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ANNUAL REPORT TO THE COMMISSION
PART 1: INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS

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UNITED STATES OF AMERICA

2011 Annual Report to the Western and Central Pacific Fisheries Commission

United States of America

PART I. INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS [1]
(For 2010)

National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Scientific data was provided to the Commission in accordance with the decision relating to the provision of scientific data to the Commission by 30 April 2011	**YES**
If no, please indicate the reason(s) and intended actions:	

Summary

Large-scale fisheries of the United States and its Participating Territories for highly migratory species (HMS) in the Pacific Ocean include purse seine fisheries for skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*); longline fisheries for bigeye tuna (*Thunnus obesus*), swordfish (*Xiphias gladius*), albacore (*Thunnus alalunga*), and associated species; and a troll fishery for albacore. Small-scale fisheries include troll fisheries for a wide variety of tropical tunas and associated species, handline fisheries for yellowfin and bigeye tuna, a pole-and-line fishery for skipjack tuna, and miscellaneous-gear fisheries. 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 nations. The small-scale fisheries operate in nearshore waters off Hawaii and the U.S. Territories of American Samoa and Guam, and the Commonwealth of the Northern Mariana Islands (CNMI).

Overall trends in total landings by U.S. and U.S. associated-Participating Territory fisheries in the Western and Central Pacific Fisheries Commission (WCPFC) statistical area in 2010 are dominated by the catch of the purse seine fishery. Preliminary 2010 purse seine estimates total 215,587 t of skipjack, 25,686 t of yellowfin, and 4,251 t of bigeye tuna. U.S. purse seine landings in 2009 have been revised upwards to 283,219 t from last year's preliminary estimate. Longline landings in 2010 decreased after peaking in 2007. Bigeye tuna and albacore landings by longliners declined from record highs in 2007 to 4,067 t and 4,273, respectively, in 2010. Excluding landings by the U.S. Participating Territories (i.e., American Samoa), longline landings of bigeye tuna declined to 3,571 t in 2010 from 5,381 t in 2007 (Table 1f). These bigeye tuna landings by the U.S. longline fishery in the North Pacific Ocean were in 2009 and 2010 below the limit of 3,763 t established in U.S. fishery regulations (74 FR 63999, December 7, 2009) pursuant to the provisions of CMM 2008-01. Longline landings of swordfish decreased to 1,030 t in 2010, down from their peak of 1,441 t in 2007. Small-scale (tropical) trollers and handliners operating in nearshore waters represented the largest number of U.S. flagged vessels but contributed only a small fraction of the landings. The longline fleet was the next largest fleet, numbering 147 in 2010, while there were 37 purse seine vessels.

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[1] PIFSC Data Report DR-11-009
Issued Aug 2011

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries Service) 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. NOAA Fisheries conducts fishery monitoring and socio-cultural research on tunas, billfishes, and animals caught as bycatch in those fisheries. In 2010, the International Billfish Angler Survey continued to provide fishery-independent information on billfish catch and angler effort in a variety of recreational fisheries across the Pacific. Shark CPUE in the Hawaii-based longline fishery was summarized from observer data. Socio-economic studies included market impact of longline bigeye closure, consumer preference surveys, catch shares economics, and analyses of time-area closures in the longline fishery. Stock assessment research was conducted almost entirely in collaboration with members 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 (Brodziak and Ishimura, 2010, 2011; Brodziak and Piner, 2010; Lee et al., 2011).

NOAA Fisheries biological and oceanographic research on tunas, billfishes, and sharks addressed fish movements, habitat preferences, post-release survival, feeding habits, abundance, maturity, and age and growth. Research on north Pacific albacore focused on otolith analysis for age and growth, and archival tagging for migration and stock structure. Tagging projects also continued for billfish, sharks, and bigeye tuna. Bycatch mitigation studies in the longline and gillnet fisheries focused on sea turtles, pelagic sharks, and false killer whales.

Section 2: ANNUAL FISHERIES INFORMATION

This report presents estimates of annual catches of tuna, billfish, and other highly migratory species (HMS), and vessel participation during 2006-2010 for fisheries of the United States and its Participating Territories operating in the western and central Pacific Ocean (WCPO). All statistics for 2010 are provisional. For the purposes of this report, the WCPO is defined as the Western and Central Pacific Fisheries Commission (WCPFC) Statistical Area.

The purse seine fishery remains the largest U.S. fishery in terms of total catch. The purse seine fishery accounts for about 94% of the total U.S. and its Participating Territories catch[2] of HMS in the WCPO. The longline, albacore troll, tropical troll, and handline fisheries account for about 4.7%, 0.1%, 0.7%, and 0.1% of the total catch, respectively. Landings by most of the fisheries decreased; only the handline and albacore troll fisheries increased in 2010 in comparison to 2009. U.S. and its Participating Territories fisheries for tunas, billfishes and other pelagic species produced an estimated 261,272 t in 2010 (Table 1a), down from 299,003 t in

[2] For the most part, U.S. estimates of catch by weight are estimates of retained catches due to lack of data on weights 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.

2009 (Table 1b). The catch consists primarily of skipjack tuna (83%), yellowfin tuna (10%), bigeye tuna (3%), and albacore (2%). Catches of albacore and yellowfin tuna increased in 2010 as compared to 2009, and the greatest increase was for albacore (up to 4,605 in 2010 from 4,186 in 2009).

Table 1a. Estimated weight (in metric tons) of landings by vessels of the United States and its Participating Territories (American Samoa, Guam, and Commonwealth of the Northern Mariana Islands) by species and fishing gear in the WCPFC Statistical Area, for 2010 (preliminary). 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	359		2	23	0	384
Albacore (ALB), South Pacific	0	3,914	307		0	0	4,221
Bigeye tuna (BET)	4,251	4,067		129	337	0	8,783
Pacific bluefin tuna (PBF)	0	3			0	0	3
Skipjack tuna (SKJ)	215,587	234		389	6		216,216
Yellowfin tuna (YFT)	25,686	930		413	237		27,266
Other tuna (TUN KAW FRI)	609	0		27	7		643
TOTAL TUNAS	246,133	9,508	307	960	609	0	257,517
Black marlin (BLM)	0	0		0	0	0	0
Blue marlin (BUM)	0	287		144		0	431
Sailfish (SFA)	0	11		2	0	0	13

Spearfish (SSP)	0	86		0	0	0	86
Striped marlin (MLS), North Pacific	0	130		5	0	0	135
Striped marlin (MLS), South Pacific	0	2			0	0	2
Other marlins (BIL)	0	1		12	0	0	
Swordfish (SWO), North Pacific	0	1,022		0		0	1,023
Swordfish (SWO), South Pacific	0	8		0	0	0	8
TOTAL BILLFISHES	0	1,547	0	163	0	0	1,710
Blue shark (BSH)	0	7		0	0	0	7
Mako shark (MAK)	0	65		0	0	0	65
Thresher sharks (THR)	0	16		0	0	0	16
Other sharks (SKH OCS FAL SPN TIG CCL)	0	3		0	0	0	3
TOTAL SHARKS	0	92	0	0	0	0	92
Mahimahi (DOL)	0	251		451	23		725
Moonfish (LAP)	0	380		0	0	0	380
Oilfish (GEP)	0	176		0	0	0	176
Pomfrets (BRZ)	0	180		0		0	180
Wahoo (WAH)	0	233		232		0	465
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	11		16	0	0	27
TOTAL OTHER	0	1,231	307	699	23	0	1,953
TOTAL	246,133	12,378	307	1,822	632	0	261,272

Table 1b. Estimated weight (in metric tons) of landings by vessels of the United States and its Participating Territories (American Samoa, Guam, and Commonwealth of the Northern Mariana Islands) by species and fishing gear in the WCPFC Statistical Area, for 2009 (updated). 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	171		3	97	0	271
Albacore (ALB), South Pacific	0	3,915	237 [1]	0	0	0	3,915
Bigeye tuna (BET)	6,561	4,029		59	136	0	10,786
Pacific bluefin tuna (PBF)	0	2		0	0	0	2
Skipjack tuna (SKJ)	253,783	266		399	11	214	254,673
Yellowfin tuna (YFT)	21,245	820		471	317	17	22,869
Other tuna (TUN KAW FRI)	1,260	0		12	3	1	1,275
TOTAL TUNAS	282,848	9,203	237	945	564	231	293,791
Black marlin (BLM)	0	1		0	0	0	1
Blue marlin (BUM)	0	389		180	1	0	570
Sailfish (SFA)	0	12		0	0	0	12
Spearfish (SSP)	0	103		0	0	0	103
Striped marlin (MLS), North Pacific	0	240		10	0	0	250
Striped marlin (MLS), South Pacific	0	4		0	0	0	4
Other marlins (BIL)	0	0		8	0	0	8
Swordfish (SWO), North Pacific	0	1,290		0	5	0	1,295
Swordfish (SWO), South Pacific	0	12		0	0	0	12

TOTAL BILLFISHES	0	2,051	0	198	6	0	2,255
Blue shark (BSH)	0	9		0	0	0	9
Mako shark (MAK)	0	104		0	0	0	104
Thresher sharks (THR)	0	29		0	0	0	29
Other sharks (SKH OCS FAL SPN TIG CCL)	0	6		0	0	0	6
TOTAL SHARKS	0	148	0	0	0	0	148
Mahimahi (DOL)	0	276		408	18	1	703
Moonfish (LAP)	0	512		0	0	0	512
Oilfish (GEP)	0	203		0	0	0	203
Pomfrets (BRZ)	0	218		0	16	0	234
Wahoo (WAH)	0	257		264	5	0	526
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	371	8		13	3	0	395
TOTAL OTHER	371	1,474	0	684	42	1	2,572
TOTAL	283,219	12,875	237	1,827	612	232	299,003

Table 1c. Estimated weight in metric tons (t) of landings by vessels of the United States and its Participating Territories by species and fishing gear in the WCPFC Statistical Area, for 2008. 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	298	1	1	28	0	328
Albacore (ALB), South Pacific	0	3,550	150	0	0	0	3,700
Bigeye tuna (BET)	4,220	4,781	0	74	148	0	9,223
Pacific bluefin tuna (PBF)	0	1	0	0	0	0	1
Skipjack tuna (SKJ)	159,741	282	0	375	9	293	160,699
Yellowfin tuna (YFT)	45,363	1,169	0	453	227	23	47,235
Other tuna (TUN KAW FRI)	51	0	0	7	1	4	63
TOTAL TUNAS	209,375	10,081	151	910	413	320	221,250
Black marlin (BLM)	0	0	0	0	0	0	0
Blue marlin (BUM)	0	367	0	180	1	0	549
Sailfish (SFA)	0	11	0	1	0	0	12
Spearfish (SSP)	0	211	0	0	0	0	211
Striped marlin (MLS), North Pacific	0	411	0	14	0	0	425
Striped marlin (MLS), South Pacific	0	1	0	0	0	0	1
Other marlins (BIL)	0	2	0	13	0	0	15
Swordfish (SWO), North Pacific	0	1,301	0	0	6	0	1,307
Swordfish (SWO), South Pacific	0	7	0	0	0	0	7
TOTAL BILLFISHES	0	2,310	0	208	7	0	2,526
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	0	4	0	0	0	0	4

TIG CCL)							
TOTAL SHARKS	0	160	0	0	0	0	160
Mahimahi (DOL)	0	335	0	309	18	1	663
Moonfish (LAP)	0	415	0	0	0	0	415
Oilfish (GEP)	0	178	0	0	0	0	178
Pomfrets (BRZ)	0	224	0	1	16	0	241
Wahoo (WAH)	0	326	0	273	5	0	604
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	0	14	0	8	0	0	22
TOTAL OTHER	0	1,493	0	591	39	1	2,123
TOTAL	209,374	14,043	151	1,709	459	321	226,058

Table 1d. Estimated weight in metric tons (t) of landings by vessels of the United States and its Participating Territories by species and fishing gear in the WCPFC Statistical Area, for 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	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	7	272	76,014
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	680	296	103,589
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	710	296	108,416

Table 1e. Estimated weight in metric tons (t) of landings by vessels of the United States and its Participating Territories by species and fishing gear in the WCPFC Statistical Area, for 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	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	247	294	56,753
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	798	300	81,428
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	833	300	86,684

Table 1f. Longline landings in metric tons (t) by species and species group, for U.S. and American Samoa vessels operating in the WCPFC Statistical Area in 2010. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0).

	U.S. in North Pacific Ocean					**American Samoa in North Pacific Ocean**		**American Samoa**					**Total**				
	2010	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2010**	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**
Vessels	124	127	129	129	127	11	10	26	26	28	29	28	147	151	155	156	154
Species																	
Albacore, North Pacific	326	178	298	243	256	33	2	0	0	0			359	179	298	243	256
Albacore, South Pacific		0	0			0	0	3,914	3,883	3,550	5,183	4,078	3,914	3,883	3,550	5,183	4,078
Bigeye tuna	3,576	3,741	4,649	5,381	4,381	315	89	176	160	132	218	181	4,067	3,990	4,781	5,599	4,562
Pacific bluefin tuna	0	1	0	0	1	0	0	3	1	1	2	0	3	2	1	2	1
Skipjack tuna	114	117	117	91	93	12	4	108	151	165	162	190	234	271	282	253	283
Yellowfin tuna	462	429	836	833	937	28	12	441	386	333	640	513	930	826	1,169	1,473	1,450
Other tuna	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	4
TOTAL TUNA	4,479	4,464	5,900	6,549	5,668	388	107	4,641	4,581	4,180	6,205	4,967	9,508	9,152	10,081	12,753	10,635
Black marlin	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
Blue marlin	238	334	333	255	409	10	4	39	37	34	38	25	287	374	367	293	433
Sailfish	9	10	10	10	9	0	0	1	2	1	1	6	11	11	11	11	15
Spearfish	79	97	210	141	160	5	1	2	3	1	1	2	86	100	211	142	162
Striped marlin, North Pacific	124	234	411	267	609	6	3	0	0	0			130	237	411	267	609
Striped marlin, South Pacific	0	0	0			0	0	2	4	1	1	4	2	4	1	1	4
Other marlins	1	0	2	1	4	0	0	0	0	0	0	0	1	0	2	1	4
Swordfish, North Pacific	1,011	1,242	1,301	1,428	1,149	11	3	0	0	0			1,022	1,244	1,301	1,428	1,149
Swordfish, South Pacific	0	0	0			0	0	8	9	7	13	38	8	9	7	13	38
TOTAL BILLFISH	1,462	1,916	2,267	2,103	2,340	33	10	52	54	43	54	75	1,547	1,980	2,310	2,156	2,415

Table 1f. (Continued.)

	U.S. in North Pacific Ocean					American Samoa in North Pacific Ocean		American Samoa					Total				
	2010	2009	2008	2007	2006	2010	2009	2010	2009	2008	2007	2006	2010	2009	2008	2007	2006
Blue shark	6	9	7	6	10	0	0	1	1	1	1	1	7	9	7	7	10
Mako shark	62	102	109	119	94	2	0	0	0	0	0	1	65	102	109	120	95
Thresher	16	28	39	42	33	0	0	0	0	0	0	0	16	28	39	42	33
Other sharks	3	6	4	7	12	0	0	1	0	0	1	0	3	6	4	7	12
TOTAL SHARKS	87	144	159	174	149	3	0	2	1	1	2	1	92	146	160	176	151
Mahimahi	229	265	323	376	316	13	4	8	16	12	14	26	251	285	335	390	342
Moonfish	356	485	412	451	477	21	9	3	3	2	3	4	380	497	415	454	482
Oilfish	164	194	178	180	173	12	4	0	2	0	0	1	176	200	178	180	175
Pomfret	170	202	224	234	250	10	7	1	1	0	0	0	180	210	224	235	251
Wahoo	100	116	194	169	231	5	2	129	139	133	197	274	233	258	326	366	505
Other fish	10	8	14	10	14	0	0	1	1	0	0	0	11	8	14	10	14
TOTAL OTHER	1,029	1,269	1,345	1,420	1,462	61	26	141	162	148	215	306	1,231	1,458	1,493	1,635	1,768
GEAR TOTAL	7,056	7,794	9,671	10,246	9,619	485	144	4,836	4,798	4,372	6,475	5,349	12,378	12,736	14,043	16,720	14,968

Table 1g. Tropical troll landings in metric tons (t) for Hawaii, Guam, CNMI, and American Samoa vessels by species and species group, for U.S. vessels operating in the WCPFC Statistical Area in2010. Totals may not match sums of values due to rounding to the nearest metric ton (<0.5 t = 0).

	Hawaii					Guam					CNMI					American Samoa				
	2010	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**
Vessels	1,560	1,668	1,541	1,447	1,394	432	368	385	370	386	31	47	52	52	69	6	10	16	19	8
Species	-																			
Albacore, North Pacific	2	3	1	3	1	0														
Albacore, South Pacific																0	0			
Bigeye tuna	129	59	74	63	56	0										0	0			
Pacific bluefin tuna																				
Skipjack tuna	95	139	157	87	100	146	150	134	71.04	67	147	109	77	108	124	1	1	7	6	5
Yellowfin tuna	387	436	427	463	262	11	23	9	22	13	15	11	8	16	20	0	1	9	4	4
Other tunas	12	7	4	5	7	1	3	2	1	0	14	2	1	2	4	0	0			
TOTAL TUNAS	625	644	663	621	426	158	176	145	94	80	176	122	86	126	148	2	2	16	10	9
Black marlin						0										0	0			
Blue marlin	130	165	175	118	144	14	15	4	9	13	0	0	1	0	1	0	0	0	0	0
Sailfish						1					1	0	1			0	0			
Spearfish						0					0					0	0			
Striped marlin, N. Pacific	5	10	14	13	21	0														
Striped marlin, S. Pacific																0	0			
Other billfish	12	8	13	10	13		0	0	2	1										
Swordfish, North Pacific	0	0	0	1	0	0														
Swordfish, South Pacific																0	0			
TOTAL BILLFISHES	147	184	202	143	178	15	15	4	11	14	1	0	2	0	1	0	0	0	0	0

Table 1g. (Continued.

	Hawaii					Guam					CNMI					American Samoa				
	2010	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**	**2010**	**2009**	**2008**	**2007**	**2006**
Blue shark																				
Mako shark																				
Thresher sharks																				
Other sharks						0										0	0			
TOTAL SHARKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mahimahi	295	316	252	304	337	131	67	51	117	74	25	26	6	12	8	0	0	0	0	1
Moonfish																0	0			
Oilfish																	0			
Pomfrets							0	1				0	0	2		0	0			
Wahoo	206	199	227	206	207	21	59	45	20	48	5	5	1	1	1	0	0	0	0	
Other pelagics	3	2	2	1	1	5	10	3	12	14	7	1	3	1	4	0	0	0		
TOTAL OTHER	504	517	481	511	545	157	136	100	149	136	37	32	10	16	13	0	0	0	1	1
GEAR TOTAL	1,277	1,345	1346	1,275	1,149	329	327	249	254	230	214	154	98	142	162	2	2	16	11	10

Table 1h. Estimated catch of swordfish, and number of U.S. vessels fishing for swordfish, south of 20° S in the WCPFC Convention Area in 2005-2010, to fulfill the reporting requirements of WCPFC Conservation and Management Measure 2009-03.

	U.S.-flagged vessels south of 20° S	
Year	Catch (mt) by all vessels	Number of vessels fishing for swordfish
2005	0	0
2006	28	2
2007	confidential	2
2008	confidential	0
2009	<1	0
2010	confidential	0

Note: The catch is only reported for years when 3 or more vessels fished, although the number of vessels fishing for swordfish may be less than the number that fished. The U.S. does not have any longline vessels operating under charter or lease as part of its domestic fishery south of 20° S nor does it have any other vessels fishing within its waters south of 20° S.

Table 2a. Estimated number of United States and Participating Territories vessels that reported catches in the WCPFC statistical area, by gear type, from 2006-2010. Data for 2010 are preliminary.

	2010	2009	2008	2007	2006
Purse seine	37	39	36	22	13
Longline (N Pac-based)[1]	124	127	129	129	127
Longline (American Samoa-based)	26	26	28	29	28
Total U.S. Longline[2]	147	151	155	156	154
Albacore troll (North Pacific) [3]		0	2	2	3
Albacore troll (South Pacific)	6	4	4	6	8
Tropical troll	2,029	2,093	1,994	1,888	1,857
Handline	469	552	475	424	375
Tropical Troll and Handline (combined)[4]	2,117	2,184	2,076	1,888	1,924
Pole and line	2	6	3	3	4
TOTAL	2,308	2,384	2,274	2,075	2,103

[1]Includes only Hawaii-based vessels in 2006-2010.
[2]Some longline vessels fish in both Hawaii and American Samoa and are counted only once in this total.
[3]Before 2009 most of these vessels fished on both sides of the equator and are counted only once in the bottom line.
[4]Some vessels fished both tropical troll and handline, and are counted only once in this total.

Table 2b. Estimated number of United States and Participating Territories purse seine, longline, pole-and-line, and albacore troll vessels that reported catches in the WCPFC statistical area, by gross registered ton categories, 2006-2010. Data for 2010 are preliminary.

	Vessel Size (gross registered tons)					
Gear and year	0-50	51-150	51-200	501-1000	1001-1500	1501+
2007 Purse seine				2	14	4
2008 Purse seine				2	21	13
2009 Purse seine				2	20	17
2010 Purse seine				0	19	18
2006 Longline	16		138			
2007 Longline	15		141			
2008 Longline	13		142			
2009 Longline	12		139			
2010 Longline	11		136			
2007 Pole and line		3				
2008 Pole and line	1	2				
2009 Pole and line	3	3				
2010 Pole and line		2				
2007 Albacore Troll			6			
2008 Albacore Troll			4			
2009 Albacore Troll			4			
2010 Albacore Troll			6			

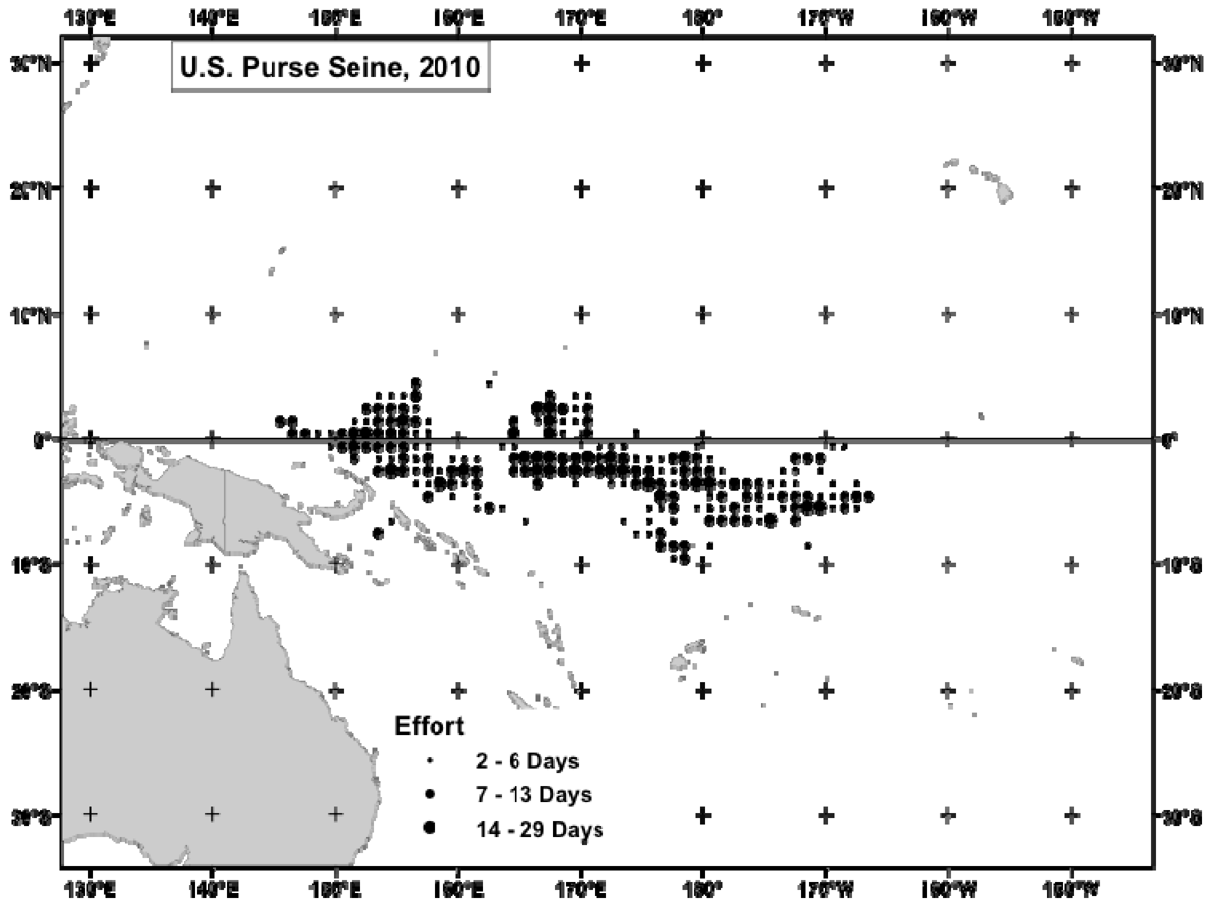

Figure 1. Spatial distribution of reported logbook fishing effort (days fished) by the U.S. purse seine fleet in the western and central Pacific Ocean in 2010 (preliminary). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

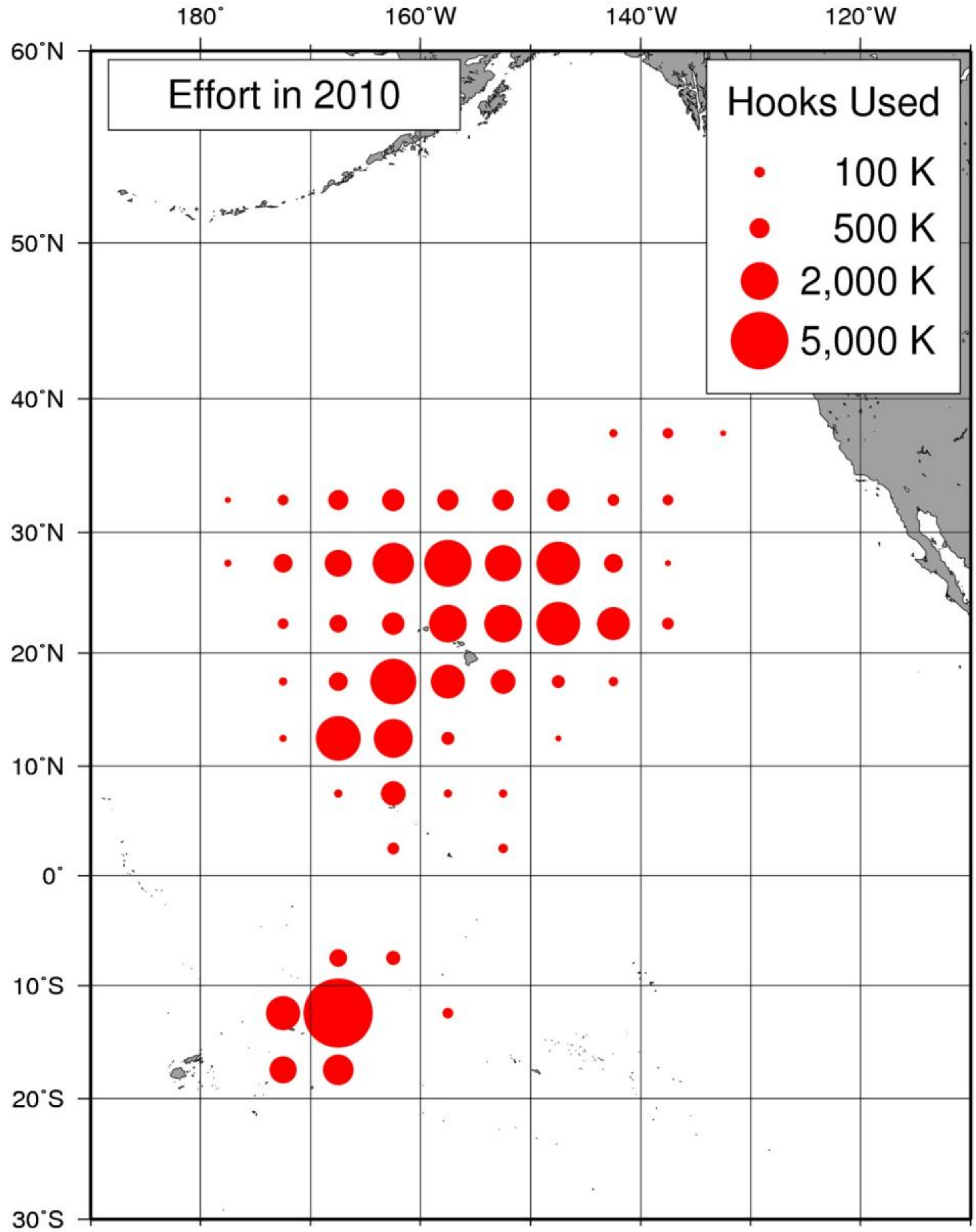

Figure 2a. Spatial distribution of fishing effort reported in logbooks by U.S. flagged longline vessels, in 1,000's of hooks (K), in 2010 (preliminary data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

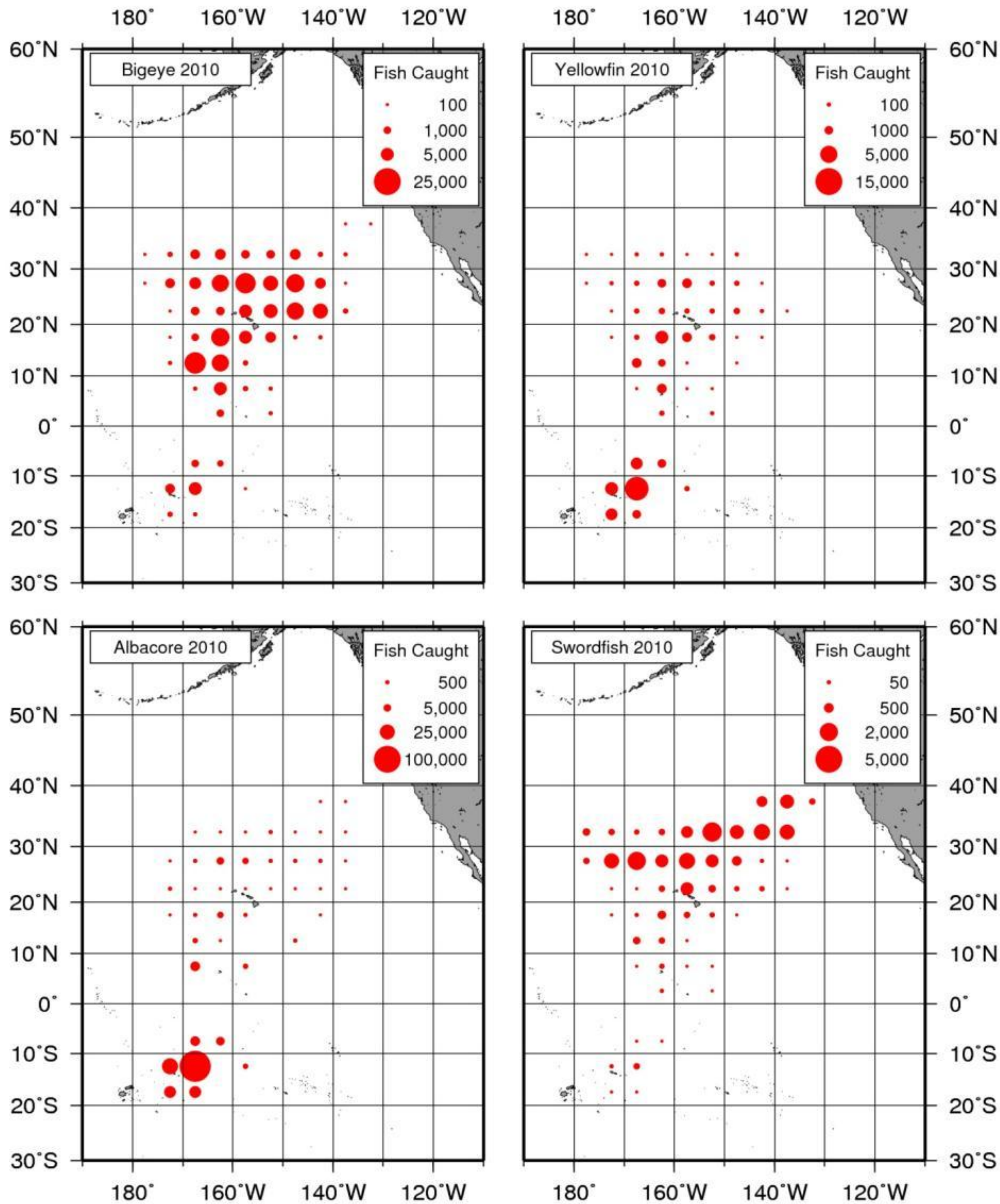

Figure 2b. Spatial distribution of catch reported in logbooks by U.S. flagged longline vessels, in numbers of fish (includes retained and released catch), in 2010 (preliminary data). Area of circles is proportional to catch. Catches in some areas are not shown in order to preserve data confidentiality.

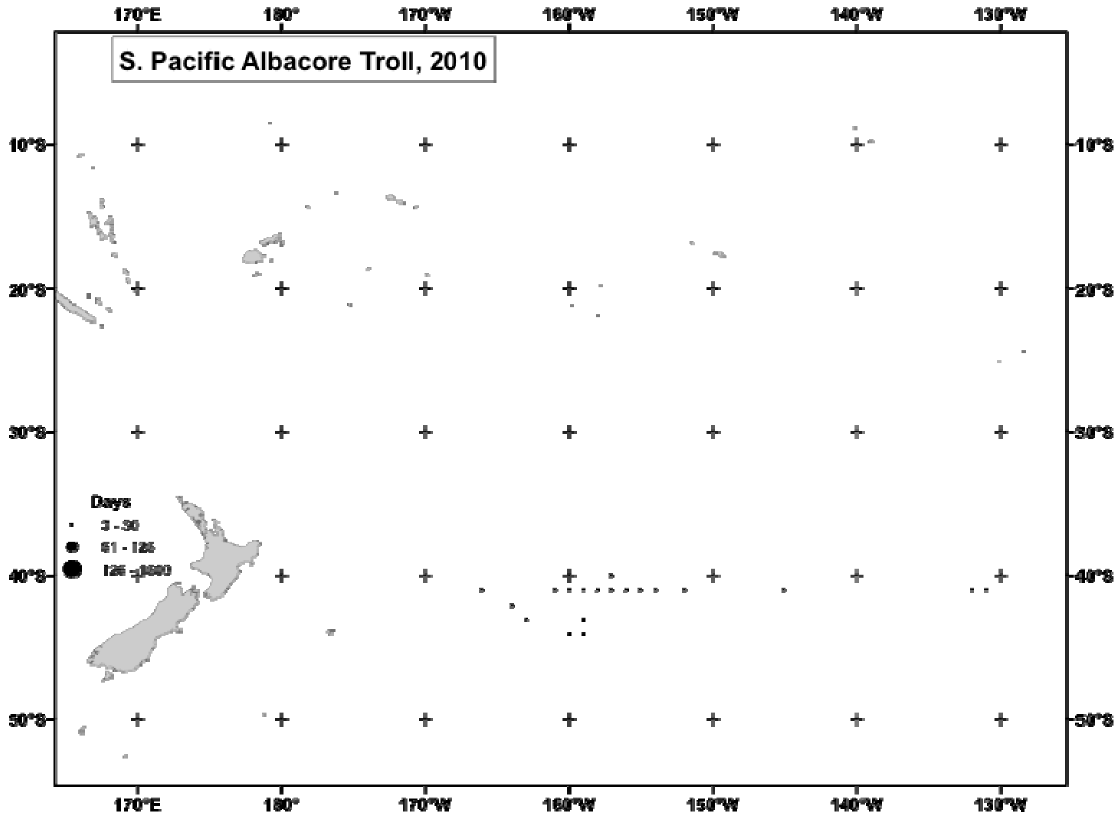

Figure 3. Spatial distribution of reported logbook fishing effort (days fished) by the U.S. albacore troll fleet in the South Pacific Ocean in 2010 (preliminary data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

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 2006-2010[3]. Estimates of total marine mammal interactions by the deep-set fishery in 2010 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	**2006**	**2007**	**2008**	**2009**	**2010**
Marine mammals					
Striped dolphin (*Stenella coeruleoalba*)	6	0	1	0	2
Bottlenose dolphin (*Tursiops truncatus*)	2	3	0	5	3
Risso's dolphin (*Grampus griseus*)	8	6	6	3	8
Blainville's beaked whale (*Mesoplodon blainvillei*)	0	0	0	0	0
Bryde's whale (*Balaenoptera edeni*)	0	0	0	0	0
False killer whale (*Pseudorca crassidens*)	17	14	12	56	4
Humpback whale (*Megaptera novangliae*)	1	0	1	0	0
Shortfinned pilot whale (*Globicephala macrorhynchus*)	6	2	5	0	0
Spotted dolphin (*Stenella attenuate*)	0	0	3	0	0
Unspecified false killer whale or shortfinned pilot whale	14	0	10	0	1
Unidentified Cetacean (Cetacea)	2	4	3	17	3
Unspecified member of beaked whales (Ziphiidae)	7	0	0	0	0
Unspecified pygmy sperm whales (Kogia)	0	0	1	0	0
TOTAL MARINE MAMMALS	63	29	42	81	21
Sea turtles					
Loggerhead turtle (*Caretta caretta*)	17	21	0	3	11
Leatherback turtle (*Dermochelys coriacea*)	11	9	13	12	13
Olive Ridley turtle (*Lepidochelys olivacea*)	52	26	19	17	10
Green turtle (*Chelonia mydas*)	6	0	1	1	1
Unidentified hardshell turtle (Cheloniidae)	2	0	0	0	0
TOTAL SEA TURTLES	88	56	33	33	35

[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	2006	2007	2008	2009	2010
Albatrosses					
Blackfooted albatross (*Phoebastria nigripes*)	70	82	122	133	103
Laysan albatross (*Phoebastria diomedia*)	14	83	87	138	196
TOTAL ALBATROSSES	84	165	209	271	299
Other Seabirds					
Red-footed booby (*Sula sula*)	0	0	4	0	0
Brown booby (*Sula leucogaster*)	0	0	0	0	0
Unspecified bird	19	0	64	25	1
TOTAL OTHER SEABIRDS	19	0	68	25	1
Observer Information					
Total trips	1,357	1,451	1,409	1,325	1320
Observed trips	332	347	380	355	361
Proportion of trips observed	24.50%	23.90%	27.00%	26.80%	27.35%
Observed sets	4,544	5,002	5,402	5,353	5,459
Observed hooks	8,285,411	8,912,119	10,126,078	9,644,989	10,012,656

Section 4: Flag State Reporting of National Fisheries (including Developments and trends)

U.S. Purse Seine Fishery

The most accurate description of the recent U.S. purse seine catch is based on the preliminary 2010 data totaling 246,133 t and the updated 2009 data totaling 283,219 t which are primarily composed of skipjack tuna, with smaller catches of yellowfin and bigeye tuna. The 2009 and 2010 total catch increased significantly from 2008 (Tables 1a-1c). Yellowfin tuna catches in the fishery decreased from 45,363 t in 2008 to 25,686 t in 2010 and skipjack tuna catches increased from 159,741 t in 2008 to 215,587 t in 2010. The number of licensed vessels in 2010 was 37 vessels (Table 2a). The fishery operated mainly in areas between 10° N and 10° S latitude and 130° E and 150°W longitude in 2010 (Figure 1). Before 1995, the fleet in the WCPO fished mainly on free-swimming schools of tunas. Fishing effort has since changed to predominantly targeting floating objects, including fish aggregating devices (FADs), rather than free-swimming schools.

U.S. Longline Fisheries

The longline fisheries of the U.S. and the Territory of American Samoa in the WCPO include vessels based in Hawaii, California, and American Samoa. The total number of longline vessels active in the WCPO declined from 156 vessels in 2007 to 147 vessels in

2010 (Table 2). The Hawaii-based U.S. longline fishery consistently had the highest number of vessels in operation, with 129 in 2007 and 2008 dropping to 124 vessels in 2010. Participation in the American Samoa-based fleet declined from 29 vessels in 2007 to 26 in 2009 and 2010. A few vessels occasionally operated in both the Hawaii-based and American Samoa-based longline fisheries. In 2009 and 2010, U.S. longline catches made outside the portion of the U.S. EEZ around Hawaii by vessels operating with both American Samoa and Hawaii longline permits and landed in Hawaii were considered to belong to the longline fishery of American Samoa and not to the U.S. longline fishery in the NPO in accordance with WCPFC CMM 2008-01 and federal fisheries regulations (74 FR 63999). These American Samoa longline landings in the NPO are shown separately from U.S. longline catches in the NPO (American Samoa in the NPO, Table 1f) The total for A. Samoa (Table 1f) includes only the South Pacific portion of the fishery, and the overall American Samoa total is the sum of the N. and S. Pacific portions.

The U.S. Hawaii-based longline fishery operated mainly from the equator to 40^{o} N latitude and from 130^{o} W to 180^{o} W in 2010 (Figure 2a), representing some expansion to the east as compared with 2007 and 2008. 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 2010 (Figure 2a). The Hawaii-based fishery targeted bigeye tuna and swordfish, with significant landings of associated pelagic species, whereas the American Samoa-based fishery targeted mainly albacore. The dominant components of the U.S. longline catch in 2010 were albacore, bigeye tuna, swordfish, and yellowfin tuna (Table 1a, Figure 2b). The total catch of all species ranged from a low of 12,378 t in 2010, to a high of 16,720 t in 2007 (Tables 1a-1e) during the past 5 years.

Most of the Hawaii-based longline fishery involved deep-set longline effort directed towards tunas. High ex-vessel tuna prices along with relatively lower operating expenses in this sector of the U.S. longline fishery in the NPO motivated longline fishers to continue targeting bigeye tuna while remaining within the catch limits in the WCPO and EPO in 2010. 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 operations. 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 five out of six complete calendar years since this sector was reopened. The effort restriction limiting this sector of the longline fishery to 2,120 shallow sets was removed in early 2010. Although shallow sets reached a record of 1,833 sets in 2010, it was still less than that which was allowed under the previous effort restriction. Swordfish longline landings in the NPO decreased from 1,428 t in 2007 to 1,022 t in 2010.

U.S. Albacore Troll Fishery

In recent years, the U.S. troll fishery for albacore experienced significant decline in participation. Six vessels participated in the WCPO portion of this fishery in 2010 (Table 2, Figure 3). All of these vessels fished in the South Pacific. The albacore troll fishery operated mostly between 35° S and 45° S latitude and 150° W and 170° W longitude. The South Pacific albacore troll catches in the WCPO increased from 237 t in 2009 to 307 t in 2010 (Tables 1a-1e). In the WCPO, the North Pacific component of the catch has declined to zero in 2010 due in part to reduced availability of juvenile albacore in these high seas areas. The catch in this fishery is composed almost exclusively of albacore.

Other Fisheries of the U.S. and Participating Territories

Other fisheries of the U.S. and Participating Territories include the small-scale tropical troll, handline, and pole-and-line fleets, as well as miscellaneous recreational and subsistence fisheries. In American Samoa, Guam, and CNMI, these fisheries are monitored by creel surveys, and the 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. and Participating Territories 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 was 2,454 t in 2010. The catch was composed primarily of yellowfin tuna, mahimahi, bigeye tuna, and skipjack tuna.

Section 6: Socio-Economic Factors and Trends in the Fisheries

Hawaii Pelagic Longline Economics – Since 2004 NOAA Fisheries has used fishery observers to collect fishing costs and other economic data from the Hawaii-based longline fisheries (over 1,900 longline fishing trips) in order to assess the change of important economic indicators of the fisheries. Over the Period 2004-2009, the average trip cost in the Hawaii longline fishery for tuna target trip increased by about 60%, from $13,900 per trip in 2004 to $22,100 per trip in 2009. Fuel cost made up about 52% of the total trip cost in 2009 after peaking in 2008 (Pan, 2010).

Regulatory impact analysis of the 2010 WCPO bigeye closure was conducted to estimate direct and indirect economic costs of the closure. Findings indicated that bigeye closure resulted in bigeye landings in December 2010 that were 2.5% lower than the average for the period 2004-2009 (Pan and Arita, 2011). This finding applies to the entire Hawaii-based fishery, not the just the US WCPO fishery.The economics data collection program is continuing and will be extended to other fisheries in Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

Ahi Poke Study – NOAA Fisheries conducted a study on the attributes of *ahi poke* that contribute to consumer choices and how awareness of carbon monoxide (CO) treatment of the *ahi poke* affects consumer purchases. The *ahi poke* survey was completed in 2008, and may help differentiate the demand for locally produced fresh tuna versus previously frozen and CO-treated tuna (Pan and Hu, 2009).

Economic Relationship between Marine Aquaculture and Wild Capture Fisheries – NOAA

Fisheries is investigating the seafood markets' and consumers' perspective on marine aquaculture and capture fisheries, and the economic relationship between the two industries. A survey was conducted in Hawaii to compare the consumer preference for wild-caught fish versus aquaculture products, and to measure the impact of income, cultural and geographical factors on consumer preference. This study will be useful to seafood producers, as well as to policy makers for setting the direction of marine aquaculture development and for promoting the aquaculture and seafood industry (Pan et al., 2011; Davidson et al., 2010; Davidson et al., in press).

Economics Workshop on Pacific Islands Regions Catch Share – NOAA Fisheries conducted a national workshop on catch shares economics in Honolulu, Hawaii in March 2010, in response to a recent NOAA policy to encourage use of catch shares as a fishery management tool to end overfishing and rebuild fisheries and fishing communities. Guest speakers were leading economists and social scientists from the U.S., Canada and New Zealand. The proceedings of this workshop will be published as a NOAA Report (Criddle et al., in press).

Time-Area Closures in the Hawaii-Based Longline Swordfish Fishery – NOAA Fisheries monitors turtle bycatch on each longline fishing trip since fishers must abide by strict fleet-wide annual upper limits on turtle bycatch. If the cumulative fleet bycatch exceeds the annual allowance, the fishery will be closed for the remainder of the year, leading to economic losses. Earlier fishery time-area modeling and analysis was significantly expanded by incorporating new economic information which helps simulate fisher decisions on where and when to fish, and for designing time-area closures, trading off risks of encountering sea turtles against risks of economic loss (Pan and Li, in press).

Global Tuna Inverse Demand Estimation -- This NOAA economic study estimates the structural breaks, price linkages, and a global inverse demand model and corresponding price flexibilities for tropical sashimi and cannery grade tuna products in the major consuming markets in Europe, US, Korea, and Japan. Specifically, the markets under consideration are the frozen tuna sashimi market in Japan and Korea and the tuna cannery markets in the European Union and United States. Changes in landings can impact ex-vessel prices and revenues of tunas, and license fees received by coastal states, most of which are developing countries. Confirmation of this relationship would provide convincing evidence that conservation through reduced catches not only lowers costs but raises revenues and hence profits and resource rent. The estimated demand price flexibilities will be utilized to simulate different scenarios of impacts such as climate change, resource abundance, and policies on markets (Pan and Sun, 2009).

Economic Impacts of Hawaii Fisheries – NOAA Fisheries economic studies also investigate contribution, linkages and impacts of the fisheries sector to the economies of Hawaii and other U.S.-affiliated Pacific Islands using an extended Input-Output (I-O) Analysis (Arita et al., 2011). The main objective of this research program in 2010 is to update the I-O analysis on Hawaii's fisheries based on the 2002 I-O model and recent cost-earnings information.

Hawaii Small Boat Economics – NOAA Fisheries conducted an economic survey to assess economic and social characteristics of the Hawaii small boat pelagic fishery. A total of 343 intercept surveys on fishing trip costs were conducted at boat ramps across the state of Hawaii in 2007 – 2008. For an average trolling trip in 2007, fuel accounted for 70% of total trip costs, and the increasing price of fuel may challenge the future economic viability of small boat pelagic fishing in Hawaii (Hospital et al., 2011).

Retail Seafood Monitoring Project – NOAA Fisheries have been conducting a retail monitoring project since late 2006 to develop a weekly time-series of consumer levels prices for the Hawaii seafood retail market. These data allow us 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 data also includes information on country of origin to allow an understanding of market demand and price premiums for locally caught seafood. A manuscript summarizing four years of data (2007-2010) will be the first published source of consumer-levels prices for Hawaii seafood (Hospital and Beavers, in press).

Hawaii Ahi Retail Pricing Study – This NOAA Fisheries retail monitoring project also analyzes the price linkages between ex-vessel and consumer markets to explore the symmetric properties of *ahi* price transmission in Hawaii. This study compares a traditional time-series approach with an endogenous switching framework to investigate how modeling assumptions affect conclusions. A greater understanding of retailer pricing behavior and how price changes at the ex-vessel level are passed on to consumers will allow fishery managers to better determine the consumer effects of fishery regulations and identify potential market power issues (Houbcharaun and Hospital, 2011).

Cost of Marine Debris to Hawaii's Longline Fishery - In the North Pacific Ocean, derelict fishing gear (mainly lost or discarded nets from other fishing fleets) impacts the Hawaii longline fishery through active gear entanglement, vessel interactions, and catch interaction. The marine debris poses a safety hazard for crew to disentangle the vessel and impacts the fishery economically by the occurrence of immobilized or slowed fishing operations and may induce behavioral responses within the fishery. In 2006, a partnership project was initiated among various NOAA offices in Hawaii to study and quantify rates of interaction and the subsequent economic impact of marine debris within the longline fishery. In 2010, efforts were made to compile marine debris encounter reports to quantify interaction rates and the scope of marine debris interactions with the Hawaii longline fleet (Hospital and Morishige, 2010, 2011).

Relevant Publications

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Davidson, K., M. Pan, W. Hu, and D. Poerwanto. In press. Consumers' Willingness to Pay for Aquaculture Fish Products vs. Wild Caught Seafood- A Case Study in Hawaii. Under review in Aquaculture Economics and Management.

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Hospital J, Scholey Bruce S, Pan M. 2011. Economic and social characteristics of the Hawaii small boat pelagic fishery. Pacific Islands Fisheries Science Center Administrative Report H-11-01, 47 p. + Appendices.

Houbcharaun, A. and J. Hospital. 2011. An empirical look at retail pricing behavior: the case of *ahi* in Hawaii. [Abstr.] North American Association of Fisheries Economists (NAAFE) Forum. Honolulu, HI May 11-13, 2011.

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Pan, M., K. Davidson, W. Hu, and D. Poerwanto. 2011. Measuring the Effect of Socioeconomic Factors on Consumer Preferences for Seafood: A Case Study in Hawaii. [Abstr.] 9th Asian Fisheries and Aquaculture Forum, April 21-23, 2011, Shanghai, China

Pan, M., and W. Hu. 2009. Imported carbon monoxide treated tunas and its impact on the consumers and fisheries industry in Hawaii. [Abstr.] North American Association of Fisheries Economists: Biennial Conference, Providence, Rhode Island, May 17-20, 2009.

Pan, M., and S. Li. (In Press). Evaluation of fishing opportunities under the sea turtle interactions caps – a decision support model for the Hawaii-based longline swordfish fishery management. Our Living Oceans.

Pan, M., and C. Sun. 2009. Structural breaks and price linkage between Hawaii and Japanese tuna sashimi markets. [Abstr.] PICES 2009 Annual Meeting, Jeju, Korea, October 23-November

1, 2009.

Section 7: Disposal of Catch

The purse seine catch is stored on board as a frozen whole product. Most of the catch has historically been off-loaded to the cannery in Pago Pago, American Samoa, however most vessels are now transshipping catches in the ports of other Pacific Island countries 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 U.S. longline vessels in the NPO 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 with a small proportion of high quality bigeye tuna exported to Japan. The American Samoa-based longline albacore catch is gilled and gutted and delivered as a frozen product to the cannery 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 catch in the albacore troll fishery in the South Pacific is frozen whole and sold in Pacific Island ports or transported to Vancouver, Canada for sale. 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 tropical fisheries chill their products with ice and sell it fresh, mainly to local markets.

Section 9: Future Prospects of the Fisheries

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. Increases in albacore fishing are resulting from record high prices and good catch rates.

In each of the calendar years 2009-2011 the U.S. longline fishery is subject to a limit of 3,763 t of retained catches of bigeye tuna. The fishery managed to stay under the limit in the WCPO with retained catches of 3,741 t in 2009 and 3,576 t in 2010 through restrictions on retained catches imposed late in the year. The U.S. longline fishery is expected to close before the end of 2011 in order to stay within the limit in that year despite the lost opportunities late in the year when the peak season and demand for bigeye tuna occurs. Catch limits established pursuant to decisions of 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. The fishery operated throughout 2007 without reaching that year's limit of 500 t. There was no bigeye tuna limit in the EPO in 2008, but a limit of 500 t for vessels greater than 24 m in length has been established for 2009 through 2011. This limit was not reached in 2009 or 2010.

The Hawaii-based longline fishery is likely to continue to target tunas primarily. However, the recent actions by regional fishery management organizations to obligate their members to implement catch limits on bigeye tuna will result in lower landings by this sector of the longline fishery than otherwise would occur. This along with recent changes allowing increased effort in the Hawaii-based shallow-set longline fishery for swordfish might result in increased effort in the swordfish segment of the fishery in the future. 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. There are viable prospects to further reduce sea turtle bycatch rates, including voluntary efforts to avoid areas of sea turtle concentrations.

The closure of one of two canneries in American Samoa in 2009 is not expected to curtail the operation of the longline fishery there, nor will that fishery be constrained by the current WCPFC conservation and management measure for bigeye tuna and yellowfin tuna. 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 a slow economy and high fuel prices. Fuel prices have increased slowly, although they were lower in 2010 than the peak prices in 2008. These fisheries are expected to continue to make single-day trips targeting tunas, billfish, and other pelagic fish, and deliver their catch fresh to local markets.

Section 10: Status of Fisheries Data Collection Systems

10a. Logsheet Data Collection and Verification

Various sources of data are used to monitor U.S. pelagic fisheries. The Statistical Data Systems that collect and process fisheries data consists of logbooks and fish catch reports submitted by fishers, at-sea observers, port samplers, market sales from fish dealers and creel surveys. The coverage rates of the various data systems vary considerably.

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 or weight), fishing effort, fishing location, and some details on fishing gear and operations. U.S. purse seine logbook and landings data are submitted as a requirement of the South Pacific Tuna Treaty (100% coverage). 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, all U.S. vessels fishing on the high seas have been required to submit logbooks to NOAA Fisheries.

Observer and port sampling programs collect scientific data including species and size of fish caught. Fish sales records from the Hawaii Division of Aquatic Resources (DAR) Commercial Marine Dealer Report data are other important sources of data that supplement the logbook data. 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 on a trip level 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). The number of individual fish weights recorded in the sales data far outnumber the fish measured by observers in the Hawaii-based longline fishery. Fish sales records cover close to 100% of the 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).

10b. 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.

Starting on January 1, 2010 the coverage observer rate as prescribed by the WCPFC conservation and management measure 2008-01 was 100%. Through a modified agreement with the FFA, the required observer coverage rate was maintained throughout the year. The data collected under this enhanced arrangement by FFA deployed- observers are currently provided directly to the WCPFC. In 2010, NMFS also began to develop relationships with counter-part offices in the Marshall Islands and the Federated States of Micronesia to assist with monitoring and sampling of US purse seine vessels transshipping their catches through Majuro and Pohnpei.

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 2010, the observer coverage rate (on a trip basis) in the deep-set (tuna) component of the Hawaii-based longline fishery was 21.1%--for a total of 257 observer trips and 3,580 sets observed. In the shallow-set (swordfish) component of the Hawaii-based fishery, which has a regulatory requirement of 100% observer coverage, all 104 trips were observed, totaling 1,879 sets.

Overall, 257 out of 1,216 deep-set trips were observed, and all 104 shallow-set trips, resulting in a combined coverage rate of 27.4% in 2010 (Table 3). The results indicated a very similar number of interactions with sea turtles and seabirds and a much lower number of interactions with marine mammals in 2010 as compared with 2009.

For the American Samoa-based component of the U.S. longline fishery, 2010 was the fourth full calendar year observed. The coverage rate was 25.0%--for a total of 33 trips and 798 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.

10c. Port Sampling

Less than 2% of the fish caught by U.S. purse seine, longline, and albacore troll fisheries in the WCPO are measured (fork length) by NOAA Fisheries personnel as vessels are unloading in American Samoa and by port samplers in ports where transshipping takes place. Species composition samples are also taken for more accurately determining catches of yellowfin tuna and bigeye tuna from U.S. purse seine vessel landings. Fish caught by U.S. albacore troll vessels are also measured (fork length) by port samplers in American Samoa when vessels unload there.

10d. Unloading / Transhipment

A small amount of transhipment of highly migratory fish stocks occurs in the U.S. longline fishery (within the WCPFC Convention Area) between domestic vessels. For the Hawaii-based longline fishery, there were 5 transhipments from 5 longline vessels in 2010, and 14 transhipments from 8 longline vessels in 2009; all were landed in Honolulu. For the American Samoa-based longline fishery, there was 1 transhipment from 1 longline vessel in 2010, and 4 transhipments from 4 longline vessels in 2009; all were landed in Pago Pago.

For the U.S. purse seine fishery in the WCPFC Convention Area, there were an estimated 299 transshipments in 2010.

10d. Scientific Survey Data

Cooperative Data Collection Program for North Pacific Albacore – NOAA Fisheries has been collaborating with the American Fishermen's Research Foundation (AFRF) and the American Albacore Fishing Association (AAFA) on monitoring programs for North Pacific albacore. Since 1961, a port sampling program using State fishery personnel has been collecting biological and size data from albacore landings made by the U.S. and Canadian troll fleets along the U.S. Pacific coast. In recent years, with AFRF support, fishermen have collected biological data during selected fishing trips. In the 2008 season, fishermen on 5 vessels measured 2,154 albacore; and in 2009, 3 vessels measured 280 fish. The sample information provided by the fishermen helped to fill in gaps missed by the port sampling program, and the sizes were found to be generally similar.

International Billfish Angler Survey – NOAA Fisheries has been collaborating with the billfish angling community since 1963 to study various aspects of billfish biology and to obtain an index of angler success in the Pacific Ocean. The International Billfish Angler Survey, initiated in 1969, provides a 41-year time series of recreational billfish angling catch and effort (number caught per angler fishing day), and is the only survey independent of commercial fisheries in the Pacific Ocean. The main fishing areas include Hawaii, Baja California, southern California, Guatemala, Costa Rica, Panama, Tahiti, and Australia.

Central and Western Pacific Fisheries Monitoring – WPacFIN collects and manages data from most of the U.S. central and western Pacific fisheries (Hawaii, American Samoa, Guam, Commonwealth of the Northern Mariana Islands). This includes integrating longline logbook data, longline observer data, and dealer sales reports in order to link catch in numbers, catch in weight, value of landings, and geographical location. WPacFIN completed the 25th edition of Fishery Statistics of the Western Pacific which was published as a NOAA report (Hamm et al., 2010).

Analysis of Troll Fishery Data for North Pacific Albacore – To prepare for the ISC albacore stock assessment, a manuscript was recently completed (Teo et al., 2010) that describes changes in the distribution of catch, effort and CPUE of the albacore troll fishery from 1960 to 2008. From the 1970s to 1990s, a large proportion of the catch effort occurred along the transition zone of the North Pacific. However, from 2000 to 2008, ~75% of the catch and effort was concentrated in a 5° x 10° area off the Oregon and Washington coasts. The range of lengths caught by the albacore troll fishery was similar in all areas (corresponding to approximately age-2, -3, and -4 year classes). Length compositions in all areas were multimodal, with the strongest mode at age-3 (~65 cm FL).

Shark Data Analysis from Longline Observer Program Data – NOAA Fisheries is currently producing standardized CPUE time series for blue shark, whitetip shark, and silky shark in the Hawaii longline fishery using the Pacific Islands Regional Observer Program data (1995–2010). This work can be used as input for stock assessment for these shark species.

Relevant Publications

Childers, J., and A. Betcher. 2010. Summary of the 2009 U.S. North and South Pacific albacore troll fisheries. SWFSC Admin. Rep., La Jolla, LJ-10-01, 22 p.

Glaser, S. M., H. Ye, M. Maunder, A. MacCall, M. Fogarty, and G. Sugihara. 2011. Detecting and forecasting complex nonlinear dynamics in spatially structured catch-per-unit-effort time series for North Pacific albacore (*Thunnus alalunga*). Can. J. Fish. Aquat. Sci. 68:400–412.

Hamm DC, Quach MMC, Brousseau KR, Graham CJ (compilers). 2010. Fishery statistics of the western Pacific, Volume 25. Pacific Islands Fisheries Science Center Administrative Report H-10-03.

Teo, S. T. H., H. Lee, and S. Kohin. 2010. Spatiotemporal characterization and critical time series of the US albacore troll fishery in the North Pacific. ISC-ALBWG working document submitted for the ISC Albacore Working Group Meeting, April 20-27, 2010. Shimizu, Japan.

Section 11: Research Activities

11a. Biological Research - TUNAS

Age and Growth of North Pacific Albacore – NOAA Fisheries scientists have expanded the biological sampling program for north Pacific albacore started in the Southern California Bight to a North Pacific-wide sampling program using otolith-based methods. Annual growth increments in sagittal otoliths were examined from 338 fish collected throughout the North Pacific Ocean. A wide size range of albacore (53-128 cm fork length, FL) was collected in the western, central, and eastern Pacific Ocean in an attempt to incorporate size-at-age information over juvenile, sub-adult, and adult life history stages. Overall, ages ranged from 1 to 15 years with the majority of fish between 2 to 4 years of age. A specialized von Bertalanffy model provided the best fit, and biological parameters of the growth model included L_∞=120.0, K=0.184, and t_0=-1.945. Several albacore otoliths were processed for daily increments and confirmed our results using the annual method. In addition to otolith-based techniques, dorsal fin spines and length frequency (LF) analysis were used to generate estimates of size-at-age. These new otolith data provided improved, updated age-specific growth information which was used in the 2011 albacore stock assessment.

Otolith Chemistry and Population Structure of North Pacific Albacore – NOAA Fisheries conducted a study using otolith chemistry to investigate population structure of the North Pacific albacore, which appears to be more complex than the current single stock hypothesis. The purpose of this study was to examine otolith stable isotopes of carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) in addition to several trace elements in whole otoliths of albacore collected in two regions of the eastern Pacific Ocean that have shown limited mixing: northern region (offshore Oregon and Washington, > 40°N) and southern region (offshore southern California and northern Baja California, Mexico, < 40°N). Samples from three age classes (ages 2-4) were collected in 2010 from each region through recreational and commercial fishing vessels.

Significant differences existed in otolith chemistry from fish collected between the two regions ($P < 0.05$), and overall cross-validated classification success to respective collection region was 100% with age-specific comparisons exceeding 90% success. Otolith chemistry results were also consistent with regional physicochemical conditions. Preliminary findings support previous studies that have shown limited regional mixing of albacore in the eastern Pacific Ocean and provide life history information useful for management of North Pacific albacore.

North Pacific Albacore Archival Tagging – NOAA Fisheries and American Fishermen's Research Foundation (AFRF) initiated an archival tagging program in 2001 to study the migration patterns and stock structure of juvenile albacore in the North Pacific. Since 2001, a total of 630 archival tags and 43 dummy tags have been deployed. In 2010 NOAA Fisheries conducted two tagging charters and deployed 37 tags. To date, 22 archival and 6 dummy tags have been recovered; no tags were returned in 2010. Tagged albacore were at liberty from 63 to 697 days and exhibited five distinct, seasonal migratory patterns. The majority swam offshore during the fall, overwintered offshore, and then returned in the spring to the area in which they were tagged. Depth and temperature data revealed a broad range of vertical behaviors. Water temperatures encountered ranged from 3.3 to 22.7°C. Peritoneal temperatures were significantly higher by an average of approximately 4°C. The results reveal diverse behavior that varies regionally and seasonally as albacore move among different habitats throughout the entire North Pacific (Childers et al., 2011).

Since information on the distribution and migrations of adult albacore is needed, NOAA Fisheries launched a pilot project in 2010 to deploy mini-PAT tags on adult albacore that are caught near Hawaii in an artisanal handline fishery. The study is also designed to determine whether there are distinct spawning populations and spawning areas of albacore in the central and western Pacific.

Central Pacific Bigeye Tuna Tagging – NOAA Fisheries investigated the spatiotemporal variability in bigeye tuna dive behavior 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. Results indicated the following: 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. Dive type also varied with oceanographic conditions, with more shallow and intermediate dive behavior found in colder surface waters. 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 catch per unit effort (CPUE) of bigeye tuna by the Hawaii-based longline fishery (Howell et al., 2010).

Bioacoustic Survey of Bigeye at Cross Seamount – NOAA Fisheries has been using bioacoustics, a non-invasive, efficient, non-lethal, and fishery independent method, to estimate bigeye tuna biomass and to study its spatiotemporal distribution and movement patterns at Cross Seamount. In addition, bioacoustics allows for the simultaneous study of bigeye and its forage, micronekton, an important component influencing bigeye tuna's movement patterns and aggregative behavior. Cross Seamount is known to aggregate juvenile and subadult bigeye, and to a lesser degree, yellowfin tuna, a population heavily targeted by Hawaii fishermen. Moderate exploitation rates, coupled with declining catch, have raised concerns that juveniles are being removed from the seamount that would otherwise recruit to adult grounds.

Three NOAA cruises were conduced to Cross Seamount in the spring of 2005, 2007, and 2008. Data analyses of physical oceanographic data have indicated the formation of Taylor Cones over Cross Seamount, which trap micronekton in the area, providing increased forage opportunity for bigeye tuna. Bioacoutics data show that bigeye appear around dawn on the upstream slopes of the seamount's palateau, where they spend an hour or two in an apparent feeding frenzy, targeting vertically migrating micronekton. Later in the morning, bigeye tends to spread out and form huge aggregations exhibiting vertical diving behavior never observed before as an aggregation. Bigeye dispersed in the afternoon, occupying the entire plateau, and most acoustic detections were observed during that time. By evening, bigeye seemed to leave the Seamount for the night, to appear again at the upstream edge at dawn. Findings from this study will be essential in managing this economically important resource (Domokos et al, in prep).

11b. Biological Research - BILLFISHES

Billfish Life History Studies **–** NOAA Fisheries is collaborating with Charles Sturt University, Australia on a Pelagic Fisheries Research Program grant to conduct an age and growth study of striped marlin harvested in the Hawaii-based longline fishery. Dorsal fin rays and otoliths are being collected by observers onboard Hawaii-based longline vessels for age determination. Gonad sub-samples are concurrently collected for determination of gender and sex-specific length at 50% reproductive maturity. Observers also continue to collect small (<110 cm eye-fork length) whole juvenile specimens since billfish of this size are rarely available.

Recreational Billfish Tagging Program – NOAA Fisheries has been collaborating with the billfish angling community since 1963 in the Billfish Tagging Program, and has provided tagging supplies to recreational billfish anglers for 48 consecutive years. Tag release and recapture data are used to determine movement and migration patterns, species distribution, and age and growth patterns. This volunteer tagging program depends on the participation and cooperation of recreational anglers, sport fishing organizations, and commercial fishers. Since its inception, over 60,000 fish of 75 different species have been tagged and released. The number of tagged billfish went up from 840 in 2007 to 866 in 2008, to 871 in 2009. This tagging effort was due to the contribution of over 580 anglers and 135 captains, as well as NOAA Fisheries' ongoing research cruises. From 1963-2009, 22,890 striped marlin were tagged (with 343 recovered for a return rate of 1.5%), 10, 444 Pacific blue marlin were tagged (with a return rate of 0.85%), and 9,179 sailfish were tagged (with a return rate of 0.53%).

Swordfish Research and SLUTH – Since 2006, NOAA Fisheries has been studying swordfish in the Southern California Bight to examine migratory patterns, foraging ecology, and local stock structure. In 2008, NOAA Fisheries researchers launched a new initiative, Swordfish and Leatherback Use of Temperate Habitat (SLUTH) to integrate studies of swordfish and leatherback sea turtles for management and conservation purposes. The endangered leatherback is taken incidentally in swordfish fisheries, and concerns about leatherback populations are currently shaping the management of swordfish fisheries along the U.S. West Coast. A stakeholder workshop was conducted in 2008, and a NOAA Fisheries Administrative Report detailing the workshop was published in 2009 (Benson et al., 2009).

Characterizing Target Catch and Non-target Species Catch in the California Drift Gillnet Fishery – Another objective of the SLUTH initiative is to explore creative methods to reduce the bycatch of non-target species in the California drift gillnet (CDGN) fishery. One NOAA Fisheries' study involves identifying environmental features that separate swordfish from leatherbacks, if they exist, thereby improving fishing efficiency and reducing bycatch encounters in the West Coast drift gillnet fishery. Preliminary results suggest that swordfish catch rate responds to both biotic (primary production, zooplankton abundance) and abiotic (SST, currents, depth) factors. If combined with data on location and time of year, these factors can be used to predict swordfish catch rates with impressive accuracy (e.g., cross validated R^2 of ~ 0.7). Similar efforts are ongoing with leatherback turtles.

Since fisheries data are relatively incomplete and inaccurate in other parts of the Pacific, NOAA Fisheries is investigating methods for estimating cumulative fishing effort to fill in missing data on fishing effort. Kriging, a method of spatial interpolation, and using remotely sensed oceanographic data can be compared to predict future fishing effort and thereby identify areas of potential overlap with protected species of concern.

Improving Location Estimates of Swordfish from Electronic Tags – While the traditional pop-up satellite archival tags provide valuable information on vertical behavior, obtaining an accurate assessment of location is made challenging by the diel vertical migrations of swordfish. NOAA Fisheries is exploring two approaches to improve geolocation estimates between the tagging and pop-up locations. First, in collaboration with the Commonwealth Scientific and Industrial Research Organization in Australia, software is being developed to describe the movement instead of constructing a track of the animal. The second approach involves testing the new towed satellite tags that capture a GPS signal when the tag breaks the surface. The post-processed GPS locations are much more accurate than those obtained either through Argos or using light-based geolocation methods. Having highly accurate locations and behavioral information, matched to environmental data, will be critical to mapping the preferred habitat of swordfish in this region.

Foraging Ecology of Swordfish – In order to determine the trophic relationships of highly migratory species in the California Current, NOAA Fisheries has been investigating the foraging ecology of a range of species since 1999. During 2007-10, a total of 115 broadbill swordfish stomachs were collected and analyzed. Food was present in 97% of the stomachs, representing at least 34 taxa. The five top prey as determined by the geometric index of importance were all cephalopods. The most important prey was jumbo squid (*Dosidicus gigas*), which was present in 72% of stomachs, followed by the boreopacific gonate squid (*Gonatopsis borealis*) which was in 63% of stomachs. The most important teleosts were Paralepididae (barracudinas) followed by Scopelarchidae (pearleyes). The majority of the most important prey species are associated with the deep scattering layer, although epipelagic fish also occurred in their diets.

The large number of prey taxa found in the swordfish diet suggests that these vagile fish are generalists, are capable of exploiting a range of prey in a variety of habitats, and will be less susceptible to variability in the composition of the prey base that may result from natural or anthropogenic impacts. More detailed quantitative analysis of diet studies coupled with analyses of the distribution of swordfish and vulnerable non-target species taken in the CDGN fishery, including many sharks, will help to identify habitat overlap or habitat separation among species and to develop appropriate management options to minimize bycatch.

11C. Biological Research – PELAGIC SHARKS

Electronic Tagging Studies (SPOT tags or towed GPS tags) – Since 1999, NOAA Fisheries has been using satellite technology to study the movements and behaviors primarily of blue, shortfin mako, and common thresher sharks in the California Current and link these data to physical and biological oceanography. In recent years, satellite tag deployments have been carried out in collaboration with the TOPP (Tagging of Pacific Pelagics) program (www.topp.org), Mexican colleagues at CICESE (Centro de Investigación Cientifica y de Educatión Superior de Ensenada), and colleagues at the DFO (Department of Fisheries and Oceans) Pacific Biological Station in Nanaimo, British Columbia. This approach will allow us to characterize the essential habitats of sharks and subsequently to better understand how populations might shift in response to changes in environmental conditions on short or long time scales.

In 2010, 4 shortfin mako sharks, 9 blue sharks, 1 thresher shark, and 1 basking shark were tagged with either SPOT tags or towed GPS tags. Since 1999, a total of 95 makos, 85 blue sharks, 28 common threshers, 2 hammerheads, 5 ocean sunfish, and 1 basking shark have been satellite-tagged through collaborative projects. Some deployed SPOT tags are still transmitting for over a year and these multiyear records provide data on seasonal movement patterns and regional fidelity. Fidelity to specific areas is increasingly recognized in fish from swordfish to salmon sharks (*Lamna ditropis*) and increases the potential for regional local depletion where fisheries exist.

Blue Sharks Released by the California Drift Gillnet Fishery – Since 2007 NOAA Fisheries has been studying the survivability of blue sharks caught and released alive by the CDGN by deploying pop-off satellite archival tags (PSATs). A 2009 analysis of the 1990-2008 observer data reveals that 32% of blue sharks captured were released alive, and an additional 5% were discarded with their disposition unknown. The remaining 63% were discarded dead. A set of criteria was developed to document the condition of all blue sharks released: good, fair, or poor. During the 2007-2010 seasons, 29% of blue sharks released were released in poor condition. Based on observer records, the sex ratio of blue sharks caught in this fishery is roughly 60% male and 40% female.

Since 2007, 11 blue sharks (100 to 200 cm FL, median 155 cm) have been tagged by fishery observers. Three of the 11 sharks were released in “good” condition while the remaining 8 were released in “fair” condition. To date, no sharks released in “poor” condition have been tagged. Results to date suggest a 100% survival rate for male blue sharks released in fair or better condition. Tagging efforts during the 2010-2011 season were focused on smaller sharks, females, and animals released in poor condition; no blue sharks were tagged for this study in 2010-2011.

Thresher Sharks Released from the Recreational Fishery – NOAA Fisheries have been collaborating with the Pfleger Institute of Environmental Research since spring 2007 to assess the post-release survival of thresher sharks caught by recreational anglers. During the first phase of the study, sharks were released after tail hooking and results demonstrated that survivorship is low for sharks greater than 185 cm FL or enduring fight times exceeding 85 minutes (Heberer et al., 2010). During the second phase of the study, the hypothesis that tail-hooked common thresher sharks survive the acute effects of trailing fishing gear in the southern California recreational fishery is being tested by using PSATs deployed on sub-adult and adult common thresher sharks. To date, PSATs have been deployed on 5 common thresher sharks (132 to 175 cm FL) captured using fishery standard techniques and released with trailing gear. Of the 5 sharks, 3 displayed immediate mortality (within 31 hours of release), 1 shark survived the effects of trailing gear, and one of the PSATs did not report any information.

Basking Shark Research Program – The basking shark (*Cetorhinus maximus*), with populations along the west coast of North America, was listed as endangered in Canada and as a Species of Concern (SOC) in the U.S in 2010. In order to address the lack of basic data, NOAA Fisheries initiated a basking shark research program in 2010 with SOC funding to (1) mine existing data for additional biological information, (2) conduct an electronic tagging study, (3) improve international data collection, and (4) develop a sightings website and an education and outreach program around Monterey Bay, California. Monterey is a historic basking shark hotspot where the California fishery in the early 1900s was based.

In 2010, a dedicated website and hotline was established as a part of a sightings network to help document patterns of occurrence and tagging efforts, and education and outreach has been conducted to advertise the sightings network. A team of colleagues from the U.S., Canada and Mexico was also formed to coordinate research effort; meetings were held in 2010 and 2011. In addition, a satellite tag on a basking shark was deployed off southern California in 2010, and the tag released after 53 days off Morro Bay, California. An estimated track between tag and release was obtained from the transmitted data, and the animal appears to have remained over the continental shelf and slope. Basking sharks in the Atlantic show a similar preference for nearshore regions where complex flow patterns and convergence zones act to concentrate prey, which is critical to filter feeders.

Overall, the basking shark experienced a broad range of temperatures and depths. Sea surface temperature (SST) ranged from 10.7 to 18.3^{o}C [average 12.8 ± 1.9^{o}C (SD)] and daily minimum temperatures ranged from 6 to 10.2^{o}C [average 8.9 ± 1.4^{o}C (SD)]. The maximum depth was 544 m and during most 6-h time intervals, the shark came to the surface. Depth and temperature data showed considerable variability across the track, coincident with changes in SST.

Pop-up satellite archival tags (PSATs) used to determine vertical distribution, movement and post-release survival --To address concerns about bycatch mortality, NOAA Fisheries and colleagues deployed 71 pop-up satellite archival tags (PSATs) on the five most commonly caught species of pelagic shark in the Hawaii-based commercial longline fishery to determine species-specific horizontal and vertical movement patterns and survival after release from longline fishing gear. Results indicated that only a single post-release mortality could be unequivocally documented. Meta-analysis on blue shark mortality from published and ongoing research (n = 78 reporting PSATs) indicated the summary effect for post-release mortality from longline gear was 15% (95% CI, 9 – 25%). Favorable rates of post-release survival suggest catch-and-release in longline fisheries can be a viable management tool to protect parental biomass in shark populations, although fishery related factors (hook type, soak time, handling of catch during release) can influence survival rates.

Pelagic sharks displayed species-specific depth and temperature ranges, although with significant individual temporal and spatial variability in vertical movement patterns. Pelagic species can be separated into three broad groups based on daytime temperatures occupied using a clustering algorithm. These groups, and the temperatures occupied by the sharks are characterized as: (1) epipelagic species (including silky and oceanic whitetip sharks) which spent > 95% of their time at temperatures within 2°C of sea surface temperature, (2) mesopelagic I species (including blue and shortfin mako sharks) which spent 95% of the time at temperatures from 9.7 – 26.9°C and

9.4 – 25.0°C, respectively, and (3) mesopelagic II species (including bigeye thresher shark) which spent 95% of the time at temperatures from 6.7 – 21.2°C. Distinct thermal niche partitioning was also evident within epipelagic species (Musyl et al., in press).

Performance and Meta-Analysis of Pop-up Satellite Archival Tags – NOAA is analyzing the performance of pop-up satellite archival transmitting (PSAT) tags deployed on a wide array of highly migratory species to help improve attachment methodologies, selection of target species, and experimental designs, particularly with respect to post-release survival studies. While PSATs have been used as research tools to chronicle or 'archive' the habitat preferences, horizontal and vertical movements, fishery interaction, and post-release mortality rates of a variety of pelagic animals, there still remains operational problems with lower-than-expected reporting rates, early detachment, and incomplete data returns. These issues were quantified by analysis of data from 731 PSAT deployments on 19 pelagic species provided by collaborators and from 1433 PSAT deployments on 24 pelagic species (including sharks, billfish, tunas and turtles) taken from 53 published articles.

Based on the combined data from 1433 tags described in the literature and 731 tags provided by collaborators, there is a 77% overall reporting rate. 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. Of all the PSATs attached to sharks, 80% reported and 65% detached before the programmed pop-up date. Shark PSAT reporting rates were highest in species such as oceanic whitetip (81%) which were epipelagic and remained near the ocean surface. Reporting rates were lowest in species undertaking large (~1000 m) vertical excursions, such as bigeye thresher (37%) and shortfin mako (40%). Tag retention for the three sharks species averaged 155 days for oceanic whitetip, 220 days for bigeye thresher and 164 days for shortfin mako. Species-specific reporting rates were used to make recommendations for future PSAT sampling designs for fisheries researchers. Information derived from this study should allow an unprecedented and critical appraisal of the overall efficacy of the technology (Musyl et al., in press).

11d. Research on Bycatch and Fishing Technology

SEA TURTLES

Longline and Gillnet Gear Modification to Reduce Bycatch – Since 2006 NOAA Fisheries has been contracting or otherwise assisting in longline and gillnet fishing trials to test the efficacy of sea turtle bycatch mitigation methods in Brazil, Uruguay, Spain, Vietnam, Peru, Mexico, and Italy. The trials are designed to test the effects of gear modifications (e.g., use of large circle hooks, hook rings, net illumination) on the rates of hooking and entanglement of sea turtles in longline and gillnet fisheries. These trials are also aimed to determine catch rates of target species as well in order to understand the potential viability of this modification in a commercial fishery.

Research from the previous few years indicates that relatively large circle hooks effectively reduce the bycatch of both loggerhead and leatherback sea turtles in longline fishing gear (Sales et al. 2010; Swimmer et al., 2010, 2011). These hooks also show acceptable catch rates of tuna species, but slightly reduced catch rates of targeted swordfish.

Recent studies to reduce capture rates of sea turtles in gill net fishing gear have had promising results (Wang et al 2010), and have expanded to Northern Peru where preliminary findings also suggest the potential utility of illuminating nets with LED as a means to both maintain target species catch rates as well as reduce catch of sea turtles.

Methods to estimate post-release survival of loggerhead turtles caught on longline fishing gear involve use of pop-up satellite archival tags (PSATs) and platform terminal transmitters (PTTs) in the North Pacific Ocean, South Atlantic Ocean and Mediterranean Sea. Preliminary results of tracking studies indicate no differences in duration of transmissions as a function of turtles 'severity' of injury, specifically deep or shallow hookings, and that most sea turtles were tracked for the duration of the tags' battery life.

***Drag Effects of Biotelemetry Devices on Sea Turtles* –** NOAA Fisheries in collaboration with the University of British Columbia, and Moss Landing Marine Laboratory conducted studies to determine the drag effects associated with biotelemetry devices on sea turtles. The recent trials focused on leatherback specific attachments such as the backpack harness, a Wildlife Computers ridgemount tag which attaches directly to the longitudinal ridge, and submersible cameras on an adult sea turtle body form. Trials were also conducted to determine the effects of double tagging hard-shell turtles for post-hook mortality studies.

It is important that researchers using biotelemetry devices in their research strive to minimize the added drag caused by the devices, thus ensuring the applicability of the research data to tag-free turtles in the wild and lessening the adverse effects to the turtles.

The overarching conclusions are as follows: to lessen the drag effects, the frontal area of the tags should be reduced, the tags should have a teardrop shape and low profile, the antenna length and diameter minimized, and the tags should not be placed at the peak height of the carapace. Studies incorporating multiple tags should reduce the interference drag by bunching transmitters or separating them by several tag widths. With respect to the large drag increases of the leatherback harness (> 100%), it is recommended that the use of the ridgemount tags directly attached to the longitudinal ridge be pursued. However, the use of direct attachment should be scrutinized with respect to health issues associated with drilling into the ridge (Jones et al., in press).

***Dive Behavior of Juvenile Loggerhead Turtles* –** NOAA Fisheries conducted a study using satellite telemetry data from 17 juvenile loggerhead turtles (43.5–66.5 cm straight carapace length) in conjunction with oceanographic data to analyze the influence of regional and seasonal oceanography on dive behavior in the North Pacific Ocean. Combined dive behavior for all individuals showed that turtles spent more than 80% of their time at depths less than 5 m, and more than 90% of their time at depths less than15 m. Turtles made deeper, longer dives during the first quarter of the year within this region, the reported time and area where the highest loggerhead bycatch occurs by the longline fishery. These results represent the first comprehensive study of dive data for this species in this region. The increased understanding of juvenile loggerhead dive behavior and the influences of oceanography on dive variability should provide further insight into why interactions with longline fisheries occur and suggest methods for reducing the bycatch of this threatened species (Howell et al., 2010).

Research on Escape Solutions in Japan Pound Nets – NOAA Fisheries has been collaborating with the Sea Turtle Association of Japan (STAJ), Tokyo University of Marine Science and Technology, and ProPeninsula to develop methods to identify mitigation measures useful in reducing loggerhead sea turtle bycatch in mid-water pound net fisheries in Japan. In the initial phase of this project, the researchers designed and constructed a 50% scale model of the cod end of a pound net (4.5m x 4.5m x 3m). The scale model was used to test turtle escape solutions in a controlled tank environment to simulate the conditions experienced by sea turtles inside actual pound net gear. A system of panels was designed that allowed researchers to change out different prototype pound net escape devices (PEDs) during testing. Six PED designs were developed based on observations of gear in pound net and other fisheries. By testing these designs, a protocol was established for handling turtles and characterizing turtle escape behavior, and one promising PED prototype was identified.

In 2010 Phase II of this project was conducted at Suma Aqualife Park in Kobe, Japan. Based on Phase I findings, the trap of the pound net was redesigned to allow for better and more controlled testing of the PED. There are three characteristics that successful PED designs need to deliver: a) turtle encounter of PED; b) turtle escape via PED; and c) fish retention. During Phase II of the project we tested characteristic b) viability of turtle escape. As part of Phase II, fishers from Japan and Mexico, as well as gear manufacturers, were invited to participate in PED brainstorming of ideas, designing, developing, and testing. A total of 34 trials of 11 variations of 3 PED designs were conducted in 2010. The team refined a detailed research protocol, tested several PEDs, gained a better understanding of PED design pitfalls, and identified several promising PED designs. Of the 11 PEDs tested, all allowed turtles to escape (Ishihara et al., in press).

Visual Deterrents to Reduce Turtle Bycatch in Gill Nets -- Visual cues play important roles in sea turtle foraging behavior and likely influence their interactions with fishing gear. Altering these cues may be a useful strategy to reduce the incidental catch of sea turtles in various fisheries. NOAA Fisheries examined the potential effectiveness of 3 visual cues—shark shapes placed along the length of the gill net, illumination of nets by LED lights, and nets illuminated with chemical lightsticks—in reducing bycatch of green sea turtles in gill nets. These potential deterrents were then adapted into the commercial bottom gill net fishery to quantify their effects on target fish catch rates and the catch value. Results indicated that the presence of shark shapes significantly reduced the mean catch rates of green turtles by 54% but also reduced target catch by 45% and, correspondingly, catch value by 47%. In contrast, nets illuminated by LED lights significantly reduced mean sea turtle catch rates by 40% while having negligible impacts on target catch and catch value. Similarly, nets illuminated by chemical lightsticks also significantly reduced mean sea turtle catch rates by 60% while having no significant impact on target catch and catch value. These results illustrate the potential for modifying fishing gear with visual deterrents to effectively reduce sea turtle catch rates (Wang et al., 2010).

PELAGIC SHARKS

Longline Hook Effects on Shark Bycatch – A NOAA study was conducted 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.) in the longline fishery that might reduce shark bycatch. Sixteen contracted vessels within the Hawaii- based deep-set tuna fleet with fishery observers were used to test catch efficacy of large (size 18/0) circle hooks versus traditional Japanese style tuna hooks (size 3.6 sun) in controlled comparisons (Curran and Bigelow, 2010, 2011). Fishery observers monitored a total of 1,182 sets comparing circle hooks versus tuna hooks, and also tested for fish size selectivity and survival upon longline retrieval.

The eighteen most caught species were analyzed representing 97.6% of the total catch by number. Catch rates on large 18/0 circle hooks were significantly reduced by 17% for blue shark, 27% for bigeye thresher shark and 69% for pelagic stingray. Bycatch rates for other incidental species such as billfish, opah (*Lampris guttatus*), and mahi mahi were also reduced compared to traditional tuna hooks. There was no significant difference in the catch rate of the target species, bigeye tuna, by hook type. In contrast to tuna hooks, large circle hooks have conservation potential for use in the world's pelagic tuna longline fleets for some highly migratory species based on demonstrated catch rate reductions.

Electromagnetic Deterrents to Shark Bycatch -- NOAA Fisheries have been investigating the use of electropositive metals (lanthanide series) to selectively repel sharks from longline hooks while not affecting targeted fish. Feeding behavior experiments conducted with on Oahu indicated that sharks significantly reduced their biting of bait in proximity to electropositive metal objects, and exhibited significantly more aversion behaviors. Other experiments off Oahu were conducted to test the effects of Nd/Pr (Neodymiun/Praseodymium) alloy on the catch rates of sharks on bottom set longline gear using metal branchlines and control branchlines. Analysis showed a significant reduction in CPUE on hooks with the control treatment.

Further collaborative studies involved conducting longline trials off the coast of Southern California and Ecuador. Branchlines with lead weight were alternated with branchlines with Nd/Pr metal weight. However, analysis of catch data indicated no difference in the catch rates of blue sharks, mako sharks, thresher sharks, silky sharks, and scalloped hammerhead sharks between control branchlines and branchlines with Nd/Pr metal (Wang et al., 2010; Hutchinson et al., in press).

OTHER BYCATCH

False Killer Whale Bycatch in the Central North Pacific -- Cetaceans are occasionally caught in the Hawaii-based deep-set longline fishery in the central North Pacific, and the bycatch of false killer whales, *Pseudorca crassidens*, currently exceeds allowable levels under the Marine Mammal Protection Act (MMPA). NOAA Fisheries examined longline observer data collected between 1994 and 2009, with emphasis on 2003–2009, to identify patterns of cetacean bycatch and depredation in relation to area, time, vessel, habitat variables, fishing gear, and set characteristics. The objectives of these analyses were to reduce depredation by cetaceans, reduce the likelihood of incidentally catching a cetacean when present, or reduce the severity of injuries to cetaceans if caught.

The results of this study were provided to the False Killer Whale Take Reduction Team, convened under the MMPA, in order to develop a plan to reduce serious injury and mortality of false killer whales in these fisheries. No correlates were identified that could markedly reduce depredation rates, but a slight (16%) reduction in repeat depredation within a fishing trip was evident when vessels moved at least 100 km following a depredation event. The most practical option for reducing bycatch of false killer whales was determined to be the use of small (14/0–

16/0) circle hooks, which could result in an estimated 6% reduction in bycatch and a greater likelihood of releasing animals with non-serious injuries (Forney et al., 2011; Oleson et al., 2010).

Genetic Analysis of Opah – Though mainly caught as bycatch in the Hawaii longline fishery, opah (*Lampris* spp.) commands a high price in the market and thus is rarely discarded. NOAA Fisheries port samplers in Honolulu discovered the existence of two opah morphotypes in the Central Pacific with differences in the relative size of the eye. Genetic analyses confirmed that the two morphotypes are distinct, and represent separate species. Further investigations of worldwide genetic samples revealed that the Hawaii morphotypes are also different from opah captured in the same geographical range as the originally described *Lampris guttatus*. A DNA bar-coding manuscript, in review, will reveal multiple cryptic lineages of opah and their general distribution.

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