processed further, e.g., with gills and/or guts removed. Since December 2004, NMFS has required that billfish be landed gilled and gutted to comply with U.S. food safety (HACCP) standards. Conversion factors are used as necessary to estimate the round weights of all fish landed.

Except for fragmentary summaries of size data in early scientific papers (e.g., Royce 1957), fish weight statistics collected prior to the 1960's have not been preserved. From 1960 through 1970, biologists at the NMFS Honolulu Laboratory routinely collected size composition data from

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samples of billfishes (and tunas) landed whole at the fish auction. The round weight of sampled fish was recorded, and the eye-fork length (EFL) was measured on a subset of fish. Gender of the fish was also determined when possible. These data are available in NMFS archives. They were used by Skillman and Yong (1974) in a study of length-weight relationships for central Pacific billfishes and a study of growth rates in blue marlin and striped marlin (Skillman and Yong 1976). The numbers of striped marlin, blue marlin, and shortbill spearfish measured by NMFS samplers are given in Tables 1a, 1b, and 1c. The data set also includes smaller samples of measurements for other billfish species and large samples for tunas (not shown).

The NMFS auction sampling program was suspended in 1971, and then resumed in the early 1980's under a joint monitoring program by staff of NMFS and HDAR. The program was phased out in June 2002. Data on individual fish weights were collected from archived weigh-in slips of the United Fishing Agency, Ltd., or directly from the auction floor. Samplers also recorded an area code roughly indicating the location of fishing. The level of auction sampling varied by year and was dependent on availability of staff. The total number of billfish size records in the auction sampling data set is given in Table 2, by species, for years 1984-1999.

Honolulu fish dealer reports --- Beginning in 2000, the State of Hawaii implemented a new law requiring that all wholesale fish dealers buying from licensed commercial fishermen report the number, weight, and total price of the fish purchased each day, by species and license holder. Because the dealer report data set includes records from the fish auction, the auction sampling program of NMFS and HDAR was phased out; there was roughly a 2-year period of overlap. The total number of billfish records in the dealer data set is given in Table 2, for the years 2000-2004.

Table 2 indicates the maximum number of records available for computing weight composition statistics before any selection or filtering. For all species except blue marlin, nearly all billfish records are from the longline fleet. The majority of blue marlin size records are from landings by longline vessels. Most of the remaining records are from the troll fleet. Vessel identification numbers or commercial marine license numbers can be used to select by gear type.

The fish dealer data (and the auction records in earlier years) are a key component of the NMFS procedure for estimating Category I statistics for the Hawaii-based longline fleet. Average round weights estimated from these data are multiplied by numbers of fish caught, as reported by vessel captains in NMFS-mandated longline logbooks, to estimate the total annual catch by the fleet.

NMFS observer program --- Since 1994, NMFS has placed trained observers on Hawaii-based longline vessels to monitor the fleet's interactions with sea turtles and other protected species. Observers record set-by-set information on the longitude and latitude of setting and hauling, number of hooks used and other details of the fishing operation, and catch by species. They also collect biological data and specimens under guidelines provided by NMFS scientists.

When conditions permit, billfishes and other primary fish species are measured. Until recently, observers were instructed to take three measurements of each billfish sampled, to the nearest whole centimeter. In order of priority these were:

- Eye-to-fork (EFL): distance "from the posterior margin of left eye orbit to the inside of the fork in the tail". A 2m caliper is used.
- Cleithrum-to-keel (CKL): distance "from the posterior margin of cleithrum, i.e., hook caliper over the edge of the cleithrum, to the anterior insertion of the keel". A 2m caliper is used.
- Half-girth (HGR): distance "from the anterior insertion of the dorsal fin to the anterior insertion of the left pectoral fin". A flexible measuring tape is used. The fish is measured before being dressed.

Observers were also instructed to determine the gender of sampled billfish, if possible. Sample sizes for billfish measurements taken by observers, given in Table 3, indicate the total number of records before any filtering or extensive validation. Table entries are given for the number of fish measured for EFL and the number of fish for which at least one of the three measurement types was recorded. Sample sizes for CKL and HGR measurements are approximately the same as for EFL measurements, so there are ample data for computing conversion formulas. In March 2005, measurement of CKL and HGR was eliminated from the observer protocol for billfish sampling; only EFL is now measured.

Changes in the sample sizes over time (Table 3) have been affected by several factors, including restrictions on fishing grounds and targeting, shifts in fishing effort, and regulations on observer coverage. In particular, targeting of swordfish was temporarily banned in 2001. Fishing effort directed towards tuna then increased. At the same time, observer coverage, which had averaged about 4-5% of longline trips before 2001, was increased to 20% (minimum). New observers, placed on tuna vessels only, continued to measure billfish but were not well trained in billfish sex determination. The swordfish fishery resumed in April 2004, subject to 100% observer coverage and other restrictions. Accordingly, observers are now receiving full training in billfish sex determination.

Histograms of eye-fork length for swordfish, striped marlin, blue marlin, and shortbill spearfish are given in Figures 1a, 1b, 1c, and 1d.

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Table 1a. Number of striped marlin landed at the Honolulu fish auction during 1960-1970 by Hawaii-based commercial fishing vessels for which gender and size data were collected by NMFS staff.

	Female		Male		Undetermined		Total	
Year	Length	Weight	Length	Weight	Length	Weight	Length	Weight
1960	0	208	0	233	0	534	0	975
1961	0	937	0	1,248	0	418	0	2,603
1962	0	877	0	1,193	0	917	0	2,987
1963	0	1 ,717	0	2,243	0	26	0	3,986
1964	0	2,782	0	3,106	0	552	0	6,440
1965	0	1,566	0	1,938	0	863	0	4,367
1966	0	1,200	0	1,647	0	2,405	0	5,252
1967	133	931	224	1,881	30	1,977	387	4,789
1968	391	1,434	381	1,670	124	1,516	896	4,620
1969	102	1,291	63	1,305	4	1,224	169	3,820
1970	13	1,039	7	718	13	74	33	1,831
TOTAL	670	13,982	689	17,182	171	10,506	1,530	41,670

Table 1b. Number of blue marlin landed at the Honolulu fish auction during 1960-1970 by Hawaii-based commercial fishing vessels for which gender and size data were collected by NMFS staff.

	Female		Male		Undetermined		Total	
Year	Length	Weight	Length	Weight	Length	Weight	Length	Weight
1960	0	52	0	56	0	43	0	151
1961	0	306	0	353	0	53	0	712
1962	0	226	0	121	0	13	0	360
1963	0	231	0	118	0	0	0	349
1964	0	239	0	139	0	2	0	380
1965	0	216	0	176	0	8	0	400
1966	0	211	0	125	0	6	0	342
1967	26	83	64	134	3	32	93	249
1968	32	84	19	83	8	24	59	191
1969	4	71	0	110	0	17	4	198
1970	0	12	0	5	0	1	0	18
TOTAL	85	1,731	116	1,420	11	199	212	3,350

Table 1c. Number of shortbill spearfish landed at the Honolulu fish auction during 1960-1970 by Hawaii-based commercial fishing vessels for which gender and size data were collected by NMFS staff.

	Female		Male		Undetermined		Total	
Year	Length	Weight	Length	Weight	Length	Weight	Length	Weight
1960	0	5	0	3	0	3	0	11
1961	0	40	0	75	0	22	0	137
1962	0	30	0	35	0	38	0	103
1963	0	32	0	68	0	0	0	100
1964	0	178	0	319	0	72	0	569
1965	0	82	0	125	0	88	0	295
1966	0	107	0	128	0	189	0	424
1967	21	82	30	113	3	292	54	487
1968	15	24	8	31	3	197	26	252
1969	8	39	0	43	1	205	9	287
1970	0	0	0	0	0	0	0	0
TOTAL	44	619	38	940	7	1,106	89	2,665

Table 2. Number of billfish landed in Hawaii fish markets by Hawaii-based commercial fishing vessels for which individual weight estimates are available in NMFS databases. For 1984-1999, weights were recorded by NMFS and HDAR biologists for samples of landed fish. For 2000-2004, weights are available for all landed billfish documented in the HDAR Commercial Marine Dealer's Report. Most of the fish were landed by longliners.

Year	Swordfish	Striped Marlin	Blue Marlin	Black Marlin	Shortbill Spearfish	Sailfish
1984	6	89	38	0	25	2
1985	223	2,768	936	29	1,184	27
1986	392	4,086	2,387	29	1,756	48
1987	343	6,585	2,601	30	1,407	14
1988	363	11,115	3,063	37	2,624	29
1989	3,277	12,652	5,154	20	3,196	87
1990	16,706	14,138	3,911	40	2,902	136
1991	31,281	12,896	2,721	9	3,859	193
1992	19,040	7,330	1,441	23	1,760	48
1993	11,216	4,715	1,774	3	1,322	74
1994	9,190	3,507	1,472	11	1,801	29
1995	8,043	7,265	2,192	31	3,281	72
1996	9,005	6,131	2,093	0	2,117	41
1997	12,117	4,104	3,360	10	2,474	105
1998	11,184	5,638	1,340	11	3,383	96
1999	9,618	5,093	1,541	8	5,749	122
2000	35,403	8,815	5,483	130	9,006	105
2001	3,868	19,755	7,463	244	9,068	262
2002	4,819	10,768	4,842	37	9,010	186
2003	2,132	26,013	5,846	26	15,698	63
2004	3,695	17,055	5,717	38	14,392	191
TOTAL	152,778	116,803	39,623	302	43,932	1,232

Table 3. Number of billfish measured at sea by observers on Hawaii-based longline vessels, 1994-2004. Type codes: EFL = eye-fork length was measured; ANY = one or more of eye-fork length, cleithrum-keel length, or half girth was measured.

		Swordfish				Striped	Blue	Black	Shortbill	
Year	Type	Female	Male	Undet.	Total	Marlin	Marlin	Marlin	Spearfish	Sailfish
1994	EFL	834	867	276	1,977	406	160	21	296	3
	ANY	999	974	336	2,309	409	161	21	296	3
1995	EFL	773	784	409	1,966	864	294	1	401	5
	ANY	788	801	428	2,017	867	296	1	404	5
1996	EFL	701	557	1,312	2,570	931	324	5	332	11
	ANY	716	564	1,360	2,640	934	326	5	338	11
1997	EFL	1,269	1,004	439	2,712	410	214	0	222	29
	ANY	1,323	1,044	481	2,848	412	217	0	222	29
1998	EFL	1,269	1,138	238	2,645	589	255	5	387	40
	ANY	1,329	1,173	264	2,766	603	271	5	394	40
1999	EFL	860	695	361	1,916	463	91	0	678	32
	ANY	869	703	367	1,939	472	92	0	684	32
2000	EFL	1,893	1,602	625	4,120	653	612	25	786	22
	ANY	1,926	1,639	641	4,206	677	640	27	800	24
2001	EFL	354	268	831	1,453	4,482	984	1	1,971	60
	ANY	360	276	858	1,494	4,520	996	1	1,982	61
2002	EFL	77	77	1,074	1,228	2,198	772	2	2,341	55
	ANY	79	77	1,109	1,265	2,204	779	2	2,352	55
2003	EFL	16	19	1,331	1,366	6,763	930	2	3,972	28
	ANY	18	23	1,353	1,394	6,806	936	2	3,991	28
2004	EFL	53	64	2,032	2,149	3,557	1,035	2	3,473	54
	ANY	74	82	2,161	2,317	3,603	1,051	2	3,505	55
ALL	EFL	8,099	7,075	8,928	24,102	21,316	5,671	64	14,859	339
	ANY	8,481	7,356	9,358	25,195	21,507	5,765	66	14,968	343

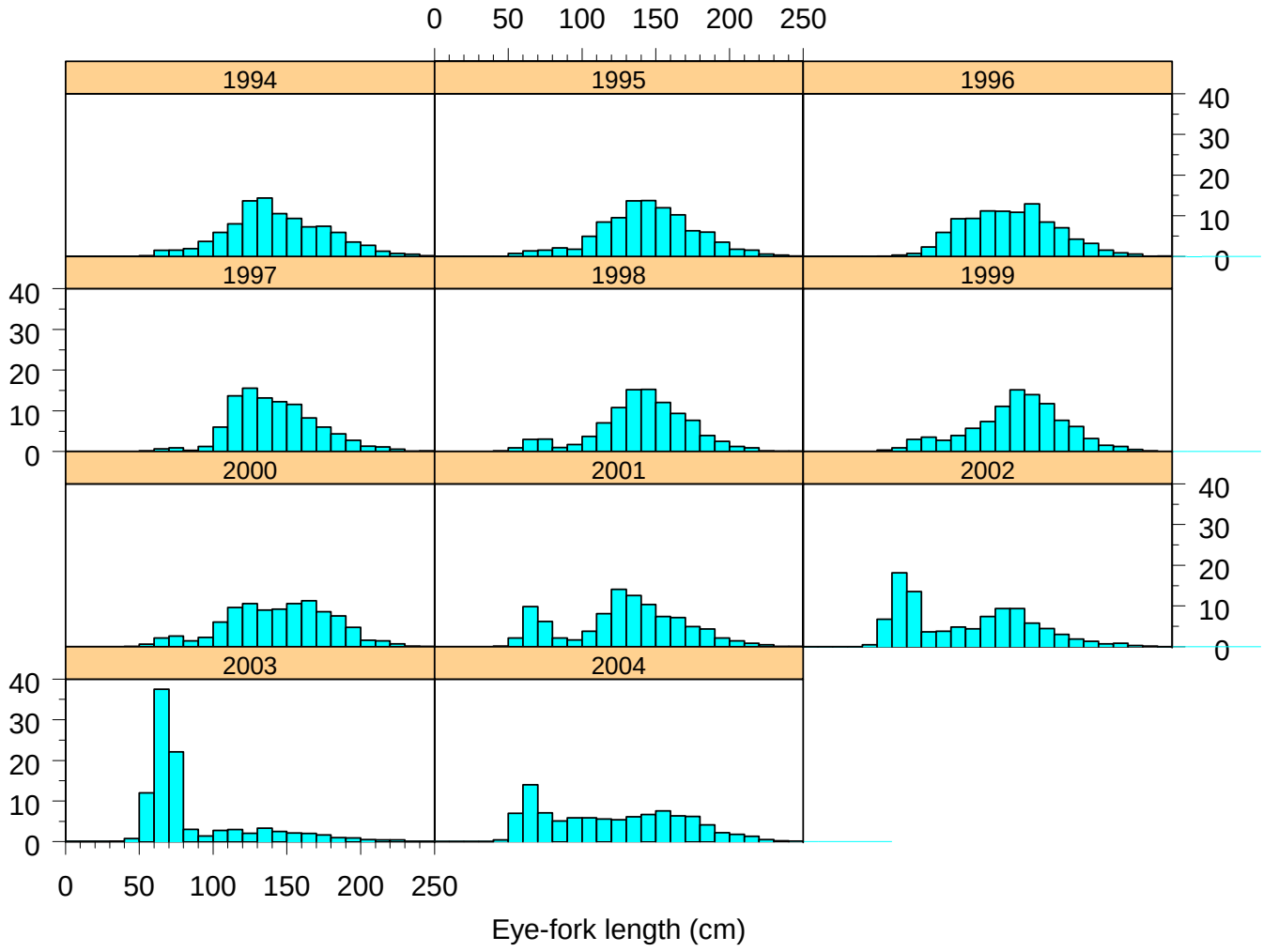

Figure 1a. Length frequency (percent of sample) of swordfish caught by Hawaii-based longline vessels. From NMFS observer data.

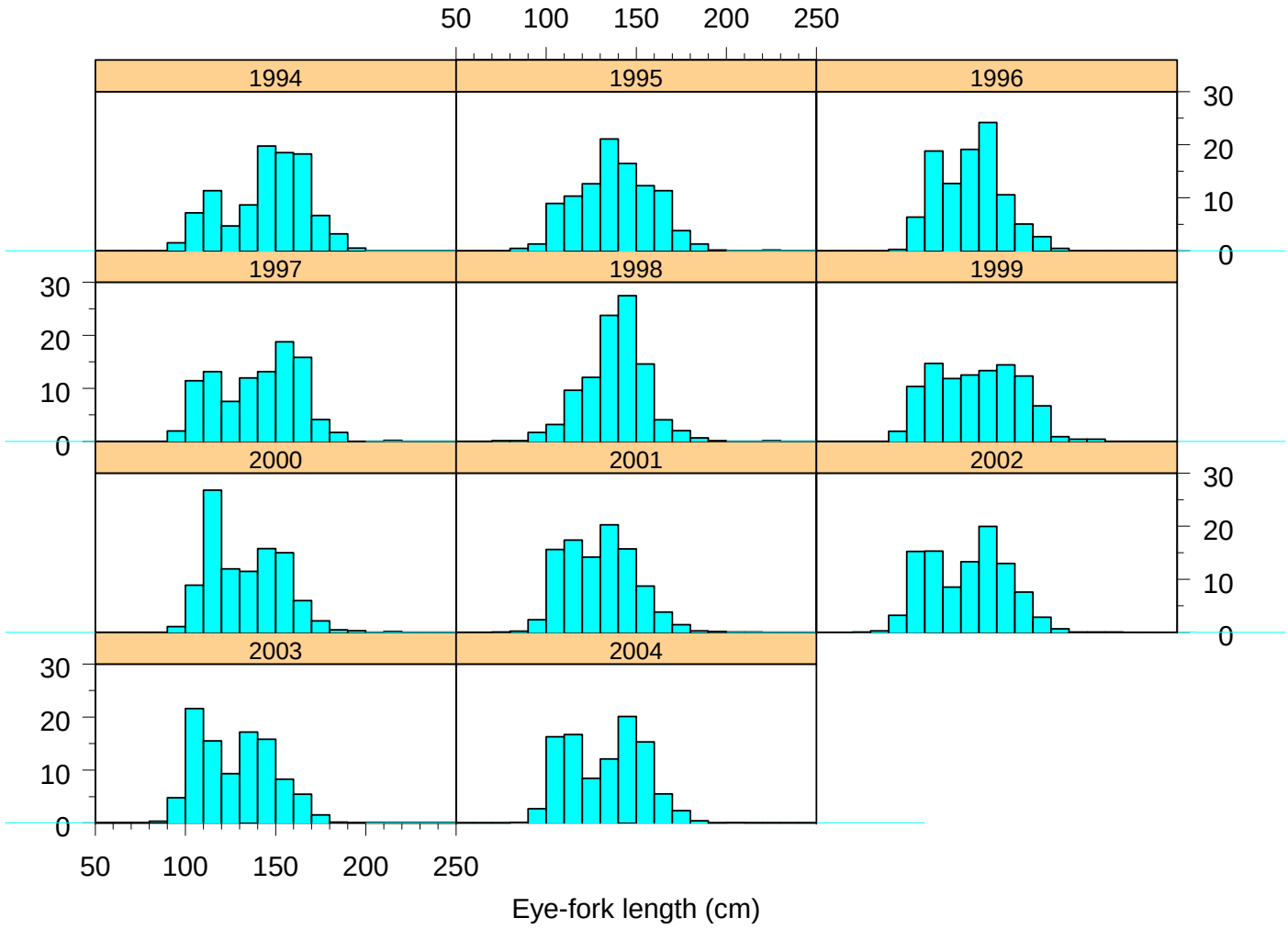

Figure 1b. Length frequency (percent of sample) of striped marlin caught by Hawaii-based longline vessels. From NMFS observer data.

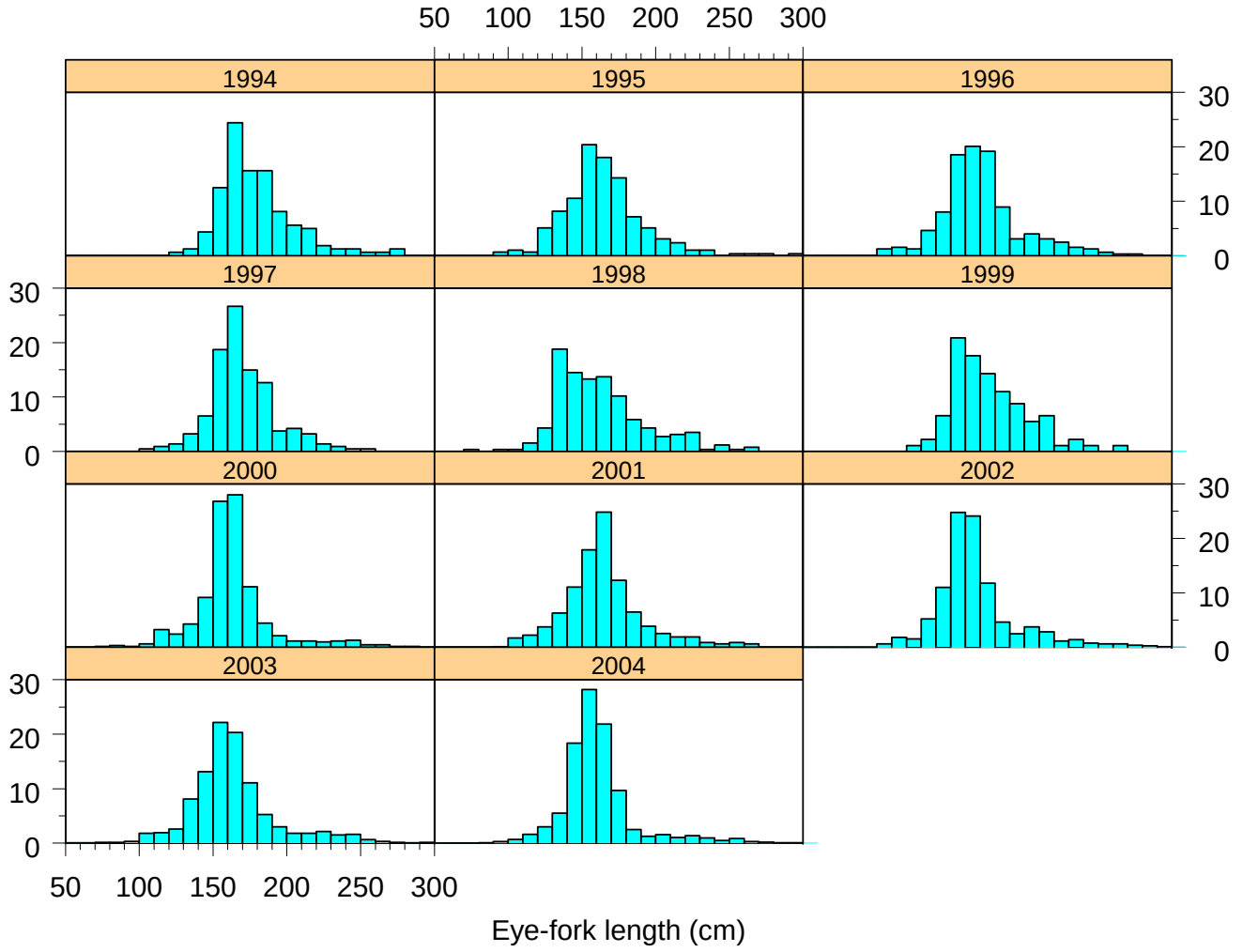

Figure 1c. Length frequency (percent of sample) of blue marlin caught by Hawaii-based longline vessels. From NMFS observer data.

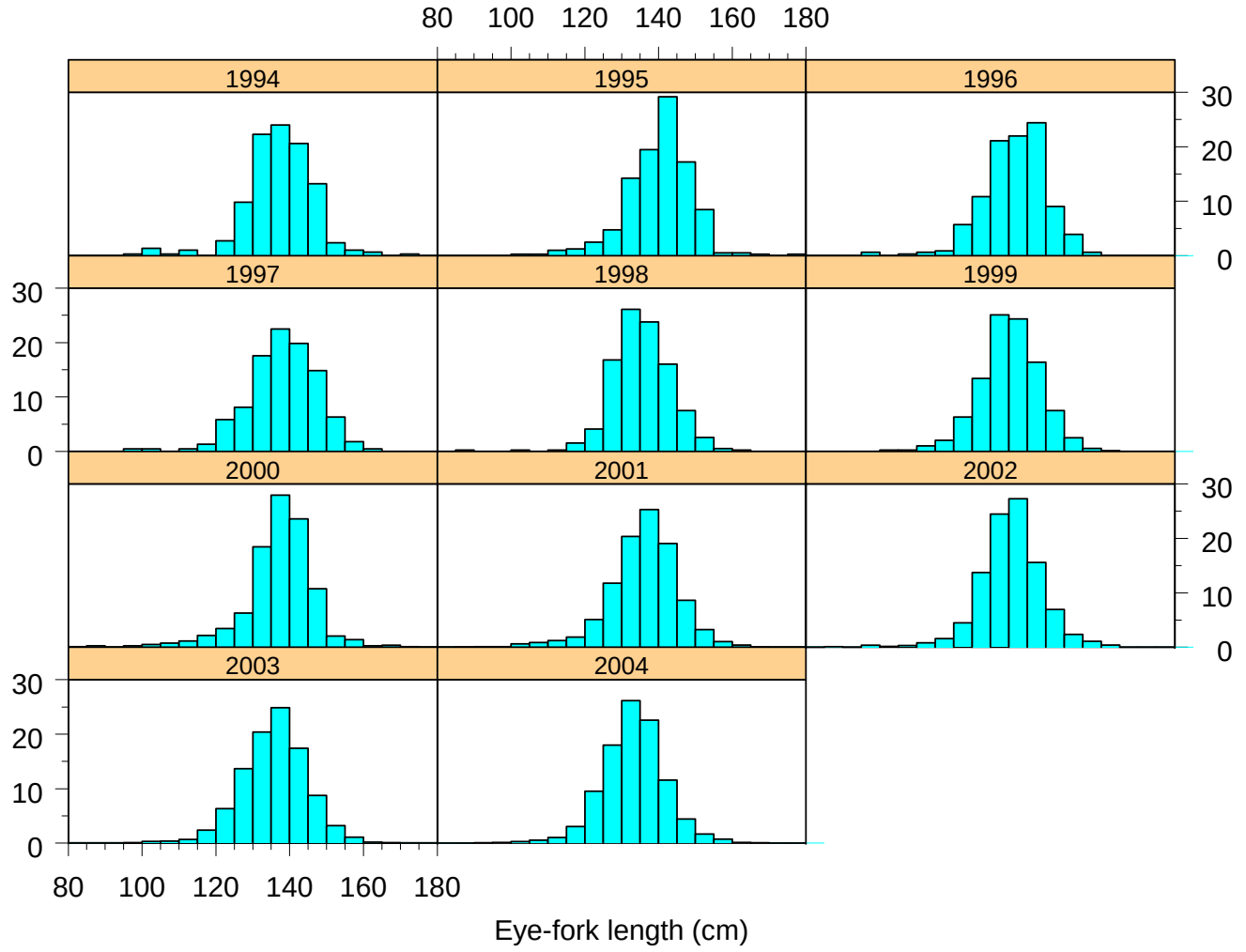

Figure 1d. Length frequency (percent of sample) of shortbill spearfish caught by Hawaii-based longline vessels. From NMFS observer data.