INTER-AMERICAN TROPICAL TUNA COMMISSION
COMISION INTERAMERICANA DEL ATUN TROPICAL

68TH MEETING

SAN SALVADOR, EL SALVADOR

JUNE 19-21, 2001

BACKGROUND PAPER A5

STATUS OF BLUEFIN TUNA IN THE PACIFIC OCEAN

PREPARED MAY 2001

STATUS OF BLUEFIN TUNA IN THE PACIFIC OCEAN

CONTENTS

1. EXECUTIVE SUMMARY

Most of the catches of bluefin, *Thunnus orientalis* , in the eastern Pacific Ocean (EPO) are taken by purse seiners. Nearly all of the purse-seine catch is made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 33°N. Lesser amounts of bluefin are caught by recreational, gillnet, and longline gear. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October.

Bluefin are exploited by various gears in the western Pacific Ocean (WPO) from Taiwan to Hokkaido. Age-0 fish about 15 to 30 cm in length are caught by trolling during July-October south of Shikoku Island and south of Shizuoka Prefecture. During November-April age-0 fish about 35 to 60 cm in length are taken by trolling south and west of Kyushu Island. Age-1 and older fish are caught by purse seining, mostly during May-September between about 30°-42°N and 140°-152°E. Bluefin of various sizes are also caught by traps, gillnets, and other gear, especially in the Sea of Japan. Small amounts of bluefin are also caught near the southeastern coast of Japan by longlining.

The high-seas longline fisheries are directed mainly at tropical tunas, albacore, and billfishes, but small amounts of Pacific bluefin are caught by these fisheries. Small amounts of bluefin are also caught by Japanese pole-and-line vessels on the high seas.

Larvae of Pacific bluefin have been found only between the Philippines and southern Japan and in the Sea of Japan, and it is assumed that spawning occurs only in those areas. Some fish apparently remain their entire lives in the WPO. Others migrate to the EPO; these migrations begin mostly, or perhaps entirely, during the first and second years of life. The first- and second-year migrants are exposed to various fisheries before beginning their journey to the EPO. The migrants, after crossing the ocean, are exposed to commercial and recreational fisheries off California and Baja California. Eventually, the survivors return to the WPO.

Bluefin are most often found in the EPO in waters where the sea-surface temperatures (SSTs) are between 17° and 23°C. Fish 15 to 31 cm in length are found in the WPO in waters where the SSTs are between 24° and 29°C. The survival of larval and early juvenile bluefin is undoubtedly strongly influenced by the environment. Conditions in the WPO probably influence the portions of the juvenile fish there that move to the EPO, and also the timing of these movements. Likewise, conditions in the EPO probably influence the timing of the return of the juvenile fish to the WPO.

In the absence of evidence to the contrary, it has been assumed that there is a single stock of Pacific bluefin.

Various indices of abundance of bluefin in the EPO have been calculated, but none of these is entirely satisfactory. The IATTC has calculated “habitat” and “bluefin-vessel” indices for the EPO routinely for several years.

A preliminary cohort analysis has indicated that the biomass of the spawning stock was relatively high during the 1960s, decreased during the 1970s and 1980s, and then increased during the 1990s. The recruitment was estimated to be highly variable, with four or five strong cohorts produced during the 1960-1998 period.

Even though the total catches of bluefin have not declined, the results of the yield-per-recruit and cohort analyses indicate that greater catches could be obtained if the catches of age-0 and age-1 fish in the EPO and WPO were reduced or eliminated.

The spawner-recruit analyses do not indicate that the recruitment of Pacific bluefin could be increased by permitting more fish to spawn.

2. DATA

2.1. Definitions of the fisheries

2.1.1. Eastern Pacific Ocean

Most of the catches of bluefin, *Thunnus orientalis*, in the eastern Pacific Ocean (EPO) are taken by purse seiners. Nearly all of the purse-seine catch is made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 33°N (Bayliff, 1994: Figure 1). Lesser amounts of bluefin are caught by recreational fishermen; this fishery is pursued in the same area, but mostly north of about 29°N. Small amounts of bluefin are caught off California by gillnet vessels fishing at least as far north as 39°N and by U. S. and Mexican longline vessels fishing west of California and northern Baja California, respectively. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October (Bayliff, 1994: Figure 6 and Table 8).

2.1.2. Western Pacific Ocean

Bluefin are exploited by various gears in the western Pacific Ocean (WPO) from Taiwan to Hokkaido. Age-0 fish about 15 to 30 cm in length are caught by trolling during July-October south of Shikoku Island and south of Shizuoka Prefecture. During November-April age-0 fish about 35 to 60 cm in length are taken by trolling south and west of Kyushu Island. Age-1 and older fish are caught by purse seining, mostly during May-September between about 30°-42°N and 140°-152°E. Bluefin of various sizes are also caught by traps, gillnets, and other gear, especially in the Sea of Japan. Small amounts of bluefin are also caught near the southeastern coast of Japan by longlining.

2.1.3. High seas

The high-seas Japanese longline fishery (Uosaki and Bayliff, 1999), and also those of the Republic of Korea (Park *et al*., 1994), Taiwan, and the United States (Ito and Machado, 1997) are directed mainly at tropical tunas, albacore, and billfishes, but small amounts of Pacific bluefin (Tomlinson, 1996) are caught by this fishery.

Small amounts of Pacific bluefin are also caught by Japanese pole-and-line vessels on the high seas (Bayliff *et al*., 1991: Table 6).

2.2. Catch and effort data

Catch data for all the major fisheries for bluefin are available for 1952-1998 (Table 2.2a), and data for the commercial and recreational fisheries of the EPO are available as far back 1918 and 1936, respectively (Bayliff, 1994: Table 7).

Bayliff (1996) discussed four indices of purse-seine fishing effort for bluefin in the EPO (Table 2.2b), but none of these is entirely satisfactory. His criteria for classification of boats as “bluefin vessels” was subsequently modified (Anonymous, 1999a: 65). Tomlinson (1996) estimated the amount of effort by Japanese longline vessels in a “core area” (his Figure 13), in which most of the high-seas catches of bluefin by Japanese longline vessels are made, during 1952-1986. Effort data for the Hawaiian longline fishery for

1991-1994, by 5-degree areas and quarters, are given by Curran *et al*. (1996). No effort data are available for any of the fisheries of the WPO.

2.3. Size composition data

Length-frequency data for the purse-seine fishery of the EPO, which takes place in IATTC sampling area 1 (Anonymous, 2000a: Figure 9), are available for 1923-1925, 1952-1971, and 1973-2000 (Bayliff, 1993: Table 1; Anonymous, 2001a: Figure 8). Data for 1995-2000 are shown in Figures 2.3a and 2.3b.

Length-frequency data for the surface fisheries of the WPO are given by Yokota *et al.* (1961: 210) and Yukinawa and Yabuta (1967), and length and weight composition data for various fisheries of the WPO and CPO are given by Yamanaka (1958 and 1982), Nakamura (1969), and Shingu *et al.* (1974). Data for small and large fish caught by surface gear in the WPO and for fish caught by longline gear in the WPO and CPO are shown in Figures 2.3b, 2.3c, and 2.3d, respectively, of Bayliff (2001).

2.4. Auxiliary data

The most important auxiliary data are probably those obtained from tagging of bluefin in the EPO and WPO with conventional tags (Bayliff *et al.*, 1991). Staff members of the National Research Institute of Far Seas Fisheries (NRIFSF) of Japan have tagged bluefin in the WPO with archival tags, and data for 40 of these that were recaptured in the WPO and for 2 that were recaptured in the EPO have been obtained (Itoh *et al*., 1999; Anonymous, 2000b). (One of the 40 that were recaptured in the WPO had migrated to the EPO and then returned to the WPO.) It is anticipated that when more data from experiments with archival and/or pop-up tags are obtained the information from these will be valuable for stock assessment.

Oceanographic data have been used to calculate the “habitat indices” (of abundance) for bluefin in the EPO described in Section 4.1.

Data from aerial surveys over waters of the EPO (Squire, 1972, 1983, and 1993) have been used to calculate indices of abundance of bluefin in the EPO (Bayliff, 1996).

3. ASSUMPTIONS AND PARAMETERS

Information on growth, reproduction, movement, natural mortality, stock structure, and influences of the environment on Pacific bluefin is summarized by Bayliff (2001).

4. STOCK ASSESSMENT

4.1. Indices of abundance

Bayliff (1996) discussed various indices of abundance of bluefin tuna in the eastern Pacific Ocean. The "habitat index" and the "bluefin vessel index" are probably the most reliable of these. The bluefin vessel index was subsequently modified (Anonymous, 1999a: 65).

4.1.1. Habitat index

Bluefin tuna are most often caught by purse-seine vessels in the EPO in waters with sea-surface temperatures of 17° to 23°C (Bell, 1963), so it was assumed that fishing effort exerted by tuna purse seiners off California and Baja California in waters of that temperature range during May through October is bluefin effort, regardless of whether bluefin were caught. The sums of the logged catches of bluefin in the EPO during May through October of each year were divided by the corresponding sums of the logged purse-seine effort in the 1-degree areas which were suitable bluefin habitat to get the annual catches per unit of effort (CPUEs). These data appear in Figure 4.1. They appear to indicate that both reduced availability and reduced fishing effort have contributed to the reduced catches of bluefin in the EPO during the 1980s and 1990s.

4.1.2. Bluefin vessel index

For this method, it is assumed that the fishing effort directed toward Pacific bluefin is proportional to the numbers of vessels that direct substantial portions of their effort to fishing for that species. Accordingly, each vessel of the purse-seine fleet was classified each year as a "bluefin vessel" or a "non-bluefin vessel." If a vessel caught bluefin in three of the years of a five-year period, it was classified as a bluefin vessel for the middle year of that period. Otherwise it was classified as a non-bluefin vessel for that year. The criteria were relaxed for vessels that entered the EPO tuna fishery less than two years before the year in question or left the fishery less than two years after the year in question. For example, if a vessel entered the EPO tuna fishery in 1971, it was classified as a bluefin vessel for that year if it caught bluefin in 1971 and in either 1972 or 1973. This system of classification is arbitrary, and perhaps some other system would be better. However, it seems to be adequate to give some insight into the value of data on bluefin vessels and their catches for estimation of the relative abundance of bluefin. The bluefin vessel index for a given year is the total catch of bluefin by bluefin vessels (from unloading data) for that year divided by the number of bluefin vessels in the fleet during that year. The total commercial catches by bluefin vessels, the numbers of bluefin vessels, and the bluefin vessel indices for 1961-1998 are shown in Figure 4.1. (Since the indices are calculated from data for the year in question, the preceding two years, and the following two years, an index for 1999 cannot be calculated until data for 2000 are available, and an index for 2000 cannot be calculated until data for 2001 are available.) They also appear to indicate that both reduced availability and reduced fishing effort have contributed to the reduced catches of bluefin in the EPO during the 1980s and 1990s.

4.2. Assessment models

The results of yield-per-recruit, cohort, spawner-recruit, and recruit-spawner analyses conducted by the IATTC staff and its attempts to predict the abundance of Pacific bluefin are summarized by Bayliff (2001).

Studies recently carried out by the NRIFSF are described by Anonymous (2000c). A preliminary cohort analysis indicated that the biomass of the spawning stock was relatively high during the 1960s, decreased during the 1970s and 1980s, and then increased during the 1990s. The recruitment was estimated to be highly variable, with four or five strong cohorts produced during the 1960-1998 period. Yield-per-recruit analyses indicated that the yield per recruit could be increased by decreasing the fishing mortality of age-0 to -4 fish and increasing it for older fish.

5. STOCK STATUS

The total catches of Pacific bluefin by all gear have not declined (Table 2.2a), but during the 1952-1986 period the catches in the core areas by the longline fishery declined precipitously, while the effort in that area declined less precipitously (Tomlinson, 1996: Tables 1 and 4). This probably indicates that large bluefin became less abundant during the 1952-1986 period. The catches of juvenile fish in the EPO were less during the 1980s and 1990s than during the 1950s, 1960s, and 1970s, but this decline could be at least partly due to the decline in the numbers of bluefin vessels in the EPO, as neither the bluefin-vessel index nor the habitat index indicates a decline in the abundance of fish. Also, it is possible that long-term changes in oceanographic conditions have affected the proportions of the juveniles that migrate from the WPO to the EPO and/or the average length of the sojourn in the EPO.

Even though the total catches of bluefin have not declined, the results of the cohort and yield-per-recruit analyses indicate that greater catches could be obtained if the catches of younger fish in the EPO and WPO were reduced or eliminated.

The spawner-recruit analyses do not indicate that the recruitment of Pacific bluefin could be increased by permitting more fish to spawn.

6. FUTURE DIRECTIONS

6.1. Collection of new and/or updated information

Better catch and effort data and size-frequency data for the WPO have recently been obtained, but there are still some deficiencies. The acquisition of better data would make it possible to calculate better indices of abundance for the WPO and to perform better cohort analyses for the WPO and for the entire Pacific Ocean.

Reliable estimates of the age-specific natural mortality are urgently needed. The present estimates could probably be improved if better catch and effort data and size-frequency data for the WPO were available.

Little is known about migration between the WPO and the EPO. Studies of the oceanography of the WPO, coupled with information on migration from the WPO to the EPO, might yield information on what causes the fish to migrate and on the timing of the migrations. Conventional tags, at best, give only information on locations and dates of release and recapture and sizes of the fish at release and recapture. All of the releases have taken place in the EPO or the WPO, and the great majority of the recaptures have been made in the EPO or the WPO, so these experiments have not produced much information on the fish while they are *en route* from the WPO to the EPO or from the EPO to the WPO. Archival and pop-up tags yield much more information. Archival tags give the position of the fish at frequent intervals between release and recapture, so it is possible to tell when the transoceanic migrations were begun and completed and where the fish are when they are in transit. Pop-up tags can be programmed to come to the surface at specified intervals, so it is possible to tell where the fish were at various intervals after release. The archival tags give more information, but the recovery rate is only about 5 to 10 percent. The recovery rates for the pop-up tags would be 100 percent, provided they are properly made and the detection equipment works properly.

A preliminary study of the costs and benefits of migrating to the EPO *versus* remaining in the WPO has recently been made, using data from a fish bearing an archival tag that migrated from the WPO to the EPO to parameterize a bioenergetics model under hypothetical scenarios with different swimming speeds and growth rates at different locations along the migration path. Published oxygen consumption rates for yellowfin were used to predict the food consumption rates of bluefin required to meet the energy demands for metabolism, waste losses, and growth, given the water temperatures most likely to have been encountered. There was more variation in the distribution of the predicted daily consumption rates for the trans-Pacific migrants than for the fish that stay in the WPO. The minimum consumption rates of the migrants was always less than that of the fish that stay in the WPO, largely due to the lower ambient temperatures in the central north Pacific and the EPO. The result was robust to differences in the period of comparison, the swimming speeds, and the growth rates. Trans-Pacific migration may represent an opportunity for the fish to capitalize on lower energy requirements in colder water, although the cost of swimming in colder water is unknown for this species. The predictions from the bioenergetics model would be improved with more detailed information on swimming speeds in holding areas, current speeds, physiological adaptions to temperature changes, and consumption of food.

It may be possible to collect better catch and effort and size-frequency data, particularly for the WPO, for previous years. The length-frequency data for purse seine-caught and sport-caught fish for the EPO should be separated (as in this report), and the possibility of obtaining more reliable catch and effort data for the sport fishery of the EPO for previous years should be explored.

6.2. Refinements to assessment models and methods

If better data, as discussed in Section 6.1, were available it would be possible to calculate better indices of abundance and perform more reliable yield-per-recruit, cohort, and spawner-recruit analyses.

REFERENCES--REFERENCIAS

Anonymous. 1999a. Annual Report of the Inter-American Tropical Tuna Commission 1997: 310 pp.

Anonymous. 1999b. Pelagic fisheries of the western Pacific region: 1998 annual report (Draft 12/01/99). Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Anonymous. 2000a. Annual Report of the Inter-American Tropical Tuna Commission 1998: 357 pp.

Anonymous. 2000b. Quarterly Report of the Inter-American Tropical Tuna Commission, July-September 2000: 45 pp.

Anonymous. 2000c. Report of the ISC bluefin tuna working group, November 30-December 1, 2000: 16 pp.

Anonymous. 2001a. Inter-Amer. Trop. Tuna Comm., Quarterly Report, Oct.-Dec. 2000: in preparation.

Anonymous. 2001b. Annual Report of the Inter-American Tropical Tuna Commission 1999: in preparation.

Bayliff, William H. 1993. Growth and age composition of northern bluefin tuna, *Thunnus thynnus*, caught in the eastern Pacific Ocean, as estimated from length-frequency data, with comments on trans-Pacific migrations. Inter-Amer. Trop. Tuna Comm., Bull., 20 (9): 501-540.

Bayliff, William H. 1994. A review of the biology and fisheries for northern bluefin tuna, *Thunnus thynnus*, in the Pacific Ocean. FAO, Fish. Tech. Pap., 336 (2): 244-295.

Bayliff, William H. 1996. Indices of abundance of northern bluefin tuna, *Thunnus thynnus*, in the eastern Pacific Ocean. FAO Fish. Tech. Pap., 365: 460-475.

Bayliff, William H. 2001. Status of bluefin tuna in the Pacific Ocean. Inter-Amer. Trop. Tuna Comm., Stock Assess. Rep., 1: 211-254.

Bayliff, William H., Yoshio Ishizuka, and Richard B. Deriso. 1991. Growth, movements, and mortality of northern bluefin, *Thunnus thynnus*, in the Pacific Ocean, as determined from tagging experiments. Inter-Amer. Trop. Tuna Comm., Bull., 20 (1): 1-94.

Bell, Robert R. 1963. Synopsis of biological data on California bluefin tuna *Thunnus saliens* Jordan and Evermann 1926. FAO, Fish. Rep., 6 (2): 380-421.

Curran, Daniel S., Christofer H. Boggs, and Xi He. 1996. Catch and effort data from Hawaii's longline fishery summarized by quarters and five degree squares. U.S. Nat. Mar. Fish. Serv., NOAA Tech. Mem. NMFS, 225: iii, 68 pp.

Ito, Russell Y., and Walter A. Machado. 1997. Annual report of the Hawaii-based longline fishery for 1996. U.S. Nat. Mar. Fish. Serv., Southwest Mar. Sci. Center, H-97-12: v, 48 pp.

Itoh, Tomoyuki, Sachiko Tsuji, and Akira Nitta. 1999. Trans-Pacific migration of bluefin tuna observed with archival tags. Proc. 50th Annual Tuna Conference, Lake Arrowhead, California, May 24-27, 1999: 36.

Leet, William S., Christopher M. Dewees, and Charles W. Haugen (editors). 1992. California's Living Marine Resources and their Utilization. Calif. Sea Grant Extension Publ., UCSGEP-92-12: iv, 257 pp.

Nakamura, Hiroshi. 1969. Tuna Distribution and Migration. Fishing News (Books) Ltd., London: 76 pp.

Park, Yeong Chull, Won Seok Yang, and Tae Ik Kim. 1994. Status of Korean tuna longline and purse-seine fisheries in the Pacific Ocean. FAO, Fish. Tech. Pap., 336 (2): 153-162.

Shingu, Chiomi, Yukio Warashina, and Norio Matsuzaki. 1974. Distribution of bluefin tuna exploited by longline fishery in the western Pacific Ocean. Far Seas Fish. Res. Lab., Bull., 10: 109-140.

Squire, James L., Jr. 1972. Apparent abundance of some pelagic marine fishes off the southern and central California coast as surveyed by an airborne monitoring program. U.S. Nat. Mar. Fish Serv., Fish. Bull., 70 (3): 1005-1019.

Squire, James L., Jr. 1983. Abundance of pelagic resources off California, 1963-78, as measured by an airborne fish monitoring program. U.S. Nat. Mar. Fish. Serv., NOAA Tech. Rep. NMFS SSRF-762: v, 75 pp.

Squire, James L., Jr. 1993. Relative abundance of pelagic resources utilized by the California purse-seine fishery: results of an airborne monitoring program, 1962-90. U.S. Nat. Mar. Fish Serv., Fish. Bull., 91 (2): 348-361.

Tomlinson, Patrick K. 1996. Movement of large bluefin tuna, *Thunnus thynnus*, in the north Pacific Ocean, as determined from the Japanese longline fishery, and implications regarding interactions between the fisheries of the western and eastern Pacific Ocean. FAO Fish. Tech. Pap., 365: 425-459.

Uosaki, Koji, and William H. Bayliff. 1999. A review of the Japanese longline fishery for tunas and billfishes in the eastern Pacific Ocean, 1988-1992. Inter-Amer. Trop. Tuna Comm., Bull., 21 (6): 273-488.

Vojkovich, Marija, and Kristine Barsky. 1998. The California-based longline fishery for swordfish, *Xiphias gladius*, beyond the U.S. Exclusive Economic Zone. U.S. Nat. Mar. Fish. Serv., NOAA Tech. Rep. NMFS 142: 147-152.

Yamanaka, Hajime. 1958. Studies on the bluefin tuna. I. The modes of the weight compositions of the catch. Nankai Reg. Fish. Res. Lab., Rep., 9: 125-135.

Yamanaka, Hajime. 1982. Fishery Biology of the Bluefin Tuna Resource in the Pacific Ocean, Suisan Kenyo Sosho, 34: 140 pp.

Yokota, Takio, Masahiro Toriyama, Fukuko Kanai, and Seizi Nomura. 1961. Studies on the feeding habit of fishes. Nankai Reg. Fish. Reg. Lab., Rep., 14: 1-234.

Yukinawa, Mori, and Yoichi Yabuta. 1967. Age and growth of the bluefin tuna, *Thunnus thynnus* (Linnaeus), in the north Pacific Ocean. Nankai Reg. Fish. Res. Lab., Rep., 25: 1-18.

.

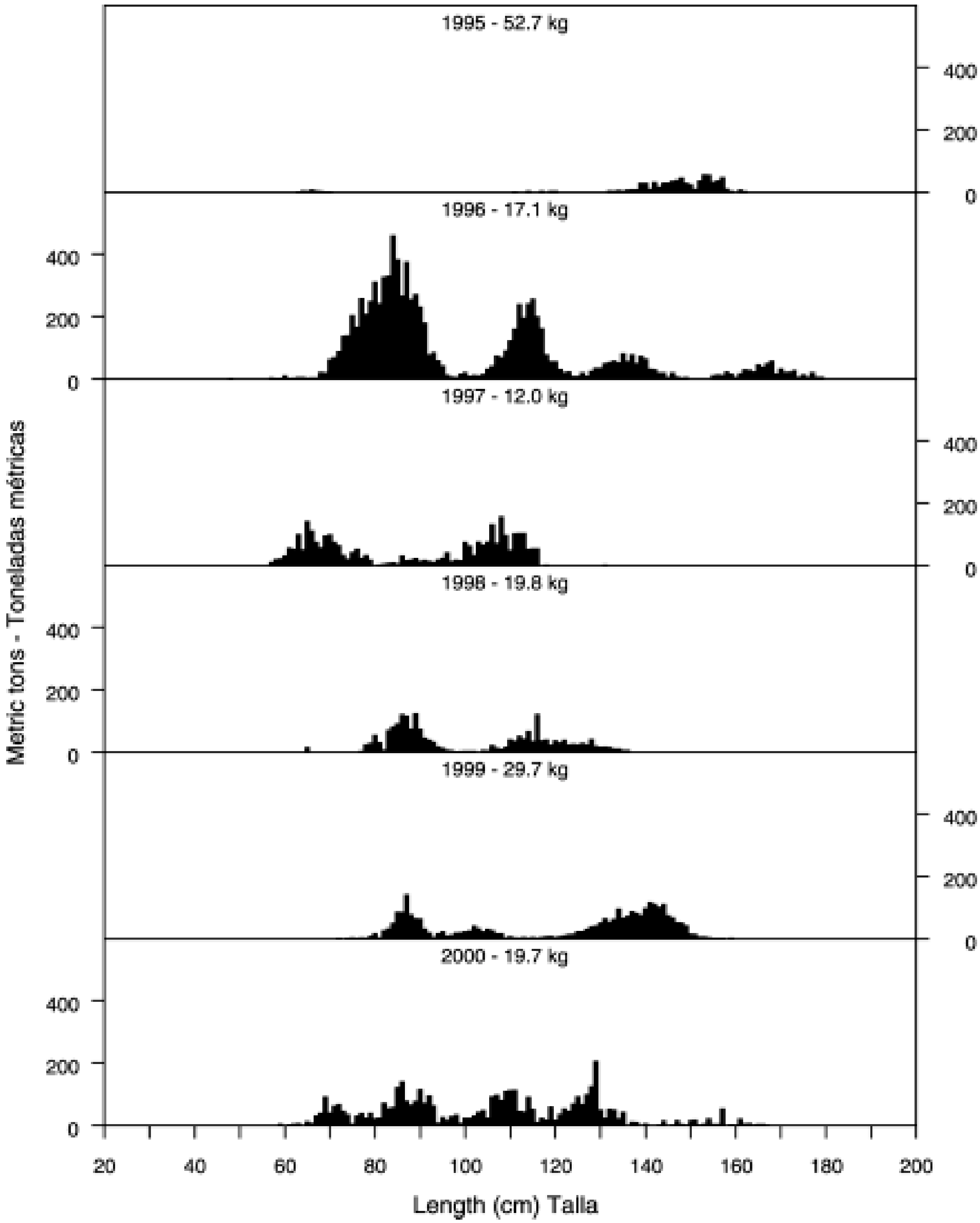

FIGURE 2.3a. Estimated size compositions of the bluefin caught in the commercial fisheries of the EPO during 1995-2000. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA 2.3a. Composición por tallas estimada para el aleta azul capturado en las pesquerías comerciales del OPO durante 1995-2000. En cada recuadro se detalla el peso promedio de los peces en las muestras.

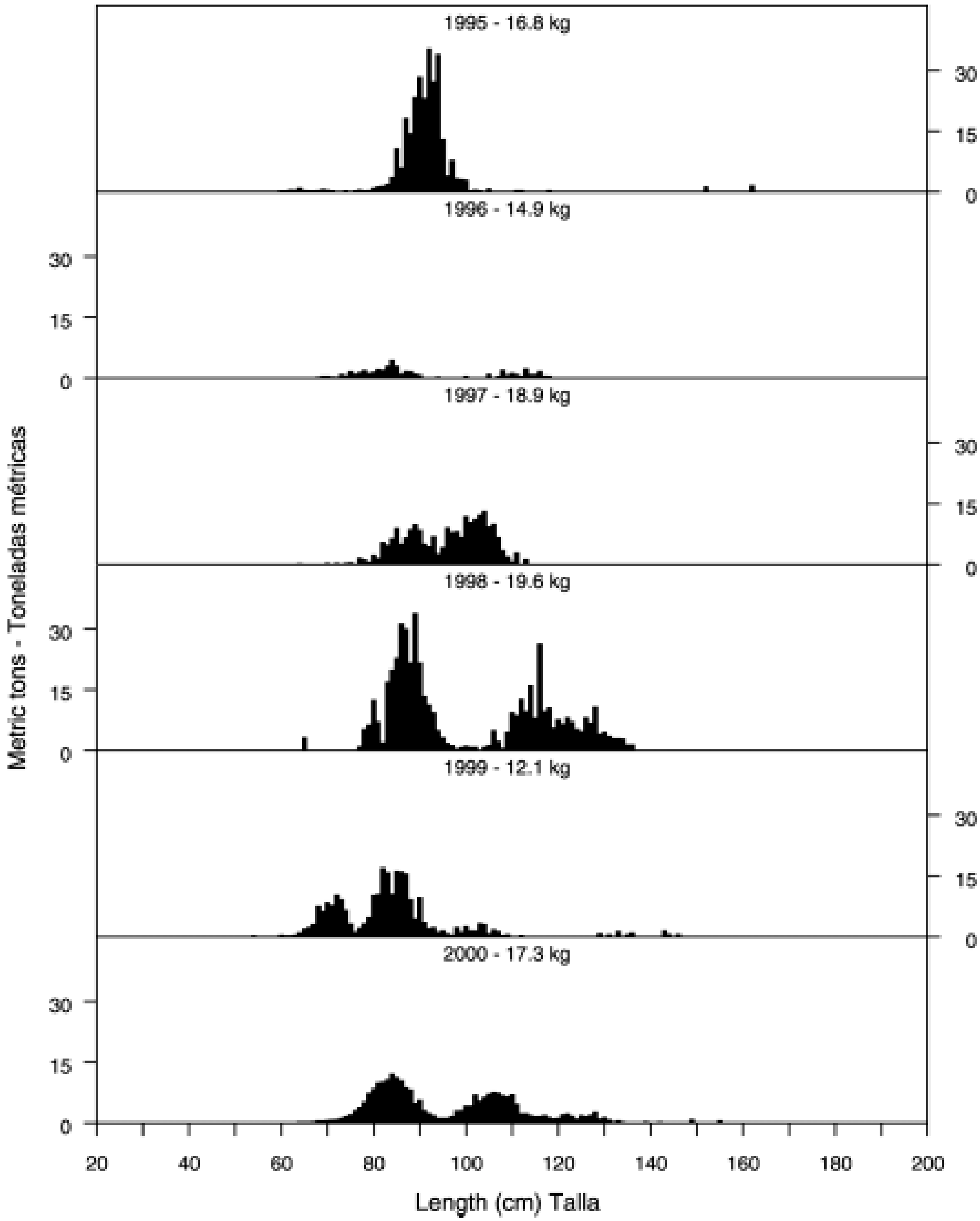

FIGURE 2.3b. Estimated size compositions of the bluefin caught in the recreational fishery of the EPO during 1995-2000. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA 2.3b. Composición por tallas estimada para el aleta azul capturado en la pesquería deportiva en el OPO durante 1995-2000. En cada recuadro se detalla el peso promedio de los peces en las muestras.

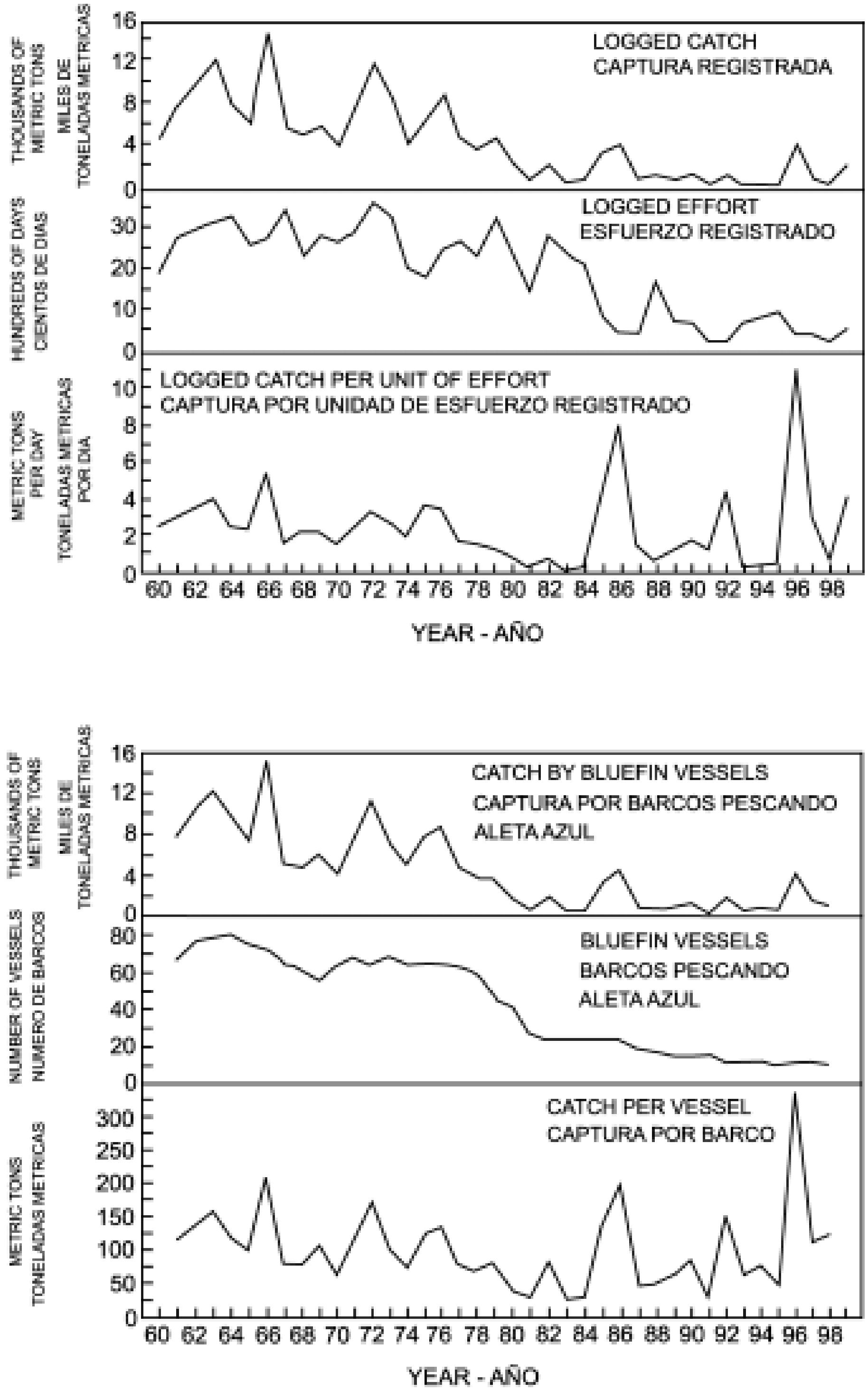

FIGURE 4.1. Catch, effort, and catch-per-unit of effort data for the surface fishery for bluefin in the EPO, as determined by the habitat index method (upper panel) and the bluefin vessel index method (lower panel).

FIGURA 4.1. Datos de captura, esfuerzo, y captura por unidad de esfuerzo para la pesquería de superficie de aleta azul en el OPO, calculados con el método de índice del hábitat (recuadro superior) y el método de índice de buques que pescan aleta azul (recuadro inferior).

TABLE 2.2a. Catches of bluefin, in metric tons, in the Pacific Ocean.
TABLA 2.2a. Capturas de atún aleta azul, en toneladas métricas, en el Océano Pacífico.

Year	Western Pacific nations			Eastern Pacific nations			Subtotal	Total
	Surface[1]	Longline[1]	Subtotal[1]	Surface		Longline[4]		
				Commercial[2]	Recreational[3]			
Año	Naciones del Pacífico occidental			Naciones del Pacífico oriental			Subtotal	Total
	Superficie[1]	Palangre[1]	Subtotal[1]	Superficie		Palangre[4]		
				Comercial[2]	Deportiva[3]			
1952	12,203	2,581	14,784	2,076	1		2,077	16,861
1953	11,676	1,998	13,674	4,433	35		4,468	18,142
1954	14,953	1,588	16,541	9,537	8		9,545	26,086
1955	18,987	2,099	21,086	6,173	67		6,240	27,326
1956	27,430	1,242	28,672	5,727	279		6,006	34,678
1957	23,767	1,490	25,257	9,215	52		9,267	34,524
1958	12,330	1,429	13,759	13,934	7		13,941	27,700
1959	11,948	3,667	15,615	6,914	11		6,925	22,540
1960	14,214	5,784	19,998	5,422	1		5,423	25,421
1961	14,977	6,175	21,152	8,116	19		8,135	29,287
1962	14,764	2,238	17,002	11,125	20		11,145	28,147
1963	17,370	2,104	19,474	12,266	6		12,272	31,746
1964	14,603	2,379	16,982	9,211	6		9,217	26,199
1965	15,496	2,062	17,558	6,887	1		6,888	24,446
1966	12,080	3,388	15,468	15,881	16		15,897	31,365
1967	12,983	2,102	15,085	5,862	26		5,888	20,973
1968	14,171	2,340	16,511	5,966	10		5,976	22,487
1969	7,883	1,377	9,260	6,914	12		6,926	16,186
1970	7,505	1,152	8,657	3,951	15		3,966	12,623
1971	8,673	762	9,435	8,354	6		8,360	17,795
1972	7,951	755	8,706	13,335	12		13,347	22,053
1973	8,798	1,270	10,068	10,700	44		10,744	20,812
1974	14,773	3,546	18,319	5,570	47		5,617	23,936
1975	10,836	1,563	12,399	9,556	27		9,583	21,982
1976	9,199	580	9,779	10,628	17		10,645	20,424
1977	12,765	718	13,483	5,458	15		5,473	18,956
1978	21,362	1,074	22,436	5,393	4		5,397	27,833
1979	25,359	1,254	26,613	6,108	9		6,117	32,730
1980	18,488	1,194	19,682	2,933	6		2,939	22,621
1981	29,751	835	30,587	1,084	5		1,089	31,676
1982	24,273	897	25,170	3,145	5		3,150	28,320
1983	18,233	712	18,945	837	16		853	19,798
1984	11,045	363	11,408	858	23		881	12,289
1985	12,472	507	12,979	4,014	41		4,055	17,034
1986	14,599	276	14,875	5,079	6		5,085	19,960
1987	13,771	383	14,154	990	15	0	1,005	15,159
1988	7,677	256	7,933	1,421	3	0	1,424	9,357
1989	10,057	490	10,547	1,117	53	0	1,170	11,717

TABLE 2.2a. (continued)
TABLA 2.2a. (continuación)

Year	Western Pacific nations			Eastern Pacific nations			Subtotal	Total
	Surface[1]	Longline[1]	Subtotal[1]	Surface		Longline[4]		
				Commercial[2]	Recreational[3]			
Año	Naciones del Pacífico occidental			Naciones del Pacífico oriental			Subtotal	Total
	Superficie[1]	Palangre[1]	Subtotal[1]	Superficie		Palangre[4]		
				Comercial[2]	Deportiva[3]			
1990	6,294	585	6,879	1,511	31	0	1,542	8,421
1991	14,084	627	14,711	418	43	0	461	15,172
1992	10,221	1,037	11,258	1,929	70	1	2,000	13,258
1993	7,818	1,328	9,146	581	298	45	924	10,070
1994	11,052	1,521	12,573	974	88	24	1,086	13,659
1995	22,825	920	23,745	629	245	27	901	24,646
1996	10,148	1,873	12,021	8,222	37	53	8,312	20,333
1997	14,757	2,823	17,580	2,657	150	52	2,859	20,439
1998	7,389	3,134	10,523	1,826	397	56	2,279	12,802
1999	16,868	3,490	20,358	2,644	447	39	3,130	23,181
2000*				3,873	225		4,098	

[1] Sources: The data for Japan were obtained from the National Research Institute of Far Seas Fisheries of Japan. The data for Taiwan and the Republic of Korea were obtained from FAO yearbooks of fisheries statistics and data published by the Institute of Oceanography, National Taiwan University, Taipei, Taiwan, and the National Fisheries Research and Development Agency of Korea.

[1] Fuentes: Los datos de Japón provienen del Instituto Nacional de Investigación de Pesquerías de Ultramar del Japón. Los datos de Taiwan y la República de Corea provienen de compendios anuales de estadísticas pesqueras de la FAO y datos publicados por el Instituto de Oceanografía de la Universidad Nacional de Taiwan en Taipei y la Agencia Nacional de Investigación y Desarrollo Pesquero de Corea.

[2] Sources: 1952-1960, Bell, 1963: Table VIII; 1961-1999, Anonymous, 2001b, Table 3d minus recreational catch.

[2] Fuentes: 1952-1960, Bell, 1963: Tabla VIII; 1961-1999, Anónimo, 2001b, Tabla 3d menos la captura deportiva.

[3] Sources: 1952-1990, Leet *et al*., 1992; 1991-1992, California Department of Fish and Game, unpublished data; 1993-1999, Calif. Coop. Ocean. Fish. Inves., Rep., 35-41.

[3] Fuentes: 1952-1990, Leet *et al*., 1992; 1991-1992, California Department of Fish and Game, datos inéditos; 1993-1999, Calif. Coop. Ocean. Fish. Inves., Rep., 35-41.

[4] Sources: Vojkovich and Barsky, 1998: page 149; Anonymous, 1999b: page 3-57.

[4] Fuentes: Vojkovich y Barsky, 1998: página 149; Anónimo, 1999b: página 3-57.

* preliminary--preliminares

TABLE 2.2b. Measures of fishing effort for bluefin in the eastern Pacific Ocean. Most of the data for 1959-1991 are from Bayliff (1996: Table 3), and most of those for 1992-1999 are from the IATTC data base.

TABLA 2.2b. Medidas de esfuerzo de pesca de aleta azul en el Océano Pacífico oriental. La mayoría de los datos de 1959-1991 proviene de Bayliff (1996: Tabla 3), y la mayoría de los de 1992-1999 de la base de datos de la CIAT.

Year	Calkins index	Habitat index	Habitat index north of 28°N	Number of bluefin vessels
Año	Indice de Calkins	Indice de hábitat	Indice de hábitat al norte de 28°N	Número de buques que pescan aleta azul
1959	824.0			
1960	1453.0	1889.5	932.0	
1961	2051.0	2721.5	1265.5	67
1962	2886.5	2890.5	1572.1	76
1963	2677.0	3131.5	1957.5	78
1964	2941.0	3240.0	1182.0	81
1965	2370.0	2569.5	861.0	76
1966	2422.5	2727.0	1102.5	73
1967	2812.0	3483.0	998.0	65
1968	1968.0	2336.0	1279.5	63
1969	2258.0	2801.0	1092.0	56
1970	1682.5	2658.5	916.0	64
1971	2595.5	2944.5	1196.0	69
1972	3220.0	3613.0	1727.5	65
1973	2664.5	3271.0	1461.0	69
1974	1974.0	2105.5	699.5	66
1975	1673.0	1811.0	484.5	65
1976	2322.0	2524.5	1685.5	66
1977	1948.0	2723.0	1251.0	65
1978	1841.0	2356.5	1211.5	60
1979	1770.0	3284.0	1010.0	48
1980	1329.5	2481.0	600.0	43
1981	664.5	1515.5	673.5	28
1982	1060.0	2845.5	1260.5	24
1983	651.0	2430.0	1215.0	24
1984	1022.0	2159.5	1463.5	25
1985	566.0	916.5	587.5	25
1986	384.0	522.0	370.0	24
1987	174.5	500.0	242.5	19
1988	755.5	1705.5	493.0	18
1989	140.0	808.0	292.5	16
1990	234.0	764.5	375.0	17
1991	75.0	335.0	150.5	16
1992		297.0	252.0	14
1993		757.5	238.5	13
1994		921.5	204.5	13
1995		1007.0	286.0	11
1996		467.0	439.5	13
1997		482.0	324.5	13
1998		331.5	202.0	11
1999		591.0	203.5	