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INTRODUCTION

This report summarizes historical trends and recent developments are summarized for all U.S. fisheries taking marlins (Istiophoridae) in the North Pacific Ocean. Marlin are targeted and taken incidentally by commercial and recreational fisheries. Only the commercial fisheries are discussed in this paper.

At least five species of marlins are exploited commercially by the U.S. fisheries in the North Pacific Ocean. These include striped marlin (*Tetrapturus audax*), blue marlin (*Makaira nigricans*), shortbill spearfish (*T. angustirostris*), sailfish (*Istiophorus platypterus*), and black marlin (*M. indica*). The first two species predominate the commercial landings.

1. FISHERIES AND CATCHES

U.S. fisheries for marlins in the North Pacific Ocean can be categorized according to three distinct gear types: longline, troll, and handline. The largest is the longline fishery, which for the purposes of this report, refers solely to the Hawaii-based longline fishery (Table 1.). This fishery takes marlins as incidental catch on sets targeting tuna or swordfish. Troll fisheries in Hawaii, Guam, and Commonwealth of the Northern Mariana Islands (CNMI) comprise the second largest category for marlins. These fisheries opportunistically target marlins on a seasonal basis. The Hawaii handline fishery represented the third category, with small incidental catches of marlin.

Blue marlin, taken by both longline and troll fisheries, was the largest component of the marlin landings from 1992 through 2004 (Fig. 1). Striped marlin, landed predominantly by the longline fishery, was the next largest component (Fig 2). Catches

of shortbill spearfish ranked third among the marlin landings, ranging from 100 t to 236 t between 1997 and 2004 (Table 2).

Hawaii-based Longline Fishery

Marlins are taken as incidental catch by the Hawaii longline fishery on gear that consists of a single continuous monofilament mainline about 30 to 80 km in length with floats attached to the mainline supporting the gear in the water column. Branchlines with baited hooks are attached to the mainline between the floats.

Two different gear configurations and operational techniques are used when vessel operators target tunas versus swordfish. Vessels targeting tunas usually set the longline gear in the morning and haul in the afternoon, use saury or sardines for bait, attach 15-30 (or more) hooks between floats, and a line thrower, which causes the gear to sag between floats and results in a "deep set". In contrast, vessels targeting swordfish typically set in the evening and haul the following morning, use squid for bait, attach chemical lightsticks to the branchlines, and attach only 2-5 hooks between floats. The swordfish gear is set relatively shallow so a line thrower is not used. Nearly all of the Hawaii-based longline fleet targeted tunas from 2000 to 2004 due to restrictions on the shallow set segment of the longline fishery.

The Hawaii-based longline fishery has operated under a limited entry program since 1994 that capped participation at 164 vessels. Vessel participation ranged from 100 to 125 vessels, the latter value being the level of activity in 2004.

Two other important characteristics of this fishery are its geographic range and total annual hook deployment. The Hawaii-based longline fishery ranged from the equator to 40^{o} N latitude and from 140^{o} to 175^{o} W longitude in 2004 but has at times extended from the equator to 50^{o} N latitude and from 130^{o} W to 175^{o} E longitude in the years since 1991. The Hawaii-based longline fishery set 32.0 million hooks in 2004 with most of the effort on the high seas (54%) and in the Main Hawaiian Islands (MHI) Exclusive Economic Zone (EEZ) (34%).

Longline landings of striped marlin rose from 272 t in 1987 and peaked at 663 t in 1991 (Table 4). Striped marlin landings ranged from 326 t (1994) to 543 t (1995) in the 1990s. The range of landings since 2000 was 200 t to 538 t, with 384 t in 2004. Blue marlin landings grew from 51 t in 1987 and reached an apparent peak of 570 t in 1995 (see Species Identifications, below). Blue marlin then exhibited a slow decline thereafter with landings at 281 t in 2004. Plots of the geographic distributions in 2004 show that the highest catches for both striped marlin and blue marlin occurred east of Johnston Island (Figs. 3 and 4).

Nominal catch per unit effort (CPUE) was measured in number of fish per 1000 hooks. Striped marlin CPUE on tuna targeted trips peaked at 2.2 in 1992 (Fig. 5). In general, striped marlin CPUE trended downward from 1992 to 1997 and remained

somewhat low thereafter. Striped marlin CPUE was 0.5 in 2004. Blue marlin CPUE exhibited a peak of 0.8 in 1991, dropped 45% in 1992 and declined slowly thereafter to 0.2 in 2004 (Fig. 6). Though CPUE for the two marlin species exhibited declines, this does not indicate decreased apparent abundance. Some factors that could be related to the decline in CPUE are increased regulations, shift in targeting strategy, gear modification, and area fished.

Hawaii, Guam, and CNMI Troll Fisheries

The troll fisheries in Hawaii, Guam, and CNMI are hook and line fisheries that use relatively small boats. These fisheries employ the use of fishing rods, reels, and artificial lures that are typically made of resin or chrome metal heads dressed with colored rubber skirts. Live bait bridled with hooks is also used to catch marlins and other pelagic fishes.

The number of troll vessels peaked at 2,166 in 1996 and was on a declining trend to a low of 1,847 fishermen in 2004. The duration of a troll trip is one day. Since this fishery employs small vessels most trips remain within 50 miles from shore, well inside the 200 mile EEZ.

Blue marlin landings usually made up more than 80% of the troll marlin landings. Blue marlin landings peaked at 434 t in 1996 then fell to 194 t in 2004. Striped marlin landings were relatively low with 56 t in 2004.

Hawaii Handline Fishery

The Hawaii handline fishery targets tunas and is made up of diurnal and nocturnal components known as the palu ahi and ika shibi fisheries in Hawaii, respectively. The diurnal handline fishery employs the use of “palu” (chum in Hawaiian) to evoke a feeding frenzy in an aggregate of juvenile tuna (ahi in Hawaiian) and hooks the catch with a handline. The nocturnal handline fishery has two sets of gear, one used to catch the “ika” (squid in Japanese) for bait and the other for catching large tuna “shibi” (tuna in Japanese).

The Hawaii Division of Aquatic Resources (HDAR) asks commercial fishermen to identify their primary fishing method. The number of fishermen who listed handline gear as their primary fishing ranged from 150 in 1994 to 199 in 1999. A total of 172 fishermen identified themselves as handline fishers (primarily) in 2004.

The duration of a handline trip is typically one day for the day handline fishery and overnight for the night handline fishery. As with the troll fisheries, most trips remain within 50 miles from shore inside the EEZ.

The handline fishery landed negligible amounts of striped and blue marlin. The highest striped marlin landings were 2 t in 2001 and 2004. Blue marlin landings were slightly higher with a peak of 9 t in 1997.

2. DATA SOURCES

Category I: Annual Catch Data

Category I data for the longline, troll, and handline fisheries are collected by federal (NOAA Fisheries), State (Hawaii), and Pacific Island (Guam and CNMI) agencies. Logbook, market sample, fish catch report, and creel survey data sets were used, and in some instances were combined with each other to estimate annual catches. The coverage and duration for each of the data sets vary (Table 8). Conversion factors were applied to processed catch to raise the nominal weight to an estimated whole weight. Data were extrapolated when necessary to represent full coverage and complete landing estimates. Category I data summaries are accessible on the internet at:

http://www.pifsc.noaa.gov/fmsd/

Species Identifications

An ongoing project at the NOAA Fisheries PIFSC is devoted to the improvement of longline logbook accuracy by correction of billfish misidentifications. The principal investigator is the junior author of this report (W.A. Walsh). Results to date have shown that the nominal blue marlin catch by the Hawaii-based longline fishery from March 1994 through June 2002 was inflated by approximately 29%, caused primarily by misidentification and reporting of striped marlin as blue. This work is presented in "Analysis of logbook accuracy for blue marlin (*Makaira nigricans*) in the Hawaii-based longline fishery with a generalized additive model and commercial sales data", by W. A. Walsh, R.Y. Ito, K.E. Kawamoto, and M. McCracken, Fisheries Research (2005), Vol. 75:175-192). Current efforts are devoted to correction of the catch histories of the other four billfish species, along with updating the blue marlin records, from March 1994 through February 2004. This time span represents the first 10 years in the existence of the Hawaii Longline Observer Program conducted by the Pacific Islands Regional Office in Honolulu.

The analytical procedures used in this project are based upon integrated use of three data sets. First, a statistical model of blue marlin catch is fitted to observer data. The fitted coefficients are then applied to the logbook data from unobserved trips to predict catches, which then permits comparison of observed and predicted results. Potential outliers and errors are then checked against commercial sales records as a means of verification.

Category II: Spatial Catch and Effort Data

Area fished, catch and effort were the required data elements for Category II data. Logbook, observer, and fish catch reports contained the necessary data elements to generate catch and effort by area summaries. The Hawaii-based longline, Hawaii troll, and Hawaii handline fisheries were the only fisheries with Category II data.

Category III: Biological (size composition) Data

Biological measurements were obtained for the longline troll, and handline fisheries. Size frequency distributions were produced from market, fish dealer, creel surveys, or observer data.

Table 1.--U.S. commercial marlin landings* (metric tons) from the North Pacific Ocean by gear type, 1987-2004.

Year	Longline	Troll	Handline	Total catch
1987	368	324	9	701
1988	675	362	7	1,044
1989	1,100	404	6	1,510
1990	973	373	6	1,352
1991	1,029	444	6	1,479
1992	947	351	5	1,303
1993	910	422	6	1,338
1994	787	385	4	1,176
1995	1,295	424	5	1,724
1996	999	504	8	1,511
1997	983	467	10	1,460
1998	945	305	3	1,253
1999	963	387	6	1,356
2000	666	267	3	936
2001	886	367	4	1,257
2002	650	266	3	919
2003	1,153	249	2	1,404
2004	872	282	3	1,157

* Based on estimated whole weight and does not include discards.

Table 2.--U.S. commercial marlin landings* (metric tons) by species from the North Pacific Ocean, 1987-2004.

Year	Striped marlin	Blue marlin	Spearfish	Other marlins	Total catch
1987	303	334	43	21	701
1988	559	398	65	22	1,044
1989	636	721	128	25	1,510
1990	565	715	50	22	1,352
1991	703	684	60	32	1,479
1992	498	648	46	111	1,303
1993	540	678	54	66	1,338
1994	360	696	59	61	1,176
1995	595	921	139	69	1,724
1996	473	908	89	41	1,511
1997	391	909	100	60	1,460
1998	404	659	134	56	1,253
1999	393	689	214	60	1,356
2000	215	549	123	49	936
2001	395	694	120	48	1,257
2002	255	493	136	35	919
2003	566	572	236	30	1,404
2004	442	476	186	53	1,157

* Based on estimated whole weight and does not include discards.

Table 3.—Number of U.S. commercial vessels fishing in the North Pacific landing marlins, 1987-2004.

Year	Longline	Troll	Handline
1987	37	NA	NA
1988	50	NA	NA
1989	88	NA	NA
1990	138	NA	NA
1991	141	NA	NA
1992	123	1977	156
1993	122	2010	161
1994	125	2018	150
1995	110	2069	151
1996	103	2166	186
1997	105	2149	170
1998	114	2135	180
1999	119	2127	199
2000	125	1993	190
2001	101	1937	163
2002	100	1916	164
2003	110	1938	156
2004	125	1847	172

Table 4.—The Hawaii-based longline fishery marlin landings* (metric tons) from the North Pacific Ocean, 1987-2004.

Year	Striped marlin	Blue marlin	Spearfish	Other marlins	Total catch
1987	272	51	43	2	368
1988	504	102	65	4	675
1989	612	356	128	4	1,100
1990	538	378	50	7	973
1991	663	297	60	9	1,029
1992	459	347	46	95	947
1993	471	339	54	46	910
1994	326	362	59	40	787
1995	543	570	139	43	1,295
1996	418	467	89	25	999
1997	352	487	100	44	983
1998	378	395	134	38	945
1999	364	357	214	28	963
2000	200	314	123	29	666
2001	351	399	120	16	886
2002	226	264	136	24	650
2003	538	363	236	16	1,153
2004	384	281	186	21	872

* Based on estimated whole weight and does not include discards.

Table 5.--The Hawaii-based longline fishery marlin CPUE (number of fish per 1000 hooks) in the North Pacific Ocean, 1991-2004.

Year	Striped marlin	Blue marlin
1991	1.9	0.7
1992	2.2	0.4
1993	1.8	0.4
1994	1.2	0.3
1995	1.8	0.5
1996	1.2	0.4
1997	0.8	0.4
1998	0.9	0.3
1999	0.7	0.2
2000	0.3	0.2
2001	0.7	0.3
2002	0.3	0.2
2003	0.9	0.2
2004	0.5	0.2

Table 6.—The U.S. troll fishery marlin landings* (metric tons) from the North Pacific Ocean, 1987-2004.

Year	Striped marlin	Blue marlin	Spearfish	Other marlins	Total catch
1987	30	275	0	19	324
1988	54	290	0	18	362
1989	24	359	0	21	404
1990	27	331	0	15	373
1991	40	381	0	23	444
1992	38	297	0	16	351
1993	68	334	0	20	422
1994	34	330	0	21	385
1995	52	346	0	26	424
1996	54	434	0	16	504
1997	38	413	0	16	467
1998	26	261	0	18	305
1999	28	327	0	32	387
2000	14	233	0	20	267
2001	42	293	0	32	367
2002	29	226	0	11	266
2003	28	207	0	14	249
2004	56	194	0	32	282

* Based on estimated whole weight and does not include discards.

Table 7.—The U.S. handline fishery marlin landings* (metric tons) from the North Pacific Ocean, 1987-2004.

Year	Striped marlin	Blue marlin	Spearfish	Other marlins	Total catch
1987	1	8	0	0	9
1988	1	6	0	0	7
1989	0	6	0	0	6
1990	0	6	0	0	6
1991	0	6	0	0	6
1992	1	4	0	0	5
1993	1	5	0	0	6
1994	0	4	0	0	4
1995	0	5	0	0	5
1996	1	7	0	0	8
1997	1	9	0	0	10
1998	0	3	0	0	3
1999	1	5	0	0	6
2000	1	2	0	0	3
2001	2	2	0	0	4
2002	0	3	0	0	3
2003	0	2	0	0	2
2004	2	1	0	0	3

* Based on estimated whole weight and does not include discards.

Table 8.—Data sources for the longline, troll, and handline fisheries by category.

	Hawaii-based longline	Hawaii troll	Guam troll	CNMI troll	Hawaii handline
Category I: Annual catch data					
Market sample	~33-90%	+++	---	---	+++
Fish dealer	~50-100%	+++	---	+++	+++
Logbook	~100%	---	---	---	---
Fish catch report	---	+++	---	---	+++
Creel survey	---	---	+++	---	---
Observer	NA	NA	NA	NA	NA
Category II: Spatial catch and effort data					
Market sample	NA	NA	NA	NA	NA
Fish dealer	NA	NA	NA	NA	NA
Logbook	~100%	---	---	---	---
Fish catch report	---	+++	---	---	+++
Creel survey	NA	NA	NA	NA	NA
Observer					
Category III: Biological (size composition) data					
Market sample	~33-90%	+++	---	---	+++
Fish dealer	~50-100%	+++	---	+++	+++
Logbook	NA	NA	NA	NA	NA
Fish catch report	NA	NA	NA	NA	NA
Creel survey	---	---	+++	---	---
Observer	3-25%	---	---	---	---

NA - not applicable, +++ - available but coverage unknown, --- - not collected

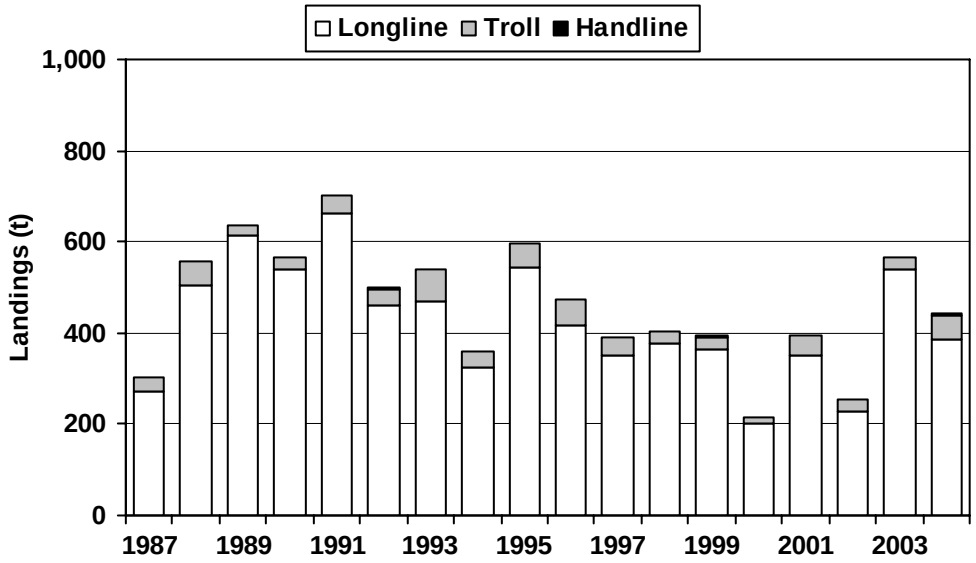


Figure 1.--Catch of striped marlin by U.S. fisheries in the North Pacific Ocean, 1987-2004.

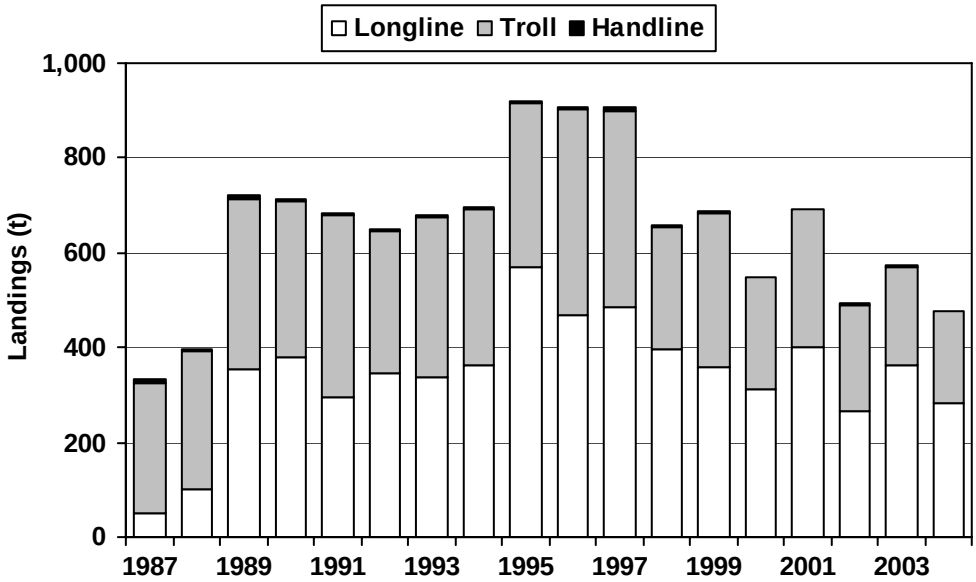


Figure 2.–Catch of blue marlin by U.S. fisheries in the North Pacific Ocean, 1987-2004.

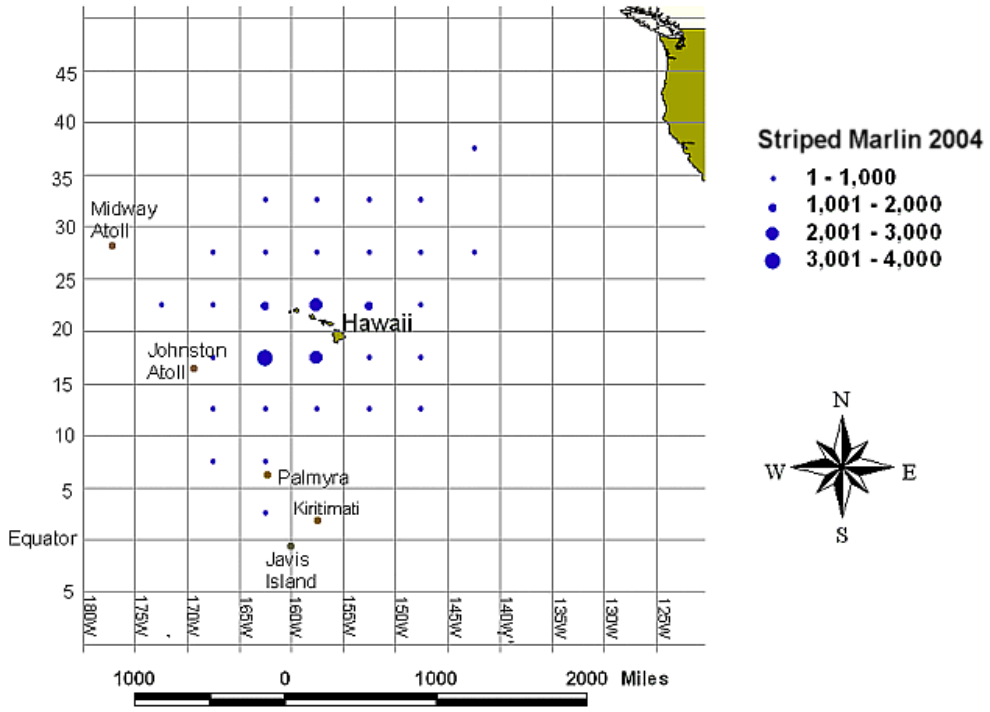


Figure 3.—Hawaii-based longline striped marlin catch (numbers of fish) by area, 2004.

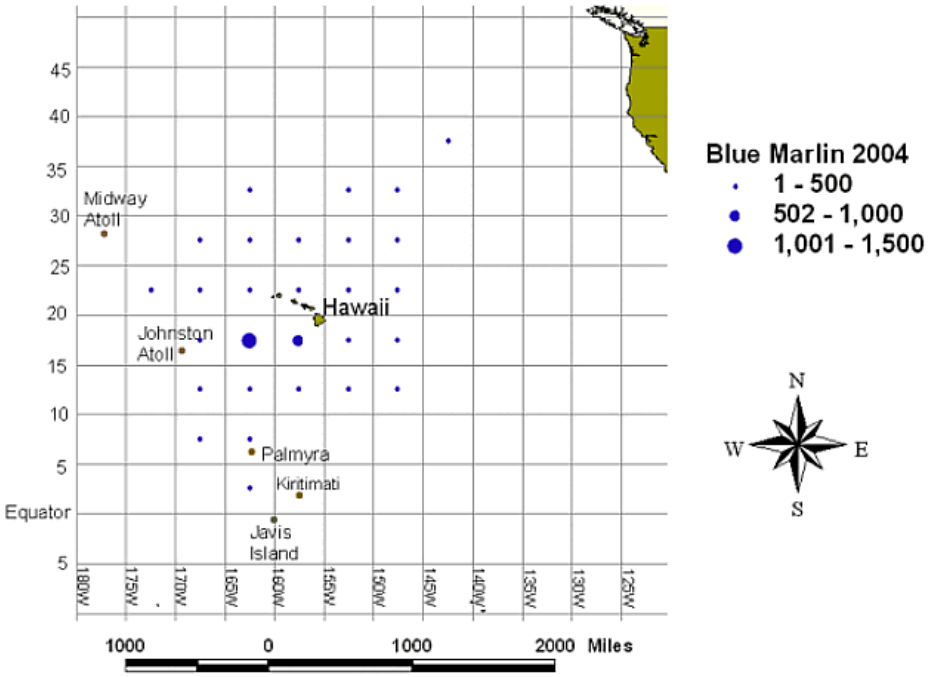
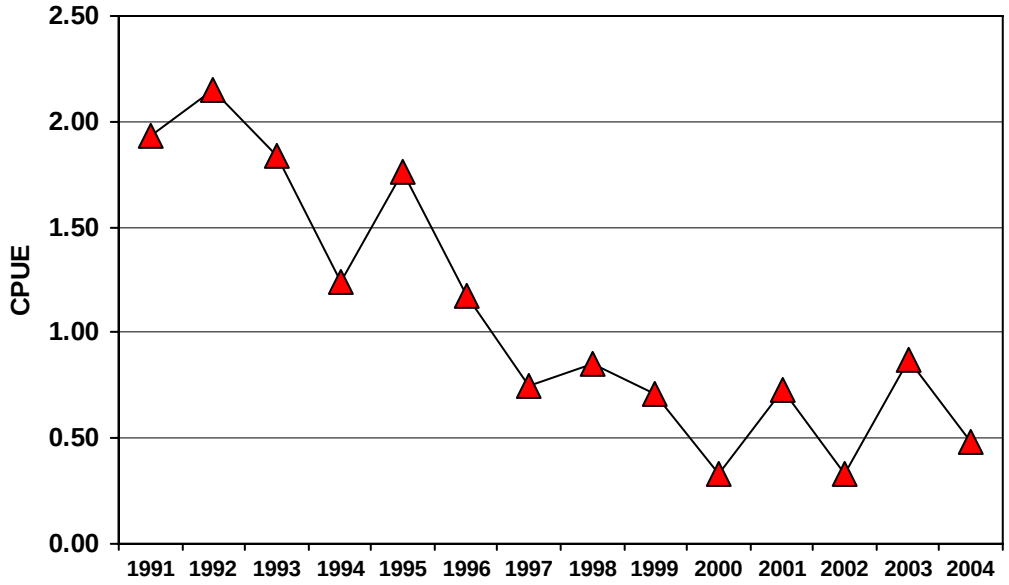
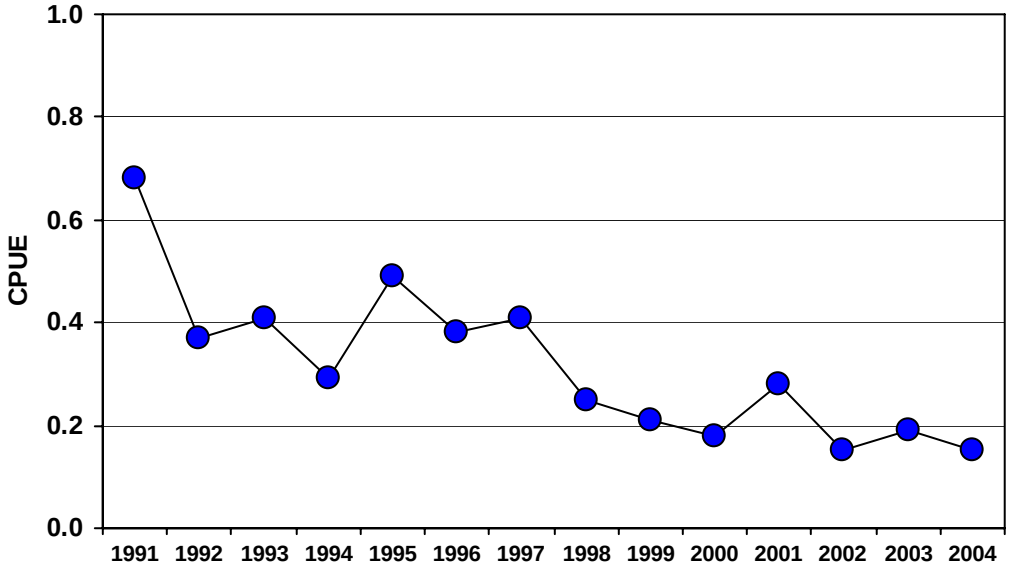


Figure 4.—Hawaii-based longline blue marlin catch (numbers of fish) by area, 2004.



*CPUE = number of fish per 1000 hooks

Figure 5.—Hawaii-based longline striped marlin CPUE*, 1991-2004.



*CPUE = number of fish per 1000 hooks

Figure 6.—Hawaii-based longline blue marlin CPUE*, 1991-2004.