2009 Annual Report to the Western and Central Pacific Fisheries Commission

United States of America

PART I. INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS [1]
(For 2008)

National Oceanic and Atmospheric Administration National Marine Fisheries Service

Summary

Large-scale U.S. fisheries for highly migratory species in the Pacific include purse seine fisheries for skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*); 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 U.S. small-scale fisheries operate in nearshore waters in the EEZs of American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and Hawaii.

Total USA landings in the Western and Central Pacific Fisheries Commission (WCPFC) statistical area in 2008 increased as a result of increased purse seine activity. Purse seine landings increased to 157,849 metric tons (t) (or 78% over 2007 landings) in 2008. Longline landings decreased in 2008 after peaking in 2007. Bigeye tuna and albacore landings by longliners reached record highs in 2007 of 5,599 t and 5,426 t, respectively. Excluding landings from U.S. territories (i.e., American Samoa), longline landings of bigeye tuna declined to 4,526 t in 2008 from 5,381 t in 2007 (Table 1f). Swordfish longline landings decreased slightly to 1,302 t in 2008 from a peak of 1,441 t in 2007. Small-scale (tropical) trollers and handliners operating in Pacific island waters represented the largest number of U.S. flagged vessels but contributed a small fraction of the landings. The longline fleet was the next largest fleet, numbering 156 in 2008, the same as in 2007. The troll fishery for albacore declined with active vessels reduced to 4 in 2008 from 6 in 2007.

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries) conducted a wide range of research on Pacific tuna and associated species at its Southwest and Pacific Islands Fisheries Science Centers and in collaboration with scientists from other organizations. Monitoring and economic survey work included retail market monitoring in Honolulu to explore market impacts of regulations and how price changes affect

[1] PIFSC Data Report DR-09-007
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producers, retailers, and consumers. Economic studies showed increasing costs of longline fishing operations primarily due to rising fuel prices. Interviews were conducted to explore longline fishermen's experiences with bycatch reduction methods. Longline observer data were used to describe shark catches. Stock assessment research was conducted in collaboration with member scientists of 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 research on tunas, billfishes, and sharks addressed fish movements, habitat choices, post-capture survival, and age and growth. Results included a high rate of post-release survival of longline-caught sharks. A meta-analysis of pop-up satellite archival tag deployments across a wide variety of species over many years indicated very low retention of tags to their programmed pop-up dates, and found lower tag reporting rates for deep-diving species and increasing tag reporting rates in recent years. Research on bycatch and longline fishing technology included continued testing of circle hooks to reduce bycatch of sea turtles or to demonstrate successful fishing for target species, and testing of electropositive metal ingots to reduce shark bycatch.

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 2004-2008 for U.S. fisheries operating in the western and central Pacific Ocean (WCPO). All statistics for 2008 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 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 2008, accounting for 89% 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 8%, 0.1%, 0.9%, 0.2%, and 0.2% of the total catch, respectively. Landings by the purse seine and pole-and-line fisheries increased while landings by the longline, tropical troll, handline, and albacore troll fisheries decreased in 2008 in comparison to 2007. U.S. fisheries for tunas, billfishes and other pelagic species produced an estimated 174,360 t in 2008 (Table 1a), up from 108,409 t in 2007 (Table 1b). The catch consisted primarily of skipjack tuna (72%), yellowfin tuna (14%), bigeye tuna (7%), and albacore (2.3%). Catches of all these species except albacore increased in 2008 as compared to 2007, and the greatest increase was for skipjack tuna (up 52,236 t from 2007).

[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. flagged vessels operating in the WCPO in 2008 (provisional). 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 & line**	**TOTAL**
Albacore (ALB), North Pacific	0	300	0	1	28	0	330
Albacore (ALB), South Pacific[1]	0	3,589	148	0	0	0	3,737
Bigeye tuna (BET)	6,741	4,662	0	79	122	0	11,604
Pacific bluefin tuna (PBF)	0	1	0	0	0	0	1
Skipjack tuna (SKJ)	127,307	280	0	366	0	292	128,244
Yellowfin tuna (YFT)	23,801	1,162	0	438	216	22	25,639
Other tuna (TUN KAW FRI)	0	0	0	9	1	3	14
TOTAL TUNAS	157,849	9,994	148	892	368	317	169,569
Black marlin (BLM)	0	0	0	0	0	0	0
Blue marlin (BUM)	0	368	0	173	1	0	542
Sailfish (SFA)	0	11	0	1	0	0	12
Spearfish (SSP)	0	212	0	0	0	0	212
Striped marlin (MLS), North Pacific	0	420	0	14	0	0	433
Striped marlin (MLS), South Pacific	0	1	0	0	0	0	1
Other marlins (BIL)	0	2	0	14	0	0	15
Swordfish (SWO), North Pacific	0	1,295	0	0	6	0	1,301
Swordfish (SWO), South Pacific	0	7	0	0	0	0	7
TOTAL BILLFISHES	0	2,315	0	201	8	0	2,524
Blue shark (BSH)	0	7	0	0	0	0	7
Mako shark (MAK)	0	109	0	0	0	0	109
Thresher sharks (THR)	0	39	0	0	0	0	39
Other sharks (SKH OCS FAL SPN TIG CCL)	0	4	0	0	0	0	4
TOTAL SHARKS	0	160	0	0	0	0	160
Mahimahi (DOL)	0	336	0	303	17	1	656
Moonfish (LAP)	0	413	0	0	0	0	413
Oilfish (GEP)	0	178	0	0	0	0	178
Pomfrets (BRZ)	0	224	0	0	18	0	242
Wahoo (WAH)	0	325	0	267	5	0	597
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	13	0	7	0	0	21
TOTAL OTHER	0	1,490	0	578	39	1	2,107
TOTAL	157,849	13,959	148	1,671	415	318	174,360

Table 1b. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. flagged vessels operating in the WCPO in 2007. 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 & line	TOTAL
Albacore (ALB), North Pacific	0	243	0	3	94	0	340
Albacore (ALB), South Pacific[1]	0	5,183	272	0	0	0	5,455
Bigeye tuna (BET)	2,985	5,599	0	63	324	0	8,970
Pacific bluefin tuna (PBF)	0	2	0	0	0	0	2
Skipjack tuna (SKJ)	75,210	253	0	272	0	272	76,008
Yellowfin tuna (YFT)	10,541	1,473	0	505	254	23	12,796
Other tuna (TUN KAW FRI)	0	0	0	8	1	1	11
TOTAL TUNAS	88,736	12,753	272	851	673	296	103,582
Black marlin (BLM)	0	1	0	0	0	0	1
Blue marlin (BUM)	0	293	0	128	1	0	422
Sailfish (SFA)	0	11	0	0	0	0	11
Spearfish (SSP)	0	142	0	0	0	0	142
Striped marlin (MLS), North Pacific	0	267	0	13	0	0	280
Striped marlin (MLS), South Pacific	0	1	0	0	0	0	1
Other marlins (BIL)	0	1	0	12	0	0	14
Swordfish (SWO), North Pacific	0	1,428	0	1	5	0	1,434
Swordfish (SWO), South Pacific	0	13	0	0	0	0	13
TOTAL BILLFISHES	0	2,156	0	154	6	0	2,316
Blue shark (BSH)	0	7	0	0	0	0	7
Mako shark (MAK)	0	120	0	0	0	0	120
Thresher sharks (THR)	0	42	0	0	0	0	42
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	390	0	433	12	0	835
Moonfish (LAP)	0	454	0	0	0	0	454
Oilfish (GEP)	0	180	0	0	0	0	180
Pomfrets (BRZ)	0	235	0	2	8	0	244
Wahoo (WAH)	0	366	0	228	3	0	598
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	10	0	14	0	0	24
TOTAL OTHER	0	1,635	0	677	23	0	2,335
TOTAL	88,736	16,720	272	1,682	703	296	108,409

Table 1c. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. flagged 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).

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	5	0	256
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	29	0	2,492
TOTAL	68,445	14,968	587	1,551	586	300	86,437

Table 1d. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. flagged 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).

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	0	0	1
Blue marlin (BUM)	0	350	0	185	2	0	537
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	4	0	274
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	32	0	2,340
							0
TOTAL	86,172	13,700	576	1,535	741	422	103,146

Table 1e. Estimated weight in metric tons (t) of reported landings by species, species group, or geographic subset, by fishing gear, for U.S. flagged 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 & 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	8	0	329
							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	51	1	2,662
							0
TOTAL	67,419	13,078	1,855	1,958	834	297	85,441

Table 1f. Longline landings in metric tons (t) for U.S. NPO-based and American Samoa by species and species group, for U.S. vessels operating in the WCPFC Statistical Area in 2008. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0).

	U.S. NPO-based				American Samoa				Total			
	2008	2007	2006	2005	2008	2007	2006	2005	2008	2007	2006	2005
Number of vessels	128	129	127	125	28	29	28	36	156	156	154	156
Catch by species (t)												
Albacore, North Pacific	300	243	256	287					300	243	256	287
Albacore, South Pacific					3,589	5,183	4,078	2,936	3,589	5,183	4,078	2,936
Bigeye tuna	4526	5,381	4,381	4,462	136	218	181	134	4,662	5,599	4,562	4,596
Pacific bluefin tuna	0	0	1	0	1	2	0	0	1	2	1	0
Skipjack tuna	117	91	93	90	163	162	190	142	280	253	283	233
Yellowfin tuna	837	833	937	698	325	640	513	526	1,162	1,473	1,450	1,224
Other tuna	0	0	0	0	0	0	3	3	0	0	4	4
TOTAL TUNA	5780	6,549	5,668	5,538	4,214	6,205	4,967	3,741	9,994	12,753	10,635	9,279
Black marlin	0	1	0	1	0	0	0	0	0	1	1	1
Blue marlin	334	255	409	326	34	38	25	23	368	293	433	350
Sailfish	10	10	9	6	1	1	6	2	11	11	15	8
Spearfish	211	141	160	201	1	1	2	2	212	142	162	203
Striped marlin, North Pacific	420	267	609	493	0				420	267	609	493
Striped marlin, South Pacific					1	1	4	3	1	1	4	3
Other marlins	2	1	4	2	0	0	0	0	2	1	4	2
Swordfish, North Pacific	1295	1,428	1,149	1,475	0				1,295	1,428	1,149	1,475
Swordfish, South Pacific					7	13	38	8	7	13	38	8
TOTAL BILLFISH	2272	2,103	2,340	2,504	43	54	75	38	2,315	2,156	2,415	2,542

Table 1f. (Continued.)

	U.S. NPO-based				American Samoa				Total			
	2008	**2007**	**2006**	**2005**	**2008**	**2007**	**2006**	**2005**	**2008**	**2007**	**2006**	**2005**
Number of vessels	128	129	127	125	28	29	28	36	156	156	154	156
Catch by Species (t)												
Blue shark	7	6	10	25	1	1	1	0	7	7	10	25
Mako shark	109	119	94	96	0	0	1	0	109	120	95	96
Thresher	39	42	33	33	0	0	0	0	39	42	33	33
Other sharks	4	7	12	3	0	1	0	0	4	7	12	4
TOTAL SHARKS	159	174	149	157	1	2	1	0	160	176	151	157
Mahimahi	323	376	316	421	12	14	26	28	336	390	342	449
Moonfish	411	451	477	407	2	3	4	5	413	454	482	412
Oilfish	178	180	173	155	0	0	1	0	178	180	175	156
Pomfrets	224	234	250	269	0	0	0	1	224	235	251	270
Wahoo	194	169	231	201	131	197	274	219	325	366	505	420
Other fish	13	10	14	14	0	0	0	0	13	10	14	14
TOTAL OTHER	1343	1,420	1,462	1,467	146	215	306	254	1,490	1,635	1,768	1,721
GEAR TOTAL	9,555	10,246	9,619	9,666	4,404	6,475	5,349	4,033	13,959	16,720	14,968	13,700

Table 1g. Tropical troll landings in metric tons (t) for Hawaii, Guam, CNMI, and American Samoa by species and species group, for U.S. vessels operating in the WCPFC Statistical Area in 2008. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0).

	Hawaii					**Guam**					**CNMI**					**American Samoa**				
	2008	**2,007**	**2006**	**2005**	**2004**	**2008**	**2007**	**2006**	**2005**	**2004**	**2008**	**2007**	**2006**	**2005**	**2004**	**2008**	**2007**	**2006**	**2005**	**2004**
Number of vessels	1,512	1,447	1,394	1,402	1,394	385	370	386	358	401	47	52	69	77	71	17	19	8	9	18
Catch by species (t)																				
Albacore, North Pacific	1	3	1	6	3															
Albacore, South Pacific																				
Bigeye tuna	79	63	56	85	149															
Pacific bluefin tuna																				
Skipjack tuna	152	87	100	86	112	134	71	67	65	73	72	108	124	108	66	7	6	5	5	9
Yellowfin tuna	412	463	262	319	309	9	22	13	17	46	7	16	20	22	12	9	4	4	3	3
Other tunas	5	5	7	7	20	2	1	0	1	11	1	2	4	4	6	0				
TOTAL TUNAS	650	621	426	503	593	145	94	80	83	130	80	126	148	134	84	17	10	9	8	12
Black marlin																				
Blue marlin	168	119	144	178	163	4	9	13	6	22	1	0	1	1	1		0	0	0	0
Sailfish						0					1					0	0			
Spearfish																				
Striped marlin, N. Pacific	14	13	21	20	34															
Striped marlin, S. Pacific																				
Other billfish	14	10	13	15	21		2	1	0	2										
Swordfish, North Pacific	0	1	0	0	0															
Swordfish, South Pacific																				
TOTAL BILLFISHES	195	143	178	213	218	5	11	14	6	24	1	0	1	1	1	0	0.1	0	0	0

Table 1g. (Continued.)

	Hawaii					Guam					CNMI					American Samoa				
	2008	**2,007**	**2006**	**2005**	**2004**	**2008**	**2007**	**2006**	**2005**	**2004**	**2008**	**2007**	**2006**	**2005**	**2004**	**2008**	**2007**	**2006**	**2005**	**2004**
Number of vessels	1,512	1,447	1,394	1,402	1,394	385	370	386	358	401	47	52	69	77	71	17	19	8	9	18
Catch by species (t)																				
Blue shark																				
Mako shark																				
Thresher sharks																				
Other sharks																				
TOTAL SHARKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mahimahi	247	304	337	265	528	51	117	74	74	89	5	13	8	11	16	0	0	1	0	0
Moonfish																				
Oilfish																				
Pomfrets						1					0	2								
Wahoo	222	206	207	186	187	45	20	48	28	53	1	1	1	1	3	0	0			
Other fish	1	1	1	2	1	3	12	14	12	17	3	1	4	8	2	0				
TOTAL OTHER	469	511	545	453	716	100	149	136	114	159	9	17	13	20	21	1	1	1	0	0
GEAR TOTAL	1,315	1,275	1,149	1,169	1,527	250	254	230	203	313	90	143	162	155	106	17	11	10	8	12

Table 2a. Number of United States vessels that reported catches in the WCPO, by gear type, 2004-2008. Data for 2008 are provisional.

	2008	2007	2006	2005	2004
Purse seine	32	21	13	15	21
Longline (N Pac-based)[1]	129	129	127	125	125
Longline (American Samoa-based)	28	29	28	36	41
Total U.S. Longline[2]	156	156	154	156	183
Albacore troll (N Pac)	2[3]	1[3]	3[3]	5[3]	28
Albacore troll (S Pac)	4	6	8	8	11[4]
Tropical troll	1,961	1,888	1,857	1,846	1,884
Handline	470	424	375	432	451
Tropical Troll and Handline (combined)[4]	1,961	1,888	1,924	1,917	2,012
Pole and line	6	3	4	3	4
TOTAL	2160	2,085	2,103	2,099	2,333

[1]Includes Hawaii- and California-based vessels that fished west of 150° W (none from California in 2005–2008).
[2]Some longline vessels fish in both Hawaii and American Samoa and are counted only once in this total for 2005-2008. Some vessels that fished in both fisheries may be double-counted for 2004.
[3]These vessels fished on both sides of the equator and are counted only once in the bottom line TOTAL, except in 2008 when one vessel fished exclusively in the N. Pac., making a total count of 4 vessels in the whole.
[4]Some vessels fished both tropical troll and handline, and are counted only once in this total.

Table 2b. Number of United States purse seine, longline, and pole-and-line vessels that reported catches in the WCPO, by gross registered ton categories, 2005-2008. Data for 2008 are provisional.

	Vessel size (gross registered tons)						
Gear and year	0-50	51-150	51-200	501-1000	1001-1500	1500+	Unknown
2007 Purse seine				2	11	5	3
2008 Purse seine				2	13	11	6
2005 Longline	23		133				
2006 Longline	16		138				
2007 Longline	15		141				
2008 Longline	15		141				
2007 Pole and line		3					
2008 Pole and line	3	3					

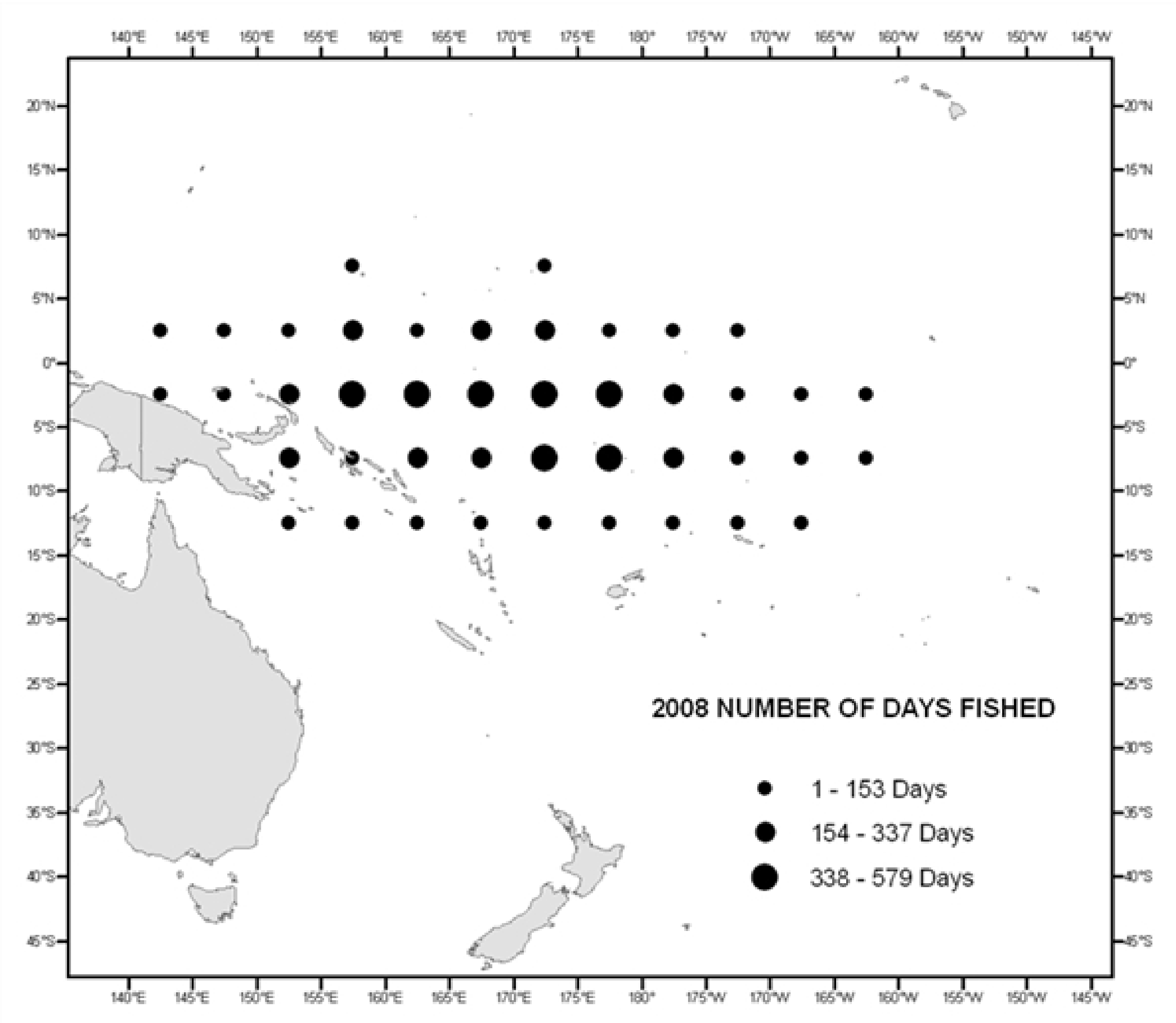


Figure 1. Distribution of annual U.S. purse seine effort, 2008 (provisional). NB that Days Fished may not equal 'fishing days' as defined under some subregional arrangements.

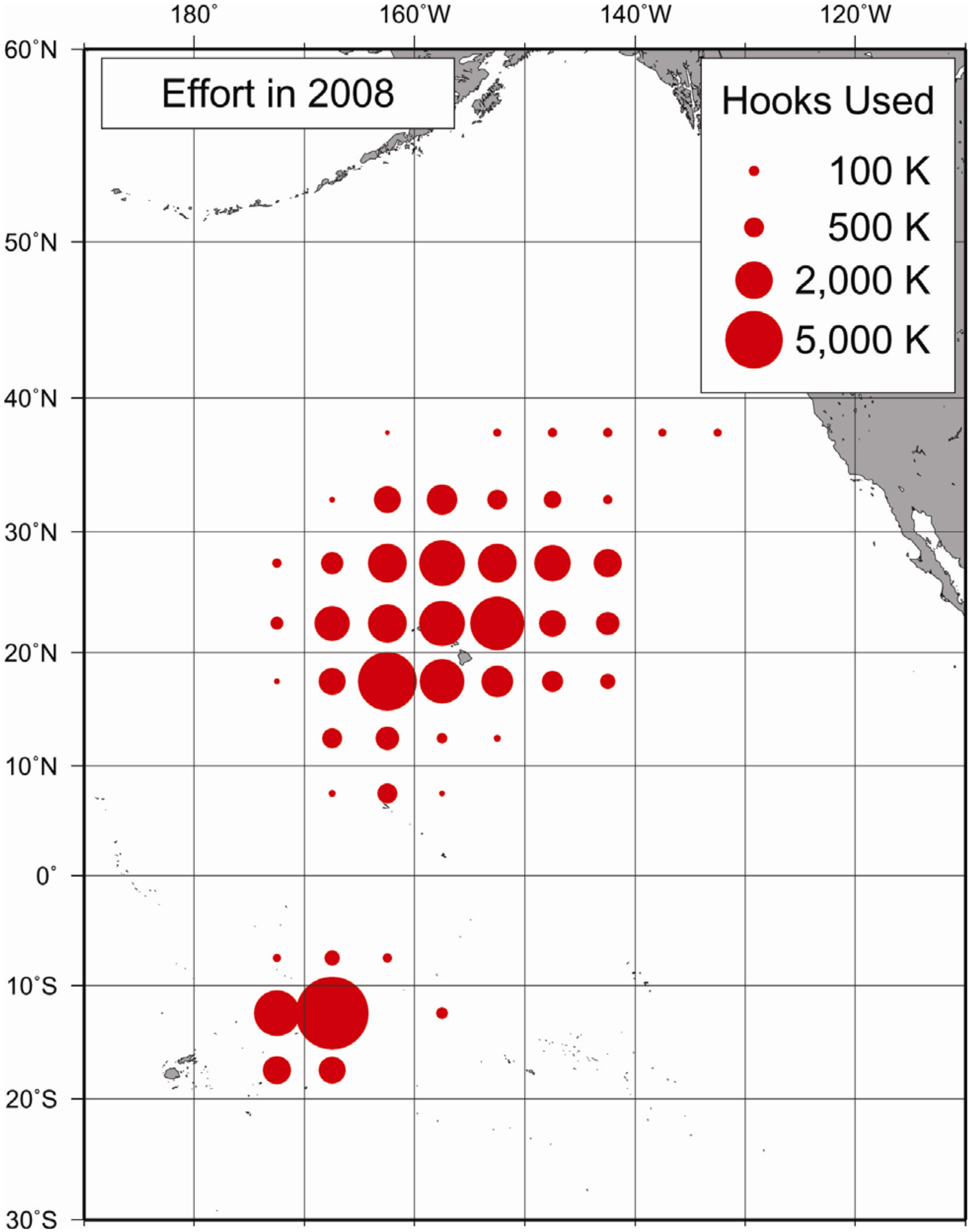


Figure 2a. Spatial distribution of fishing effort reported in logbooks by U.S. flagged longline vessels, in 1,000's of hooks (K), in 2008 (provisional data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

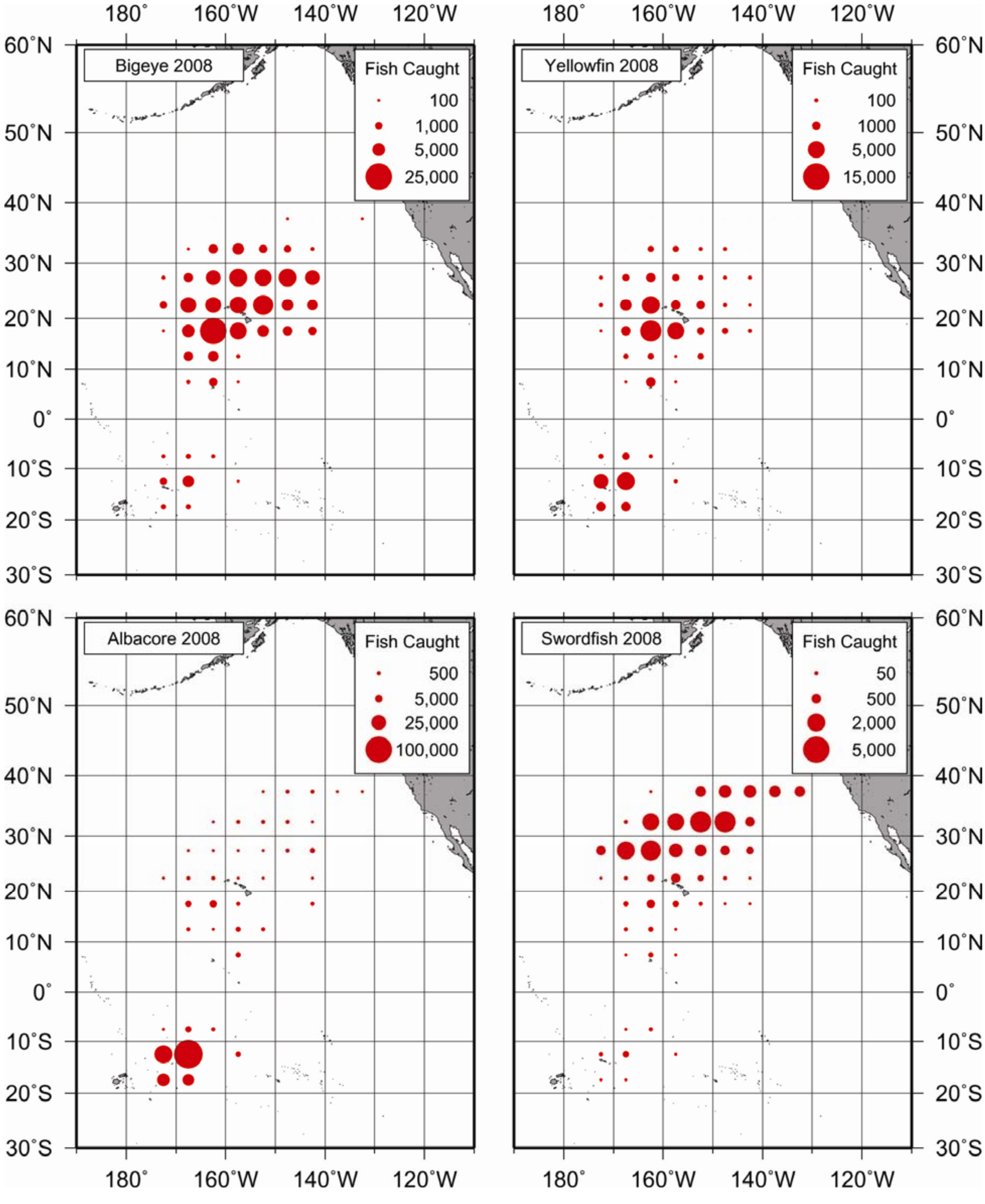


Figure 2b. Spatial distribution of catch in the WCPO reported in logbooks by U.S. flagged longline vessels, in numbers of fish (includes retained and released catch), in 2008 (provisional data). Area of circles is proportional to catch. Catches in some areas are not shown in order to preserve data confidentiality.

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 2005-2008[3]. Estimates of total marine mammal interactions by the deep-set fishery in 2008 have not yet been completed; only the observed values are included here. Statistically 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	2008
Marine mammals				
Striped dolphin (*Stenella coeruleoalba*)	0	6	0	1
Bottlenose dolphin (*Tursiops truncatus*)	0	2	3	0
Risso's dolphin (*Grampus griseus*)	4	7	6	5
Unidentified dolphin (Delphinidae)	0	0	2	0
Blainville's beaked whale (*Mesoplodon blainvillei*)	6	0	0	0
Bryde's whale (*Balaenoptera edeni*)	1	0	0	0
False killer whale (*Pseudorca crassidens*)	7	17	14	4
Humpback whale (*Megaptera novangliae*)	0	1	0	1
Shortfinned pilot whale (*Globicephala macrorhynchus*)	6	6	2	2
Spotted dolphin (*Stenella attenuate*)	0	0	0	1
Unspecified false killer whale or shortfinned pilot whale	1	14	0	4
Unidentified Cetacean (Cetacea)	1	2	2	1
Unspecified member of beaked whales (Ziphiidae)	0	7	0	0
Unspecified pygmy sperm whales (Kogia)	0	0	0	1
TOTAL MARINE MAMMALS	26	62	29	20
Sea turtles				
Loggerhead turtle (*Caretta caretta*)	10	17	22	0
Leatherback turtle (*Dermochelys coriacea*)	12	11	9	13
Olive Ridley turtle (*Lepidochelys olivacea*)	16	54	27	20
Green turtle (*Chelonia mydas*)	0	6	0	1
Unidentified hardshell turtle (Cheloniidae)	0	2	0	0
TOTAL SEA TURTLES	38	90	58	34

[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/reports.php

Table 3 (Continued.)

Species	2005	2006	2007	2008
Albatrosses				
Blackfooted albatross (*Phoebastria nigripes*)	89	73	85	124
Laysan albatross (*Phoebastria diomedia*)	105	15	83	88
TOTAL ALBATROSSES	194	88	168	212
Other Seabirds				
Red-footed booby (*Sula sula*)	0	0	0	4
Brown booby (*Sula leucogaster*)	3	0	0	0
Unspecified bird	0	19	0	64
TOTAL OTHER SEABIRDS	3	19	0	68
Observer Information				
Total trips	1,483	1,357	1,451	1,409
Observed trips	466	332	347	380
Proportion of trips observed	31.4%	24.5%	23.9%	27.0%
Observed sets	6,206	4,544	5,002	5,402
Observed hooks	10,689,477	8,285,411	8,912,119	10,126,078

1.1.1 Developments and trends

U.S. Purse Seine Fishery

The U.S. Purse seine catch of 157,849 t in 2008 was composed primarily of skipjack tuna, with smaller catches of yellowfin and bigeye tuna. Total catches and effort increased significantly from 2007 (Tables 1a-1e). The number of licensed vessels increased by approximately 50% from 21 in 2007 to 32 in 2008 (Table 2a). Yellowfin tuna catches in the fishery increased from 10,541 t in 2007 to 23,801 t in 2008 and skipjack tuna catches increased from 75,210 t in 2007 to 127,307 t in 2008. The fishery operated mainly in areas between 5° N and 10° S latitude and 150° E and 180° longitude in 2008 (Figure 1). Before 1995, the fleet in the WCPO fished mainly on free-swimming schools of tunas. Though highly variable 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 166 in 2004 to 156 vessels in 2005 and has remained about the same since then (Table 2). The Hawaii-based fishery consistently had the highest number of vessels in operation, increasing from 125 in 2005 to 129 in 2007 with 128 vessels in 2008. Participation in the American Samoa-based fleet declined from 36 vessels in 2005 to 28 in 2006 and remained about the same in 2007 and 2008. A few vessels occasionally operated in both Hawaii and American Samoa longline fisheries.

The Hawaii-based longline fishery operated mainly from 5° N to 40° N latitude and from 130° W to 175° W in 2008 (Figure 2a), representing some expansion to the east as compared with 2007. Effort in 2008 shifted more eastward. The American Samoa-based longline fishery operated mostly from 5° S to 20° S latitude and 155° W to 175° W longitude during 2006 - 2008 (Figure 2a). The Hawaii-based fishery targeted bigeye tuna and swordfish, with respectable landings of associated pelagic 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 U.S. longline catch in 2008 were bigeye tuna, albacore, swordfish, and yellowfin tuna (Figure 2b). The total catch of all species ranged from a low of 13,700 t in 2005, to a high of 16,720 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-based longline vessels to relocate to Hawaii. In fact, most of these vessels had been home ported 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 involved deep-set longline effort directed towards tunas. Swordfish landings were low in 2006 and 2008 and higher in 2005 and 2007. In 2006, the Hawaii-based 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. This sector of the Hawaii-based longline fishery managed to stay under the allowable annual sea turtle limits and remained open all year in 2007 and 2008.

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 6 vessels in 2007 to 4 vessels in 2008 (Table 2). Three of these vessels fished in the South Pacific, and 2 fished in the North Pacific. The albacore troll fishery operated mostly between 35° S and 45° S latitude and 115° W and 170° W longitude. The South Pacific albacore troll catches in the WCPO declined from 272 t in 2007 to 148 t in 2008 (Tables 1a-1e). In the WCPO, the North Pacific component of the catch has declined dramatically since 2004 due to reduced participation by U.S. vessels in high seas areas. The catch by this fishery was composed exclusively of albacore.

Other U.S. Fisheries

The data on other U.S .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 2,385 t in 2008. The catch was composed primarily of skipjack tuna, yellowfin tuna, and mahimahi.

1.1.2 Disposition of the Landings

The purse seine catch is stored as a frozen whole product. Most of the catch has historically been off-loaded to the canneries in Pago Pago, American Samoa, however more and more vessels are transshipping catches in Pacific Islands ports for canning and loining destinations in Southeast Asia and Latin America. The final product that is canned in American Samoa is typically destined for the domestic U.S. canned tuna 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 primarily sold fresh locally to restaurants and retail markets, or exported to the U.S. mainland; a small proportion of high quality bigeye tuna is exported to Japan. 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

Generally 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 repeatedly indicated its commitment to the South Pacific Tuna Treaty and to maintaining a viable U.S. purse seine fleet in the WCPO.

The scientific finding that current levels of fishing mortality for bigeye and yellowfin tuna are higher than those that can sustain maximum yield prompted a new WCPFC measure to reduce purse seine effort and bigeye tuna longline catch. In 2009-2011 the U.S. longline fishery based in Hawaii will not exceed a limit of 3,763 t of bigeye tuna. 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 (EPO) in 2006 when it was projected that the U.S. longline fishery would reach its annual bigeye tuna catch limit of 150 t established by the IATTC. The fishery operated throughout 2007 without reaching a revised limit of 500 t. There was no bigeye tuna limit in the EPO in 2008, but a limit of 500 t has been instituted for 2009.

In the future the Hawaii-based component of the longline fishery is likely to continue to target tunas primarily. However, the recent actions by Regional Fishery Management Organizations to implement output-based catch limits on bigeye tuna will result in lower landings by this sector of the longline fishery. This could result in increased effort directed at swordfish. The swordfish segment of the Hawaii-based longline fishery is highly seasonal and operates under strict regulations to limit interactions with sea turtles and seabirds. The rules include an effort limit (number of shallow sets) that has not been reached in the last several years. However, this effort level could be reached or even exceeded if the current limit is eased. There are viable prospects for achieving an increase in the effort limit through further reductions in sea turtle bycatch rates, including voluntary efforts to avoid areas of sea turtle concentrations. U.S. fishery managers are currently considering proposals to allow increased effort in the Hawaii-based shallow-set fishery for swordfish and increased limits on annual sea turtle interactions.

The recent closure of one of two canneries in American Samoa is not expected to curtail the operation of the longline fishery there, nor will that fishery be limited by the WCPFC bigeye tuna conservation measure. The American Samoa-based component of the longline fishery is expected to continue targeting albacore and delivering its catch frozen to the remaining cannery.

The prospect for the U.S. small-scale fisheries is believed to be fairly stable although participation is sensitive to high fuel prices. These prices have eased from their 2008 high levels, and 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 Pacific Island Country (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 bycatch 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 main focus of the longline observer program is to collect scientific data on interactions with protected species, primarily sea turtles. The observer program also collects relevant information on the fish catch and on the biology of target and non-target species. Fish catch data collection 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 observer-collected protected species data to estimate the total number of interactions. In 2008, the observer coverage rate (on a trip basis) in the deep-set (tuna) component of the Hawaii-based longline fishery was 21.7%--for a total of 285 observer trips and 3,915 sets observed. In the shallow-set (swordfish) component of the Hawaii-based fishery, which has a regulatory requirement of 100% observer coverage, all 95 trips were observed, totaling 1,487 sets. These shallow-set summary data include data from the 4th quarter of 2007 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 to allow submission of fisheries confidential information to the WCPFC are nearing completion.

Overall, 285 out of 1,314 deep-set trips were observed, and all 95 shallow-set trips, resulting in a combined coverage rate of 27.0% in 2008 (Table 3). The results indicated a lower number of interactions with sea turtles and a higher number of interactions with seabirds in 2008 as compared with 2007. Statistically robust estimates of marine mammal interactions for the deep-set fishery in 2008 have not yet been completed, and only the actually observed (minimum) values are provided (Table 3).

For the American Samoa-based component of the U.S. longline fishery, 2008 was the second full calendar year observed. The coverage rate was 6.4%--for a total of 9 trips and 379 sets. Scientists have not yet provided rigorous estimates of the total interactions with protected species for this fishery. 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

Approximately 1-2% of the fish caught by U.S. purse seine, longline, and albacore troll fisheries are measured (fork length) by NOAA Fisheries personnel as vessels are unloading in American Samoa. Species composition samples are also taken for use in adjusting purse seine logbook-reported data on the numbers of yellowfin tuna versus bigeye tuna. Fish caught by U.S. albacore troll vessels are also measured (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 2007, billfish anglers reported catching 3786 Pacific billfish during 5575 fishing days. The mean CPUE for all billfish in the Pacific was 0.68, which is high compared to the annual CPUE reported over the last 20 years but well below the 0.82 CPUE reported in 2006. CPUE time series were extended for each of the main species caught, including Pacific blue marlin (*Makaira mazara*), 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).

Longline Observer Report on Shark Catch Data

NOAA Fisheries submitted a manuscript on shark catches in the Hawaii-based longline fishery for publication in a peer-reviewed journal (Walsh, Bigelow and Sender. *In Press*). The report is a detailed quantitative description of 12 years of shark catch data from the Pacific Islands Regional Observer Program. The results include a detailed summary of the species composition of the sharks catch and additional information pertinent to either the management (e.g., nominal catch rates; disposition of caught sharks; distributions of shark catches relative to those of target species) or the basic biology (e.g., mean sizes; sex ratios) of the common species.

Hawaii Retail Fish Market Monitoring System and Ahi Poke Study

A new retail monitoring system was established in 2007 to collect data on fresh fish retail markets in Honolulu and monitoring has continued for nearly three years. Information collected by the retail monitoring system will help local fisheries managers 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 fishermen to the consumer. The monitoring system covers retail-level price data for bigeye tuna, yellowfin tuna, blue marlin and striped marlin.

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. A report based on the study is being prepared.

Fishing Costs in the Hawaii Pelagic Longline Fishery

Significant strides have been made recently to assess the change of important economic indicators of Hawaii-based longline fisheries that target tuna and swordfish. Since the project was started in August 2004, data on fishing costs and other economic information have been collected for over 1,000 longline fishing trips. The data collected provide important economic indicators of the fisheries. For example, the data showed an increasing trend in cost of tuna trips (not including fixed cost and labor costs) over the past five years. Over the period 2004-2008, the average trip cost in the Hawaii longline fishery for tuna targeted trips increased by about

112%, from $12,300 per trip to $26,100 per trip. Fuel cost made up about 50% of the total trip cost.

Hawaii Small Boat Economics

An economic survey was conducted to assess the fishing trip cost structure within the Hawaii small boat fishery to shed light on the social and economic importance of small boat fishing. Intercept interviews were conducted at boat ramps across the state of Hawaii during April 2007 – April 2008, and researchers completed approximately 345 interviews. Results suggest that fuel is the primary cost fishers must incur on a fishing trip. For an average trolling trip in 2007, fuel accounted for 70% of total trip costs. Thus, variation in the price of fuel may affect the economic viability of small boat fishing in Hawaii.

Hawaii Longline Industry Perspectives on Bycatch

In 2008, NOAA Fisheries completed a study of Hawaii longline fishermen's perspectives on bycatch reduction. The research consisted of developing five case studies to complement more-comprehensive studies of sociocultural characteristics of the Hawaii longline industry (Allen and Gough 2006; Allen and Gough 2007). The case studies were chosen to deal with a range of bycatch reduction techniques, from gear-based strategies that are already in use and mandated by law (such as the use of circle hooks and fish bait for vessels targeting swordfish), to social sanctions within ethnic networks of the fleet. This research focused on fishermen's perceptions of and reactions to the strategies. The research is being described in a NOAA Technical Memorandum. The five case studies were:

Case Study One: Fishing Vessel Operators' Experiences with Circle Hooks: Success for Fishermen and Fisheries Managers. This case study utilized open-ended interviews and focus groups to extract opinions regarding overall satisfaction with circle hooks and mackerel bait and their perceived effects on catch rates of target species, turtle interactions, cost, efficiency and on-board safety of the crew.

Case Study Two: Adoption of the Seabird Avoidance Method of Side Setting Onboard a Hawaii Longline Tuna Fishing Vessel. This case study explored the reasons why some vessel operators were able to implement side-setting techniques with relative ease, success, and satisfaction.

Case Study Three: Mechanisms of Communication and Transfer of Knowledge Within the Hawaii Longline Community: Implications for Bycatch Reduction Strategies. This case study explored the transfer of knowledge among Hawaii longline fishing vessel operators.

Case Study Four: Hawaii Longline Swordfish Fishing Vessel Operators Use of Social Sanctions to Meet Regulatory Intent. This case study assessed the human dimensions involved in the decisions of Hawaii swordfish fishermen to self-regulate their fishing practices in response to regulations limiting the number of interactions with leatherback and loggerhead sea turtles.

Case Study Five: Re-defining Bycatch: One Hawaii Longline Vessel Operator's Ideas for Marketing Bycatch. This case study explored one particular fishing vessel operator's attempt to reduce bycatch of sharks and some other non-target species by modifying his operations and creating a market for bycatch species that otherwise would have been discarded.

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.

Terry, J., and M. Pan. 2008. Findings of Two Recent U.S. Reports on Excess Harvesting Capacity in Federally Managed Commercial Fisheries, Proceedings of The International Institute of Fisheries Economics and Trade (IIFET) Fourteenth Biennial Conference, Nha Trang, Vietnam, July 22-25, 2008.

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.

Walsh, W.A., K.A. Bigelow and K.L. Sender. 2009. Decreases in shark catches and mortality in the Hawaii-based longline fishery as documented by fishery observers. Marine and Coastal Fisheries. (In Press)

1.2.2 Research on Biology, Bycatch, and Fishing Technology

BIOLOGICAL RESEARCH

Billfish Age and Growth Studies

NOAA Fisheries continued to examine striped marlin hardparts (otoliths, dorsal & anal fin rays, cleithrum, and vertebrae) for use as growth mark indicators. Striped marlin hardparts are collected through Hawaii market sampling and collected at sea by observers onboard longline vessels. Evaluation of the various hard parts has determined that the 4^{th} dorsal fin ray and sagittal otoliths are best suited for age determination. Longline observers also continue to collect samples of whole gonads, as billfish gonads typically are unavailable through the market sampling. The gonad samples will be used to determine length at 50% reproductive maturity for both sexes. Observers are now collecting subsamples of gonads and preserving them at-sea in a non-toxic histological preservative. The performance of this preservative as a substitute for Formalin will be evaluated once the samples are prepared at a histology facility. Observers also continue to collect small (<110 cm eye-fork length) whole juvenile specimens; billfish of this size are rarely available. Collaborations are being sought with researchers in Mexico who are actively conducting similar striped marlin studies.

NOAA Fisheries has also collaborated with researchers at the Commonwealth Scientific and Research Organization in 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 annuli (growth bands) 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.

Sample preparation and preliminary analysis continue in a study of the elemental composition of young-of-year swordfish otoliths. Otolith specimens have been 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 prepared 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. The data are being analyzed to determine whether otoliths contain trace elemental "fingerprints" unique to particular nursery regions.

Studies of Pelagic Shark Abundance, Age, Growth and Maturity

Fishery-independent surveys are being used to track trends in the abundance of juvenile and sub-adult blue and shortfin mako sharks and neonates of common thresher shark in the Southern California Bight. Surveys have been conducted each summer since 1994 for mako and blue sharks and since 2003 for thresher sharks. For mako and for blue sharks, the CPUE has declined for both species since the survey began. In 2008, 48 longline sets were made over an 18-day cruise, and 300 common threshers, two spiny dogfish, 28 soupfin sharks (*Galeorhinus galeus*), two leopard sharks (*Triakis semifasciata*), and 5 brown smoothhound (*Mustelus henlei*) were caught. Nearly all of the common thresher sharks caught were injected with oxytetracycline (OTC) for age and growth studies, tagged with conventional tags, and released. In addition, pop-off satellite tags were deployed on three common thresher sharks. Experiments are being planned to examine the effects of electropositive metals on the catch rates of mako and blue sharks during the annual pelagic shark surveys.

In 2007, NOAA Fisheries initiated OTC validation studies on blue sharks and continued OTC validation studies on mako and thresher sharks. Since the beginning of the program in 1997, 1959 OTC-marked individuals have been released during juvenile shark surveys. As of April 2009, recaptured OTC-marked sharks included 71 mako, 40 common thresher, and 31 blue sharks; however, vertebrae were returned for only about half of the recaptures. Time at liberty ranged from seven to 1,938 days with net movements of individual sharks as high as 3,410 nmi.

Meta-Analysis of Archival Tags

An analysis is underway on the performance of pop-off archival transmitting (PSAT) tags deployed on a wide array of highly migratory species. The study is designed to look for explanatory variables related to tag performance. By examining these factors and other information about PSATs attached to different pelagic species, it is anticipated certain patterns/commonalties may emerge to help improve attachment methodologies, selection of target species, and experimental designs, particularly with respect to post-release survival studies. 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 77% overall reporting rate. PSATs in the performance assessment database had a very similar overall reporting rate. Shark species in the database include bigeye thresher, blue, shortfin mako, silky, oceanic whitetip, great white, and basking sharks. Other species include: black, blue, and striped marlins; broadbill swordfish; bigeye, yellowfin, and bluefin tunas; tarpon; and green, loggerhead, and olive Ridley turtles. Of the tags that recorded data, 106 (18 percent) hit their programmed pop-off date and 471 tags popped off earlier than their program date. The 154 (21 percent) non-reporting tags are not assumed to reflect fish mortality. Logistic regression models showed that reporting rates have improved significantly over recent years and are lower in species undertaking large vertical excursions. There is a significant interaction with respect to reporting rates between a species' depth classification (i.e., littoral, epi-pelagic, meso-pelagic, bathy-pelagic) and tag manufacturer. Lower tag retention rates could be linked to higher infection rates at the tag anchor site or bio-fouling, in areas of higher ocean productivity. Information derived from this study should allow an unprecedented and critical appraisal of the overall efficacy of the technology.

North Pacific Albacore Archival Tagging

NOAA Fisheries and the American Fishermen's Research Foundation (AFRF) have worked together since 2001 to study migration patterns and general life history strategies of subadult (ages 2-5) North Pacific albacore using archival tags. Through December 2007, 552 archival tags were deployed, 22 of which were recovered. Preliminary data from the recovered tags demonstrate a wide range of behaviors of juvenile albacore. Most fish were at liberty for over a year and have provided over 5,000 days of data. New analyses of tag returns indicate that: During summer and fall months near the U.S. West Coast off Oregon and Washington, the mean daytime swimming depth of juvenile albacore was roughly 20 m and more than 85% of their time was spent in the top isothermal layer of the water column; during summer months off southern California and northern Baja California, Mexico, mean swimming depths were similar; however, albacore tended to spend more time diving through the thermocline during the day. In contrast, off the west coast of Japan in May one fish spent only 20% of its time during the day in the upper isothermal layer with a mean daytime swimming depth of 150 m.

Recreational Billfish Tagging Program

NOAA Fisheries' Billfish Tagging Program has provided tagging supplies to recreational billfish anglers for 46 continuous 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 57,700 fish of 75 different species have been tagged and released. In 2007, 841 billfish and 15 other fish species were tagged and released by 603 anglers and 142 fishing captains.

Pelagic Shark Migration 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 77 makos, 66 blue sharks, and 27 common threshers have been satellite tagged through these collaborative projects.

Post-release Survival of Blue Sharks Caught in Drift Gillnets

NOAA Fisheries is conducting a study to determine the survivability of blue sharks caught and released alive by the California drift gillnet fishery. During the 2007-2008 fishing season, seven sharks in various conditions at time of release were tagged with pop-up archival transmitting (PAT) tags. During the 2008-2009 season, 3 additional blue sharks were tagged. The tagged sharks were tracked and results indicate that survivability is high; 9 of the 10 sharks survived for at least 30 days following tagging and the tenth shark survived for at least 17 days, after which it appears the tag was ingested by another animal. Tagging of smaller sharks and those in the poorest condition will be conducted during the 2009-2010 season to conclude the study.

Survival of Thresher Sharks Released by the Recreational Fishery

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. Anglers often hook the tails of thresher sharks and pull the fish backwards to the boat. When the fight time is long, the fish may be exhausted by the time it reaches the boat for release. A total of 28 thresher sharks were caught and released during the 2008 season, 26 of which had been tail hooked. All individuals with fight times less than 85 minutes survived the acute effects of capture as determined by the PAT records. Preliminary data suggest that large tail-hooked thresher sharks exposed to prolonged fight times have increased mortality rates when compared to smaller individuals that can be brought to the boat more quickly. Further tagging is planned for 2009 to increase the sample size and experiment with alternative fishing techniques, including teasers with drop-back bait.

Post-release Survival of Longline-caught Sharks

NOAA Fisheries has been developing biochemical and physiological profiling techniques for use with small blood samples to estimate post-release survival of blue sharks (Moyes et al. 2006). In a complementary study, five species of pelagic sharks (bigeye thresher, blue shark, oceanic whitetip, short fin mako, silky shark) released from longline gear were tagged with PSATs. Based on 44 PSATs reporting, there was definitive data indicating post-release mortality in only 2 cases (male blue shark after 7 days, female oceanic whitetip after 9 days) for an overall mortality estimate of 4.5% (95% bootstrap CI, 0 to 11%). Antecedent stress variables to explain mortality were examined (capture temperature, soak time, etc.) but mortality was not associated with any of the variables in these two instances. These combined biochemical and PSAT analyses suggest that pelagic sharks landed in an apparently healthy condition are likely to survive long term if released (95% survival based on biochemical analyses [blue shark]; >95% based on PSATs [all sharks studied]). In this study all sharks captured and released from the longline gear were caught on circle hooks.

BYCATCH AND FISHING TECHNOLOGY RESEARCH

Gear Modification to Reduce Turtle Bycatch

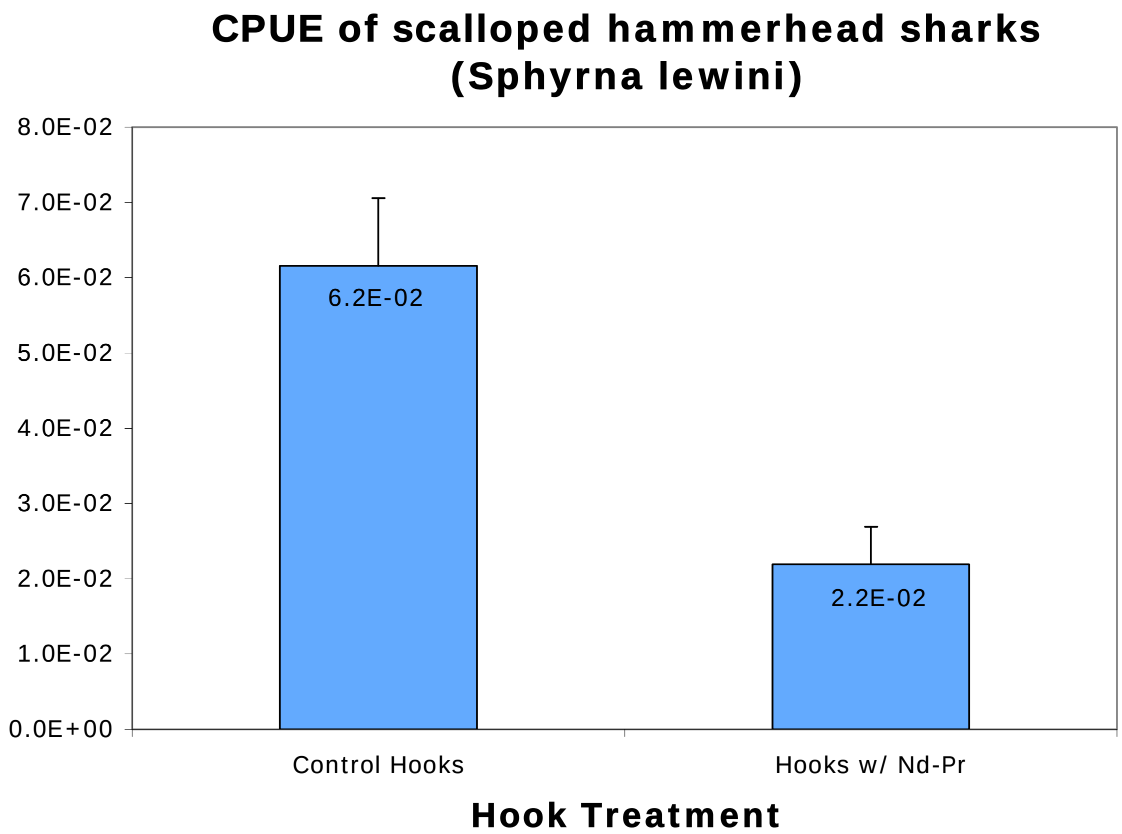
NOAA Fisheries is contracting or otherwise assisting in longline fishing vessel trials to test the efficacy of sea turtle bycatch mitigation methods in Costa Rica, Brazil, Uruguay, Indonesia, Spain, Cook Islands, Vietnam, and Italy. The trials will measure effects of gear modifications (e.g., use of large circle hooks, appendage hooks, hook offsets, rings) on the rates of hooking and entanglement of sea turtles in longline fisheries. Research from the previous few years indicate that relatively large circle hooks effectively reduce the bycatch of both loggerhead and leatherback sea turtles. These hooks have also been shown to produce acceptable catch rates of tuna species, but slightly reduced catch rates of targeted swordfish. In addition, use of circle hooks has been found to reduce the rates of capture of pelagic stingrays, motivating some fishermen, particularly in Italy, to convert to circle 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. Technical assistance was provided to numerous programs, both governmental and non-governmental, as experimental longline tests expand worldwide. A recently completed relational database linked to NOAA's bycatch web site provides public access to the data.

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. However, more modeling of the data is necessary in order to tease out effects of fishing gear variables likely to influence capture rates of sharks, most notably bait type and gangion material. 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.

Investigation of the post-release mortality of sea turtles after their release from fishing gear continues. Manuscripts are in press describing use of pop-up satellite archival tags (PSATs) to estimate post-release survival of olive Ridley turtles caught on longline fishing gear in the Eastern Tropical Pacific and loggerhead turtles caught in the North Pacific Ocean. Additionally, platform terminal transmitters (PTTs) were placed on loggerhead sea turtles that were incidentally caught and released from longline fishing gear in the Mediterranean and S.W. Atlantic Ocean. Results indicate no differences in duration of transmissions as a function of the turtles' "severity of injury", specifically whether the hook was deep or shallow, and that most sea turtles were tracked for the duration of the tag's battery life. Results will be presented along with those from other studies by collaborating NOAA scientists to provide an empirical basis for NOAA's assumed post-release mortality levels.

Chemical and Electromagnetic Deterrents to Shark Bycatch

Since 2007, NOAA Fisheries has been testing the ability of electropositive metals (lanthanide series) to repel sharks from longline hooks in Hawaii. Electropositive metals release electrons and generate large oxidation potentials when placed in seawater. It is thought that these large oxidation reactions perturb the electrosensory system in sharks and rays, causing the animals to exhibit aversion behaviors. Since commercially targeted pelagic teleosts do not have an electrosensory sense, this method of perturbing the electric field around baited hooks may selectively reduce the bycatch of sharks and other elasmobranchs.



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*) in waters off the North Shore of Oahu in the Hawaiian Islands. Results indicate that sharks significantly reduced their biting of bait on hooks close 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 than 40 cm to baits in the presence of the metal objects (ingots approximately the same size as a 60g lead fishing weight used by Hawaii longline fishermen).

Initial longline experiments to examine effects of the electropositive ingots on shark catch rates are also being conducted using Nd/Pr (Neodymiun/Praseodymium) alloy. Preliminary results from longline field trials in Kaneohe Bay, Hawaii suggest that catch rates of juvenile scalloped hammerhead sharks (*Sphyrna lewini*) are reduced by 63% on branch lines when the Nd/Pr alloy is attached to branch lines as compared to lead-weight controls. Sharks for behavioral experiments are being collected, experimental observation arenas are being prepared for behavioral experiments, and initial behavioral experiments examining effects of electropositive metals on swimming and feeding behavior have been initiated on scalloped hammerhead and sandbar sharks.

Longline Gear Effects on Shark Bycatch

To explore operational differences in the longline fishery that might reduce shark bycatch, the Hawaii longline observer database is being used to compare bycatch rates under different operational factors (e.g., hook type, branch line material, bait type, the presence of light sticks, soak time, etc.). A preliminary analysis was completed comparing the catches of vessels using traditional tuna hooks to vessels voluntarily using size 14/0 to 16/0 circle hooks in the Hawaii-based tuna fleet. The study was inconclusive due to the small number of vessels using the circle hooks. Subsequently, 19 contracted vessels were used to test large (size 18/0) circle hooks versus tuna hooks in controlled comparisons. Preliminary analysis does not indicate these large circle hooks increase the catch rate of sharks. In contrast, studies in other fisheries comparing smaller circle hooks with J hooks have found that the smaller circle hooks produce higher catch rates.

Testing Deeper Sets to Reduce Bycatch

An experiment with deeper-set longline gear conducted in 2006 has been published (Beverley et al. 2009). 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 was to maximize target catch of deeper dwelling species such as bigeye tuna, and reduce incidental catch of many marketable but less desired species (e.g., billfish and sharks). 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 of bigeye tuna and sickle pomfret were greater on the deep set gear than on the controlled sets; but the bigeye results were not statistically significant. Catch of several less valuable incidental fish (e.g., blue marlin, striped marlin, shortbill spearfish, dolphinfish, and wahoo) was significantly lower on the deep set gear than the controlled sets. No significant results were found for sharks.

Relevant Publications

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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-, American Samoa-, and California-based longline fisheries are monitored using the NOAA Fisheries Western Pacific Daily Longline Fishing Logs for effort and resulting catch. The coverage of logbook data is assumed to be complete (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 collect scientific data including species and size of fish caught (Section 1.2.1). Fish sales records are another important source of data that supplements the logbook data. The number of individual fish weights recorded in sales data far outnumber the fish measured by observers in the Hawaii-based longline fishery. Fish sales records cover 100% of landings for the purse seine fleet, and close to 100% of the albacore troll and Hawaii-based longline landings.

Small-scale fisheries in Hawaii, i.e., tropical troll, handline, and pole-and-line, are monitored using 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 of fish caught) 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 integration of data 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. Other enhancements to this integration are under development, such as linking the weight of longline-caught fish from the Hawaii Marine Dealer records with the Hawaii-based longline logbook data to approximate the weight of catch by geographic location. In addition, species misidentifications on a trip level have been corrected by cross-referencing the longline logbook data, the Hawaii Marine Dealer data, and the longline observer data. Information on these corrections is published (Walsh et al., 2007) but is not yet operationally applied to routine data reporting (i.e., the data reported here).