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UNITED STATES OF AMERICA

2008 Annual Report to the Western and Central Pacific Fisheries Commission

United States of America

PART I. INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS [1] (For 2007)

National Oceanic and Atmospheric Administration National Marine Fisheries Service

Revised September 25, 2008

Summary

Large-scale U.S. fisheries for highly migratory species in the Pacific include purse seine fisheries for skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) tunas, longline fisheries for bigeye tuna (*Thunnus obesus*), swordfish (*Xiphias gladius*), and associated species, and a troll fishery for albacore (*Thunnus alalunga*). Small-scale fisheries include troll fisheries for a wide variety of tropical tunas and associated species, handline fisheries for yellowfin and bigeye tuna, and a pole-and-line fishery for skipjack tuna. Associated species include other tunas and billfishes, mahimahi (*Coryphaena hippurus*), and wahoo (*Acanthocybium solandri*). The large scale fisheries operate on the high seas, within the U.S. exclusive economic zone (EEZ), and within the EEZs of other states. The small-scale fisheries operate in nearshore waters in the EEZs of American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and Hawaii.

The increase in total USA landings in the Western and Central Pacific Fisheries Commission (WCPFC) statistical area in 2007 was primarily a result of increased purse seine and longline activity. The purse seine industry responded to improved skipjack tuna prices. Longline landings increased in 2007 after decreasing in 2006 when the fishery sector targeting swordfish was closed during April–December to limit the bycatch of sea turtles. Bigeye tuna landings by longliners reached a record high of 5,614 t in 2007. Swordfish landings increased to 1,443 t in 2007 from 1,149 t in 2006. Small-scale (tropical) trollers and handliners operating in Pacific island waters represented the largest number of vessels but contributed a small fraction of the catch. The longline fleet was the next largest fleet, numbering 156 in 2007, up from 154 in 2006. The troll fishery for albacore declined with active vessels reduced to 6 in 2007 from 8 in 2006.

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries) conducted research on Pacific tuna and associated species at its Southwest and Pacific Islands Fisheries Science Centers and in collaboration with scientists from other organizations. Fisheries monitoring and economics work included a continuing survey of recreational billfish anglers, indicating improved catch rates in recent years. Improvements were made to the integration of fisheries statistics from fishermen's reports with data from fish sales. Monitoring of the retail fish market in Honolulu was initiated to investigate consumer choices with regard to raw tuna products prepared from fresh tuna and

[1] **PIFSC Data Report DR-08-008**
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tuna treated with carbon monoxide. Stock assessment research was conducted in collaboration with member scientists of international regional fisheries management organizations, including the WCPFC and the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). The stock assessment work is not described in this report.

NOAA Fisheries biological and oceanographic research on tunas, billfishes, and sharks addressed fish movements, habitat choices, post capture survival, feeding habits, and age and growth. Salient results include a model analysis of bigeye tuna habitat depth derived from archival tag studies that predicts the high CPUE found in the fourth quarter in the Hawaii-based longline fishery. Another study suggests that the South Equatorial Counter Current (SECC) strongly influences the American Samoa longline fishery for albacore and changes strength in concert with seasonal and ENSO cycles. Research on bycatch and fishing technology included testing of circle hooks and development of a near real-time advisory to help longline vessels avoid areas in the North Pacific Subtropical Frontal Zone with a high potential for interaction with loggerhead sea turtles. Other studies were carried out to test a promising technique to reduce shark bycatch by attaching electropositive metal ingots to longline fishing gear.

1.1 ANNUAL FISHERIES INFORMATION

This report presents estimates of annual catches of tuna, billfish, and other highly migratory species (HMS), and vessel participation during 2003-2007 for U.S. fisheries operating in the western and central Pacific Ocean (WCPO). All statistics for 2007 are provisional. For the purposes of this report, the WCPO is defined as the Western and Central Pacific Fisheries Commission (WCPFC) Statistical Area. Information on fisheries is provided and pelagic research over the last year is described. U.S. fisheries include large-scale purse seine, longline, and albacore (*Thunnus alalunga*) 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 (tropical) 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 in 2007, accounting for 79% of the total U.S. catch[2] of HMS in the WCPO. The longline, albacore troll, tropical troll, handline, and pole-and-line fisheries accounted for 18%, 0.2%, 1.8%, 0.7%, and 0.3% of the total catch, respectively. The purse seine, longline, tropical troll, and handline catch increased and the albacore troll and pole-and-line catch decreased in 2007 in comparison to 2006. U.S. fisheries for tunas, billfishes and other pelagic species produced an estimated 91,844 metric tons (t) of catch in 2007 (Table 1a), up from 86,432 t in 2006 (Table 1b). The catch consisted primarily of skipjack tuna (*Katsuwonus pelamis*, 67%), bigeye tuna (*Thunnus obesus*, 11%), yellowfin tuna *Thunnus albacares*, 11%), and albacore (6.4%). Catches of all these species except yellowfin tuna increased in 2007 as compared with 2006, and the greatest increase was for skipjack tuna (up 4,940 t from 2006).

[2] 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, weight estimates do not include at-sea discards or subsistence or recreational catches. In the future, the longline weight estimates may include at-sea discards.

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 2007 (provisional). Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0). Revised data in colored font.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Pole & line	TOTAL
Albacore (ALB), North Pacific	0	244	0	4	96	0	344
Albacore (ALB), South Pacific[1]	0	5,337	218	0	0	0	5,555
Bigeye tuna (BET)	3,938	5,614	0	62	259	0	9,873
Pacific bluefin tuna (PBF)	0	0	0	0	0	0	0
Skipjack tuna (SKJ)	60,641	257	0	276	0	272	61,446
Yellowfin tuna (YFT)	7,625	1,451	0	472	231	23	9,802
Other tuna (TUN KAW FRI)	0	2	0	13	1	1	17
TOTAL TUNAS	72,204	12,905	218	827	587	296	87,037
Black marlin (BLM)	0	1	0	0	0	0	1
Blue marlin (BUM)	0	295	0	122	1	0	418
Sailfish (SFA)	0	11	0	0	0	0	11
Spearfish (SSP)	0	142	0	0	0	0	142
Striped marlin (MLS), North Pacific	0	265	0	13	0	0	278
Striped marlin (MLS), South Pacific	0	1	0	0	0	0	1
Other marlins (BIL)	0	1	0	12	0	0	13
Swordfish (SWO), North Pacific	0	1,443	0	0	5	0	1,448
Swordfish (SWO), South Pacific	0	13	0	0	0	0	13
TOTAL BILLFISHES	0	2,171	0	147	6	0	2,324
Blue shark (BSH)	0	7	0	0	0	0	7
Mako shark (MAK)	0	119	0	0	0	0	119
Thresher sharks (THR)	0	43	0	0	0	0	43
Other sharks (SKH OCS FAL SPN TIG CCL)	0	7	0	0	0	0	7
TOTAL SHARKS	0	176	0	0	0	0	176
Mahimahi (DOL)	0	398	0	419	10	0	827
Moonfish (LAP)	0	454	0	0	0	0	454
Oilfish (GEP)	0	181	0	0	0	0	181
Pomfrets (BRZ)	0	237	0	0	0	0	237
Wahoo (WAH)	0	365	0	216	3	0	584
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	10	0	14	0	0	24
TOTAL OTHER	0	1,645	0	649	13	0	2,307
TOTAL	72,204	16,897	218	1,623	606	296	91,844

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 2006. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0). Revised data in colored font.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Pole & line	TOTAL
Albacore (ALB), North Pacific	0	256	2	1	94	0	353
Albacore (ALB), South Pacific[1]	0	4,078	585	0	0	0	4,663
Bigeye tuna (BET)	4,364	4,562	0	56	247	0	9,229
Pacific bluefin tuna (PBF)	0	1	0	0	0	0	1
Skipjack tuna (SKJ)	55,633	283	0	296	0	294	56,506
Yellowfin tuna (YFT)	8,448	1,450	0	299	209	3	10,409
Other tuna (TUN KAW FRI)	0	4	0	11	1	3	19
TOTAL TUNAS	68,445	10,635	587	663	551	300	81,181
Black marlin (BLM)	0	1	0	0	0	0	1
Blue marlin (BUM)	0	433	0	158	2	0	593
Sailfish (SFA)	0	15	0	0	0	0	15
Spearfish (SSP)	0	162	0	0	0	0	162
Striped marlin (MLS), North Pacific	0	609	0	21	0	0	630
Striped marlin (MLS), South Pacific	0	4	0	0	0	0	4
Other marlins (BIL)	0	4	0	14	0	0	18
Swordfish (SWO), North Pacific	0	1,149	0	0	4	0	1,153
Swordfish (SWO), South Pacific	0	38	0	0	0	0	38
TOTAL BILLFISHES	0	2,415	0	193	6	0	2,614
Blue shark (BSH)	0	10	0	0	0	0	10
Mako shark (MAK)	0	95	0	0	0	0	95
Thresher sharks (THR)	0	33	0	0	0	0	33
Other sharks (SKH OCS FAL SPN TIG CCL)	0	12	0	0	0	0	12
TOTAL SHARKS	0	151	0	0	0	0	151
Mahimahi (DOL)	0	342	0	420	20	0	782
Moonfish (LAP)	0	482	0	0	0	0	482
Oilfish (GEP)	0	175	0	0	0	0	175
Pomfrets (BRZ)	0	251	0	0	0	0	251
Wahoo (WAH)	0	505	0	256	4	0	765
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	14	0	19	0	0	33
TOTAL OTHER	0	1,768	0	695	24	0	2,487
TOTAL	68,445	14,968	587	1,551	581	300	86,432

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 2005. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0). Revised data in colored font.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Pole & line	TOTAL
Albacore (ALB), North Pacific	0	287	89	6	169	0	551
Albacore (ALB), South Pacific[1]	0	2,936	487	0	0	0	3,423
Bigeye tuna (BET)	6,108	4,596	0	85	210	0	10,999
Pacific bluefin tuna (PBF)	0	0	0	0	0	0	0
Skipjack tuna (SKJ)	62,379	233	0	264	0	353	63,229
Yellowfin tuna (YFT)	17,685	1,224	0	361	321	68	19,659
Other tuna (TUN KAW FRI)	0	4	0	12	2	1	19
TOTAL TUNAS	86,172	9,279	576	728	702	422	97,879
							0
Black marlin (BLM)	0	1	0	0	2	0	3
Blue marlin (BUM)	0	350	0	185	0	0	535
Sailfish (SFA)	0	8	0	0	0	0	8
Spearfish (SSP)	0	203	0	0	0	0	203
Striped marlin (MLS), North Pacific	0	493	0	20	0	0	513
Striped marlin (MLS), South Pacific	0	3	0	0	0	0	3
Other marlins (BIL)	0	2	0	15	0	0	17
Swordfish (SWO), North Pacific	0	1,475	0	0	5	0	1,480
Swordfish (SWO), South Pacific	0	8	0	0	0	0	8
TOTAL BILLFISHES	0	2,542	0	220	7	0	2,769
							0
Blue shark (BSH)	0	25	0	0	0	0	25
Mako shark (MAK)	0	96	0	0	0	0	96
Thresher sharks (THR)	0	33	0	0	0	0	33
Other sharks (SKH OCS FAL SPN TIG CCL)	0	4	0	0	0	0	4
TOTAL SHARKS	0	157	0	0	0	0	157
							0
Mahimahi (DOL)	0	449	0	350	23	0	822
Moonfish (LAP)	0	412	0	0	0	0	412
Oilfish (GEP)	0	156	0	0	0	0	156
Pomfrets (BRZ)	0	270	0	0	0	0	270
Wahoo (WAH)	0	420	0	215	5	0	640
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	14	0	22	0	0	36
TOTAL OTHER	0	1,721	0	587	0	0	2,308
							0
TOTAL	86,172	13,700	576	1,535	737	422	103,142

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 2004. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0).

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Pole-and-line	TOTAL
Albacore (ALB), North Pacific	0	356	714	3	154	0	1,227
Albacore (ALB), South Pacific	0	2,462	1,141	0	0	0	3,603
Bigeye tuna (BET)	5,031	4,438	0	149	232	0	9,850
Pacific bluefin tuna (PBF)	0	1	0	0	0	0	1
Skipjack tuna (SKJ)	47,896	371	0	260	0	279	48,806
Yellowfin tuna (YFT)	14,492	1,589	0	370	379	17	16,847
Other tuna (TUN KAW FRI)	0	9	0	37	8	0	54
TOTAL TUNAS	67,419	9,226	1,855	819	773	296	80,388 0
Black marlin (BLM)	0	10	0	0	0	0	10
Blue marlin (BUM)	0	290	0	186	2	0	478
Sailfish (SFA)	0	13	0	0	0	0	13
Spearfish (SSP)	0	182	0	0	0	0	182
Striped marlin (MLS), North Pacific	0	378	0	34	1	0	413
Striped marlin (MLS), South Pacific	0	2	0	0	0	0	2
Other marlins (BIL)	0	0	0	23	0	0	23
Swordfish (SWO), North Pacific	0	1,072	0	0	7	0	1,079
Swordfish (SWO), South Pacific	0	4	0	0	0	0	4
TOTAL BILLFISHES	0	1,951	0	243	10	0	2,204 0
Blue shark (BSH)	0	59	0	0	0	0	59
Mako shark (MAK)	0	65	0	0	0	0	65
Thresher sharks (THR)	0	55	0	0	0	0	55
Other sharks (SKH OCS FAL SPN TIG CCL)	0	8	0	0		0	8
TOTAL SHARKS	0	187	0	0	0	0	187 0
Mahimahi (DOL)	0	472	0	633	39	1	1,145
Moonfish (LAP)	0	329	0	0	0	0	329
Oilfish (GEP)	0	143	0	0	0	0	143
Pomfrets (BRZ)	0	321	0	0	0	0	321 0
Other fish (WAH PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	449	0	263	4	0	716
TOTAL OTHER	0	1,714	0	896	43	1	2,654 0
TOTAL	67,419	13,078	1,855	1,958	826	297	85,433

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 2003. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0).

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Pole-and-line	TOTAL
Albacore (ALB), North Pacific	0	524	2,419	5	80	0	3,028
Albacore (ALB), South Pacific	0	3,931	1,573	0	0	0	5,504
Bigeye tuna (BET)	4,470	3,632	0	37	176	0	8,315
Pacific bluefin tuna (PBF)	0	0	0	0	0	0	0
Skipjack tuna (SKJ)	62,907	320	0	277	0	586	64,090
Yellowfin tuna (YFT)	20,079	1,306	0	376	362	33	22,156
Other tuna (TUN KAW FRI)	0	1	0	23	2	4	30
TOTAL TUNAS	87,456	9,714	3,992	718	620	623	103,1230
Black marlin (BLM)	0	11	0	0	0	0	11
Blue marlin (BUM)	0	366	0	209	2	0	577
Sailfish (SFA)	0	11	0	0	0	0	11
Spearfish (SSP)	0	241	0	0	0	0	241
Striped marlin (MLS), North Pacific	0	543	0	29	0	0	572
Striped marlin (MLS), South Pacific	0	4	0	0	0	0	4
Other marlins (BIL)	0	0	0	18	0	0	18
Swordfish (SWO), North Pacific	0	1,957	0	0	9	0	1,966
Swordfish (SWO), South Pacific	0	7	0	0	0	0	7
TOTAL BILLFISHES	0	3,140	0	256	11	0	3,4070
Blue shark (BSH)	0	17	0	0	0	0	17
Mako shark (MAK)	0	87	0	0	0	0	87
Thresher sharks (THR)	0	49	0	0	0	0	49
Other sharks (SKH OCS FAL SPN TIG CCL)	0	8	0	0	0	0	8
TOTAL SHARKS	0	161	0	0	0	0	1610
Mahimahi (DOL)	0	339	0	323	20	0	682
Moonfish (LAP)	0	460	0	0	0	0	460
Oilfish (GEP)	0	116	0	0	0	0	116
Pomfrets (BRZ)	0	180	0	0	0	0	1800
Other fish (WAH PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	435	0	274	6	0	715
TOTAL OTHER		1,530		597	26	0	2,1530
TOTAL	87,456	14,545	3,992	1,571	657	623	108,844

Table 2. Number of United States vessels that reported catches in the WCPO, by gear type, 2003-2007. Data for 2007 are provisional. Revised data in colored font.

	2007	2006	2005	2004	2003
Purse seine[1]	13	13	15	21	26
Longline (N Pac-based)[2]	129	127	125	125	110
Longline (American Samoa-based)	29	28	36	41	51
Total U.S. Longline[3]	156	154	156	183	185
Albacore troll (N Pac)	1[4]	3[4]	5[4]	28	69
Albacore troll (S Pac)	6	8	8	11[4]	14[4]
Tropical troll	1,835	1,857	1,846	1,884	1,890
Handline	401	375	432	451	432
Tropical Troll and Handline (combined)[5]	1,907	1,924	1,917	2,012	1,960
Pole and line[6]	3	4	3	4	7
TOTAL	2,085	2,103	2,099	2,333	2,321

[1]Two purse seine vessels were between 51-1,000 gross registered tons (GRT), 10 were between 1,001-1,500 GRT, and 1 was greater than 1,500 GRT in 2007. Data on prior years is being compiled for the next report.
[2]Includes Hawaii- and California-based vessels that fished west of 150° W (none from California in 2005–2007).
[3]Some vessels fish in both Hawaii and American Samoa and are counted only once in this total. There were were 15 longline vessels between 0-50 GRT, and 141 between 51-200 GRT in 2007.
[4]These vessels fished on both sides of the equator and are counted only once in the bottom line TOTAL.
[5]Some vessels fished both tropical troll and handline and are counted only once in this total.
[6]One pole-and-line vessels was less than 50 GRT and two were between 51 and 100 GRT in 2007.

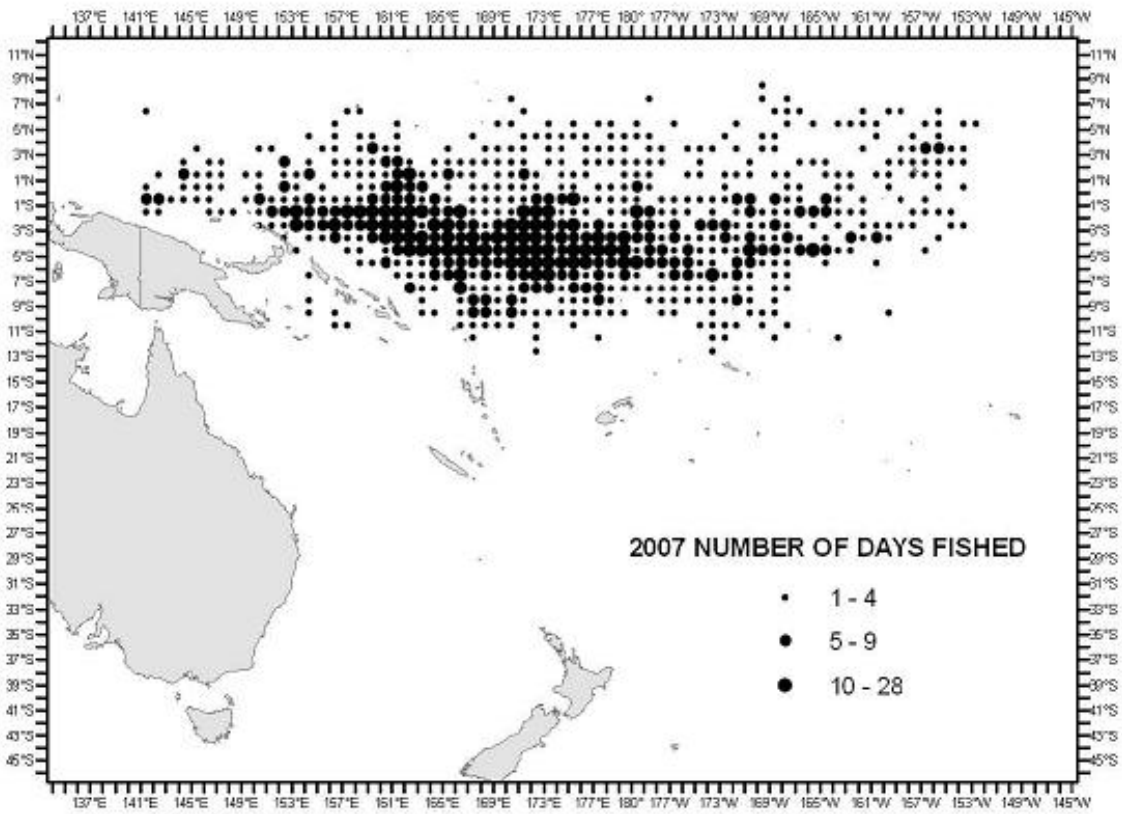

Figure 1. Distribution of annual U.S. purse seine effort, 2007 (provisional).

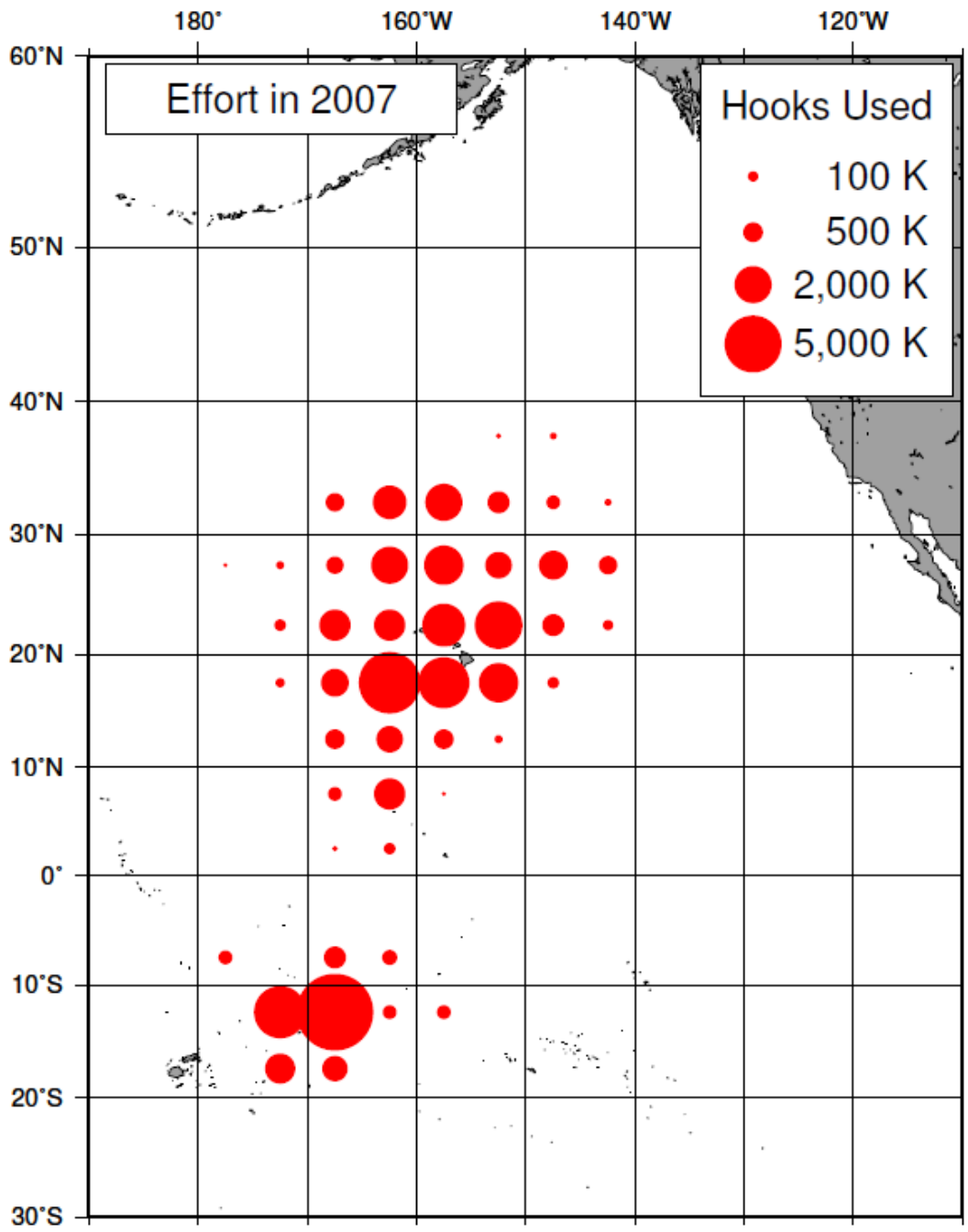

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Figure 2a. Spatial distribution of reported logbook fishing effort by the U.S. longline fleet, in 1,000's of hooks (K), in 2007 (provisional data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

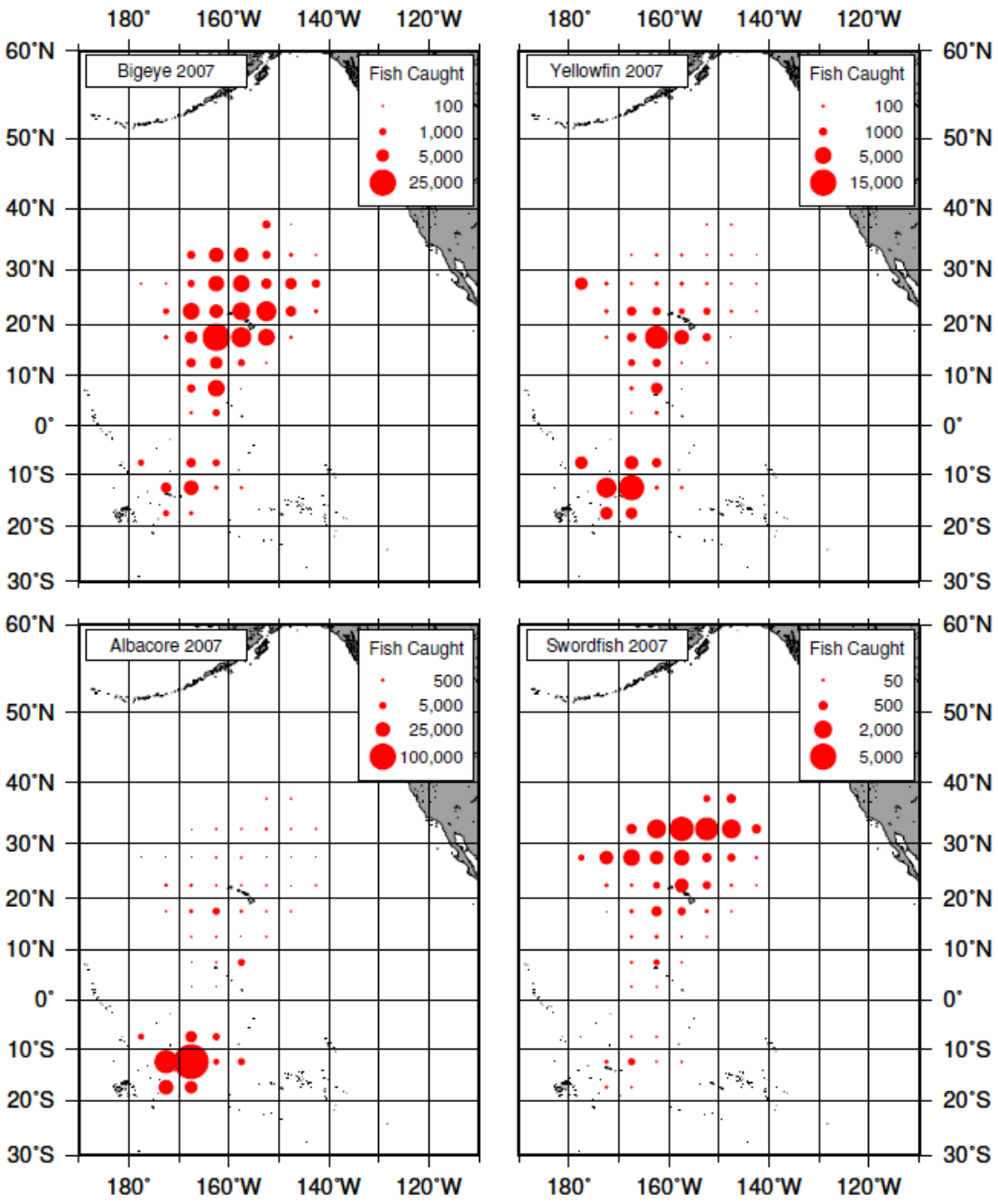

Figure 2b. Spatial distribution of reported logbook catch in the WCPO by the U.S. longline fleet, in numbers of fish (includes retained and released catch), in 2007 (provisional data). Area of circles is proportional to catch. Catches in some areas are not shown in order to preserve data confidentiality.

Table 3. Estimated total numbers of fishery interactions (not necessarily resulting in mortalities or serious injury) with non-fish species by shallow-set and deep-set (combined) longline fishing in the Hawaii-based fishery during 2005-2007[3]. Data from the shallow-set fishery in the 4th quarter of 2007 were excluded to preserve confidentiality (<3 vessels were observed). Estimates of total marine mammal interactions by the deep-set fishery in 2007 have not yet been completed; only the observed values are included here. Rigorous estimates have not yet been developed for the American Samoa-based fishery given the low-level of observer coverage in that fleet.

Species	2005	2006	2007
Marine mammals			
Striped dolphin (*Stenella coeruleoalba*)	0	6	0
Bottlenose dolphin (*Tursiops truncatus*)	0	2	3
Risso's dolphin (*Grampus griseus*)	4	7	4
Unidentified dolphin (Delphinidae)	0	9	1
Blainville's beaked whale (*Mesoplodon blainvillei*)	6	0	0
Bryde's whale (*Balaenoptera edeni*)	1	0	0
False killer whale (*Pseudorca crassidens*)	6	17	4
Humpback whale (*Megaptera novangliae*)	0	1	
Shortfinned pilot whale (*Globicephala macrorhynchus*)	6	6	1
Unidentified Whale (Cetacea)	1	14	1
TOTAL MARINE MAMMALS	24	62	14
Sea turtles			
Loggerhead turtle (*Caretta caretta*)	10	17	22
Leatherback turtle (*Dermochelys coriacea*)	12	11	9
Olive Ridley turtle (*Lepidochelys olivacea*)	16	54	27
Green turtle (*Chelonia mydas*)	0	6	0
Unidentified hardshell turtle (Cheloniidae)	0	2	0
TOTAL SEA TURTLES	38	90	58
Albatrosses			
Blackfooted albatross (*Phoebastria nigripes*)	89	73	85
Laysan albatross (*Phoebastria diomedia*)	105	15	83
TOTAL ALBATROSS	194	88	168
Observer Information			
Total trips	1,483	1,357	1,451
Observed trips	466	332	347
Proportion of trips observed	31.4%	24.5%	23.9%
Observed sets	6,206	4,544	5,002
Observed hooks	10,689,477	8,285,411	8,912,119

[3] 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 07-006 and IR-08-007. Hawaii-based longline logbook reported data on fish discards are available at http://www.pifsc.noaa.gov./fmsd/hlrep.php

1.1.1 Developments and trends

U.S. Purse Seine Fishery

The U.S. Purse seine catch of 72,204 t in 2007 was composed primarily of skipjack tuna, with smaller catches of yellowfin and bigeye tuna. Total catches were higher in 2003 and 2005, and lower in 2004 and 2006 (Tables 1a-1e). The number of active vessels declined from 26 in 2003 to 13 in 2006. Preliminary logbook data compiled for this report indicate the same number (13) of vessels active in 2007 as in 2006 (Table 2) but vessel participation is known to be increasing in 2008, partly in response to improving prices for skipjack tuna. Yellowfin tuna catches in the fishery declined by 10% from 2006 to 2007 (823 t) and skipjack tuna catches increased by 9% (5,008 t). The fishery operated mainly in areas between 5° N and 10° S latitude and 130° E and 150° W longitude in 2007 (Figure 1). Fishing effort expanded eastward, and also had an increased concentration northward in the western part of the fishing grounds compared with 2006. 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 on free-swimming schools and schools associated with floating objects, including logs and fish aggregating devices (FADs).

U.S. Longline Fisheries

The U.S. longline fisheries include vessels based in Hawaii, California (together these comprise the North Pacific-based fishery, Table 2), and American Samoa. The total number of longline vessels in the WCPO declined from 185 in 2003 to 156 vessels in 2007 (Table 2). The Hawaii-based fishery consistently had the highest number of vessels in operation, increasing from 110 in 2003 to 129 in 2007. Participation in the American Samoa-based fleet declined from 51 vessels in 2003 to 29 in 2007. A few vessels occasionally operated in both fisheries.

The Hawaii-based longline fishery operated mainly from the equator to 40^{o} N latitude and from 140^{o} W to the dateline in 2007 (Figure 2a), representing some expansion to the east, north, and west as compared with 2006. Effort in 2007 more closely resembled the norm for the fishery which was somewhat constrained in 2006 by early curtailment of shallow-set fishing for swordfish (*Xiphias gladius*) to conserve sea turtles. 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 and 2007, with a little expansion to the west of this area in 2007 (Figure 2a). The Hawaii-based fishery targeted bigeye tuna, swordfish, and associated species, whereas the American Samoa-based fishery targeted mainly albacore, with a small number of vessels exploring shallow-set fishing for swordfish in recent years. The dominant components of the catch in 2006 and 2007 were bigeye tuna, albacore, yellowfin tuna, and swordfish (Figure 2b). The total catch of all species ranged from a low of 13,078 t in 2004, to a high of 16,897 t in 2007 (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 California-based longline fishery was closed concomitantly with the reopening of the Hawaii fishery; this prompted many California 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. Swordfish landings were low in 2004 and 2006 and higher in 2005 and 2007. In 2006, the shallow-set longline fishery reached its allowable annual limit of loggerhead interactions (17) in March and accordingly was closed for the remainder of the year. The fishery remained open all year in 2007.

U.S. Albacore Troll Fishery

In recent years, the U.S. troll fishery for albacore experienced significant decline in participation. The number of vessels participating in the WCPO portion of this fishery declined from 69 vessels in the North Pacific in 2003 (of which 14 also fished in the South Pacific) to only 6 vessels in 2007, down from 8 in 2006 (Table 2). All 6 of these vessels fished the South Pacific in 2007 but only 1 also fished in the WCPO north of the equator, down from 3 in 2006. The albacore troll fishery operated mostly between 35° S and 45° S latitude and 115° W and 170° W longitude. In the North Pacific the location of fishing and catch by the single vessel in the WCPO is company-sensitive (or "fisheries confidential") information and accordingly was excluded from this report. The South Pacific albacore troll catches in the WCPO also declined substantially, dropping from 1,573 t in 2003 to 585 t in 2006 and 218 t in 2007 (Tables 1a-1e). In the WCPO, the North Pacific component of the catch declined dramatically from 2,419 t in 2003 to only 2 t in 2006. The catch by this fishery was composed exclusively of albacore.

Other U.S. Fisheries

The data on other US fisheries come mostly from vessels participating in small-scale tropical troll, handline, and pole-and-line fleets, but also include some data from miscellaneous recreational and subsistence fisheries monitored by creel surveys in American Samoa and Guam. These miscellaneous recreational and subsistence data are included in the tropical troll statistics, as this fishing method is the most common recreational and subsistence fishing technique in these areas. Most of the vessels comprising the U.S. tropical troll fishery, and all of the U.S. handline and pole-and-line vessels are located in Hawaii. The total catch by these fisheries over the last 5 years ranged from a high of 3,081 t in 2004 to a low of 2,432 t in 2006, with a catch of 2,525 t in 2007. The catch was composed primarily of skipjack tuna, yellowfin tuna, and mahimahi (*Coryphaena hippurus*).

1.1.2 Disposition 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 North Pacific-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. These products are sold fresh 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 fresh (for vessels making day trips) or frozen (for vessels making extended trips).

The albacore troll fishery in the South Pacific froze their catch whole and sold the fish to the canneries in Pago Pago, American Samoa, and Papeete, Tahiti. The other fisheries store their catch in ice. Large tunas and marlins are gilled and gutted while other species are kept whole. The small-scale fisheries chill their products with ice and sell it 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 which will likely continue to constrain the economic performance of most U.S. pelagic fisheries. If the current scenario persists, the likely outcome would be lower participation and declining catches in most fisheries. This outcome has been predicted for several years but has not been evident, except perhaps in the albacore troll fishery in the WCPO. Increased investment and participation in the U.S. purse seine fishery is evident. The U.S. Government has indicated its commitment to the South Pacific Tuna Treaty and to maintaining 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 for 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 by the Inter-American Tropical Tuna Commission (IATTC) affected the portion of the Hawaii-based longline fleet that operated in the eastern Pacific Ocean in 2006 when it was projected that the U.S. longline fishery would reach its annual bigeye tuna catch limit established by the IATTC. The fishery operated throughout 2007 without reaching the limit.

In the future the Hawaii-based component of the longline fishery is likely to continue to target tunas primarily, although the proportion of effort targeting swordfish may increase. The swordfish segment of the Hawaii-based longline fishery is seasonal and must operate under strict rules to limit interactions with sea turtles. The rules include an effort limit (number of shallow sets) that has not been reached in the last several years, but could be fully utilized or even increased if current limits are eased. There are viable prospects for achieving this through further reductions in sea turtle bycatch rates, including voluntary efforts to avoid areas of sea turtle concentrations. Domestic managers are considering proposals to allow increased fishing effort for swordfish.

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 may 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 Observer Programs, Port Sampling, and Scientific Survey Data

Observer Programs

U.S. purse seine vessels operating in the WCPO under the Treaty on Fisheries between the Governments of Certain Pacific Island States and the United States of America (The South Pacific Tuna Treaty) pay for, and are monitored by observers from the Pacific Island States 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. These data are not described here. NOAA Fisheries 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 met every year in the last five years.

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.

All U.S. longline vessels are subject to observer placement as a condition of the fishing permits issued by NOAA Fisheries. 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. Fish catch data now includes measurement of a systematic subsample of 33% of all fish brought on deck, including bycatch species. Prior to 2006, fish measurement by observers covered 100% of tunas, billfishes and sharks brought on deck, but not other species.

Researchers use the protected species data to estimate the total number of interactions. In 2007, the observer coverage rate (on a trip basis) in the deep-set (tuna) component of the Hawaii-based longline fishery was 20.1%--for a total of 278 observer trips and 3,506 sets observed. In the shallow-set (swordfish) component of the Hawaii-based fishery, which has a regulatory requirement of 100% observer coverage, all 69 trips were observed, totaling 1,546 sets. These shallow-set summary data exclude data from the 4th quarter when less than 3 vessels fished, making the data for that quarter sensitive with regard to fisheries confidentiality. The U.S. law governing fisheries management was recently changed, making observer data sensitive with respect to fisheries confidentiality. Rules that will allow release of aggregated observer data, as well as provisions that will allow submission of fisheries confidential information to the WCPFC are under development.

Overall 278 + 69 trips were observed out of 1,451 deep-set + 69 shallow-set trips resulting in a combined coverage rate of 23.9% in 2007 (Table 3). The results indicated a lower number of interactions with sea turtles and a higher number of interactions with seabirds in 2007 as compared with 2006. Marine mammal estimates for the deep set fishery in 2007 have not yet been completed, and only the actually observed (minimum) values are provided (Table 3).

Researchers have been using fish species identifications from the Hawaii longline fishery observer database and from the State of Hawaii's fish dealer reporting system to address species misidentifications in longline logbook data. A project estimating corrected species compositions and catch histories of billfishes in the Hawaii-based longline fishery from 1994-2006 was completed and published, but is not yet operationally applied to routine data reporting (i.e., the data reported here).

For the American Samoa-based component of the U.S. longline fishery, 2007 was the first full calendar year observed. The coverage rate was 7.1%--for a total of 11 trips and 410 sets. Scientists have not yet provided rigorous estimates of the total interactions with protected species for this fishery, although some estimates have been made for administrative purposes (not provided here). Detailed information on the U.S. Pacific Islands Regional Observer Program can be found at http://www.fpir.noaa.gov/OBS/obs_index.html.

Port Sampling

U.S. Purse seine, longline, and albacore troll landings are measured for fork length by NOAA Fisheries personnel as vessels land their catches in American Samoa (coverage approximately 1-2% of landings for purse seine, longline, and albacore troll fisheries). Species composition samples are also taken for use in adjusting purse seine logbook-reported data on the numbers of yellowfin tuna versus bigeye tuna. U.S. albacore troll vessel landings are also measured for fork length by port samplers along the U.S. west coast.

International Billfish Angler Survey

NOAA Fisheries and the billfish angling community have worked together since 1963 to study various aspects of billfish biology and obtain an index of angler success in the Pacific Ocean. In 2006, billfish anglers reported catching 5,123 Pacific billfish during 6,045 fishing days. The mean CPUE for all billfish in the Pacific was 0.85, which is just above the previous record of 0.82 set in 2003. With the 2006 data, the new five-year average catch rate is 0.72 billfish per angler day. The time series extends back to 1969, with the lowest five-year average value (0.34) reported for the late 1970s (1975-79). CPUE time series were extended for each of the main species caught, including Pacific blue marlin (*Makaira nigricans*, striped marlin (*Kajikia audax*), Pacific sailfish (*Istiophorus platypterus*), and black marlin (*Makaira indica*) in the main fishing areas (Tahiti, Hawaii, Baja California, Southern California, Mexico, Guatemala, Costa Rica, Panama, and Australia).

Pelagic Shark Survey

To track trends in the abundance of juvenile and sub-adult blue shark (*Prionace glauca*) and shortfin mako shark (*Isurus oxyrinchus*) and neonates of common thresher shark (*Alopias vulpinus*), fishery-independent surveys have been conducted in the Southern California Bight each summer since 1994 for mako and blue sharks and since 2003 for thresher sharks. For mako and blue sharks, there is a declining trend in CPUE for both species since the survey began. While it is still too early to develop a pre-recruit thresher shark index, a number of interesting patterns are emerging across years. Depth-stratified sampling revealed that over half of the neonates were caught in shallow waters from 0 to 46 m and almost all individuals are caught shallower than 90 m. The distribution of thresher sharks is very patchy and areas of high abundance are not consistent across years. In all years, a large percentage of the catch has been neonates, which were found in all areas surveyed.

Economic Surveys

A new retail monitoring system completed a year of data collection on fresh fish retail markets in Honolulu in 2007 to better understand the economic contribution of fisheries and the market impacts of regulations by exploring how price changes travel through the fish 'value chain' from the fisherman to the consumer. The database includes retail-level price data for bigeye and yellowfin tuna. A related study was launched to investigate the attributes of *ahi poke* (a very popular raw tuna product mixed with seasoning) that contribute to consumer choices and to assess how awareness of carbon monoxide (CO) treatment of the *ahi poke* affects consumer purchases. The *ahi poke* survey was completed in May 2008, and may help differentiate the demand for locally produced fresh tuna versus previously frozen and CO-treated tuna.

A new cost-earnings survey was initiated on the Hawaii small boat fishery that harvests mainly pelagic fish using trolling and handling gear. This research was designed to allow fishery managers to better understand the costs of fishing and the economic and social value fishing provides to local communities. Information collected include levels of investment, trip expenditures, scale of fishing effort, spatial effort allocation, gear usage, and access to markets.

Relevant Publications

Allen, S. D., and A. Gough. 2007. Hawaii longline fishermen's experiences with the observer program. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-8, 39 p.

Curran, D., P. Dalzell, J. Schultz, J. O'Malley, and S. Pooley. 2007. Recreational metadata: using tournament data to describe a poorly documented pelagic fishery. Pelagic Fisheries Research Program, JIMAR, SOEST, SOEST 06-03, JIMAR Contribution 06-363.

Walsh, W. A., K. A. Bigelow, and R. Y. Ito. 2007. Corrected catch histories and logbook accuracy for billfishes (Istiophoridae) in the Hawaii-based longline fishery. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-13, 40 p.

1.2.2 Research on Biology, Oceanography, Bycatch, and Fishing Technology

Meta Analysis of Archival Tags

An analysis is underway on the performance of pop-off archival transmitting (PAT) tags deployed on a wide array of highly migratory species. Based on the fate of 1433 tags described in the literature and data from 731 tags provided by collaborators in a performance assessment database, there is a 75% overall reporting rate. There are only two vendors of PSATs, and one vendor's tags were deployed about twice as much as the other's. Logistic and Cox proportional hazards analyses performed on the 731 tags in the database indicate both vendors' tags had virtually the same reporting rate, and that deployment on slow-moving and deep-diving animals are key issues in reduced tag reporting. The slow-moving effect could be due to bio-fouling, and deep diving may cause tag failure due to repeated and extreme variation in pressure. Lower tag retention rates could be linked to higher infection rates, through tag anchor rejection, in areas of higher ocean productivity. Of 662 PSATs attached to

sharks, billfish, tunas and turtles, 520 or 79% reported data, but only 87 or 17% stayed attached until their programmed pop-off date.

North Pacific Albacore Tuna Tagging

The migration patterns and general life history strategies of subadult (ages 2-5) North Pacific albacore have been studied by NOAA Fisheries working with the American Fishermen's Research Foundation (AFRF) since 2001. Through December 2007, 504 archival tags were deployed, twenty of which were recovered. Most of these were at liberty for over a year and provided over 5,000 days of data and nearly nine million samples of water depth, water temperature, and body temperature from tagged fish. Tag returns indicate that the tagged fish: migrated from the southern tip of Baja California to Vancouver Island and from the coast of North America to the eastern coast of Japan; routinely dove to depths of 250 to 300 m during the day while remaining near the surface at night; spent most of their time in areas where surface water temperatures are 15°C to 19°C but dove into deeper waters with temperatures as low as 9°C; conserved internal heat with visceral temperatures averaging 3°C to 4°C above ambient water temperatures. Tagging efforts will continue in 2008.

Central Pacific Bigeye Tuna Tagging

The spatiotemporal variability in bigeye tuna dive behavior in the central North Pacific Ocean was investigated based on data from 29 pop-up archival transmission (PAT) tags deployed on commercial size tuna (mean fork length 122.2 +/- 7.8 cm SD) in the central North Pacific Ocean from 4ºN - 32ºN. During the day, bigeye tuna generally spent time in the 0 – 50 m and 300 – 400 m depth ranges, with spatial and temporal variability in the deep mode. At night, bigeye tuna generally inhabited the 0 – 100 m depth range. Three daily dive types: shallow, intermediate, and deep, were defined based on the distribution of time spent in specific depth layers during the day. . The daily dive types for each fish on each day were tallied, and the totals by dive type represented 24.4% (shallow), 18.8% (intermediate), and 56.8% (deep) of the total number of days for all fish in the study. More shallow and intermediate dive type behavior was found in the first half of the year, and at latitudes between 14ºN and 16ºN and north of 28º N. A greater amount of deep dive behavior was found in south of 10ºN and between 18ºN and 28ºN during the third and fourth quarters of the year. Dive type also varied with oceanographic conditions, with more shallow and intermediate dive behavior found in colder surface waters. Intermediate and deep dive types were pooled to reflect the depths where bigeye may have potential interactions with fishing gear. A generalized additive model showed that sea surface temperature had the most significant effect on the pooled intermediate and deep dive behavior, and predicted that the largest percentage of potential interaction would be in the fourth quarter from 18°N to 20ºN, which corresponds to the time and place of the highest CPUE of bigeye tuna by the Hawaii-based longline fishery.

Oceanographic Influences on the American Samoa Longline Fishery for Albacore

The American Samoa longline fishery for albacore accounts for about 20% of all albacore caught in the South Pacific and supplies a significant portion of canned albacore to the U.S. market. A dramatic drop in albacore catch per unit effort (CPUE) -- preceded by an extraordinary expansion of the fleet in 1999-2001 -- and a slow recovery in recent years spurred an investigation of the oceanographic environment of the fishing grounds and its effects on albacore. Results of this work show that the South Equatorial Counter Current

(SECC) strongly influences the biological oceanography of the American Samoa Exclusive Economic Zone (AS EEZ) and changes strength on seasonal and ENSO cycles. A strong SECC is associated with a predominantly anticyclonic eddy field and increased micronekton biomass and higher CPUE for albacore. A strong SECC carries chlorophyll a-rich waters from upwelling regions off the north coast of New Guinea towards the AS EEZ, presumably resulting in the observed increase in micronekton biomass, forage for albacore. Relatively stable anticyclonic eddies show a further increase in micronekton biomass, apparently advected in from neighboring SECC waters. The presence of forage presumably concentrates albacore, resulting in the observed increase in CPUE. Areas characterized by South Equatorial Current (SEC) waters correspond to areas with the lowest micronekton biomass and the highest number of aggregative structures, which are thought to be small pelagic fish shoals. Micronekton composition in SEC waters differs from that in the SECC. During El Niños, the seasonal signals off the north shore of New Guinea and in the SECC are much stronger than average and correspond to higher albacore CPUE in the AS EEZ. Results suggest that the strength of upwelling and resulting increase in chlorophyll a at New Guinea, as well as the Southern Oscillation Index, could be used to predict the performance of the AS EEZ fishery.

Billfish Recreational Tagging Program

NOAA Fisheries' Billfish Tagging Program has provided tagging supplies to recreational billfish anglers for 45 years. Tag release and recapture data are used to determine movement and migration patterns, species distribution, and age and growth patterns of billfish. Since the program's inception, over 57,000 fish of 75 species have been tagged and released. In 2006, 1,121 billfish and 15 other fish species were tagged and released by 807 anglers and 188 fishing captions.

Billfish Age and Growth Studies

An examination of striped marlin hardparts has been initiated to evaluate their use as growth mark indicators. The study initially focused on hardparts (otoliths, dorsal & anal fin rays, cleithrum, and vertebrate) collected through Hawaii market sampling, and has now expanded to include otoliths dissected from fish heads collected at sea by observers onboard longline vessels. The observers also collect samples of whole gonads. Billfishes are gutted at sea, so gonads and information on gender are unavailable through the market sampling. The gonad samples will be used to determine length at 50% reproductive maturity for both sexes. Observers have also been able to collect about 20 small (<110 cm eye-fork length) whole juvenile specimens; billfish of this size are rarely available. Collaborations are currently being sought with researchers in Mexico and Australia who are actively conducting similar striped marlin studies in those regions.

NOAA Fisheries has collaborated with researchers from Australia on a review of regional differences in swordfish length at 50% female reproductive maturity and length-at-age curves. Results indicate the need for high quality histological sections of gonads (fixation at sea rather than stored frozen) in order to distinguish resting-mature from immature females when sampling does not coincide temporally and/or spatially with spawning activity. Interpretation of diffuse and/or multiple growth banding in fin ray sections will require more standard and objective criteria to estimate age and growth characteristics unaffected by or corrected for differences in estimation protocols.

Progress has also been made in studies of young-of-year swordfish otoliths collected from the main Hawaiian Islands, the equatorial central Pacific Ocean, French Polynesia, coastal Japan, the subtropical convergence zone north of Hawaii, coastal Ecuador, and the western Indian Ocean. Sagittal otoliths were polished to expose the otolith core region and the daily growth increments formed during the larval stage (ca. first 60 increments). Otoliths were analyzed for the presence of 12 trace elements (plus calcium and strontium) using the laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) instrument at Oregon State University. These data are currently being analyzed to determine whether otoliths contain trace elemental "fingerprints" unique to particular nursery regions.

Pelagic Shark Tagging Studies

Since 1999, NOAA Fisheries has used satellite technology to study the movements and behaviors of blue, shortfin mako and common thresher sharks, and to link the data to physical and biological oceanography in the California Current. In recent years, tag deployments have been carried out in collaboration with the Tagging of Pacific Pelagics research program (www.topp.org), Mexican colleagues at Centro de Investigación Científica y de Educación Superior de Ensenada and Canadian colleagues at the Department of Fisheries and Oceans Pacific Biological Station in Nanaimo, British Columbia. Since 1999, a total of 68 makos, 62 blue sharks, and 32 common threshers have been satellite tagged through these collaborative projects.

The survivability of blue sharks caught and released alive by the California drift gillnet fishery is also being studied using PAT tags. During the 2007-08 fishing season, seven sharks in various conditions at time of release were tagged and tracked, with preliminary results indicating that survivability is high; all seven sharks survived for at least six weeks following tagging. A collaborative project was initiated by NOAA Fisheries and Pfleger Institute of Environmental Research in spring 2007 to determine the survivability of thresher sharks caught and released alive by recreational fishermen. Four thresher sharks hooked by the tail by anglers were fitted with PAT tags and released.

Pelagic Shark Feeding Ecology, Age, Growth, and Maturity Studies

Since 1999, NOAA Fisheries has investigated the feeding ecology and diet of the blue shark, shortfin mako shark, common thresher shark, and bigeye thresher shark (*Alopias. superciliosus*). Stomach content data from recent years reveal that jumbo squid (*Dosidicus gigas*) are an increasingly important component of the mako shark diet. Of 228 stomachs examined since 2002, 49 contained jumbo squid remains. The large number and diversity of taxa in the bigeye thresher diet suggest that the bigeye thresher is an opportunistic feeder that forages over a broad range of habitats to exploit locally abundant prey. In 2007, NOAA Fisheries initiated ageing validation studies on tagged blue sharks by injecting them with oxytetracycline prior to their release and continued similar validation studies on mako and thresher sharks. Since the beginning of the program in 1997, 1,368 oxytetracycline-marked individuals have been released during juvenile shark surveys. As of January 2008, recaptured marked sharks included 68 mako, 19 common thresher, and two blue sharks; however, vertebrae were returned for only about half of the recaptures. Time at liberty ranged from 7 to 1,938 days with net movements of individual sharks as high as 3,410 nautical miles.

Sea Turtle Bycatch Mitigation

Operational longline fishery characteristics, bycatch information, and loggerhead turtle satellite tracks were used in conjunction with remotely sensed sea surface temperature data to identify the ocean area where the majority of historical loggerhead turtle bycatch in the Hawaii longline fishery occurred between 1994 and 2006. Most shallow longline sets and associated loggerhead turtle bycatch were near the North Pacific Subtropical Frontal Zone. A map of the area where interactions with loggerheads was most likely to occur was created with the idea that this information, released as an advisory to Hawaii longline fishers, could help them reduce inadvertent interactions with loggerhead turtles. The "TurtleWatch" advisory was released in near real-time to fishers and managers starting in late 2006, recommending that shallow sets be deployed in waters warmer than the 18.5ºC isotherm, representing the warm edge of the zone where interactions were most likely to occur. Fishery information from 2007 was later compared with data from 2005-2006 to assess the response of the fishery. The analysis indicated increased effort north of the 18.5°C isotherm, in the area recommended for avoidance by the TurtleWatch advisory. However, turtle bycatch was reduced. The TurtleWatch advisory was subsequently refined to recommend avoidance of the temperature band from 17.5ºC to 18.5ºC (~63.5ºF to 65.5ºF) such that the area recommended for fishing could be either north or south of this band.

NOAA Fisheries is contracting or otherwise assisting in longline fishing vessel trials to test the efficacy of sea turtle bycatch mitigation methods in Costa Rica, Brazil, Uruguay, Indonesia, and Italy. The trials will measure 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 primary new result in 2008 was a finding of improved target species capture rates and reduced bycatch in the Indonesian tuna fishery using circle hooks (size 16/0) compared to the tuna hook traditionally used. Otherwise, similar trends are being found as reported last year; that is, circle hooks (size 18/0) resulted in nearly equivalent rates of swordfish capture rates and reduced rates of capture of sea turtles and pelagic rays in Italy, Brazil, and Uruguay as compared to J hooks. The Italy results indicate that circle hook shape (not just its width) may be effective in reducing turtle bycatch rates, since the J hook and circle hooks tested had very similar minimum widths.

Circle hooks may sometimes result in increased rates of shark capture, as was found in the circle hook testing studies in Indonesia, Brazil and Uruguay.

Research on the effects of shark-shaped objects and light sticks on rates of sea turtle capture in a gillnet fishery in Baja California, Mexico is also underway.

Reducing Incidental catches of Sharks

Due to growing concern over increased capture of sharks in longline fisheries, a meeting was hosted at the New England Aquarium in April 2008 entitled the "Shark Deterrent and Incidental Capture Workshop". Participants included researchers from academic institutions, NOAA Fisheries Science Centers, and NGO research institutions, as well as industry leaders.

The ability of electropositive metals (lanthanide series) to repel sharks from fishing gear is being tested off Oahu in Hawaii. Electropositive metals generate large oxidation potentials in seawater. It is thought that this perturbs the electrosensory system in sharks and rays, causing them to exhibit aversion behaviors. Since most targeted fish do not have an electrosensory system, this method of perturbing the electric field around baited hooks may

selectively reduce the bycatch of sharks. Feeding behavior experiments were conducted to determine whether the presence of these metals would deter sharks from biting fish bait. Experiments were conducted with Galapagos sharks (*Carcharhinus galapagensis*) and sandbar sharks (*Carcharhinus plumbeus*). Results indicate that sharks significantly reduced their biting of bait in proximity to electropositive metal objects. In addition, sharks exhibited significantly more aversion behaviors as they approached bait associated with these metals. Further studies on captive sandbar sharks in tanks indicated sharks would not get any closer to baits than 40 cm in the presence of the metal objects (ingots approximately the same size as a 60g lead fishing weight used by Hawaii longline fishermen).

Testing of dehookers on sharks has indicated removal of ordinary barbed circle hooks from shark jaws can be quite difficult. The feasibility of using barbless circle hooks to facilitate dehooking of unwanted catch with less harm is being investigated. Preliminary research in the Hawaii shoreline fishery for ulua (Carangidae) and other species indicated that barbless circle hooks catch as much as barbed hooks, but the situation could be different with longline gear, where bait soaks unattended for much of the day and fish have more time to try to throw the hook. Preliminary results from very limited longline testing of barbless hooks indicated a substantial increase in bait loss using barbless hooks. Subsequent testing used rubber retainers to prevent bait loss. Summary information from before and after the use of bait retainers showed no difference between barbed and barbless hooks in the catch and catch rates of targeted species and sharks, although catches have so far been too few to provide much statistical power for the comparison. The pigtail dehooker required by U.S. regulations for releasing sea turtles showed much higher success rate in dehooking and releasing live sharks caught on barbless hooks, compared to those caught on barbed hooks. A new type of dehooker was developed and tested, indicating >90 percent effectiveness in removing both barbed and barbless circle hooks from sharks.

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1.2.3 Statistical data systems

The primary monitoring system for the major U.S. fisheries (purse seine, longline, and albacore troll) fisheries in the WCPO consists of the collection of logbooks that provide catches in numbers of fish, fishing effort, fishing location, and some details on fishing gear and operations. U.S. purse seine logbook and landings data with 100% coverage are submitted as a requirement of the South Pacific Tuna Treaty. The Hawaii- and American Samoa-based longline fisheries are monitored using the NOAA Fisheries Western Pacific Daily Longline Fishing Logs for effort and resulting catch. The California-based fishery uses a different logbook. The coverage of these logbooks is 100%, except for the American Samoa fishery where under-reporting of a very small percentage of trips is estimated via a creel survey that includes catch by small longline vessels. Beginning in 1995, troll vessels on the high seas have been required to submit logbooks to NOAA Fisheries. The albacore troll logbook coverage rate in 2007 was approximately 62% of the landings.

Observer and port sampling programs for collecting scientific data that include, among other information, the size composition and species composition of landings were described earlier in this report (Section 1.2.1). Reports of fish sales at landing provide another very important supplement to the monitoring system, often providing much more information on the weights of individual fish than is obtained from port sampling; such is the case for the Hawaii-based longline fishery. Fish sales records cover 100% of landings for the purse seine fleet, and close to 100% for the albacore troll and Hawaii-based longline fleets.

Small-scale fisheries in Hawaii, i.e., tropical 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, as part of the Western Pacific Fishery Information Network (WPacFIN). WPacFIN has recently improved its basic procedures for integrating Hawaii fisheries catch data (numbers) and information on fishing trips from fishermen's reports with fish weight and sales data from the dealers' sales reports. As a result, data on the weight and value of most catches can be linked. This provides average fish weight data by gear type, time period, and species that are used to estimate total catch weights for the Hawaii fisheries in this report[4]. Other enhancements to this integration are under development, such as linking the dealer data on weights of longline-caught fish with an approximation of the geographic location, and correcting species misidentifications in fishermen's logbooks using species information indicated by dealer and observer data for the same trip.

[4] Submission of 2005-2007 U.S. Fishery Statistics for the Western and Central Pacific Ocean to the Western and Central Pacific Fisheries Commission. PIFSC Data Report DR-08-006. Issued 6 June 2008.