2007 Annual Report to the Western and Central Pacific Fisheries Commission

United States of America

PART I. INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS [1]
(For 2006)

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2007 Annual Report to the Western and Central Pacific Fisheries Commission

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PART 1. INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS (For 2006)

This report presents estimates of annual catches of tuna, billfish, and other highly migratory species (HMS), and vessel participation during 2002-2006 for U.S. fisheries operating in the western and central Pacific Ocean (WCPO). All statistics for 2006 are provisional. For the purposes of this report the WCPO is defined as the Western and Central Pacific Fisheries Commission (WCPFC) Statistical Area[2]. Information on fisheries is provided, and pelagic research during 2006 is described. U.S. fisheries include large-scale purse seine, longline, and distant-water troll fisheries operating on the high seas, within the U.S. exclusive economic zone (EEZ), and within the EEZs of other states, and small-scale troll, handline, pole-and-line and miscellaneous-gear fisheries operating in nearshore waters in the EEZs of American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and Hawaii.

The purse seine fishery was the largest U.S. fishery, accounting for 79% of the total U.S. catch[3] of HMS in the WCPO during 2006. The longline, small-scale (troll, handline, pole-and line, and miscellaneous-gear) and distant-water troll fisheries accounted for 18%, 2.6%, and 0.7% of the total catch, respectively. These U.S. fisheries for tunas, billfishes and other pelagic species produced an estimated 84,505 metric tons (mt) of catch in 2006. The catch consisted primarily of skipjack tuna (65%), yellowfin tuna (12%), and bigeye tuna (11%).

[2] WCPFC/SC1/2005/MEETING REPORT, ANNEX VIII, paragraph 8 of Recommendation SC1-ST-1.

[3] For the most part, U.S. estimates of catch by weight are actually landings due to lack of data on the weight of discarded fish. With the exception of some small-scale fisheries, estimates do not include subsistence or recreational catches. In the future, the estimates will include available information on at-sea discards, landed product not sold, and recreational catches, etc. The plots of longline catch in numbers of fish refer to total catch including both retained and discarded catch.

1.1 ANNUAL FISHERIES INFORMATION

Table 1a. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. vessels operating in the WCPO in 2006 (provisional). Small-scale consists of troll, handline, pole-and-line, and miscellaneous-gear fisheries, but does not include some boats used for subsistence or recreational fishing. Values are rounded to the nearest metric ton (<0.5 t = 0).

	Purse seine	Longline	Distant-water troll	Small-scale	TOTAL
Albacore (*Thunnus alalunga*) N. Pacific	0	261	3	86	350
Albacore (*Thunnus alalunga*) S. Pacific	0	4,176	578	0	4,754
Bigeye tuna (*Thunnus obesus*)	4,114	4,562	0	222	8,898
Pacific bluefin tuna (*Thunnus orientalis*)	0	0	0	0	0
Skipjack tuna (*Katsuwonus pelamis*)	54,380	305	0	571	55,256
Yellowfin tuna (*Thunnus albacares*)	8,193	1,443	0	461	10,097
Other tuna (tribe *thunnini)*	0	0	0	14	14
TOTAL TUNAS	66,687	10,747	581	1,354	79,369
Black marlin (*Makaira indica*)	0	0	0	0	0
Blue marlin (*Makaira mazara*)	0	443	0	144	587
Sailfish (*Istiophorus platypterus*)	0	15	0	0	15
Spearfish (*Tetrapterus angustirostris*)	0	161	0	0	161
Striped marlin (*Tetrapterus audax*) N. Pacific	0	599	0	25	624
Striped marlin (*Tetrapterus audax*) S. Pacific	0	6	0	0	6
Unidentified marlins (Istiophoridae)	0	0	0	13	13
Swordfish (*Xiphias gladius*) N. Pacific	0	1,131	0	0	1,131
Swordfish (*Xiphias gladius*) S. Pacific	0	30	0	0	30
TOTAL BILLFISHES	0	2,385	0	182	2,567
Blue shark (*Prionace glauca*)	0	0	0	0	0
Mako sharks (*Isurus* spp.)	0	93	0	0	93
Thresher sharks (*Alopias* spp.)	0	33	0	0	33
Other sharks	0	12	0	0	12
TOTAL SHARKS	0	138	0	0	138
Mahimahi (*Coryphaena hippurus*)	0	343	0	396	739
Moonfish (*Lampris guttatus*)	0	477	0	0	477
Oilfishes (Gempylidae)	0	175	0	0	175
Pomfrets (Bramidae)	0	251	0	0	251
Other fish	0	526	0	263	789
TOTAL OTHER	0	1,772	0	659	2,431
TOTAL	66,687	15,042	581	2,195	84,505

Table 1b. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. vessels operating in the WCPO in 2005. Small-scale consists of troll, handline, pole-and-line, and miscellaneous-gear fisheries, but does not include some boats used for subsistence or recreational fishing. Values are rounded to the nearest metric ton (<0.5 t = 0).

	Purse seine	Longline	Distant-water troll	Small-scale	TOTAL
Albacore (*Thunnus alalunga*) N. Pacific	0	291	89	170	550
Albacore (*Thunnus alalunga*) S. Pacific	0	2,924	600	0	3,524
Bigeye tuna (*Thunnus obesus*)	6,108	4,571	0	0	10,925
Pacific bluefin tuna (*Thunnus orientalis*)	0	0	0	0	0
Skipjack tuna (*Katsuwonus pelamis*)	62,379	229	0	0	63,227
Yellowfin tuna (*Thunnus albacares*)	17,685	1,218	0	0	19,642
Other tuna (tribe *thunnini)*	0	0	0	0	18
TOTAL TUNAS	86,172	9,233	689	0	97,886
Black marlin (*Makaira indica*)	0	0	0	0	0
Blue marlin (*Makaira mazara*)	0	350	0	0	527
Sailfish (*Istiophorus platypterus*)	0	11	0	0	11
Spearfish (*Tetrapterus angustirostris*)	0	201	0	0	201
Striped marlin (*Tetrapterus audax*) N. Pacific	0	496	0	0	515
Striped marlin (*Tetrapterus audax*) S. Pacific	0	3	0	0	3
Unidentified marlins (Istiophoridae)	0	0	0	0	15
Swordfish (*Xiphias gladius*) N. Pacific	0	1,451	0	0	1,451
Swordfish (*Xiphias gladius*) S. Pacific	0	3	0	0	3
TOTAL BILLFISHES	0	2,515	0	0	2,726
Blue shark (*Prionace glauca*)	0	29	0	0	29
Mako sharks (*Isurus* spp.)	0	97	0	0	97
Thresher sharks (*Alopias* spp.)	0	34	0	0	34
Other sharks	0	6	0	0	6
TOTAL SHARKS	0	166	0	0	166
Mahimahi (*Coryphaena hippurus*)	0	425	0	0	765
Moonfish (*Lampris guttatus*)	0	408	0	0	408
Oilfishes (Gempylidae)	0	156	0	0	156
Pomfrets (Bramidae)	0	273	0	0	273
Other fish	0	215	0	0	448
TOTAL OTHER	0	1,477	0	0	2,050
TOTAL	86,172	13,391	689		102,828

Table 1c. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. vessels operating in the WCPO in 2004. Small-scale consists of troll, handline, pole-and-line, and miscellaneous-gear fisheries, but does not include some boats used for subsistence or recreational fishing. Values are rounded to the nearest metric ton (<0.5 t = 0).

	Purse seine	Longline	Distant-water troll	Small-scale	TOTAL
Albacore (*Thunnus alalunga*) N. Pacific	0	356	714	160	1,230
Albacore (*Thunnus alalunga*) S. Pacific	0	2,462	960	0	3,422
Bigeye tuna (*Thunnus obesus*)	5,031	4,438	0	279	9,748
Pacific bluefin tuna (*Thunnus orientalis*)	0	1	0	0	1
Skipjack tuna (*Katsuwonus pelamis*)	47,896	371	0	539	48,806
Yellowfin tuna (*Thunnus albacares*)	14,492	1,589	0	751	16,832
Other tuna (tribe *thunnini)*	0	9	0	44	53
TOTAL TUNAS	67,419	9,226	1,674	1,773	80,092
Black marlin (*Makaira indica*)	0	10	0	0	10
Blue marlin (*Makaira mazara*)	0	290	0	178	468
Sailfish (*Istiophorus platypterus*)	0	13	0	0	13
Spearfish (*Tetrapterus angustirostris*)	0	182	0	0	182
Striped marlin (*Tetrapterus audax*) N. Pacific	0	378	0	22	400
Striped marlin (*Tetrapterus audax*) S. Pacific	0	2	0	0	2
Unidentified marlins (Istiophoridae)	0	0	0	20	20
Swordfish (*Xiphias gladius*) N. Pacific	0	1,072	0	0	1,072
Swordfish (*Xiphias gladius*) S. Pacific	0	4	0	0	4
TOTAL BILLFISHES	0	1,951	0	220	2,171
Blue shark (*Prionace glauca*)	0	59	0	0	59
Mako sharks (*Isurus* spp.)	0	65	0	0	65
Thresher sharks (*Alopias* spp.)	0	55	0	0	55
Other sharks	0	8	0	0	8
TOTAL SHARKS	0	187	0	0	187
Mahimahi (*Coryphaena hippurus*)	0	472	0	626	1,098
Moonfish (*Lampris guttatus*)	0	329	0	0	329
Oilfishes (Gempylidae)	0	143	0	0	143
Pomfrets (Bramidae)	0	321	0	0	321
Other fish	0	449	0	247	696
TOTAL OTHER	0	1,714	0	873	2,587
TOTAL	67,419	13,078	1,674	2,866	85,037

Table 1d. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. vessels operating in the WCPO in 2003. Small-scale consists of troll, handline, pole-and-line, and miscellaneous-gear fisheries, but does not include some boats used for subsistence or recreational fishing. Values are rounded to the nearest metric ton (<0.5 t = 0).

	Purse seine	Longline	Distant-water troll	Small-scale	TOTAL
Albacore (*Thunnus alalunga*) N. Pacific	0	524	2,419	85	3,028
Albacore (*Thunnus alalunga*) S. Pacific	0	3,931	1,574	0	5,505
Bigeye tuna (*Thunnus obesus*)	4,470	3,632	0	237	8,339
Pacific bluefin tuna (*Thunnus orientalis*)	0	0	0	0	0
Skipjack tuna (*Katsuwonus pelamis*)	62,907	320	0	706	63,933
Yellowfin tuna (*Thunnus albacares*)	20,079	1,306	0	758	22,143
Other tuna (tribe *thunnini)*	0	1	0	15	16
TOTAL TUNAS	87,456	9,714	3,993	1,801	102,964
Black marlin (*Makaira indica*)	0	11	0	0	11
Blue marlin (*Makaira mazara*)	0	366	0	207	573
Sailfish (*Istiophorus platypterus*)	0	11	0	0	11
Spearfish (*Tetrapterus angustirostris*)	0	241	0	0	241
Striped marlin (*Tetrapterus audax*) N. Pacific	0	543	0	28	571
Striped marlin (*Tetrapterus audax*) S. Pacific	0	4	0	0	4
Unidentified marlins (Istiophoridae)	0	0	0	15	15
Swordfish (*Xiphias gladius*) N. Pacific	0	1,957	0	0	1,957
Swordfish (*Xiphias gladius*) S. Pacific	0	7	0	0	7
TOTAL BILLFISHES	0	3,140	0	250	3,390
Blue shark (*Prionace glauca*)	0	17	0	0	17
Mako sharks (*Isurus* spp.)	0	87	0	0	87
Thresher sharks (*Alopias* spp.)	0	49	0	0	49
Other sharks	0	8	0	0	8
TOTAL SHARKS	0	161	0	0	161
Mahimahi (*Coryphaena hippurus*)	0	339	0	322	661
Moonfish (*Lampris guttatus*)	0	460	0	0	460
Oilfishes (Gempylidae)	0	116	0	0	116
Pomfrets (Bramidae)	0	180	0	0	180
Other fish	0	435	0	256	691
TOTAL OTHER		1,530		578	2,108
TOTAL	87,456	14,545	3,993	2,629	108,623

Table 1e. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. vessels operating in the WCPO in 2002). Small-scale consists of troll, handline, pole-and-line, and miscellaneous-gear fisheries, but does not include some boats used for subsistence or recreational fishing. Values are rounded to the nearest metric ton (<0.5 t = 0).

	Purse seine	Longline	Distant-water troll	Small-scale	TOTAL
Albacore (*Thunnus alalunga*) N. Pacific	0	525	3,296	235	4,056
Albacore (*Thunnus alalunga*) S. Pacific	0	5,951	1,337	0	7,288
Bigeye tuna (*Thunnus obesus*)	4,889	4,595	0	586	10,070
Pacific bluefin tuna (*Thunnus orientalis*)	0	2	0	0	2
Skipjack tuna (*Katsuwonus pelamis*)	88,535	371	0	664	89,570
Yellowfin tuna (*Thunnus albacares*)	27,191	1,063	0	639	28,893
Other tuna (tribe *thunnini)*	0	2	0	6	8
TOTAL TUNAS	120,615	12,509	4,633	2,130	139,887
Black marlin (*Makaira indica*)	0	1	0	0	1
Blue marlin (*Makaira mazara*)	0	298	0	225	523
Sailfish (*Istiophorus platypterus*)	0	3	0	0	3
Spearfish (*Tetrapterus angustirostris*)	0	137	0	0	137
Striped marlin (*Tetrapterus audax*) N. Pacific	0	226	0	29	255
Striped marlin (*Tetrapterus audax*) S. Pacific	0	2	0	0	2
Unidentified marlins (Istiophoridae)	0	24	0	13	37
Swordfish (*Xiphias gladius*) N. Pacific	0	1,524	0	0	1,524
Swordfish (*Xiphias gladius*) S. Pacific	0	6	0	0	6
TOTAL BILLFISHES	0	2,221	0	267	2,488
Blue shark (*Prionace glauca*)	0	30	0	0	30
Mako sharks (*Isurus* spp.)	0	84	0	0	84
Thresher sharks (*Alopias* spp.)	0	45	0	0	45
Other sharks	0	20	0	0	20
TOTAL SHARKS	0	179	0	0	179
Mahimahi (*Coryphaena hippurus*)	0	328	0	419	747
Moonfish (*Lampris guttatus*)	0	418	0	0	418
Oilfishes (Gempylidae)	0	88	0	0	88
Pomfrets (Bramidae)	0	212	0	0	212
Other fish	0	309	0	202	511
TOTAL OTHER	0	1,355	0	621	1,976
TOTAL	120,615	16,264	4,633	3,018	144,530

Table 2. Number of United States vessels that reported catches in the WCPO, by gear type, 2002-2006. Small-scale consists of troll, handline, pole-and-line, and miscellaneous-gear fisheries, but does not include some boats used for subsistence or recreational fishing. Data for 2006 are provisional.

	2006	2005	2004	2003	2002
Purse seine	13	15	21	26	29
Longline	154	160	166	180	184
Distant-water troll NPO	3*	5*	28	69	78
Distant-water troll SPO	8	8	11*	14*	12*
Small-scale	2,015	2,000	2,044	2,120	2,102
TOTAL	2,190	2,183	2,259	2,395	2,393

*These vessels fished on both sides of the equator (NPO and SPO) and are counted only once in the vessel total.

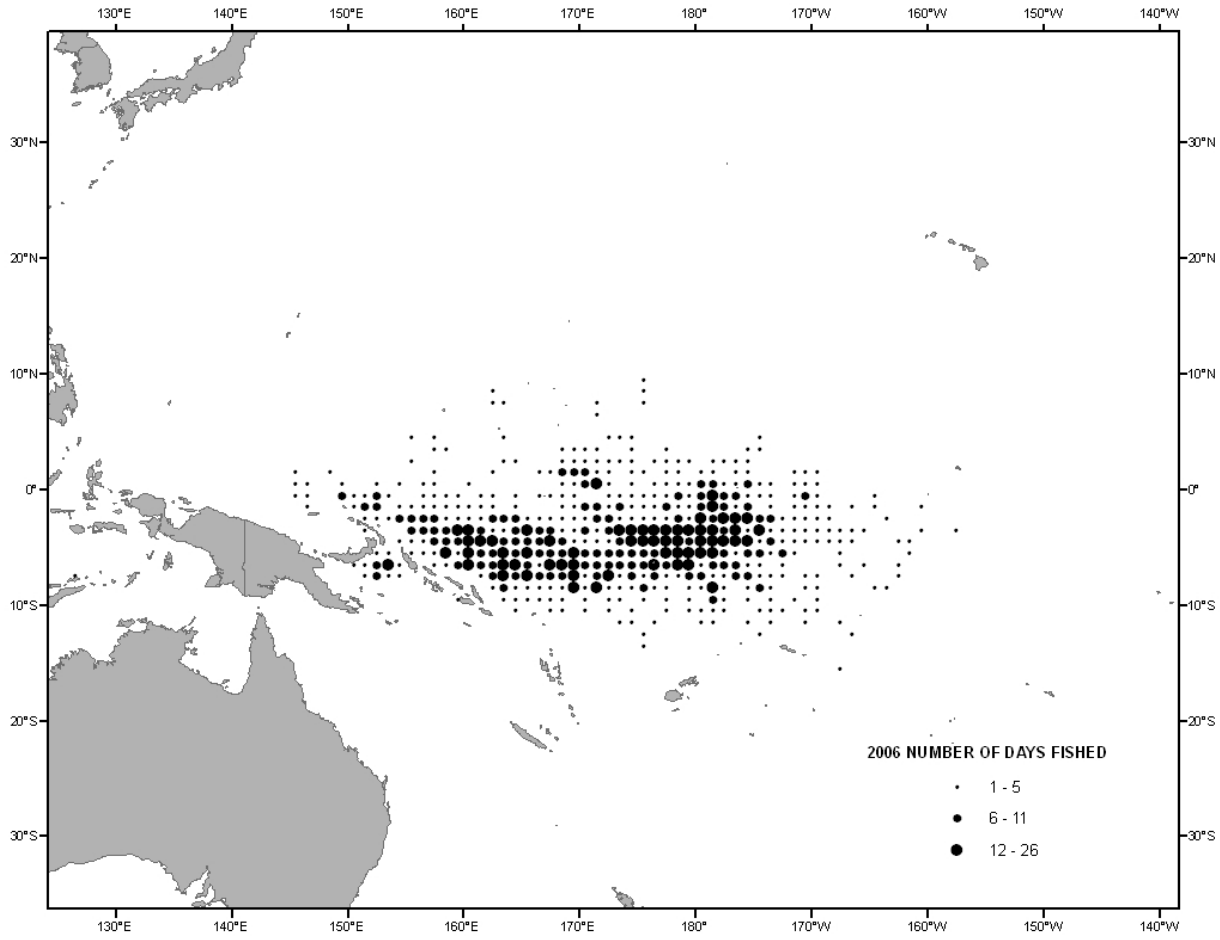

Figure 1. Distribution of annual U.S. purse seine effort, 2006 (provisional).

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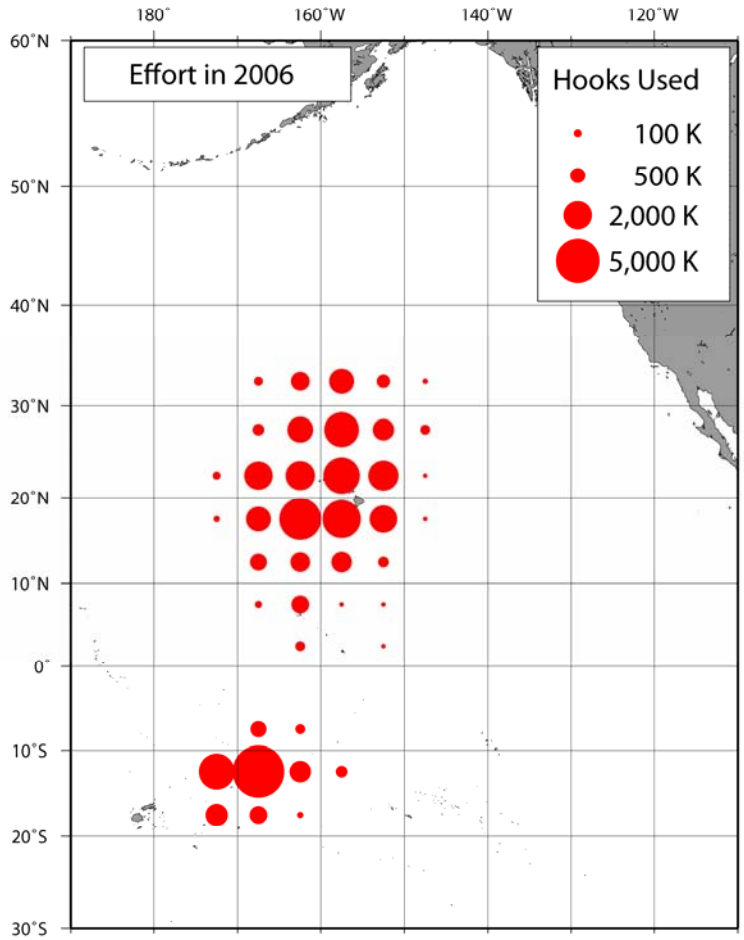

Figure 2a. Spatial distribution of reported logbook fishing effort in the WCPO by the U.S. longline fleet, in 1,000's of hooks (K), in 2006 (provisional data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality (e.g., California-based fishing effort is not shown).

NOAA Fisheries/Pacific Islands Fisheries Science Center
Mercator Projection Scale = 0.0625000000 inches/degree
Data as of 2007-06-27 gridded 5 deg x 5 deg x year (3 or more vessels)

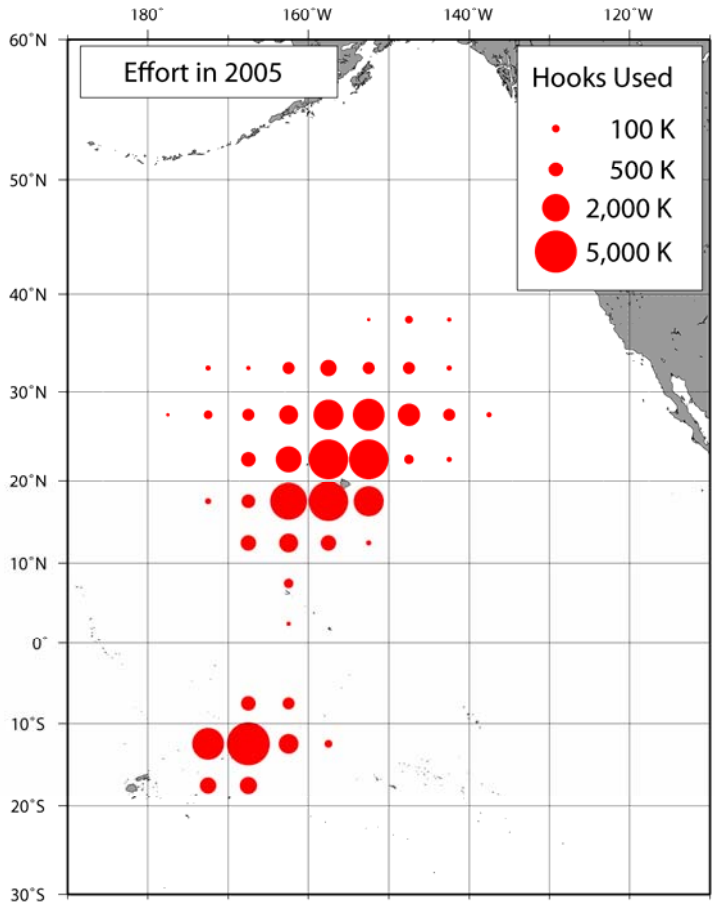

Figure 2b. Spatial distribution of reported logbook fishing effort in the WCPO by the U.S. longline fleet, in 1,000's of hooks (K), in 2005. Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality[4].

[4] The previous year's report for 2005 and earlier years displayed less data because a more exclusive confidentiality screening was applied.

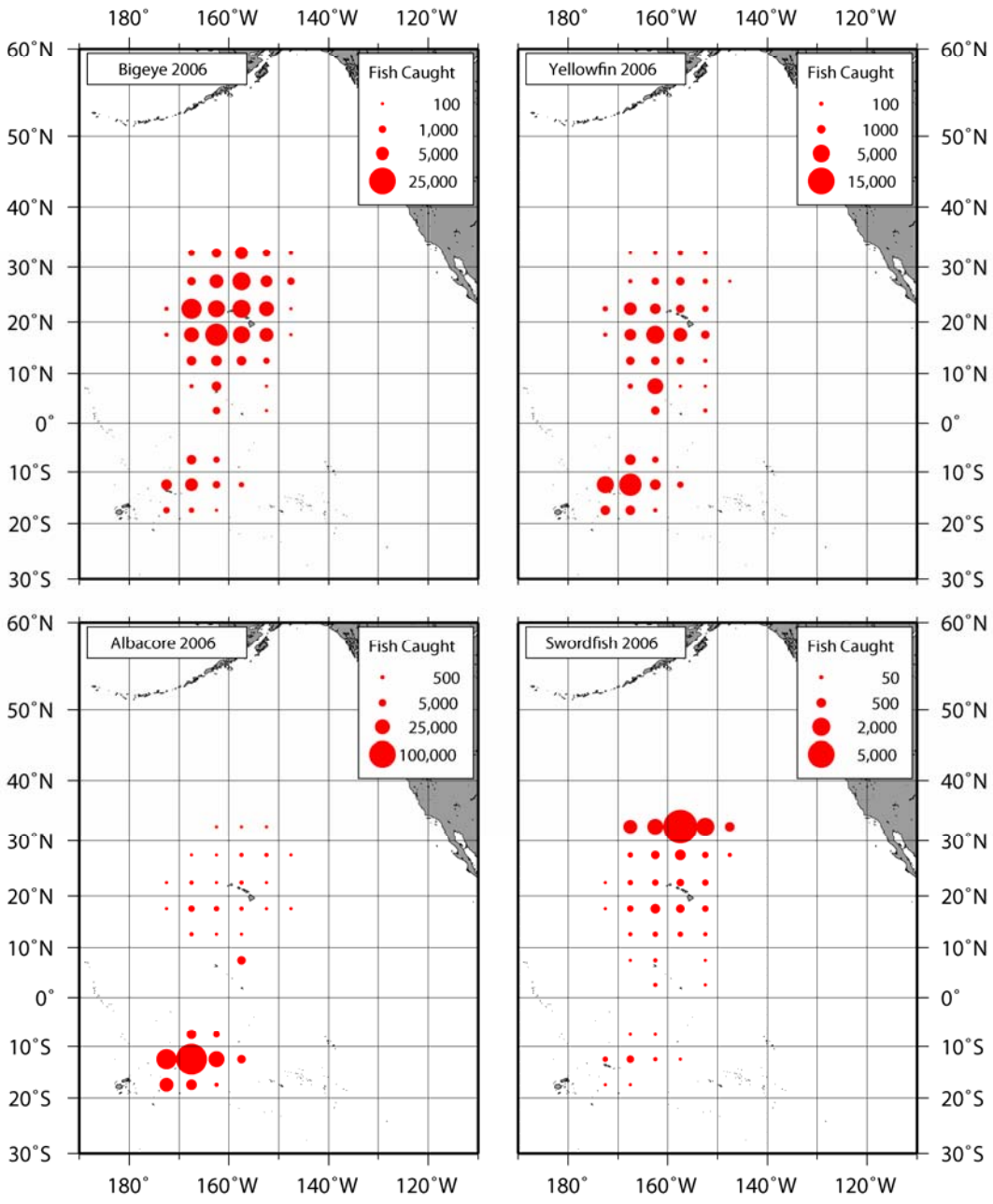

Figure 2c. Spatial distribution of reported logbook catch in the WCPO by the U.S. longline fleet, in numbers of fish (includes retained and released catch), in 2006 (provisional data). Area of circles is proportional to catch. Catches in some areas are not shown in order to preserve data confidentiality.

NOAA Fisheries/Pacific Islands Fisheries Science Center
Mercator Projection Scale = 0.0312500000 inches/degree
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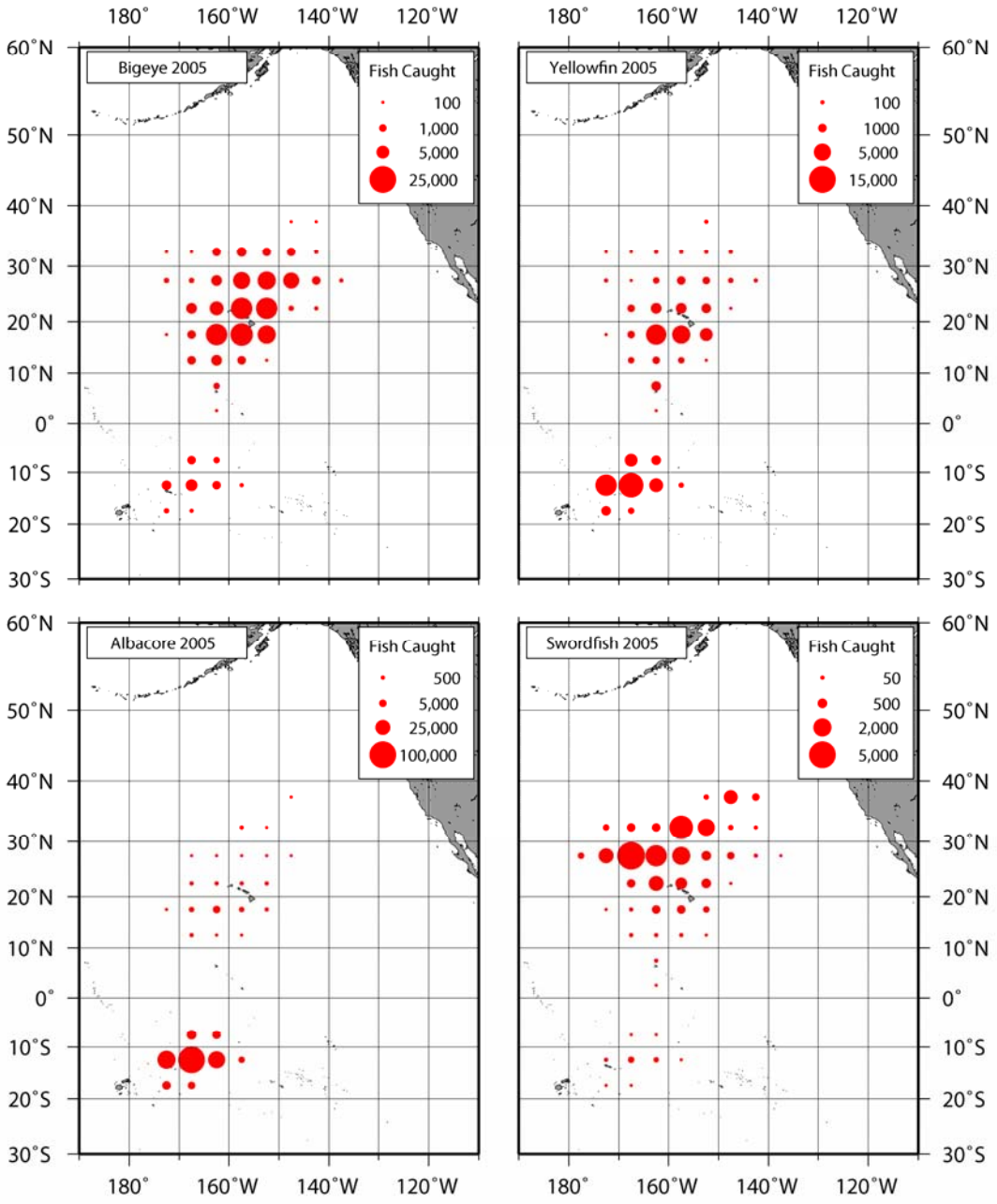


Figure 2d. Spatial distribution of reported logbook catch in the WCPO by the U.S. longline fleet, in numbers of fish (includes retained and released catch), in 2005. Area of circles is proportional to catch. Catches in some areas are not shown in order to preserve data confidentiality.

NOAA Fisheries/Pacific Islands Fisheries Science Center
Mercator Projection Scale = 0.0312500000 inches/degree
Data as of 2007-06-27 gridded 5 deg x 5 deg x year (3 or more vessels)

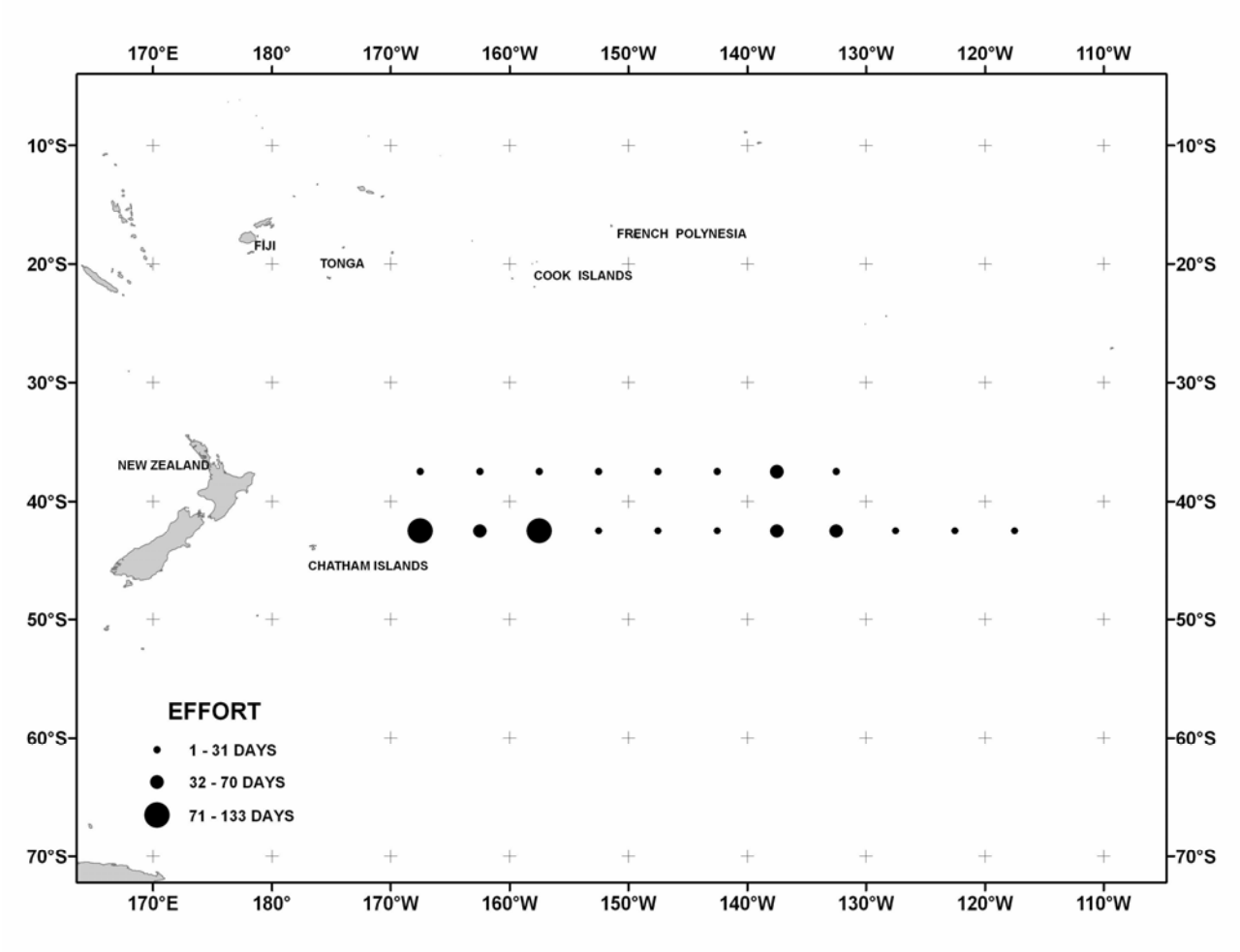


Figure 3a. Spatial distribution of effort (days fished) in the South Pacific by the U.S. distant-water troll fishery in 2006. Catches in some areas are not shown in order to preserve data confidentiality.

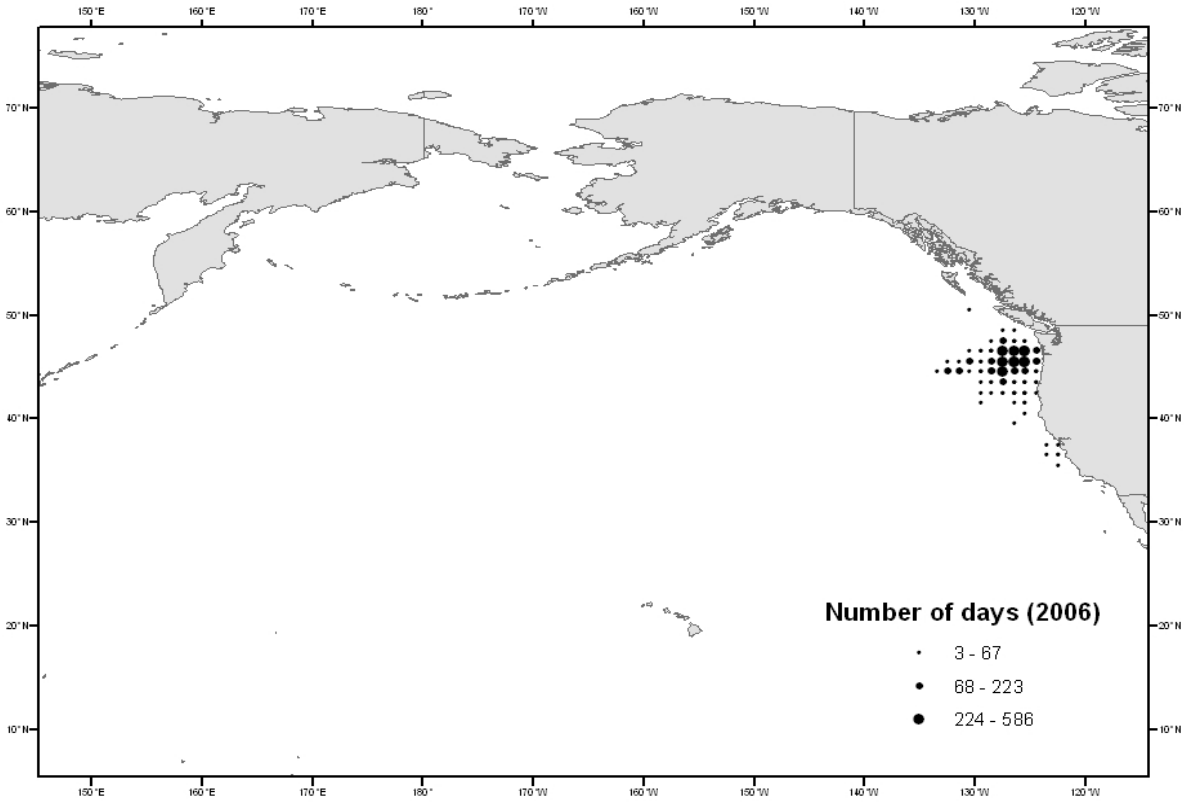


Figure 3b. Spatial distribution of effort (days fished) in the North Pacific by the U.S. distant-water troll fishery in 2006. Catches in some areas, including the WCPO, are not shown in order to preserve data confidentiality.

Table 3. Estimated total numbers of fishery interactions (not necessarily resulting in mortalities) with non-fish species (all of which are non-target, associated, or dependent species) by vessels in the Hawaii-based longline fishery during 2005 and 2006[5]. There were no CA-based longline vessels fishing in the WCPFC area in 2005-2006, and estimates have not yet been developed for the American Samoa-based fishery given the relatively new and low-level observer coverage in that fleet. Estimates for non-fish species are not available for other U.S. WCPO fisheries.

Species	2005	2006
Marine mammals		
Striped dolphin (*Stenella coeruleoalba*)	0	6
Bottlenose dolphin (*Tursiops truncatus*)	0	2
Risso's dolphin (*Grampus griseus*)	4	7
Unidentified dolphin (Delphinidae)	0	9
Blainville's beaked whale (*Mesoplodon blainvillei*)	6	0
Bryde's whale (*Balaenoptera edeni*)	1	0
False killer whale (*Pseudorca crassidens*)	6	17
Humpback whale (*Megaptera novangliae*)	0	1
Shortfinned pilot whale (*Globicephala macrorhynchus*)	6	6
Unidentified Whale (Cetacea)	1	14
TOTAL MARINE MAMMALS	24	62
Sea turtles		
Loggerhead turtle (*Caretta caretta*)	10	17
Leatherback turtle (*Dermochelys coriacea*)	12	11
Olive Ridley turtle (*Lepidochelys olivacea*)	16	54
Green turtle (*Chelonia mydas*)	0	6
Unidentified hardshell turtle (Cheloniidae)	0	2
TOTAL SEA TURTLES	38	90
Albatrosses		
Blackfooted albatross (*Phoebastria nigripes*)	89	73
Laysan albatross (*Phoebastria diomedia*)	105	15
TOTAL ALBATROSS	194	88
Observer Information		
Total trips	1,483	1,357
Observed trips	466	332
Proportion of trips observed	31.4%	24.5%
Observed sets	6,206	4,544
Observed hooks	10,689,477	8,285,411

[5] The estimates are made by raising the number of observed interactions by a factor determined according to the design of the observer sampling program. The species listed are those that have been observed. Sources: Pacific Islands Regional Office observer program reports (http://www.fpir.noaa.gov/OBS/obs_qrtrly_annual_rprts.html) and Pacific Islands Fisheries Science Center Internal Reports IR-06-006 and IR 07-006. Hawaii-based longline logbook reported data on fish discards are available at http://www.pifsc.noaa.gov./fmsd/hlrep.php.

Table 4. Discards of target and non-target fish species reported in Regional Purse Seine logbooks by U.S. purse seine vessels fishing in the WCPO during 2005 and 2006 (preliminary).

Species or species group	Metric tons	
	2005	2006
Target species discards		
Total:	**3900**	**1245**
Skipjack tuna (*Katsuwonus pelamis*)	3796	1190
Yellowfin tuna (*Thunnus albacares*)	104	55
Other discards		
Billfish:	**16.09**	**18.1**
Black marlin (*Makaira indica*)	0.17	0.34
Sailfish (*Istiophorus platypterus*)	0.08	0.12
Marlin (Istiophoridae)	15.84	17.64
Sharks/Rays:	**11.18**	**1.06**
Oceanic whitetip shark (*Carcharhinus longimanus)*	0	0.03
Silky shark (*Carcharhinus falciformis)*	0.23	1.03
Shark	10.76	0
Rays, skates, mantas (Rajiformes)	0.19	0
Other tunas/Tuna-like:	**10.13**	**3.87**
Albacore (*Thunnus alalunga*)	**4.50**	**0**
Tuna unspecified (tribe thunnini)	**2**	**0**
Mackerel (Scombridae)	**3.23**	**3.51**
Wahoo (*Acanthocybium solandri*)	**0.40**	**0.36**
Other fish:	**234.94**	**80.22**
Bait	**7.98**	**0.83**
Mahimahi (*Coryphaena hippurus*)	**0..69**	**0.62**
Ocean sunfish (*Mola mola*)	**0**	**0.02**
Rainbow runner (*Elagatis bipinnulatus*)	**2.65**	**5.02**
Triggerfish (Balistidae)	**0.69**	**0.58**
Yellowtail (*Seriola lalandi*)	**11.61**	**14.79**
Other unspecified	**212.01**	**58.36**

1.1.1 Developments and trends

U.S. Purse Seine Fishery

The number of active vessels and annual catches by the U.S. purse seine fishery declined from 2002 through 2006. The number of vessels declined from 29 in 2002 to 15 in 2006. The U.S. purse seine fishery operated mainly in areas between 5° N and 10° S latitude and 150° E and 170° W longitude (Figure 1). Before 1995 the fleet in the WCPO fished mainly on free-swimming schools of tunas. During the last 5 years, the fleet has been fishing equally between free-swimming schools and schools associated with floating objects, including logs and fish aggregating devices (FADs). The catch was composed primarily of skipjack tuna, with smaller catches of yellowfin tuna and bigeye tuna (Tables 1a-1b). Catches by the purse seine fishery declined by 45% from 2002 to 2006.

U.S. Longline Fisheries

The U.S. longline fisheries include vessels based in Hawaii, American Samoa, and California. The total number of longline vessels in the WCPO declined from 184 in 2005 to 154 vessels in 2006 (Table 2). The Hawaii-based fishery consistently had the highest number of vessels in operation (102 to 127). From 2005-2006 there was only one vessel operating out of California, and it did not fish in the WCPO. The Hawaii-based longline fishery operated mainly from the equator to 35^{o} N latitude and from 145^{o} W to 175^{o} W longitude while the American Samoa-based longline fishery operated mostly from 5^{o} S to 20^{o} S latitude and 155^{o} W to 175^{o} W longitude in 2006 (Figure 2a). The range of the Hawaii-based fishery contracted somewhat in 2006 as compared to 2005 (Figure 2b) due to early curtailment of fishing for swordfish. The Hawaii-based fishery targeted bigeye tuna and swordfish, whereas the American Samoa-based fishery targeted albacore. The dominant components of the catch in 2006 were bigeye tuna, albacore, yellowfin tuna, and swordfish. The U.S. longline catch ranged from a high of 16,264 metric tons (t) in 2002 to a low of 13,078 t in 2004, and was 15,042 t in 2006 (Tables 1a-1e).

Targeting of swordfish in the Hawaii-based longline fishery was prohibited from 2001 until early 2004. The swordfish fishery was reopened in April 2004 under a new set of regulations intended to reduce interactions with sea turtles. However, the West Coast-based longline fishery was closed concomitantly with the reopening of the Hawaii fishery; this prompted many West Coast longline vessels to relocate to Hawaii. In fact, most of these vessels had been based in Hawaii before the 2001 closure so their movement in 2004 was essentially a return to their prior base of operation. Most of the Hawaii-based longline fishery was deep-set longline effort directed towards tunas. Shallow-set (swordfish) longline effort was low in 2004 but increased in 2005 and 2006. The shallow-set longline fishery reached its allowable annual limit of loggerhead interactions (17) and accordingly was closed from March 2006 until the end of the year.

U.S. Distant-water Troll Fishery

In recent years, the U.S. distant-water troll fishery, which targets albacore, experienced significant decline in participation. The number of vessels participating

in the WCPO portion of this fishery declined from 78 vessels in the North Pacific in 2002 (of which 12 also fished in the South Pacific) to only 8 vessels in 2006 (Table 2). All 8 of these vessels fished the South Pacific in 2006 but only 3 also fished in the WCPO north of the equator. The U.S. distant-water troll fishery operated mostly between 35° S and 45° S latitude and 115° W and 170° W longitude (Figure 3a). In the North Pacific most effort was concentrated east of the WCPO (Figure 3b) The distant-water troll catches in the WCPO also declined substantially, dropping from 4,633 t in 2002 to 581 t in 2006 (Tables 1a-1e). In the WCPO, the North Pacific component of the catch declined dramatically from 4633 t in 2002 to only 3 t in 2006. The catch by this fishery was composed exclusively of albacore.

U.S. Small-Scale Fisheries

The small-scale fisheries data come mostly from vessels participating in the commercial troll, handline, and pole-and-line fleets, but also include some data from miscellaneous gears and recreational and subsistence fisheries monitored by creel surveys in American Samoa and Guam. Most of the small-scale vessels were located in Hawaii. The total catch by these fisheries decreased from 3,018 t in 2002 to 2,195 t in 2006. The catch was composed primarily of skipjack tuna, yellowfin tuna, and mahimahi.

1.1.2 Disposal of the catch

The purse seine catch is stored as a frozen whole product. Most of the catch was off-loaded to the canneries in Pago Pago, American Samoa. The final product was canned tuna for domestic U.S. markets. Frozen non-tuna catches may be processed locally (e.g., wahoo) or transshipped to foreign destinations (e.g., billfish and shark).

The Hawaii- and California-based longline vessels store their catch on ice and deliver their product fresh. Large tunas and marlins are gilled and gutted before storage on the vessel, swordfish are headed and gutted, and the rest of the catch is kept whole. Hawaii and California longline catches are sold as a fresh product with restaurant, retail, and U.S. mainland markets as their primary outlets and a smaller proportion is exported to foreign markets. The American Samoa-based longline albacore catch is gilled and gutted and delivered as a frozen product to the canneries in Pago Pago, American Samoa. Other associated catch is either marketed whole (for vessels making day trips) or frozen (for vessels making extended trips).

The distant-water troll fishery in the South Pacific froze their catch whole and sold the fish to the canneries in Pago Pago, American Samoa. The fishery operating in the North Pacific also froze their catch and landed the fish on the U.S. West Coast. Some vessels fishing closer to the West Coast landed their catch fresh and marketed the fish locally.

The small-scale fisheries store their catch in ice. Large tunas and marlins are gilled and gutted while other species are kept whole. The small-scale fisheries sell their product fresh, mainly to local markets.

1.1.4 Future prospects

High fuel costs and increasing prices for supplies and goods will result in higher operating costs. If there is no commensurate increase in fish prices, these increasing costs will likely continue to constrain the economic performance of all U.S. pelagic fisheries. If the current scenario persists, the likely outcome might be lower participation and declining catches. In terms of participation, the U.S purse seine fleet has been experiencing constant decline since the mid to late 1990s. In 2005 and 2006 the decline continued at a slower pace. The U.S. purse seine fleet and distant-water albacore troll fleet both operate over large distances in their search for fish may, and may have difficulty competing with other fleets in an environment of rising costs. The continuing decline in the albacore troll fishery may also be related to declining catch rates in the WCPO in recent years, a trend that has also been evident in the catch rates of the Japan pole-and-line fleet.

Future prospects for the U.S. purse seine fleet continue to be uncertain especially for those operators who employ a traditional business model. However, there are indications that alterative methods of operation are economically viable. Despite continued adverse prices related to key inputs (e.g., fuel and insurance) there are indications that new or increased investment in the fishery may occur in the coming year(s). The U.S. Government has indicated its commitment to the South Pacific Tuna Treaty and the private sector is reportedly engaged in various activities to maintain a viable U.S. purse seine fleet to ensure its continuation through the time period currently negotiated with the relevant Pacific Island parties.

The scientific finding that current levels of fishing mortality on bigeye and yellowfin tuna are higher than those that can sustain maximum yield is expected to prompt some reduction in tuna fishing effort in the WCPO. International management measures have already affected the portion of the Hawaii-based longline fleet that operated in the EPO. Fishing by these vessels in the EPO was halted late in March of 2006 when it was projected that the U.S. longline fishery would reach its annual bigeye tuna catch limit in the EPO established to implement the IATTC conservation and management measure.

In the future the Hawaii-based component of the longline fishery is likely to continue to mostly target tunas although a growing proportion of effort is expected to target swordfish. The swordfish segment of the Hawaii-based longline fishery is seasonal and must operate under strict rules to reduce interactions with sea turtles. The rules include an effort limit that has not been reached in the last several years, but could be fully utilized or even increased if further reductions in sea turtle bycatch rates could be achieved. There are viable prospects for achieving this, including seasonal closed areas or further development of more selective fishing gear.

Currently, the California-based component of the longline fishery is only allowed to target tunas. The American Samoa-based component of the longline fishery is expected to continue targeting albacore and delivering its catch frozen to the canneries. There has been some swordfish exported from Pago Pago to the U.S. mainland market and that segment of the fishery could expand, however, the availability of air freight service out of American Samoa will be a determining factor.

The prospect for the U.S. small-scale fisheries is believed to be fairly stable. These fisheries are expected to continue to make single-day trips, target tunas, billfish, and other pelagic fish, and deliver their catch fresh to local markets.

1.2 RESEARCH AND STATISTICS

1.2.1 Observers, port sampling, and estimation of fishing capacity

All U.S. longline vessels operating in the WCPO are subject to observer placement as a condition of the fishing permits issued by the National Marine Fisheries Service (NMFS). The longline observer program focuses primarily on the collection of scientific data on interactions with protected species and secondarily collects relevant information on the fish catch and on the biology of target and non-target species. Fisheries data are collected for NMFS by trained observers, who are employed by a private contracting firm.

Researchers use the data to estimate protected species interactions in the Hawaii-based deep-set (tuna) component of the longline fishery and to tabulate the same for the shallow-set (swordfish) component. Domestic longline observers are now deployed out of Pago Pago and plans are underway to increase longline observer coverage in the American Samoa-based component of the longline fishery, where NMFS has augmented existing staff to establish a permanent, full-time presence directed specifically at longline operations.

In 2006, the observer coverage rate (on a trip basis) in the deep-set (tuna) component of the Hawaii-based longline fishery was 21.2%--for a total of 275 observer trips and 3,605 sets observed. In the shallow-set (swordfish) component of the Hawaii-based fishery, which has a regulatory requirement of 100% observer coverage all 57 trips were observed, totaling 939 sets. Overall 275 + 57 trips were observed out of 1300 deep-set + 57 shallow-set trips resulting in a combined coverage rate of 24.5% in 2006 (Table 3). The results indicated a higher number of interactions with sea turtles and marine mammals in 2006 as compared with 2005. For the recent deployment of observers in the American Samoa-based component of the fishery (in the last three quarters of 2006), the coverage rate was 8.1%--for a total of 10 trips and 287 sets. NOAA Fisheries has not yet attempted to estimate total interactions with protected species from these observer data. Detailed information on the Pacific Islands Regional Observer Program can be found at:

http://www.fpir.noaa.gov/OBS/obs_index.html

U.S. purse seine vessels operating in the WCPO under the Treaty on Fisheries between the Governments of Certain Pacific Island States (PIC) and the United States of America (Treaty) pay for, and are monitored by Pacific Island Country (PIC) observers deployed by the Forum Fisheries Agency (FFA). Monitoring includes both the collection of scientific data as well as information on operator compliance with various Treaty-related and PIC-mandated regulations. Logbook and landings data are submitted as a requirement of the Treaty (coverage 100%). NMFS has a field station in Pago Pago, American Samoa that facilitates the placement of FFA-deployed observers on U.S. purse seine vessels. The target coverage rate is 20% coverage of all U.S. purse seine trips, which has been exceeded in the last four years. For the 2005/2006 licensing period—the latest data are readily available—the

coverage rate was 21.2 %. Landings are measured for fork length by NOAA Fisheries personnel as vessels land their catches in American Samoa (coverage approximately 1-2% of landings). Species composition samples are also taken and used to adjust the logbook-reported data on the numbers of yellowfin tuna versus bigeye tuna.

Purse seine fishing capacity in the region was reviewed by NOAA Fisheries PIRO in late 2003. To augment a previous study of the fishing capacity of the longline and pole-and-line fleets, a vendor was contracted to review the fishing capacity of these two fleets. According to data collected during this study, the longline and pole-and-line vessels of at least 29 nations were active in the WCPFC area in 2005. The largest longline fleets were those of Japan and Taiwan. The largest pole-and-line fleets were those of Japan and Indonesia. Taking the national longline fleets for which the study's database had good coverage (25 countries, 1,021 vessels) and adding estimates from other sources for the number of vessels of Japan, Taiwan, Indonesia, and Vietnam (3,493 vessels) results in the study's best estimate of the number of longliners 14 meters and above: 4,514 vessels. Taking the national pole-and-line fleets for which the study's database had good coverage (7 countries; 138 vessels) and adding estimates from other sources for the vessels of Japan (215 vessels) results in the study's best estimate of the number of pole-and-line 14 meters and above: 353 vessels. The lack of detailed vessel information from Japan and Taiwan was the study's greatest constraint to obtaining an accurate assessment of fishing capacity in the region.

Fiscal support has been provided to the FFA by the United States government to augment PIC observer training to also address protected species and bycatch issues. This has included training on protected species (mammals and turtles) identification, data recording, turtle handling, and mitigation. Support is also provided for equipment and materials required to implement appropriate turtle handling and bycatch mitigation techniques. This support has been augmented with technical assistance from Honolulu NOAA Fisheries longline observer program staff as well as private contractors attending in-country training sessions conducted by FFA.

U.S. distant-water troll vessels voluntarily submitted logbook records to the SWFSC until 1995, when those vessels fishing on the high-seas were required to submit logbooks. Starting in 2005, all vessels, including those fishing exclusively in the U.S. EEZ, have been required to submit logbooks. The logbook coverage rate in 2006 was approximately 66% (in terms of landed weight). Landings (weight) are monitored by NOAA Fisheries and various state fisheries agencies through landing receipts. Coverage is 100% of landings. Landings are also measured for fork length by port samplers along the U.S. west coast and in American Samoa. The coverage rate in 2006 was approximately 2% of the landings.

1.2.2 Research activities

U.S. government research on tunas and tuna-like species of the North Pacific Ocean is conducted by the Pacific Islands Fisheries Science Center (PIFSC) and the Southwest Fisheries Science Center (SWFSC). These Science Centers also conduct collaborative research with scientists from other governments or university scientists. Both Centers have studies devoted to stock assessment, biological and oceanographic research, and domestic and international fishery management issues. Each Center concentrates on different fisheries, species, and issues in order to minimize duplication. In this section, selected studies are described and results are discussed.

Pacific Islands Fisheries Science Center (PIFSC)

Studies are underway on stock assessment, biology, oceanography, economics, and methods to reduce the incidental catch and mortality of species that are particularly affected by longline fisheries. This research addresses fishery resource status and sustainability and fishery impacts on the ecosystem.

Fishery Monitoring and Socioeconomic Research-

Fishery Monitoring and Analysis

The Western Pacific Fishery Information Network (WPacFIN) completed the first phase of data integration between the Hawaii Division of Aquatic Resources (DAR) Commercial Fishing Report (FR) and the Commercial Marine Dealer Report (DR). In this phase, FR catch data by fishing trip were matched with DR daily sales data to create a complete database of fish sales and fish weight information. This database includes catch data from Federal Longline Logbooks (LL) and DAR FR data. Unmatched data and issues such as misidentified species in matched trips will be addressed during subsequent development phases. The integration work is an important aspect of improving reporting to the RFMO's because it incorporates the best estimates of the sizes of fish caught by area, information needed to convert U.S. catches in number of fish in the EPO and WCPO into catches in weight. The WPacFIN program also continued to improve data quality control for the DR data. DR data on longline landings were verified against Federal LL data to ensure that vessel names and captain Commercial Marine License (CML) numbers matched between the two datasets. This increases the success rate for data integration.

The PIFSC developed and implemented a real-time system for monitoring and forecasting U.S. longline catches of bigeye tuna in the Eastern Pacific Ocean (EPO). The system was created in collaboration with NMFS administrators, federal enforcement staff, NOAA Fisheries scientists in Hawaii and California, the Western Pacific and Pacific Fishery Management Councils, and the U.S. longline industry. The system enables the U.S. to stay within the U.S. longline fishery quota for bigeye tuna established by the IATTC to conserve the bigeye resource. New protocols for the system include dockside monitoring and manual tallying of EPO bigeye tuna catches and calculating catch rates from logbook data, daily vessel monitoring system counts of longline vessels present in the EPO as a proxy for daily real-time longline effort, market monitoring of bigeye tuna landed for area specific mean weight of fish, and in-season prediction of the date when the quota is expected to be reached. The latter predicted date is based on real-time catch and effort estimates that change in response to dynamics of the fishery. The system enabled the U.S. to keep its 2006 longline catch of bigeye tuna in the EPO within the established quota.

In other fishery monitoring research, statistical models of blue marlin catches by Hawaii-based longline vessels were developed. The new models increase predictive accuracy and comprehensibility with little loss of precision. Species misidentifications were corrected in the reported commercial logbook records for five species of billfishes taken as incidental catch by the Hawaii-based longline fleet from March 1994 through 2004. The study has provided a corrected catch database along with a 10-year time series of standardized catch rates.

Economic Research

A study is underway to estimate the economic value of opportunities to recreationally catch blue marlin in Hawaii. Data are being collected using a mail survey add-on to the Hawaii Marine Recreational Fishing Survey. Similar estimates may also be developed for tunas, mahimahi, and a variety of other pelagic species. Results will allow comparisons between recreational value and commercial values for these species. Data collection began in 2006 and is continuing into 2007.

A study was conducted on the adoption of new technology in the Hawaii-based longline fishery and resulting effects on fishing capacity and fishing productivity. A multiple linear regression model was computed to estimate the effects of technological factors on productivity. This model indicated, for example, that a 1% increase in hook numbers should yield a 0.9% increase in catch rates (catch per set). Other factors exerting positive effects on fishing capacity were vessel speed, vessel length, and use of sea surface temperature maps. It is expected that this work will be useful in determining the appropriate capacity of this fishery within the overall context of managing total fishing effort.

A bio-economic model was developed to explore tradeoffs between reductions in incidental interactions with sea turtles and economic returns by Hawaii-based longline vessels. Through simulation analysis of hypothetical time and area closures for the fishery, the study assessed possible policy options that allow the fleet to maximize fishing opportunity without exceeding federally enforced annual limits on sea turtle interactions. Several levels of fishing effort were employed in the simulations. The model provided a suite of policy options for consideration in managing the shallow-set Hawaii-based longline fishery that targets swordfish.

Fish Biology and Stock Assessment Research- The PIFSC conducts research on stock assessment, the biology and life history of exploited stocks and bycatch species, the selectivity of fishing gear for target species and bycatch. Staff also conduct fishing trials with alternative fishing gears with the objective of reducing bycatch of unwanted fish and protected species.

Blue Shark Stock Assessment

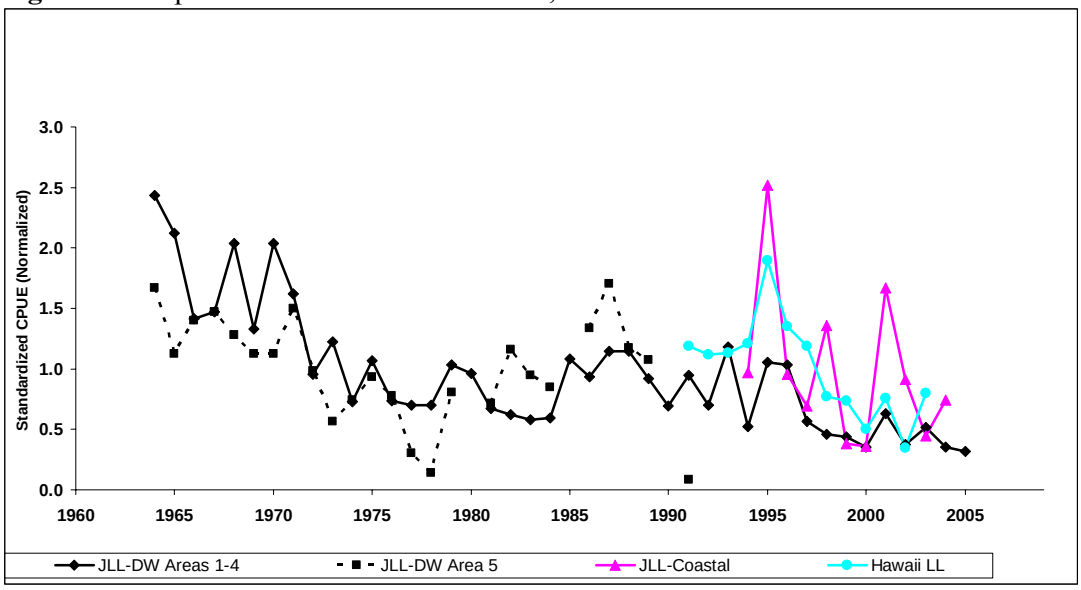
In 2006, the PIFSC collaborated with scientists from the JIMAR, Imperial College of London, and Japan's National Research Institute of Far Seas Fisheries and Fisheries Research Agency to revise and update a stock assessment of blue sharks in the North Pacific. The blue shark assessment will be confined to the North Pacific because of the relatively wide availability of data for the region, the purported separation of northern and southern hemisphere stocks of blue shark, and documented high catches and finning rates. The objectives of the study are to determine the degree to which the population has been affected by fishing activity and whether current fishing practices need to be managed to ensure continued viability and utilization of the resource. The study will update the blue shark assessment published by Kleiber et al. in 2001. In addition to re-estimating catch and effort data based on a longer time series of data, the current study will incorporate several new features. In particular, effort data will be provided by the Fisheries Administration of Taiwan and catches for the Japanese inshore longline fleet will be included. Catch estimates will be contrasted with harvest estimates from the shark fin trade, and catch per unit effort will be

standardized using both a generalized linear model and a statistical habitat model. Two different stock assessment models will be applied.

Billfish Stock Assessment

PIFSC collaborated with other members of the ISC Marlin Working Group (MARWG) and Swordfish Working Group (SWOWG) in 2006 to review data inputs and develop models for a North Pacific swordfish stock assessment and a North Pacific striped marlin stock assessment. North Pacific swordfish catch statistics were compiled and reviewed by ISC member countries. Major issues to be considered in the assessment of swordfish in the North Pacific swordfish are its differential growth by sex and the possible existence of multiple stocks in the North Pacific Ocean. For striped marlin, standardized CPUE indices (1962-2005; Fig.1) declined over from the mid-1960's through mid-1970's; exhibited a relatively flat trend (with year-to-year fluctuation) over the next two decades; and then generally declined (with year-to-year fluctuation) from themid-1990's through mid-2000's. These CPUE indices – all derived from longline fisheries – can be considered roughly proportional to the number of spawners in the population (ages 5+); and should be highly influential in the population model, which is expected to completed in March, 2007.

Figure 1. Striped marlin standardized CPUE, 1964-2005.



Swordfish Age & Growth Study

A paper entitled "Age and Growth of Swordfish, *Xiphias gladius*, Caught by the Hawaii-based Pelagic Longline Fishery" was accepted for publication. Annuli observed using the cross-sectioned 2nd anal fin ray were corroborated by scanning electron microscopy (SEM) observations of daily microincrement formation within otoliths (sagittae) and also were consistent with the observed growth of three recaptured tagged fish at liberty from 1 to 4 yrs. Growth rates of swordfish in the central North Pacific were found to be similar those of swordfish caught off the coast of Chile and considerably higher than those of fish caught near Taiwan.

Age & Growth Study of Striped Marlin Initiated

The examination of bony hardparts from striped marlin was initiated to evaluate their feasibility as growth mark indicators for age estimation. Hardpart samples collected at the fish market included dorsal and anal fin rays, vertebrae, cleithrum, and otoliths. Each type of hardpart was examined for the presence of apparent annuli and evaluated for utility in age determination. Initial results indicated that cross-sections of vertebrae and cleithrum do not reveal distinct growth marks. Examination of various 1st dorsal fin and 1st anal fin ray cross-sections indicated that dorsal rays have smaller vascularized cores than anal rays, an advantage for age determination. Further work has indicated that cross-sections of rays 3-5 on 1st dorsal fins provide the best clarity in terms of visually identifying apparent annuli. Within the smaller sized specimens examined, sagittal otoliths were found to have structures presumed to be daily microincrements.

Collaboration on Blue Marlin Growth Study

PIFSC helped with a doctoral research project by a graduate student from University of the Ryukyus on the age and growth of blue marlin caught off Yonaguni Island, Japan. PIFSC staff described and demonstrated the Center's protocols for identifying annulus growth marks on swordfish dorsal fin ray sections and helped assemble digital images from a subsample of blue marlin spine sections, allowing several scientists to view and assign ages to the same sections, enabling a comparison between readers. It appeared that the first annulus mark in the blue marlin is formed at approximately 8 mm from the focus of spine sections. However, annulus marks observed in blue marlin were considerably less distinct than those in swordfish, making growth estimation for blue marlin difficult. Two sagittal otolith sections were examined and photographed under SEM at the University of Hawaii BEMF facility. Internal microincrements were visualized but there were unreadable gaps between the focus and edge of the otolith.

Early Life History Studies of Pelagic Species

Two research cruises by the NOAA Ship *Oscar Elton Sette* were conducted in 2006 off the Kona coast of the Island of Hawaii to learn about species-specific spawning dynamics of pelagic fishes and the oceanographic parameters associated with the presence/absence of their eggs and larvae.. The cruises focused on the surface net collection of eggs and larvae of billfishes and other species. An at-sea multiplex-PCR assay was used to confirm species identities of net-captured eggs and larvae of billfishes, wahoo, and mahimahi. A spring cruise collected primarily swordfish eggs and shortbill spearfish larvae while a late summer cruise collected primarily wahoo eggs and few billfish larvae. Environmental data indicated that billfish egg stages are present in surface waters along the Kona coast primarily when the sea surface is less saline (~34.5), warmer (25-27°C), and calm (low wind conditions). The first record of spawning (presence of larvae) for striped marlin in Hawaiian waters was published in Bulletin of Marine Science in 2006, based on observations during May 2005 research cruise.

Trace Element Study of Juvenile Swordfish Otoliths Initiated

In a new study trace element signatures of juvenile swordfish otoliths collected from distant nursery areas throughout the Pacific will be analyzed. Young-of-the-year juveniles caught

seasonally in the warm water tuna longline fisheries of various regions and will be sampled by onboard observers or cooperating fishermen. The objective is to evaluate whether distinct trace element signatures exist that would serve as unique markers of nursery origin. The analysis will be conducted using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). If successful, these markers will provide a basis for future studies to identify the origins of adult swordfish that typically inhabit the cooler higher latitude fishing grounds targeted by swordfish longline fleets in the Pacific. Juvenile swordfish otoliths were acquired from Ecuador and the western Pacific to supplement samples previously obtained from the central north Pacific and French Polynesia.

Wahoo and Dolpinfish Studies

A study documenting length-weight relationship for wahoo (*Acanthocybium solandri*) and mahimahi (*Coryphaena hippurus*) around Hawaii has been completed and submitted for publication. Histological sections of mahimahi ovaries are being studied to document oocyte development and spawning frequency in Hawaiian waters.

Shark bycatch research

Researchers have undertaken several projects to address shark bycatch on longline gear, including studies of chemical deterrents to bycatch. Experiments in early 2006 with demersal longline sets in South Bimini using the chemicals, and similar testing of magnets, were quite successful. In late 2006, the PIFSC began testing the ability of electropositive metals to deter sharks from biting freshly caught baits, observing the sharks at sea off the North Shore of Oahu.

The NMFS longline observer database is being used to compare shark bycatch rates under different operational factors (e.g., hook type, branch line material, bait type, presence of light sticks, soak time, etc.). Preliminary results do not indicate that large circle hooks (size 18/0) increase the catch rate of sharks. This contrasts with results in other fisheries, where studies comparing smaller circle hooks with J shaped hooks found an increased shark catch on circle hooks.

Research is being conducted at sea to study the release and survivorship of shark bycatch, including the testing of de-hookers and barbless hooks. In the Hawaiian longline fishery, sharks are generally released from the gear by one of the following methods, a) severing the branchline, b) hauling the shark to the vessel to slice the hook free, or c) dragging the shark from the stern until the hook pulls free. Fishermen are encouraged to use de-hooking devices to minimize trauma and stress of by-catch by reducing handling time and to mitigate post-hooking mortality. In the current study, the effectiveness of barbed and barbless circle hooks was investigated by assessing catch rates and catch retention of both targeted and by-catch species (e.g., sharks). Results showed no difference between barbed and barbless hooks in the catch and catch rates of targeted species and sharks. Efficacy of the pigtail de-hooker, a device required by U.S. regulations for releasing sea turtles, showed a 67% success rate in de-hooking and releasing live sharks on barbless hooks, compared to a zero success rate when used with sharks caught on barbed hooks.

Alternative Longline Gear to Reduce Bycatch

An experiment with deep-set longline gear was conducted by PIFSC in coordination with the Secretariat of the Pacific Community (SPC) and JIMAR. The experiment altered current commercial tuna longline setting techniques by eliminating all shallow set hooks (less than 100 m depth) from tuna longline sets. The objective of eliminating all shallow set hooks, a method developed by SPC, was to maximize target catch of deeper dwelling species such as bigeye tuna, reduce bycatch of turtles and other protected species, and reduce incidental catch of many marketable by less desired species (e.g., billfish and sharks). A single vessel was contracted to perform 90 longline sets – 45 sets using the deep setting technique and 45 control sets using standard methods. A deep set was achieved by attaching paired 3 kg lead weights directly below paired floats on long portions of the mainline, thereby sinking the entire fishing portion of the line below the target depth of the shallowest hook (100 m). The deep setting technique was easily integrated into daily fishing activities with only minor adjustments in methodology. The main drawback for the crew was increased time to deploy and retrieve the gear. Catch totals on the deep set gear were greater for both bigeye tuna and moonfish; whereas catch of less valuable incidental fish (e.g., striped marlin and wahoo) was lower. Temperature-depth recorders placed on the gear verified that the deep set method achieved the goal of ensuring that all hooks sink below 100 m. Results have shown that the deep set technique works and would be practical to incorporate into existing fishing practices in Hawaii's tuna longline fleet.

Marine Turtle Bycatch Mitigation

Research was conducted to track movements of longline-caught sea turtles after their release from a fisheries encounter by tagging them with pop-off satellite archival tags (PSATs) and platform terminal transmitters (PTTs). To maximize the number of turtles tagged, PIFSC worked with observers in several foreign longline fisheries with relatively high sea turtle encounter rates. During 2006, observers were trained in Hawaii, Brazil and Uruguay in the attachment of satellite transmitters and deployed about 10 tags.

The PIFSC is leading studies on longline fishing vessels to test the efficacy of sea turtle bycatch mitigation methods. Specifically, we have coordinated field trials in Costa Rica, Brazil, Ecuador, and other countries to test effects of gear modifications (e.g., use of large circle hooks, appendage hooks, hook offsets) on the rates of hooking and entanglement of sea turtles in longline fisheries. The PIFSC is also conducting research on effects of shark shapes and light sticks on rates of sea turtle capture in a gillnet fishery in Baja California, Mexico. This work is conducted with the Aquatic Adventures Science Education Foundation with support from a NOAA Environmental Literacy Award. The PIFSC also hosted a meeting of the Sensory Physiology Working Group (Virginia, USA, September 2006), from which a NOAA Technical Memo has been drafted.

Ecosystem and Oceanographic Research- The PIFSC investigates oceanographic and ecosystem relationships that often have important influences on fish and protected species distribution, population dynamics, and vulnerability to fishing gear.

Pelagic Habitat of Loggerhead Sea Turtles

A satellite telemetry study of 43 juvenile loggerhead sea turtles (*Caretta caretta*) in the western North Pacific together with satellite-remotely sensed oceanographic data identified the Kuroshio Extension Current Bifurcation Region (KECBR) as a forage hotspot for these turtles. In the KECBR, juvenile loggerheads resided in Kuroshio Extension Current (KEC) meanders and associated anti-cyclonic (warm core) and cyclonic (cold core) eddies during the fall, winter, and spring when the KEC surface water contains high concentrations of chlorophyll. Turtles often remained at a specific feature for several months. However, in the summer when the KEC waters become vertically stratified and surface chlorophyll levels are low, the turtles moved north up to 600 km from the main axis of KEC to the Transition Zone Chlorophyll Front (TZCF).

In some instances, the loggerheads swam against geostrophic currents, and seasonally all turtles moved north and south across the strong zonal flow. Loggerhead turtles traveling westward in the KECBR had their directed westward movement reduced 50% by the opposing current, while those traveling eastward exhibited an increase in directed zonal movement. It appears, therefore, that these relatively weak-swimming juvenile loggerheads are not merely passive drifters in a major ocean current but are able to move east, west, north, and south through this very energetic and complex habitat. These results indicate that oceanic regions, specifically the KECBR, represent an important juvenile forage habitat for this threatened species. Interannual and decadal changes in productivity of the KECBR may be important to the species' population dynamics. Further, conservation efforts should focus on identifying and reducing threats to the survival of loggerhead turtles in the KECBR

Tagging of Longline-caught Opah

Data from 11 pop-up archival transmitting tags attached to opah (*Lampris guttatis*) in the central North Pacific were used to describe their vertical movement and habitat. The tags were deployed over the period 2002 to 2005 in the subtropical gyre northwest of the Hawaiian Islands. Based on the results, opah in the central North Pacific generally inhabit a 50–400 m depth range and a 8–22^{o}C temperature range. They are frequently found in shallower depths, between 50 and 150 m, during the night and in greater depths ranging from 100 to 400 m during the day. However, opah are constantly moving vertically within this broad habitat. During the day, they are very likely to spend some time in water shallower than 175 m, while at night, excursions occurring below 200 m are not uncommon. Speed of their vertical movements is generally less than 25 cm/s; however, a burst descent in excess of 4 m/s has been recorded. While the vertical extent of opah habitat can vary with local oceanographic conditions, over a 24-hour period the integrated temperature opah experience remains in a narrow range from about 14.7 to 16.5^{o}C.

Southwest Fisheries Science Center (SWFSC)

The Southwest Fisheries Science Center has a long history of research on stocks and fisheries for highly migratory species (HMS). During the past few years, the SWFSC has focused increased resources on research of North Pacific HMS in order to address growing concerns about resource status and sustainability. Studies described in the following section are primarily designed to address the growing concerns and are guided by NMFS strategic plan objectives of promoting resource stewardship and building sustainable fisheries.

Stock Assessment Studies − The SWFSC investment in stock assessment research is founded on delivering accurate information on stock status and subsequently, for providing meaningful advice to fishery managers. During the past year, SWFSC scientists have been conducting assessment related research to support the goals of the ISC Albacore, Marlin, and Bluefin Working Groups.

Albacore

Researchers participated in an assessment-based meeting of the ISC Albacore Working Group (ISC-ALBWG), which was held in November-December 2006 in Shimizu, Japan, and was attended by researchers from Japan, Taiwan, and Canada. The meeting primarily focused on assessment-related activities, including: (1) completing a formal assessment based on a backward-simulation Virtual Population Analysis (VPA) model; (2) developing a preliminary forward-simulation Stock Synthesis 2 (SS2) model; (3) continuing discussion regarding appropriate biological reference points for potential management of the stock; (4) research studies needed to improve knowledge of albacore biology; and (5) maintenance and improvement of the ISC Albacore Working Group database catalog, which contains catch, length, and catch and effort information collected from the various international fleets that harvest the stock. Scientists from the SWFSC presented various papers that addressed the meeting topics above. Assessment results indicated the population is currently being harvested at a spawning potential ratio of roughly $F_{17\%}$. Figure 1 presents the spawning stock biomass (historical, current, and projected) time series estimated from the assessment model. Finally, further fishery-related statistics and conclusions concerning the status of the stock generated from the assessment research are presented in the overall meeting report.

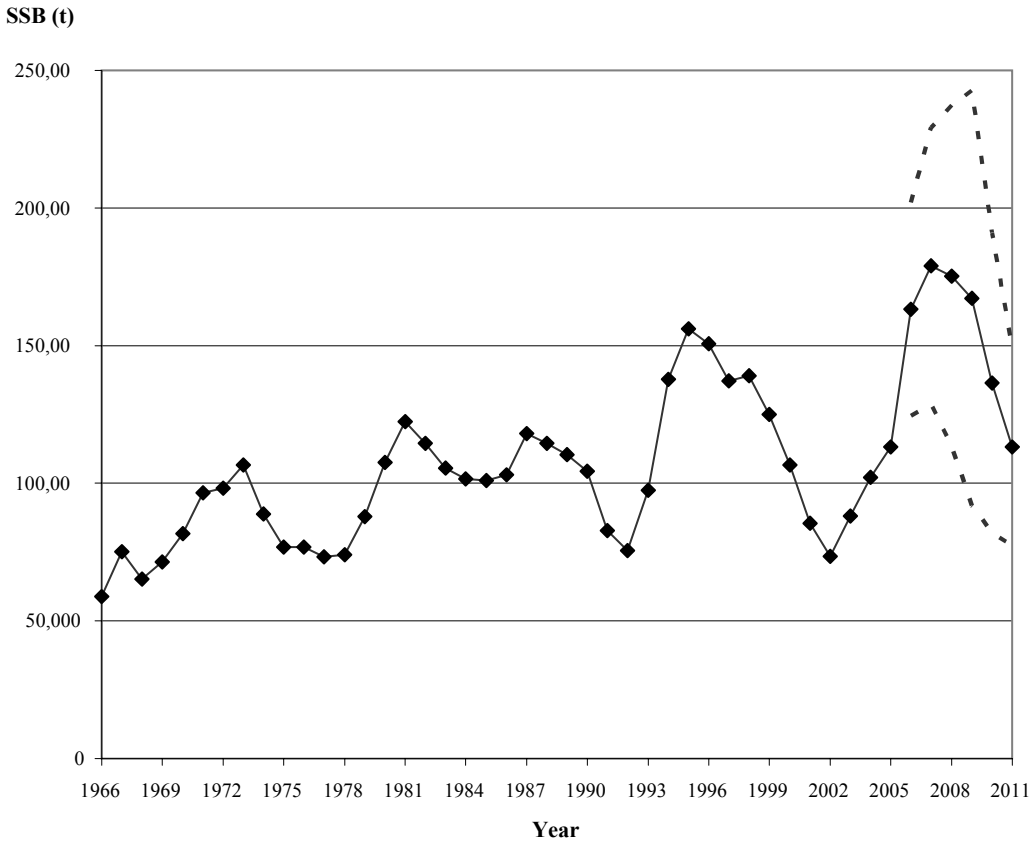


Figure 1. North Pacific albacore spawning stock biomass (SSB in mt) time series estimated from the VPA-based assessment conducted in 2006. Projected estimates from 2006-11 are bounded by an 80% confidence interval.

Work continues concerning population analysis efforts based on a fully integrated, length-based and age-structured modeling platform (SS2), which in the near future is expected to become the formal model for assessing the status of the albacore stock in the North Pacific Ocean; currently, a robust baseline model configuration has been developed. In this context, an intersessional meeting will be held in spring 2008 that will address two assessment-related topics: (1) refinement of the SS2 model, along with (2) re-evaluation of CPUE indices of abundance utilized in the current assessments of this species, including discussion regarding prioritizing/omitting particular indices, spatial/temporal characteristics of the indices, age-aggregated vs. age-specific time series, etc. Finally, the next formal assessment-related meeting of the ISC-ALBWG is scheduled for late 2008.

Marlin

In 2006, marlin assessment research at the SWFSC focused on meeting the ISC Marlin Working Group (ISC-MARWG) goal of completing a North Pacific striped marlin assessment in 2007. The SWFSC scientists participated in an ISC-MARWG meeting held in Shimizu, Japan. That initial meeting was held to prepare data for an assessment that should be completed in March 2007 at a meeting held in Chinese-

Taipei. The SWFSC scientists were charged by the working group with producing initial assessment model runs for presentation at the March meeting in Taipei. In addition, SWFSC scientists, in conjunction with international colleagues, will use the initial modeling results to develop the final model configuration at the 2007 meeting. Results of the Working Group's assessment efforts will be presented at the 2007 ISC Plenary meeting.

Bluefin Tuna

In 2006, bluefin tuna assessment research at the SWFSC focused on completing a North Pacific bluefin tuna assessment in 2008. The SWFSC scientists participated in an ISC Bluefin Tuna Working Group (ISC-PBFWG) meeting held in Shimizu, Japan, in 2006, where an initial assessment of bluefin tuna was presented. That assessment of bluefin tuna was conducted using a Virtual Population Analysis, and several areas of uncertainty within the assessment were discovered. The SWFSC scientists are participating with international scientists in the Working Group to improve the reliability of the data and to develop alternative assessment modeling approaches. Results of the Working Group's efforts to improve the stock assessment of bluefin tuna will be presented at the 2007 ISC Plenary meeting.

Biological and Oceanographic Research − The SWFSC conducts research on the biology of a tuna, billfishes and pelagic sharks. Projects range from behavior and movement of North Pacific albacore to food habits of sharks. A few of the projects are described below.

Albacore

- Since 1971, the SWFSC has had an ongoing partnership with the West-Coast based U.S. albacore fishing industry. Research is conducted in cooperation with the American Fishermen's Research Foundation (AFRF), a private foundation established by the Western Fishboat Owner's Association to promote research on albacore and related species. Since 2001, SWFSC and AFRF have been conducting an archival tagging project to study migratory patterns, depth and temperature preferences of North Pacific albacore. The original objectives of the long-term study were to deploy 500 archival tags from 2001-06 and recover tags from 50 fish assuming a 10% recovery rate. Through October 2006, 504 archival tags were deployed of which 17 have been recovered. Most fish were at liberty for over a year and have provided over 5,000 days of data and nearly 8 million records of depth, water temperature, and body temperature as well as information on large-scale movement patterns. Fish ranged from the southern tip of Baja to Vancouver Island and from the coast of North America to the central North Pacific. Most fish demonstrated a diurnal pattern of repetitive deep diving (routinely to depths of 250 to 300 meters) during the day while remaining in the upper 50 m at night.

- The SWFSC is also collaborating with PIFSC scientists to better define albacore habitat in the north Pacific. Catches recorded in logbook data from the U.S. albacore troll fishery are being examined in relation to satellite derived images of oceanographic features on a fine scale resolution (sea surface temperature, chlorophyll and height).

Billfishes

- The SWFSC's Billfish Tagging Program began in 1963 and has provided tagging supplies to recreational billfish anglers for 44 continuous years. Tag release and recapture data are used to determine movement and migration patterns, species distribution, and the age and growth patterns of billfish. This volunteer tagging program depends on the participation and cooperation of recreational anglers, sport fishing organizations, and commercial fishers. Since its inception over 54,000 fish of 75 different species have been tagged and released. Emphasis continues to be on the skillful tagging of billfish and bluefin tuna only. The tagging of other sport fish is not encouraged by this program. Billfish Tagging Report cards received for 2005 indicate that a total of 1,359 billfish and 122 other fish were tagged and released by 1,010 anglers and 173 fishing captains In all, 728 blue marlin, 268 striped marlin, 164 sailfish, 184 spearfish, 9 black marlin and 5 unknown billfish were reported tagged and released.

- In 2002, National Marine Fisheries Service scientists from the SWFSC and SEFSC joined forces with the Presidential Challenge billfish tournament series conducted off the coasts of Central America and Mexico to establish the Adopt-A-Billfish satellite tagging program. During Phase I efforts, 41 satellite archival tags were deployed on sailfish during tournaments in central Mexico, Guatemala, Costa Rica and Panama yielding a wealth of information on the vertical and horizontal movements. In August 2006, the program embarked on Phase II to monitor sailfish in the Sea of Cortez and to study larger animals on their spawning grounds. The first research trip of Phase II was conducted August 8-10, 2006 at East Cape, Baja California Sur, Mexico. Working with two colleagues from Mexican Research Institutes, the NMFS team deployed 4 satellite tags on sailfish and conducted plankton net tows for billfish larvae. Although the sailfish were on the small size, averaging 40 lbs or less, the tags of all 4 fish had reported by 120 days. Predictably, the sailfish moved to the southeast toward warmer water. Plankton samples are being analyzed to determine whether billfish were spawning in the area. Further efforts in the Sea of Cortez are planned for 2007.

- The SWFSC continued monitoring recreational billfish catch in the Pacific through the Billfish Angler Survey. Results for recreational fishing in 2005 were compiled in 2006 and published in the 2006 angler survey. In 2005, billfish anglers reported catching 2,471 Pacific billfish during 4,103 fishing days. The mean CPUE for all billfish in the Pacific for 2005 was 0.62, which is lower than the record set in 2003 of 0.87 but similar to the average over the last 6 years (0.62-0.66). This was a new high six-year average catch rate for the entire time series, which extends back to 1969. The lowest value (0.34) was reported for the late 1970s (1975-1979) when billfish stocks were being impacted by large, international, commercial fisheries. CPUE time series were extended for each of the main species caught (Pacific blue marlin, striped marlin, Pacific sailfish, and black marlin) in the main fishing areas (Tahiti, Hawaii, Baja, southern California, Mexico, Guatemala, Costa Rica, Panama, and Australia).

- Starting in 2006 SWFCS initiated studies on the movements and behaviors of swordfish in the Southern California Bight. Swordfish are the primary target

species of the local drift gillnet fishery and a summer harpoon fishery and movements, behaviors, and stock structure are all poorly understood. Two of the primary objectives of this study are to examine the vertical and geographic movements of swordfish and determine the impact of oceanography on their distribution and behavior. This study is being conducted using pop-up satellite tags deployed in collaboration with the California harpoon fleet. Efforts over the last year have focused primarily on data analysis. Results to date indicate distinct shifts in vertical movements with location. For example, in fish that moved southwest away from the tagging locations, daytime depth increased from around 300 to 500 m. For fish that moved south or southeast remaining closer to the coast, daytime depth actually decreased from 300 to as shallow as 90 m during the day. Nightime depths were constrained to the mixed layer and increased significantly with lunar illumination. A third objective is to determine stock structure using otolith microchemistry. California is hypothesized to be a region of mixing of two potential stocks. The collection of otoliths was initiated in 2006 using specimens collected both from the drift gillnet fleet and the local harpoon fleet.

Pelagic Sharks

- A wide range of biological studies are conducted in conjunction with the abundance surveys for juvenile shortfin mako, blue and common thresher sharks. Some past and ongoing efforts include conventional tagging for movement information, taking biopsies for genetics studies, marking with oxytetracycline (OTC) for age and growth studies, taking blood samples for condition factors caused by capture stress and/or injury, acoustic and satellite archival tagging for movement and physical habitat pattern descriptions, and a variety of physiological studies addressing cardiac function, swimming performance, and condition factors. During the 2006 surveys 272 blue sharks, 111 shortfin mako sharks, 2 common thresher sharks, 23 pelagic rays (*Dasyatis violacea*), 3 ocean sunfish (*Mola mola)* and 1 lancet fish *(Alepisaurus brevirostris)* were caught. One hundred and eleven sharks were tagged with conventional tags and sampled for DNA analysis and 93 were marked with OTC for age and growth studies. Satellite tags were deployed on 12 makos, one thresher, two blue sharks and three ocean sunfish. The satellite tagging is being conducted in collaboration with the TOPP (Tagging of Pacific Pelagics) program.

- Studies of age and growth were initiated with mako sharks in 1997 and have since expanded to include thresher sharks as well. Since the beginning of the program, 948 OTC-marked individuals have been released during juvenile shark surveys. In 2006, 93 makos and 192 common thresher sharks were tagged and marked with OTC. As of January 2007, 50 mako sharks and 12 common thresher sharks have been recovered (6.2%). Of these, vertebrae were collected and returned from 28 sharks. Time at liberty ranged from 7 to 1,594 days with net movements of individual sharks as high as 2,648 nautical miles. Preliminary analyses of the labeled vertebrae from mako sharks indicate the formation and deposition of two band pairs (opaque and semi-translucent) per year. This is an extremely important finding as the question of whether the shortfin mako lays down one or two band pairs per year has been an ongoing uncertainty, with independent labs reporting conflicting results. The result has dramatic implications for age and productivity

estimates incorporated into stock assessments. In addition, growth during the time at liberty from these recovered mako sharks combined with recapture information from a larger-scale conventional tagging effort, demonstrates average growth rates of 18 to 25 cm/year for juvenile makos (size range of roughly 90-160 cm FL at the time of tagging).

- SWFSC scientists are also studying the movement and habitat use patterns of common thresher sharks, which are an important target species of the west coast based drift gillnet fishery. A satellite-tagging project was started in 1999 in the Southern California Bight during the spring-summer occupancy. Satellite tags have been deployed on 27 individuals during the years 1999, 2004, 2005 and 2006. While analyses are still ongoing, results provide important fishery-independent information about this species, previously known exclusively from catch data. Depth and temperature records demonstrate that common thresher sharks have a distinct diurnal pattern. Thresher sharks spend most of the day at depths around 200 m but remain close to the surface at night. The data are being examined with respect to oceanographic features (bathymetry, surface temperature, water column profile, and surface chlorophyll) in order to quantify the essential habitat of these sharks and determine how the physical environment influences movements and behaviors.

Since 1999, efforts at SWFSC have focused on the foraging ecology of pelagic sharks including blue, shortfin mako, common thresher and bigeye thresher sharks. A comparison of the first 12 prey items ranked by GII for each species reveals distinct diet differences among the species. Mako sharks fed on a combination of different taxa of teleosts and cephalopods. Blue sharks fed primarily on different squid species. Common threshers consumed mostly teleosts, especially coastal pelagic species, and very little squid. Bigeye threshers contained midwater and epipelagic species as well as some benthic species. Bigeye threshers consumed taxa covering the broadest range of prey and habitat types, suggesting that they are opportunistic feeders.

Fishery Management Research − A limited but important number of studies at the SWFSC falls into this category of fishery management research. SWFSC researchers are applying different economic models to understand the economics of fishing and factors contributing to overcapacity in tuna fisheries. Included in the studies is analysis of incentives for reducing sea turtles interaction in longline fisheries, such as in the North Pacific.

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1.2.3 Statistical data systems

Monitoring of the U.S. purse seine fishery vessels consists of collecting catch and effort logbooks, monitoring landings, and conducting a statistically based sampling program to estimate size composition of the landings. Details have been provided earlier in this report.

The Hawaii-based longline fishery is monitored using the NMFS Western Pacific Daily Longline Fishing Logs for effort and resulting catch and State of Hawaii Commercial Marine Dealer reports for landings in weight and individual fish weights. The California-based longline fishery has been monitored using a variety of logbooks (most recently the NMFS Western Pacific Daily Longline Fishing Logbook and earlier the NMFS High Seas Pelagic Longline Logbook, the California Department of Fish and Game Pacific Offshore Logbook) and the California Department of Fish and Game Landing Ticket system, which documents landings in weight. The American Samoa-based longline fishery is monitored using the NMFS Western Pacific Daily Longline Fishing Logbook for effort and resulting catch, a Territory of American Samoa Creel Survey to estimate size of catch by small longline vessels, and cannery sampling for size of catch by large longline vessels.

Prior to 1995, U.S. distant-water troll vessels targeting albacore voluntarily submitted logbook records to the NMFS. Beginning in 1995, troll vessels on the high seas have been required to submit logbooks. Details were provided above

Small-scale fisheries in Hawaii, i.e., troll, handline, and pole-and-line, are monitored by the State of Hawaii with Commercial Fishermen's Catch data and Commercial Marine Dealer data. The troll fisheries in American Samoa, Guam, and Northern Mariana Islands are monitored with a combination of Territory and Commonwealth Creel Survey and Market monitoring programs.