SCIENTIFIC COMMITTEE
FOURTEENTH REGULAR SESSION

Busan, Republic of Korea
8-16 August 2018

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

WCPFC-SC14-AR/CCM-27
Rev. 1 (11 August 2018)

UNITED STATES OF AMERICA

2018 Annual Report to the Western and Central Pacific Fisheries Commission

United States of America

PART I. INFORMATION ON FISHERIES, RESEARCH, AND STATISTICS [1] (For 2016)

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 2016	**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 pelagic fish species; and a troll fishery for albacore. Small-scale fisheries include troll fisheries for a wide variety of tropical tunas and associated pelagic species, handline fisheries for yellowfin and bigeye tuna, a pole-and-line fishery for skipjack tuna, and miscellaneous-gear fisheries. Associated pelagic species include other tunas and billfishes, mahimahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), moonfish (*Lampris* spp.), escolar (*Lepidocybium flavobrunneum*), and pomfrets (Bramidae). 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 retained catch by the United States and U.S.-associated Participating Territory fisheries in the Western and Central Pacific Fisheries Commission (WCPFC) Statistical Area in 2017 are dominated by the catch of the purse seine fishery. Preliminary 2017 purse seine catch estimates total 138,744 t of skipjack, 23,144 t of yellowfin, and 3,247 t of bigeye tuna. The estimate of total U.S. purse-seine catch in 2016 has been revised to 201,484 t from last year's preliminary

[1] PIFSC Data Report DR-18-nnn.
Issued July 2018.

estimate. Longline retained catch increased slightly in 2017. Total longline catch in the North Pacific Ocean (NPO) in 2017 was higher than any other year of the 2013-2017 time period. Longline retained catch by American Samoa in the South Pacific Ocean (SPO) decreased slightly from 2016 and was the lowest level recorded during the 2013-2017 time period. Bigeye tuna longline catch by the United States and its Territories decreased to 5,358 t in 2017. Albacore longline catch by the United States and its Territories decreased slightly to 1,381 t in 2017. Excluding catch attributed to the U.S. Participating Territories (i.e., American Samoa, Commonwealth of the Northern Mariana Islands, and Guam), longline catch of bigeye tuna by U.S. longline vessels decreased to 2,968 t in 2017. Total bigeye tuna catch estimates by the U.S. longline fishery were below the limit of 3,138 t for 2017. The annual bigeye catch limits were established in U.S. fishery regulations (50 *CFR* Part 300) pursuant to the provisions of WCPFC Conservation and Management Measure (CMM) 2008-01 for bigeye and yellowfin tuna during 2009 through 2011, CMM 2011-01 in 2012, CMM 2012-01 in 2013, CMM 2013-01 in 2014, CMM 2014-01 in 2015, CMM 2015-01 in 2016, and CMM 2016-01 in 2017.

The longline catch of swordfish by the United States and its Territories increased to 973 t in 2017. Small-scale (tropical) troll and handline vessels operating in nearshore waters represented the largest number of U.S.-flagged vessels but contributed only a small fraction of the catch. The longline fleet was the next largest fleet, numbering 150 vessels in 2017, while there were 34 purse seine vessels in 2017.

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 research, including biological and oceanographic research, fish stock assessment research, and socio-cultural studies on fisheries for tunas and billfishes. The monitoring and research also address animals caught as bycatch in those fisheries. In 2017, socio-economic studies addressed impacts of bigeye tuna catch limits on longline fishery, economics of Hawaii’s small boat fishery, and social vulnerability indicators of fishing communities in the Pacific region. Stock assessment research was conducted almost entirely in collaboration with members of the WCPFC, the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), and the Inter-American Tropical Tuna Commission (IATTC).

NOAA Fisheries biological and oceanographic research on tunas, billfishes, and sharks addressed use of observer data and the collection of biological samples to support stock assessments, the effects of biological, economic, and management factors on pelagic stocks, modelling age-based movement behavior, and migratory patterns of Pacific bluefin tuna (*Thunnus orientalis*). Oceanographic studies in the central North Pacific focused on climate change impacts and ocean acidification. Bycatch mitigation studies focused on the longline fishery and included research on sea turtles, pelagic sharks, and cetaceans.

Tabular Annual Fisheries Information

This report presents estimates of annual catches of tuna, billfish, and other highly migratory species (HMS), and vessel participation during 2013–2017 for fisheries of the United States and its Participating Territories operating in the western and central Pacific Ocean (WCPO). All statistics for 2017 are provisional. Statistics for 2016 have been updated from those reported provisionally in the submission of 2015-2016 U.S. fishery statistics for the WCPO (NOAA, NMFS 2016). Statistics for 2013–2015 have not been updated. For the purposes of this report, the WCPO is defined as the Western and Central Pacific Fisheries Commission (WCPFC) Statistical Area. 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.

The purse seine fishery remains the largest U.S. fishery in terms of total catch. It accounts for about 91% of the total catch of HMS by the United States and its Participating Territories in the WCPO. The longline, tropical troll, handline and albacore troll fisheries account for 7.2%, 0.3%, 0.7%, and 0.3% of the total catch, respectively.

Fisheries of the United States and its Participating Territories for tunas, billfishes and other HMS produced an estimated catch of 181,218 t in 2017 (Table 1a), down from 217,214 t in 2016 (Table 1b). The catch consisted primarily of skipjack tuna (77%), yellowfin tuna (15%), bigeye tuna (5%), and albacore (1%). Catches of skipjack tuna decreased in 2017 due to lower purse seine catches, but bigeye and yellowfin tuna catch increased from the previous year due to higher purse seine and longline catches.

Further discussion of the tabular fisheries information is provided in the following section on flag state reporting.

Table 1a. Estimated weight (in metric tons) of catch 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 2017 (preliminary). Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). Purse seine species composition estimates have not been adjusted for 2017.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Total
Albacore (ALB), North Pacific		90	124		34	124
Albacore (ALB), South Pacific	0	1,381	464			1,938
Bigeye tuna (BET)	3,247	5,358		36	103	8,744
Pacific bluefin tuna (PBF)		2	0			2
Skipjack tuna (SKJ)	138,744	254		349	5	139,353
Yellowfin tuna (YFT)	23,144	2,587		464	385	26,579
Other tuna (TUN KAW FRI)				5	2	7
TOTAL TUNAS	165,135	9,673	588	854	529	176,747
Black marlin (BLM)	2	1		2		5
Blue marlin (BUM)	4	606		154	4	768
Sailfish (SFA)		12		2		14
Spearfish (SSP)		234		9		243
Striped marlin (MLS), North Pacific		334		6		340
Striped marlin (MLS), South Pacific	0	2				2
Other marlins (BIL)		1				1
Swordfish (SWO), North Pacific		973			6	979
Swordfish (SWO), South Pacific		6				6
TOTAL BILLFISHES	6	2,168		173	10	2,357
Blue shark (BSH)						
Mako shark (MAK)		35				35
Thresher sharks (THR)		3				3
Other sharks (SKH OCS FAL SPN TIG CCL)		0		1		1
TOTAL SHARKS		39		1		40
Mahimahi (DOL)	1	183		239	9	432
Moonfish (LAP)		321				321
Oilfish (GEP)		115				115
Pomfrets (BRZ)		299		0	15	314
Wahoo (WAH)	5	301		108	4	418
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	4	3		1		8
TOTAL OTHER	10	1,222		349	28	1,608
TOTAL	**165,151**	**13,101**	**588**	**1,376**	**567**	**180,725**

Table 1b. Estimated weight (in metric tons) of catch 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 2016 (preliminary). Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). Purse seine species composition estimates have not been adjusted for 2016.

Species and FAO code	**Purse seine**	**Longline**	**Albacore troll**	**Tropical troll**	**Handline**	**Total**
Albacore (ALB), North Pacific		243		1	24	268
Albacore (ALB), South Pacific		1,517	145			1,662
Bigeye tuna (BET)	4,711	6,216		34	183	11,144
Pacific bluefin tuna (PBF)		1	0			1
Skipjack tuna (SKJ)	178,284	306		406	5	179,001
Yellowfin tuna (YFT)	18,162	1,654		535	269	20,620
Other tuna (TUN KAW FRI)		0		6	2	8
TOTAL TUNAS	201,156	9,936	145	983	483	212,703
Black marlin (BLM)	2	1		2		5
Blue marlin (BUM)	3	506		161	2	672
Sailfish (SFA)		19		2		21
Spearfish (SSP)		281		16		297
Striped marlin (MLS), North Pacific		327		12		339
Striped marlin (MLS), South Pacific		2				2
Other marlins (BIL)		1				1
Swordfish (SWO), North Pacific		639			4	643
Swordfish (SWO), South Pacific		6				6
TOTAL BILLFISHES	5	1,782		193	6	1,986
Blue shark (BSH)		1				1
Mako shark (MAK)		46			1	47
Thresher sharks (THR)		4				4
Other sharks (SKH OCS FAL SPN TIG CCL)		0		1		1
TOTAL SHARKS		51		1	1	53
Mahimahi (DOL)	1	234		369	9	613
Moonfish (LAP)		380				380
Oilfish (GEP)		191		0		191
Pomfrets (BRZ)	0	386		1	16	402
Wahoo (WAH)	2	403		145	5	555
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	5	9		2		15
TOTAL OTHER	7	1,602		516	30	2,156
TOTAL	**201,168**	**13,371**	**145**	**1,693**	**520**	**216,898**

Table 1c. Estimated weight (in metric tons) of catch 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 2015 (updated). Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). Purse seine species composition estimates have not been adjusted for 2015.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Total
Albacore (ALB), North Pacific		217	0	2	62	281
Albacore (ALB), South Pacific		1,855	156			2,011
Bigeye tuna (BET)	1,595	5,840		59	202	7,696
Pacific bluefin tuna (PBF)		6				6
Skipjack tuna (SKJ)	219,550	254		401	5	220,210
Yellowfin tuna (YFT)	17,019	1,041		558	401	19,019
Other tuna (TUN KAW FRI)		0		15	1	16
TOTAL TUNAS	238,164	9,213	156	1,035	671	249,239
Black marlin (BLM)	3	0		4		7
Blue marlin (BUM)	6	526		197	3	732
Sailfish (SFA)		15		3		18
Spearfish (SSP)		204		11		215
Striped marlin (MLS), North Pacific		414		11		425
Striped marlin (MLS), South Pacific		3				3
Other marlins (BIL)	1	1				2
Swordfish (SWO), North Pacific		690		1	5	696
Swordfish (SWO), South Pacific		8				8
TOTAL BILLFISHES	10	1,862		227	8	2,107
Blue shark (BSH)		1				1
Mako shark (MAK)		39				39
Thresher sharks (THR)		6			1	7
Other sharks (SKH OCS FAL SPN TIG CCL)				1		1
TOTAL SHARKS		45		1	1	47
Mahimahi (DOL)	1	226		404	13	644
Moonfish (LAP)		336				336
Oilfish (GEP)		185				185
Pomfrets (BRZ)		419			13	432
Wahoo (WAH)	1	340		203	9	554
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	4	9		1		14
TOTAL OTHER	6	1,515		608	35	2,164
TOTAL	**238,180**	**12,635**	**156**	**1,871**	**715**	**253,557**

Table 1d. Estimated weight (in metric tons) of catch 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 2014. Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). Purse seine species composition estimates have not been adjusted for 2014.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Total
Albacore (ALB), North Pacific		186	0	3	49	238
Albacore (ALB), South Pacific		1,430	445			1,875
Bigeye tuna (BET)	2,802	5,141		143	206	8,292
Pacific bluefin tuna (PBF)		3				3
Skipjack tuna (SKJ)	269,243	291		370	8	269,912
Yellowfin tuna (YFT)	40,959	1,021		582	385	42,947
Other tuna (TUN KAW FRI)				14	2	16
TOTAL TUNAS	313,004	8,072	445	1,112	650	323,283
Black marlin (BLM)	5	1		3		9
Blue marlin (BUM)	4	486		160	4	654
Sailfish (SFA)		17		1		18
Spearfish (SSP)		175		8		183
Striped marlin (MLS), North Pacific		357		12		369
Striped marlin (MLS), South Pacific	1	7				8
Other marlins (BIL)	1					1
Swordfish (SWO), North Pacific		880		1	7	888
Swordfish (SWO), South Pacific		10				10
TOTAL BILLFISHES	11	1,932		185	11	2,139
Blue shark (BSH)		1				1
Mako shark (MAK)		37				37
Thresher sharks (THR)		6		1		7
Other sharks (SKH OCS FAL SPN TIG CCL)				1		1
TOTAL SHARKS		43		2		45
Mahimahi (DOL)	2	263		535	26	827
Moonfish (LAP)		408				408
Oilfish (GEP)		182				182
Pomfrets (BRZ)		392		0	19	411
Wahoo (WAH)	3	336		259	10	608
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)	2	6		1		10
TOTAL OTHER	7	1,587		796	55	2,445
TOTAL	**313,022**	**11,635**	**445**	**2,095**	**716**	**327,913**

Table 1e. Estimated weight (in metric tons) of catch 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 2013. Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). Purse seine species composition estimates have not been adjusted for 2013.

Species and FAO code	Purse seine	Longline	Albacore troll	Tropical troll	Handline	Total
Albacore (ALB), North Pacific		298		2	46	346
Albacore (ALB), South Pacific	1	2,128	390			2,519
Bigeye tuna (BET)	8,157	4,534		148	393	13,232
Pacific bluefin tuna (PBF)		3				3
Skipjack tuna (SKJ)	226,609	288		539	14	227,450
Yellowfin tuna (YFT)	23,277	1,083		531	442	25,333
Other tuna (TUN KAW FRI)		0		5	1	6
TOTAL TUNAS	258,044	8,335	390	1,224	896	268,889
Black marlin (BLM)		1		3		4
Blue marlin (BUM)		378		137	3	518
Sailfish (SFA)		12		2		14
Spearfish (SSP)		177		11		188
Striped marlin (MLS), North Pacific		328		8		336
Striped marlin (MLS), South Pacific		4				4
Other marlins (BIL)		1				1
Swordfish (SWO), North Pacific		583		1	6	590
Swordfish (SWO), South Pacific		11				11
TOTAL BILLFISHES		1,493		161	9	1,664
Blue shark (BSH)		2				2
Mako shark (MAK)		39				39
Thresher sharks (THR)		5			1	6
Other sharks (SKH OCS FAL SPN TIG CCL)		0		1		1
TOTAL SHARKS		46		1	1	48
Mahimahi (DOL)		293		406	22	721
Moonfish (LAP)		450				450
Oilfish (GEP)		216				216
Pomfrets (BRZ)		359		0	20	379
Wahoo (WAH)		274		206	8	487
Other fish (PEL PLS MOP TRX GBA ALX GES RRU DOT)		10		1		11
TOTAL OTHER		1,602		613	50	2,265
TOTAL	**258,044**	**11,476**	**390**	**1,999**	**956**	**272,865**

Table 1f. Longline retained catch in metric tons (t) by species and species group, for U.S. and American Samoa vessels operating in the WCPFC Statistical Area in 2012–2015. Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). Catch in North Pacific Ocean = NPO and catch in South Pacific Ocean = SPO.

	U.S. in NPO					CNMI in NPO					Guam in NPO					American Samoa in NPO					American Samoa in SPO					Total				
	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013
Vessels	136	133	135	140	135	119	117	117	109	113		118	112			118	23	22	17	17	15	20	21	23	22	150	151	156	162	157
Species					-																									
Albacore, NPO	74	208	197	178	265					23						16	34	19	8	11						90	243	217	186	298
Albacore, SPO			0																		1,381	1,517	1,855	1,430	2,128	1,381	1,517	1,855	1,430	2,128
Bigeye tuna**	2,968	3,747	3,427	3,823	3,654	997	879	999	1,000	492		932	856			1,330	586	441	236	305	64	72	116	82	84	5,358	6,216	5,840	5,141	4,534
Pacific bluefin tuna	0	0	0		0											0					1	0	6	3	2	2	1	6	3	3
Skipjack tuna	157	186	176	167	188					25						35	26	11	9	9	63	94	67	116	66	254	306	254	291	288
Yellowfin tuna	1,761	1,093	681	567	568					93						293	175	105	30	32	533	386	255	424	390	2,587	1,654	1,041	1,021	1,083
Other tuna		0	0		0					0							0							0			0	0		0
TOTAL TUNA	**4,960**	**5,234**	**4,482**	**4,734**	**4,674**	**997**	**879**	**999**	**1,000**	**633**		**932**	**856**			**1,674**	**821**	**577**	**283**	**357**	**2,042**	**2,069**	**2,299**	**2,055**	**2,671**	**9,673**	**9,936**	**9,214**	**8,072**	**8,335**
Black marlin	0	1	0	1	1											0		0	0	0	0				0	1	1	0	1	1
Blue marlin	485	419	445	428	305					20						84	57	55	31	22	38	30	25	28	31	606	506	525	486	378
Sailfish	9	15	11	15	7					3						2	2	2	0	1	1	2	2	2	2	12	19	15	17	12
Spearfish	206	251	188	163	133					34						26	28	15	11	9	2	2	1	1	1	234	281	204	175	177
Striped marlin, NPO	286	280	378	343	262					42						48	48	36	14	23				0		334	327	414	357	328
Striped marlin, SPO			0																		2	2	3	7	4	2	2	3	7	4
Other marlins	1	1	1		1					0						0		0								1	1	1		1
Swordfish, NPO	924	596	665	865	558					8						49	43	24	15	17						973	639	690	880	583
Swordfish, SPO			0																		6	6	8	10	11	6	6	8	10	11
TOTAL BILLFISH	**1,910**	**1,562**	**1,688**	**1,813**	**1,266**					**107**						**209**	**179**	**133**	**72**	**72**	**48**	**41**	**40**	**47**	**48**	**2,168**	**1,782**	**1,861**	**1,932**	**1,493**

* Pacific bluefin tuna catches are reported on longline logsheets for the American Samoa fishery, however the species may be misidentified.
** In 2017 American Samoa totals include 1,000 t of bigeye caught by the Hawaii-based longline fishery and attributed to the American Samoa bigeye tuna quota.

Table 1f. (Continued.)

	U.S. in NPO					CNMI in NPO					Guam in NPO			American Samoa in NPO					American Samoa in SPO					Total				
	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013	2017	2016	2015	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013	2017	2016	2015	2014	2013
Blue shark					1										0		0			1	1	1	1		1	1	1	2
Mako shark	30	37	35	35	31					3				5	9	4	2	4	0	0				35	46	39	37	39
Thresher	2	3	5	5	5					0				0	0	1	1	0	1	0				3	4	6	6	5
Other sharks	0	0			0														0	0				0	0			0
Oceanic whitetip shark					0															0								0
Silky shark	0																							0				
Hammerhead shark		0																							0			
Tiger shark																												
Porbeagle																												
TOTAL SHARKS	**32**	**40**	**40**	**40**	**37**					**3**				**6**	**10**	**5**	**2**	**5**	**1**	**1**	**1**	**1**	**1**	**39**	**51**	**45**	**43**	**46**
Mahimahi	147	202	199	236	238					9				22	28	21	15	27	14	4	6	12	19	183	234	226	263	293
Moonfish	258	304	279	385	377					37				61	74	55	22	35	1	2	2	1	2	321	380	336	408	450
Oilfish	93	160	165	169	171					28				21	29	20	13	17	0	2	0	0	1	115	191	185	182	216
Pomfret	261	339	380	373	315					26				38	46	39	18	18	0	0	0	0		299	386	419	392	359
Wahoo	218	309	256	243	154					17				35	47	27	18	15	48	47	58	75	87	301	403	340	336	274
Other fish	2	7	7	6	9					0				0	1	1	0	0	0	1	1	0	0	3	9	9	6	10
TOTAL OTHER	**980**	**1,322**	**1,285**	**1,411**	**1,263**					**117**				**178**	**224**	**164**	**87**	**113**	**64**	**55**	**66**	**89**	**109**	**1,222**	**1,602**	**1,515**	**1,587**	**1,602**
GEAR TOTAL	**7,883**	**8,158**	**7,495**	**7,999**	**7,241**	**997**	**879**	**999**	**1,000**	**860**		**932**	**856**	**2,067**	**1,235**	**878**	**445**	**546**	**2,155**	**2,167**	**2,405**	**2,192**	**2,828**	**13,101**	**13,371**	**12,634**	**11,635**	**11,476**

*No sharks or other pelagic fish were reported for Guam in 2014 and 2013.

Table 1g. Estimated catch of tropical troll fishery 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 in 2012–2016. Totals may not match sums of values due to rounding to the nearest metric ton (< 0.5 t = 0). NPO = North Pacific Ocean and SPO = South Pacific Ocean.

	Hawaii					Guam					CNMI					American Samoa					Total Tropical Troll				
	2017	**2016**	**2015**	**2014**	**2013**	**2017**	**2016**	**2015**	**2014**	**2013**	**2017**	**2016**	**2015**	**2014**	**2013**	**2017**	**2016**	**2015**	**2014**	**2013**	**2017**	**2016**	**2015**	**2014**	**2013**
Vessels	1,394	1,478	1,576	1,649	1,662	318	408	372	447	496	8	9	9	19	28	8	12	11	22	13	1,728	1,907	1,968	2,137	2,199
Species																									
Albacore, NPO		1	2	3	2																	1	2	3	2
Albacore, SPO																									
Bigeye tuna	35	34	59	143	148											1					36	34	59	143	148
Pacific bluefin tuna																									
Skipjack tuna	94	117	96	78	149	231	198	273	177	227	21	87	29	109	159	3	4	3	6	3	349	406	401	370	539
Yellowfin tuna	420	464	492	555	488	31	58	51	15	24	6	9	13	8	16	7	4	2	3	3	464	535	558	582	531
Other tunas	3	4	15	12	4	0	0		0	0	2	1		2	1	0	1				5	6	15	14	5
TOTAL TUNAS	**552**	**620**	**664**	**791**	**791**	**261**	**256**	**324**	**192**	**251**	**29**	**97**	**42**	**120**	**176**	**11**	**10**	**5**	**9**	**6**	**854**	**983**	**1,035**	**1,112**	**1,224**
Black marlin	2	2	4	3	3																2	2	4	3	3
Blue marlin	134	141	179	144	128	19	20	17	13	7	0			3	1	0		1	1		154	161	197	160	137
Sailfish	2	2	2	1	1				0	1				0	0			1	0		2	2	3	1	2
Spearfish	9	16	11	8	11																9	16	11	8	11
Striped marlin, NPO	6	12	11	12	8																6	12	11	12	8
Striped marlin, SPO																									
Other billfish																									
Swordfish, NPO			1	1	1																		1	1	1
Swordfish, SPO																									
TOTAL BILLFISHES	**153**	**173**	**208**	**169**	**152**	**19**	**20**	**17**	**13**	**8**				**3**	**1**	**0**		**2**	**1**		**173**	**193**	**227**	**185**	**161**
Blue shark																									
Mako shark																									
Thresher sharks				1																				1	
Other sharks	1	1	1	1	1																1	1	1	1	1
TOTAL SHARKS	**1**	**1**	**1**	**2**	**1**																**1**	**1**	**1**	**2**	**1**
Mahimahi	182	253	329	408	290	53	79	72	87	75	2	36	3	39	41	2	1		1	0	239	369	404	535	406
Moonfish																									
Oilfish																	0					0			
Pomfrets							1				0	0		0	0		0				0	1		0	0
Wahoo	83	122	189	211	180	12	15	14	42	23	1	2		5	2	12	6	0	0	1	108	145	203	259	206
Other pelagics	1		1	1	1				0							0	2				1	2	1	1	1
TOTAL OTHER	**266**	**375**	**519**	**620**	**471**	**66**	**95**	**86**	**130**	**98**	**3**	**38**	**3**	**44**	**43**	**14**	**8**	**0**	**1**	**1**	**349**	**516**	**608**	**796**	**613**
GEAR TOTAL	**972**	**1,169**	**1,392**	**1,582**	**1,415**	**346**	**371**	**427**	**335**	**357**	**32**	**135**	**45**	**167**	**220**	**25**	**18**	**7**	**11**	**7**	**1,376**	**1,693**	**1,871**	**2,095**	**1,999**

Table 1h. Estimated catch of swordfish, and number of U.S. vessels fishing for swordfish, south of 20° S in the WCPFC Statistical Area in 2013–2017, to fulfill the reporting requirements of WCPFC CMM 2009-03.

	U.S.-flagged Vessels South of 20° S	
Year	Catch (t) by all vessels	Number of vessels fishing for swordfish
2017	0	1
2016	0	0
2015	< 1	0
2014	0	0
2013	confidential	0

Note: The catch is only reported for years when 3 or more vessels fished in the area, although the number of vessels fishing for swordfish may be less than the number that fished. The United States 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 operating in the WCPFC Statistical Area, by gear type, from 2012 to 2016. Data for 2017 are preliminary.

	2017	**2016**	**2015**	**2014**	**2013**
Purse seine	34	37	39	40	40
Longline (N Pac-based) [1]	136	133	135	140	135
Longline (American Samoa-based)	118	23	22	17	17
Total U.S. Longline [2]	150	151	156	162	157
Albacore troll (N Pac) [3]			4	3	
Albacore troll (S Pac) [3]	13	6	6	13	6
Tropical troll	1,728	1,907	1,968	2,137	2,199
Handline	487	475	478	499	534
Tropical Troll and Handline (combined)[4]	1,870	2,046	2,057	2,212	2,304
TOTAL	**2,067**	**2,240**	**2,258**	**2,427**	**2,507**

[1] Includes Hawaii- and California-based vessels that fished west of 150 W.

[2] Some longline vessels fished in both Hawaii and American Samoa and are counted only once in this U.S. total.

[3] Some vessels fished on both sides of the equator and are counted only once in the bottom line TOTAL.

[4] Some vessels used both tropical troll and handline gear but were counted only once in this combined total.

Table 2b. Estimated number of United States and Participating Territories purse seine, longline, pole-and-line, and albacore troll vessels operating in the WCPFC Statistical Area, by gross registered tonnage categories, from 2013 to 2017. Data for 2017 are preliminary.

Gear and year	0-50	51-200	201-500	501-1000	1001-1500	1500+
2013 Purse seine					19	21
2014 Purse seine					19	21
2015 Purse seine					17	22
2016 Purse seine					15	22
2017 Purse seine					14	20
2013 Longline	15	142				
2014 Longline	13	149				
2015 Longline	13	143				
2016 Longline	12	139				
2017 Longline	8	142				
	0-50	**51-150**	**150+**			
2013 Pole and line	1	1				
2014 Pole and line	1	1				
2015 Pole and line	1	1				
2016 Pole and line	1	1				
2017 Pole and line	1	1				
2013 Albacore Troll		4	2			
2014 Albacore Troll		9	7			
2015 Albacore Troll		6	4			
2016 Albacore Troll		4	2			
2017 Albacore Troll		6	7			

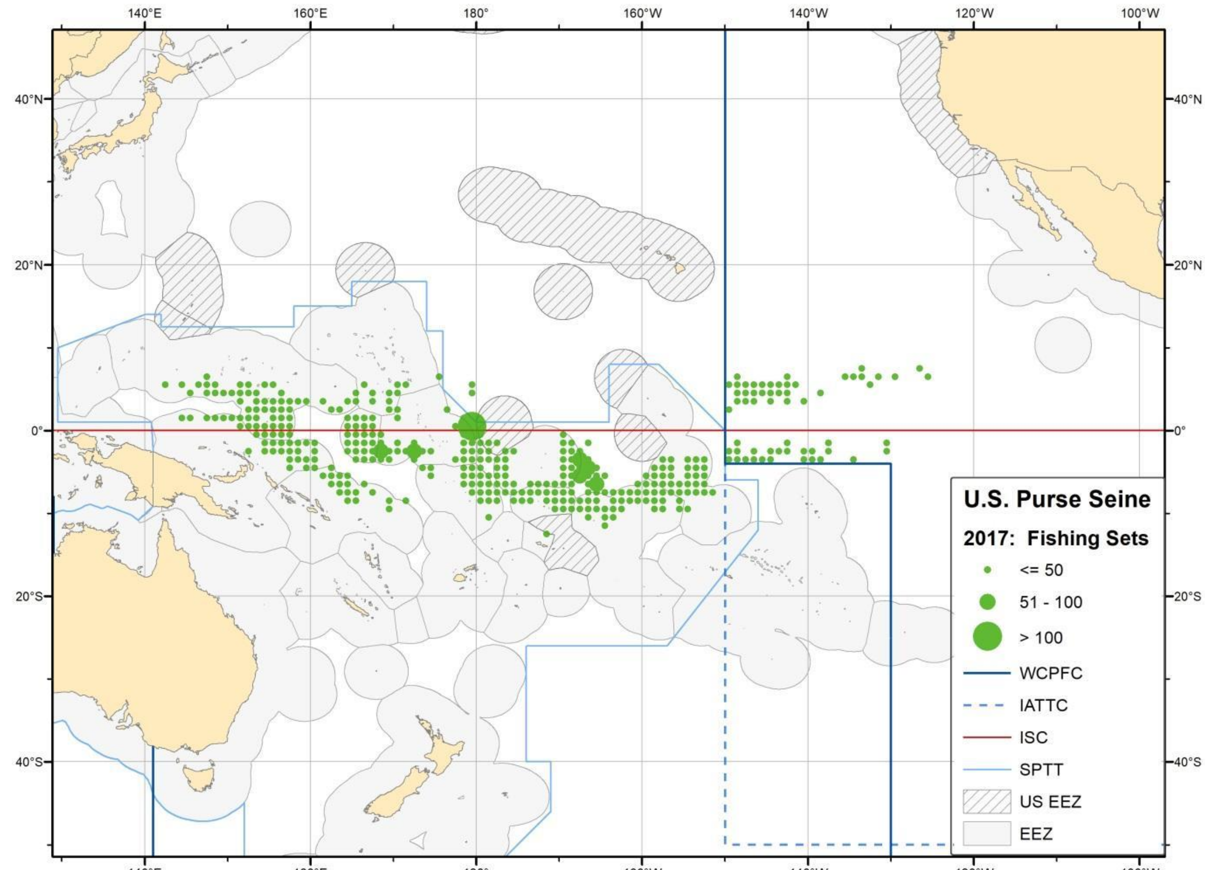

Figure 1. Spatial distribution of fishing effort (fishing sets) reported in logbooks by U.S.-flagged purse seine vessels the Pacific Ocean in 2017 (preliminary data). Effort in some areas is not shown to preserve data confidentiality.

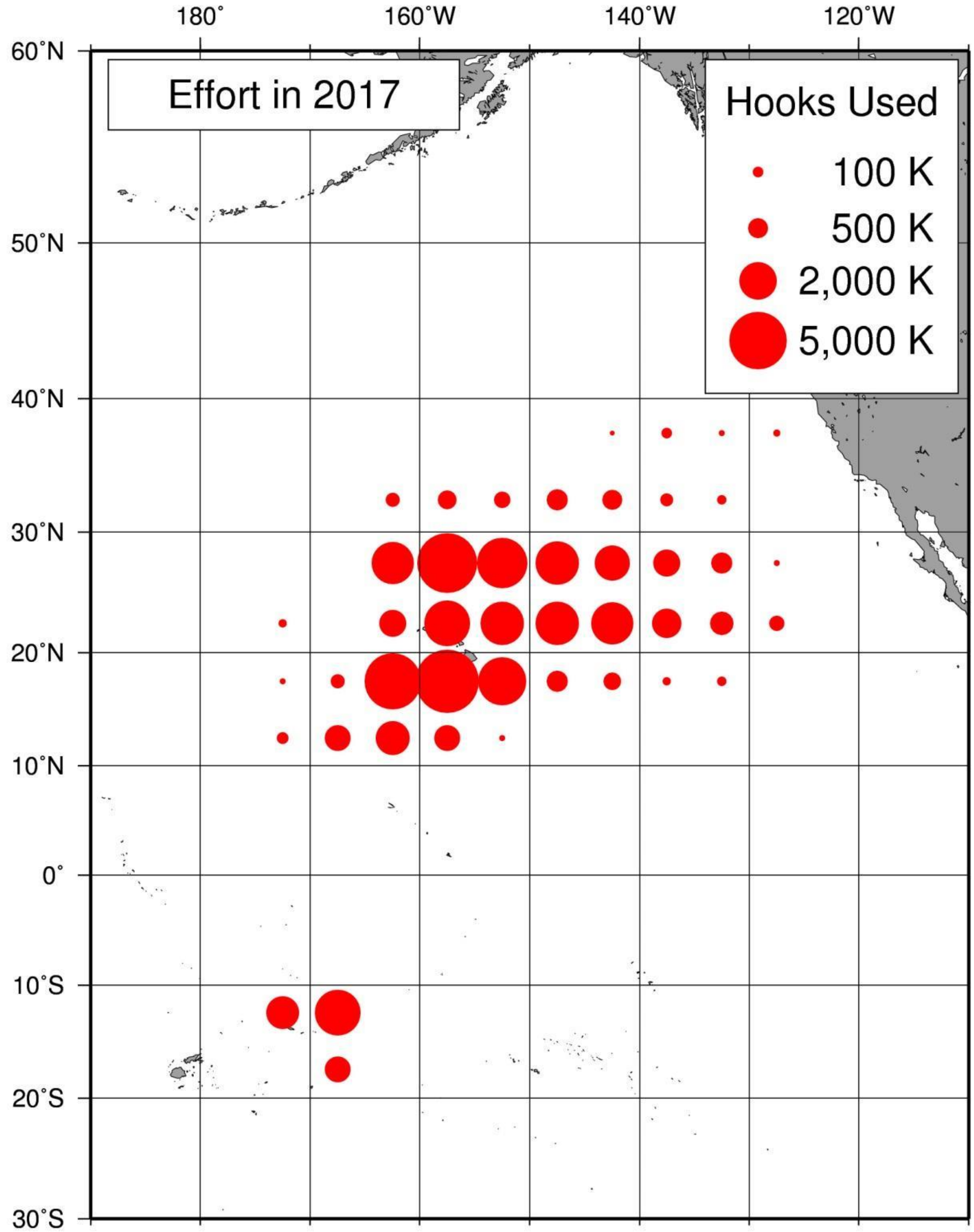

Figure 2a. Spatial distribution of fishing effort reported in logbooks by U.S.-flagged longline vessels, in 1000s of hooks (K), in 2017 (preliminary data). Area of circles is proportional to effort. Effort in some areas is not shown to preserve data confidentiality.

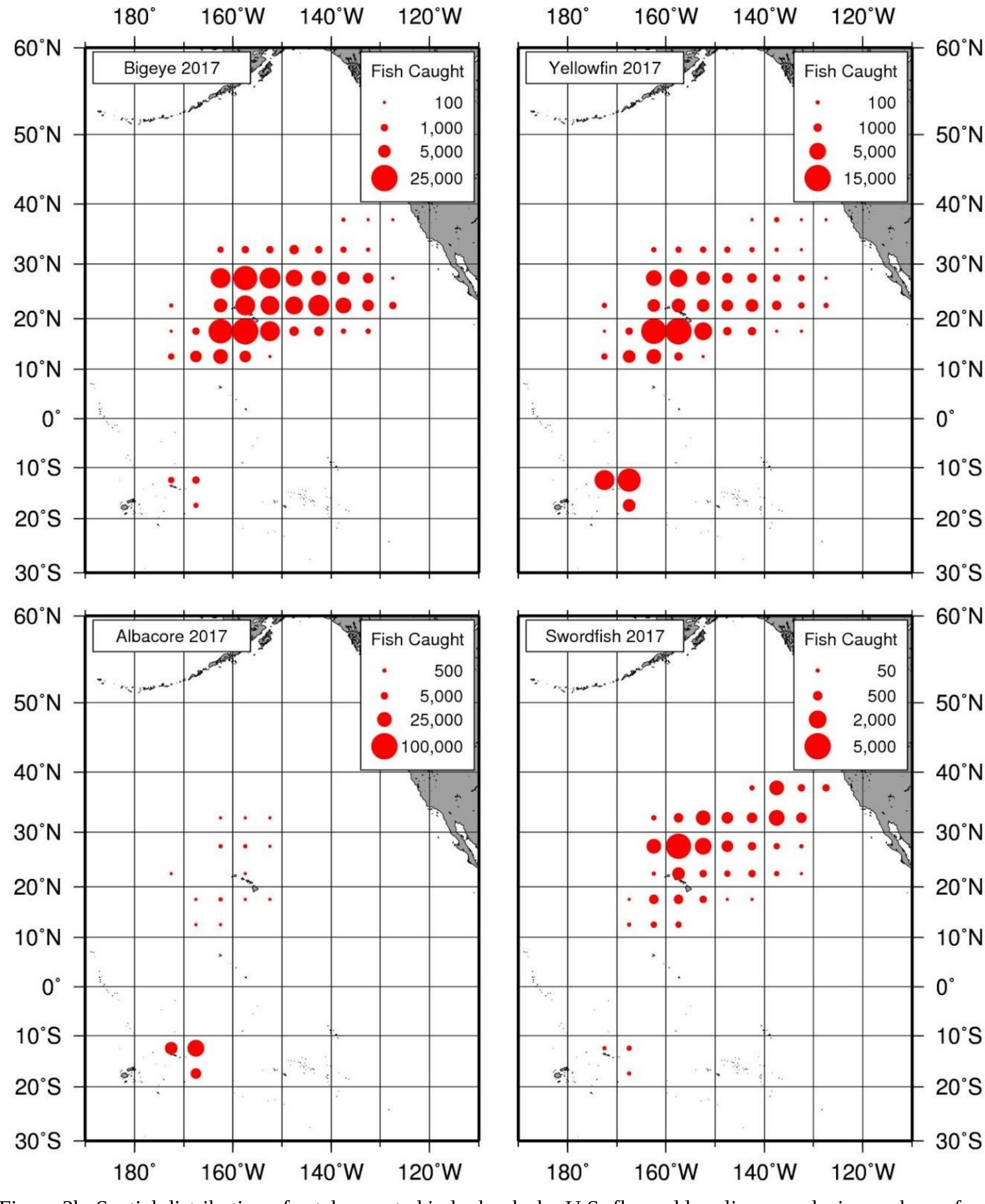

Figure 2b. Spatial distribution of catch reported in logbooks by U.S.-flagged longline vessels, in numbers of fish (includes retained and released catch), in 2017 (preliminary data). Area of circles is proportional to catch. Catches in some areas are not shown to preserve data confidentiality.

Background [n/a]

Flag State Reporting of National Fisheries

U.S. Purse seine Fishery

The U.S. purse-seine catch of tunas in the WCPO was 165,601 t in 2017 compared to 201,472 t in 2016, and was primarily composed of skipjack tuna, with smaller catches of yellowfin and bigeye tuna. The total catches of tunas have fluctuated over the past 5 years (Tables 1a-1e). The number of vessels in 2017 was 34 vessels, 3 less than in 2016 (Table 2a). The fishery operated further eastward, and not as far northward as in the prior years, mainly in areas between 5° N and 15° S latitude and 155° E and 135°W longitude (Figure 1).

U.S. Longline Fisheries

The longline fisheries of the United States 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 during 2013–2017 ranged from 150 vessels in 2017 to 162 vessels in 2014 (Table 2). The U.S. longline fishery in the NPO consistently had the highest number of vessels in operation with 136 in 2017. Participation in the American Samoa-permitted fleet operating in the South Pacific declined from 23 vessels in 2014 to 15 vessels in 2017. A few vessels occasionally operated in both the Hawaii-permitted and American Samoa-permitted longline fisheries during 2013–2017. Longline catches made outside of the U.S. EEZ in NPO by vessels operating with both American Samoa and Hawaii longline permits and landing their fish in Hawaii belong to the longline fishery of American Samoa and not to the U.S. longline fishery in the NPO in accordance with federal fisheries regulations (50 *CFR* 300.224).
These American Samoa longline landings in the NPO (labeled as American Samoa in the NPO in Table 1f) are shown separately from U.S. longline catches in the NPO. The table entries for American Samoa (Table 1f) include its catches in the South Pacific landed in American Samoa. The overall American Samoa fishery total is the sum of its catches in the South Pacific and in the NPO attributed to American Samoa. Pursuant to the Consolidated and Further Continuing Appropriations Act (CFCAA) of 2011 (Pub. L. 112-55, 125 Stat. 552 et seq.) and NMFS regulations under 50 *CFR* 300.224, if the U.S. vessel landing the fish was included in a valid arrangement under Sec. 113(a) of the CFCAA or Amendment 7 of the Pelagics Fishery Ecosystem Plan, its catch during those periods was attributed to the fishery of American Samoa in the NPO from 2011-2012 and 2017, to CNMI during 2013 through 2017, and to Guam in 2015 and 2016. Under the Amendment 7 arrangements (2014 through 2017 only bigeye tuna were attributed to the participating territory and all other incidental catch was attributed to the Hawaii-based fishery).

The U.S. longline fishery in the NPO operated mainly from the equator to 40° N latitude and from 120° W to 175° W in 2017 (Figure 2a). The American Samoa-based longline fishery operated mostly from 10° S to 20° S latitude and 165° W to 175° W longitude in 2017 (Figure 2a). The U.S. longline fishery in the NPO fishery targeted bigeye tuna and swordfish, with significant landings of associated pelagic species, whereas the American Samoa longline fishery in the SPO targeted and landed albacore but also produced a noteworthy amount of yellowfin tuna. Pacific bluefin tuna catches are reported on longline log sheets for the American Samoa fishery, however the species may be misidentified (Tables 1a-1f). The dominant components of the longline catch by the United States and its Territories in 2017 were bigeye tuna, albacore, yellowfin tuna, and swordfish (Table 1a, Figure 2b). The total catch of all species during the past 5 years ranged from a low of 11,476 t in 2013, to a high of 13,371 t in 2016 which decreased to 13,102 t in 2017 (Tables 1a-1e).

Most of the U.S. longline fishery in the NPO 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. U.S. longline landings of swordfish in the NPO (including Territories) varied substantially from 583 t in 2013 to 973 t in 2017. The shallow-set U.S. longline fishery for swordfish accounts for the majority of the swordfish catch and has operated under the allowable number of sea turtle interaction limits in 11 out of 14 years since its reopening in 2004.

U.S. Albacore Troll Fisheries

In recent years, participation in the U.S. troll fisheries for albacore in the WCPO has fluctuated greatly. Thirteen vessels participated in the South Pacific albacore troll fishery in 2017 compared to six vessels in 2016 and 2015 (Table 2). The South Pacific albacore troll fishery operates mostly between 30° S and 45° S latitude and 145° W and 175° W longitude. The catch in this fishery is composed almost exclusively of albacore. The albacore troll catches in the WCPO by both the North Pacific and South Pacific albacore fisheries increased from 145 t in 2016 to 588 t in 2017 (Tables 1a-1e).

Other Fisheries of the United States and Participating Territories

Other fisheries of the United States 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 one most commonly used in the recreational and subsistence fisheries in these areas. Most of the vessels comprising the United States 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 1,943 t in 2017. The catch was composed primarily of yellowfin tuna, skipjack tuna, bigeye tuna, and mahimahi.

Coastal State Reporting

[n/a]

Socioeconomic Factors and Trends in the Fisheries

Socio-economic Surveys and Analyses

NMFS staff and colleagues have conducted surveys and analyses to better understand the socioeconomic considerations of U.S. fisheries in the WCPO. The following summaries describe recent investigations in this area.

Bigeye tuna catch limits lead to differential impacts for Hawai`i longliners. Bigeye tuna (*Thunnus obesus*, Scombridae) are a globally important commercial fish. About 60% of the world's bigeye is caught in the Pacific Ocean, where stocks have been subject to overfishing and longline fleets are governed by increased conservation measures. One conservation measure entails multilateral bigeye quota reductions. Since 2010, quota reductions have resulted in four extended closures for Hawai`i longliners. Previous research indicated that regulatory closures may result in differential socioeconomic impacts, but little is known about how four extended closures may affect fishers and fishing trips in a diverse longline fleet with 142 active vessels. The purpose of this NOAA research (Ayers et al., 2018) is to assess the trip-level impacts of closures on Hawai`i longliners and determine whether impacts could be lessened while sill meeting conservation measures. To do this, economic data and longline logbooks for Hawai`i longliners were analyzed from 2010 to 2015, and 28 longline fishers were interviewed in Fall 2015. Vessels allowed to fish during closures spent nearly two more days at sea not fishing compared to the same month in years without a closure, with no significant difference in trip length. Vessels with special permits are allowed to fish closer to port during closures, while the larger vessels (25% of the fleet) were restricted from retaining bigeye between 32 and 61 days a year, raising equity concerns across the fleet. Findings also suggest that two levels of collective action may be needed to meet Pacific-wide economic and conservation goals for an economically and ecologically important pelagic common-pool marine resource.

Economic and social characteristics of the Hawaii small boat fishery This NOAA report presents an empirical description of the economic and social characteristics of the Hawaii small boat fishery using results from the cost-earnings study of the fleet conducted in 2014. Those surveyed included fishermen who held a State of Hawaii Commercial Marine License (CML) and fished using small vessels and sold at least one fish during 2013. This study provides a robust economic and social description of the Hawaii small boat fleet including demographics of small boat fishermen, vessel characteristics, levels of fishing activity, social aspects of small boat fishing, market participation, fishing trip costs, and annual fishing fixed costs (Chan and Pan 2017).

Exploring trade-offs in climate change response in the context of Pacific Island fisheries In this study NOAA researchers address the implications that climate change poses significant and increasing risks for Pacific Island communities. Sea-level rise, coastal flooding, extreme and variable storm events, fish stock redistribution, coral bleaching, and declines in ecosystem health and productivity threaten the wellbeing, health, safety, and national sovereignty of Pacific Islanders, and small-scale fishers in particular. Fostering the response capacity of small-scale fishing communities will become increasingly important for the Pacific Islands. Challenging decisions and trade-offs emerge when choosing and mobilizing different responses to climate change. The trade-offs inherent in different responses can occur between various exposures, across spatial and temporal scales, among segments of society, various objectives, and evaluative criteria. This study introduces a typology of potential trade-offs inherent in responses, elaborated through examples from the Pacific. The authors argue that failure to adequately engage with trade-offs across human responses to climate change can potentially result in unintended consequences or lead to adverse outcomes for human vulnerability to climate change. Conversely, proactively identifying and addressing these trade-offs in decision-making processes will be critical for planning hazard mitigation and preparing island nations, communities, and individuals to anticipate and adapt to change, not only for Pacific Islands, but for coastal communities around the world (Finkbeiner et al., 2018).

Applying national community social vulnerability indicators to fishing communities in the Pacific Island region The impetus for this NOAA research (Kleiber et al., 2018) comes from a need to evaluate social impacts of proposed fisheries management measures on fishing communities and to assess potential differential impacts of proposed measures on communities. This analysis could supplement social impact analyses, providing a broader view of community dynamics when assessing the impacts of changes in a fishery or fishing community. There is also a need to predict or evaluate impacts of environmental, economic or social disruptions such as from a natural hazard, on fishing communities. The framework presented could lay a foundation to predict vulnerabilities. Indicators are quantitative or qualitative factors or variables that provide simple, valid and reliable means to track changes over time. Similar to ecological indicators that may be used to measure the structure, function, and composition of an ecological system, social indicators can track aspects of a social system, to identify changes over time, response to disruptions, and inform policy decisions. This study draws on social indicators research investigating the different social aspects of human communities in different geographies and its application to social policy related to vulnerability

Relevant Publications

Ayers AL, Hospital J, Boggs C. 2018. Bigeye tuna catch limits lead to differential impacts for Hawai`i longliners. Marine Policy. 94:93-105. https://doi.org/10.1016/j.marpol.2018.04.032.

Chan HL, Pan M. 2017. Economic and social characteristics of the Hawaii small boat fishery 2014. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-63, 97 p. https://doi.org/10.7289/V5/TM-PIFSC-63.

Finkbeiner EM, Micheli F, Bennett NJ, Ayers AL, Le Cornu E, Doeer AN. 2018. Exploring trade-offs in climate change response in the context of Pacific Island fisheries. Marine Policy. 88:359-364. https://doi.org/10.1016/j.marpol.2017.09.032.

Kleiber D, Kotowicz D, Hospital J. 2018. Applying national community social vulnerability indicators to fishing communities in the Pacific Island region. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-65, 63 p. https://doi.org/10.7289/V5/TM-PIFSC-65.

Pan M, Arita S, Bigelow K. 2017. Cost-earnings study of the American Samoa longline fishery based on vessel operations in 2009 and recent trend of economic performance. Pacific Islands Fisheries Science Center, PIFSC Administrative Report, H-17-01, 43 p. https://doi.org/10.7289/V5/AR-PIFSC-H-17-01.

Disposition of Catch

The purse seine catch is stored onboard as a frozen whole product. Most of the catch has historically been off-loaded to canneries in Pago Pago, American Samoa; however, most vessels now transship their catches in the ports of other Pacific Island countries to canneries in Southeast Asia and Latin America. Cannery products from American Samoa are typically destined for U.S. canned tuna markets. Catches of non-tuna species are consumed onboard the vessel or discarded at sea.

U.S. longline vessels in the NPO store their catch on ice and deliver their product to the market as a fresh product. Large tunas, marlins, and mahimahi 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 in Hawaii to restaurants and retail markets, or air freighted to U.S. mainland destinations with a very 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. Most vessels transport their catches to Vancouver, Canada for sale. The other fisheries store their catch in ice. Large tunas are gilled and gutted while other species are kept whole. The small-scale tropical troll fisheries chill their products with ice and sell it fresh, mainly to local markets.

Onshore Developments

[n/a]

Future Prospects of the Fisheries

As a result of the high demand for fresh tuna in Hawaii and the U.S. mainland, the future prospect for the U.S. longline fishery in the NPO is likely to continue to have a greater proportion of effort in the deep-set sector targeting tunas. This sector of the longline fishery is constrained by catch limits for bigeye tuna in the WCPO & EPO. The U.S. longline fishery bigeye tuna limit in the WCPO was 3,554 t in 2015 and 2016 decreased to 3,138 t in 2017 and increased back to 3,554 t in 2018. In 2017, the bigeye tuna catch limit in the eastern Pacific Ocean (EPO) established pursuant to decisions of the Inter-American Tropical Tuna Commission (IATTC) was 500 t for vessels greater than 24 m in length. About 29 Hawaii-permitted and California longline vessels greater than 24 m were affected by the bigeye tuna limit in the EPO in 2017. Bigeye tuna catch in the EPO by longline vessels greater than 24 m was 492 t in 2017, 8 t below the 500 t limit. The bigeye tuna limit in the EPO for longline vessels greater than 24 m increased to 750 t in 2018.

The effort by the shallow-set sector targeting swordfish declined during 2013–2017 despite the removal of the effort restriction in 2006 and revised sea turtle interaction limits in 2012. The bigeye tuna catch limits do not affect the shallow-set longline fishery as adversely as the deep- set sector since this species represents only a small proportion of its catch. The shallow-set longline fishery for swordfish is highly seasonal. The shallow-set longline fishery was closed on May 4, 2018, as a result of a Court Order.

Fuel costs held steady throughout 2017 while prices for supplies and goods remained constant or increased slightly. The price of fuel is increasing in 2018 which may hinder the economic performance of both sectors of the longline fishery. Other issues facing both sectors of the U.S. longline fishery in the NPO are exceeding false killer whale (*Pseudorca crassidens*) interaction limits in the main Hawaiian Islands EEZ and the expansion on the NWHI Monument out to the 200-mile EEZ. The U.S. longline fishery in the NPO is expected to continue targeting bigeye tuna and swordfish as well as catch of other associated pelagic species and deliver them fresh to service local and mainland markets.

Catches by the American Samoa longline fishery in the South Pacific decreased from years 2013 to 2017 and were at a 5-year low in 2017 (Table 1f). Despite declining catches, the American Samoa longline fishery in the South Pacific is expected to continue targeting albacore and delivering their catch frozen.

The prospect of participation and catch from the U.S. small-scale troll and handline fisheries is expected to be fairly stable although these fisheries are challenged by a shortage of crew due to an improving economy, low unemployment rate and the uncertainty of fish prices. Fuel prices dropped dramatically in 2015, remained low in 2016 into 2017 helped with operational costs for this fishery, but the price of fuel has been rising in 2018 and may make fishing ventures more expensive. The main Hawaiian Island troll and handline 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.

Status of Fisheries Data Collection Systems

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 consist of logbooks and fish catch reports submitted by fishers, at-sea observers, and port samplers; market sales reports 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) in the WCPO consists of the collection of federally mandated 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) since 1988. The Hawaii, California, and American Samoa-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%); for the American Samoa fishery, there may be under-reporting of a very small percentage of trips which can be estimated via a creel survey that monitors 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.

In Hawaii, fish sales records from the Hawaii Division of Aquatic Resources (DAR) Commercial Marine Dealer Report database are an important supplementary source of information, covering virtually 100% of the Hawaii-based longline landings. The Western Pacific Fisheries Information Network (WPacFIN) has recently improved its procedures for integrating Hawaii fisheries catch data (numbers of fish caught, from logbooks) and information on fishing trips from fishermen’s reports with fish weight and sales data from the dealers’ purchase 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 Report 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 Report data, and data collected by NOAA Fisheries observers deployed on Hawaii-based longline vessels (see below). Information on these corrections has been published, but is not yet operationally applied to routine data reporting (i.e., the data reported here).

Small-scale fisheries in Hawaii, i.e., tropical troll, handline, and pole-and-line, are monitored using the Hawaii DAR Commercial Fishermen’s Catch Report data and Commercial Marine Dealer Report data. The tropical troll fisheries in American Samoa, Guam, and CNMI are monitored with a combination of Territory and Commonwealth creel survey and market monitoring programs, as part of WPacFIN.

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 deployed by the Pacific Islands 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 requirements. 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 observer coverage rate in the U.S. purse seine fishery in the Convention Area has been 100%. The data collected under this arrangement by FFA-deployed observers are currently provided directly to the WCPFC.

Under the Fishery Ecosystem Plan for Pacific Pelagic Fisheries of the Western Pacific Region established under the Magnuson-Stevens Fishery Conservation and Management Act, observers are required to be placed aboard Hawaii-based pelagic longline vessels targeting swordfish (shallow set, 100% coverage) and tunas (deep set, 20% coverage) and American Samoa-based longline vessels targeting tuna (deep set, 20% coverage).

The main focus of the longline observer program is to collect scientific data on interactions with protected species. 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, observers attempted to measure 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 with those species.

For the U.S. longline fishery in the NPO, there were observers on 304 trips out of a total of 1,491 deep-set trips, as well as on all 67 shallow-set trips, resulting in coverage rates of 20.4% and 100%, respectively in 2017. For the American Samoa-based longline fishery, 2017 was the eleventh full calendar year monitored by observers. The coverage rate was 20.0% for a total of 13 trips out of 65 trips. These coverage statistics are from 2017 reports of the NOAA Pacific Islands Regional Observer Program (PIROP) and are based on longline trips that departed with observers in calendar year 2017. Detailed information on the U.S. Pacific Islands Regional Observer Program can be found at: http://www.fpir.noaa.gov/OBS/obs_qrtrly_annual_rprts.html.

Per reporting requirements agreed to at WCPFC 11, Table 3 contains estimates on observer coverage in U.S. longline fisheries for 2017 in the WCPFC Area exclusive of the U.S. EEZ.

Table 3. Observer coverage in 2017 of the U.S. longline fisheries in the WCPFC Area exclusive of the U.S. EEZ.

Fishery	Number of Hooks			Days Fished			Number of Trips		
	Total estimated	Observed	%	Total estimated	Observed	%	Total estimated	Observed	%
Hawaii and California-based	25,229,619	5,370,182	21	9,712	2,412	25	985	235	24
American Samoa	222,597	32,489	15	68	10	15	7	1	14

Fishery Interactions with Protected Species

Information on estimated fishery interactions with non-fish species by the Hawaii-based longline fishery during 2013–2017 is provided in Tables 4a-4c. For the American Samoa-based component of the U.S. longline fishery, scientists have not yet provided rigorous estimates of the total interactions with protected species.

CMM 2011-01 requires CCMs to report instances in which cetaceans have been encircled by purse seine nets of their flagged vessels. In 2017, purse seine vessels reported 12 instances of interactions with 32 individual marine mammals. This included 4 spinner dolphins (*Stenella longirostris*) found dead in net, 4 false killer whales (all released alive), 1 bottlenose dolphin (*Tursiops truncatus*) with condition information unknown, 5 short-finned pilot whales released alive, 13 rough-toothed dolphins (1 dead and 12 released alive), 1 Andrew's beaked whale released alive, 4 long-beaked common dolphins (condition not provided), and one unidentified dolphin (condition not provided).

CMM 2011-04 requires CCMs to estimate the number of releases of oceanic whitetip sharks (*Carcharhinus longimanus*)including their status upon release. For the U.S. purse seine fishery, limited observer data has been processed for 2017, and information available as of June 15, 2018 indicate that there were 20 oceanic whitetip sharks released in 2017 (11 alive and 9 dead). In the longline fishery, observer data indicate that 228 oceanic whitetip sharks were released (174 alive and 54 dead) in the Hawaii-based deep set fishery, 29 oceanic whitetip sharks were released (28 alive and 1 dead) in the Hawaii-based shallow-set fishery, and 65 oceanic whitetip sharks were released (41 alive and 24 dead) in the American Samoa-based fishery.

CMM 2012-04 requires CCMs to report instances in which whale sharks have been encircled by purse seine nets of their flagged vessels. In 2017, purse seine vessels reported 16 instances of interactions with 16 individual whale sharks (*Rhincodon typus*), 15 released alive.

CMM 2013-08 requires CCMs to estimate the number of releases of silky sharks (*Carcharhinus falciformis*) including their status upon release. For the U.S. purse seine fishery, limited observer data has been processed for 2017, and information available as of June 15, 2018, indicate that there were 1,330 silky sharks released in 2017 (411 alive and 919 dead). In the longline fishery, observer data indicate that 237 silky sharks were released (184 alive and 53 dead) in the Hawaii-based deep set fishery (21% observer coverage), 9 silky sharks were released (8 alive and 1 dead) in the Hawaii-based shallow set fishery, and 270 silky sharks were released (177 alive and 93 dead) in the American Samoa-based fishery.

Table 4a. 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 2013–2017[2]. Estimates of total marine mammal interactions by the deep-set fishery in 2016 and 2017 have not yet been completed; only the observed values are included here.

Species	2017	2016	2015	2014	2013
Marine Mammals					
Striped dolphin (S*tenella coeruleoalba*)		1	4	2	
Common dolphin (*Delphinus delphis, D. capensis)*				1	
Bottlenose dolphin (*Tursiops truncatus*)	1	2	2	4	13
Risso's dolphin (*Grampus griseus*)	3	2	13	6	3
Blainville's beaked whale (*Mesoplodon blainvillei*)					
Bryde's whale (*Balaenoptera edeni*)					
False killer whale (*Pseudorca crassidens*)	8	7	17	54	22
Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens)*			1		
Humpback whale (*Megaptera novangliae*)			1	5	
Shortfinned pilot whale (*Globicephala macrorhynchus)*			4		4
Spotted dolphin (*Stenella attenuate*)					
Rough-toothed dolphin (*Steno bradenensis*)		1			6
Sperm whale *(Physeter macrocephalus*)					
Northern elephant seal (*Mirounga angustirostris*)				1	1
Pygmy killer whale (*Feresa attenuate)*					5
Pygmy sperm whale (*Kogia Breviceps*)				10	
Fin whale (*Balaenoptera physalus)*			1		
Guadalupe fur seal (*Arctocephalus townsendi*)		1			
Unspecified Mesoplodont beaked whale					1
Unspecified false killer or shortfinned pilot whale			6		
Unidentified Cetacean (*Cetacea*)	4	2		13	3
Unidentified Pinniped *(Pinnipedia*)			3		
Unspecified member of beaked whales (*Ziphiidae*)		1			1
Unspecified pygmy or dwarf sperm whales (*Kogia*)					
Unspecified eared seal (*Otariidae*)				1	
Total marine mammals	**16**	**17**	**52**	**97**	**59**
Sea Turtles					
Loggerhead turtle (*Caretta caretta*)	19	23	24	13	16
Leatherback turtle (*Dermochelys coriacea*)	4	20	24	57	22
Olive Ridley turtle (*Lepidochelys olivacea*)	30	162	70	51	42
Green turtle (*Chelonia mydas*)	5	5	4	17	5
Unidentified hardshell turtle (Cheloniidae)		5		1	1
Total sea turtles	**58**	**215**	**122**	**139**	**86**

[2] 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-08-007, IR-09-011, IR-10-009, IR-11-005, IR-12-012, IR-13-014, IR-13-029, and IR-14-022. Hawaii-based longline logbook reported data on fish discards are available at http://www.pifsc.noaa.gov./fmsd/reports.php

Table 4b. Effort and observed seabird captures 2013-2017 for Hawaii-based longline fishery for North of 23° N and 23° N – 30° S areas combined. Rate is observed captures per 1,000 hooks.

Fishing effort					Observed seabird captures	
Year	**Number of vessels**	**Number of hooks**	**Observed hooks**	**% hooks observed**	**Number**	**Rate**
2013	142	48,099,101	10,278,217	21.37	172	0.02
2014	149	47,262,156	11,117,964	23.52	112	0.01
2015	143	48,925,850	12,121,568	24.78	223	0.02
2016	139	51,924,659	10,722,120	20.65	209	0.02
2017	142	54,630,336	11,199,621	20.50	193	0.02

Table 4c. Total number of observed seabird captures by species in Hawaii-based longline fishery 2013-2017 for North of 23° N and 23° N – 30° S areas combined. Observed capture numbers for 2017 by area are preliminary.

	2017	**2017**					
Species	**>23° N**	**23° N – 30° S**	**2017 Total**	**2016**	**2015**	**2014**	**2013**
Blackfooted albatross (*Phoebastria nigripes*)	133	15	148	144	148	61	78
Laysan albatross (*Phoebastria diomedia*)	41	3	44	60	69	49	84
Unidentified albatross (*Diomedeidae*)				1			
Red-footed booby (*Sula sula*)				2	1	0	0
Sooty shearwater (*Ardenna grisea*)				2	5		
Unidentified shearwater (*Procellariidae*)		1	1			2	10
			193	**209**	**223**	**112**	**172**

Table 4d. Mitigation types mandated for use in Hawaii based longline fishery are regulated by type of set, location of set, and method employed to set (side setting or stern setting). NS = night setting, WB = weighted branch lines, SS = side setting, BC = bird curtain, BDB = blue dyed bait, DSLS = deep setting line shooter, MOD = management of offal discharge.

Fishery type/location	Combination of Mitigation Measures mandated	Proportion of observed effort using mitigation measures 2012-2017
When setting from stern:		
Shallow set (anywhere)	**BDB + WB + MOD + NS**	100%
Deep set (North of 23° N)	**BDB + WB + MOD + DSLS**	100%
When setting from side:		
Shallow set (anywhere)	**SS + DSLS + BC + WB + NS**	100%
Deep set (North of 23° N)	**SS + DSLS + BC + WB**	100%

Port Sampling

Less than 2% of the fish caught by U.S. purse seine, and longline fisheries in the WCPO are measured (fork length) by NOAA Fisheries personnel as vessels are unloading in American Samoa and by SPC 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.

Unloading / Transshipment

Information on the quantities transshipped and the number of transshipments by the U.S. longline and purse-seine fisheries in 2017 is provided in Table 5.

For the U.S. purse-seine fishery in the WCPFC Statistical Area in 2016, approximately 60% of the total landings of yellowfin, skipjack, and bigeye were transshipped to foreign ports for processing in 2017. There were an estimated 165 transshipments of purse-seine-caught fish in port in 2017.

There was no available information on transshipments for the longline fishery, albacore troll fishery, or any other HMS gear type in 2017.

Table 5. Information on quantities transshipped and numbers of transshipments of HMS species by U.S. purse seine fisheries in 2017 to satisfy reporting requirements of CMM 2009-06.

Gear Type		Purse Seine	
	2017	Quantities transshipped	Number of Transshipments
Offloaded	Transshipped in Port	102,055	165
	Transshipped at sea in areas of national jurisdiction	0	0
	Transshipped beyond areas of national jurisdiction	0	0
Received	Transshipped in Port	0	0
	Transshipped at sea in areas of national jurisdiction	0	0
	Transshipped beyond areas of national jurisdiction	0	0
Transshipped inside the Convention Area		102,055	165
Transshipped outside the Convention Area		0	0
Caught inside the Convention Area		102,055	165
Caught outside the Convention Area		0	0
Species	BET	1,777	
	SKJ	84,469	
	YFT	14,839	
Product Form	Fresh	0	
	Frozen	102,055	

Scientific Survey Data

Cooperative Data Collection Program for North Pacific Albacore. NOAA Fisheries collaborates with the American Fishermen's Research Foundation (AFRF) and the American Albacore Fishing Association (AAFA) on research and monitoring programs for North Pacific albacore. Since 1961, a port sampling program has employed state fishery personnel to collect size data from albacore landings made by the U.S. troll fleet along the U.S. Pacific coast. Since 2001 NOAA Fisheries and American Fishermen's Research Foundation (AFRF) have collaborated on an archival tagging program to study migration patterns and stock structure of juvenile (3-5 year old) albacore in the North Pacific. As of December, 2017, 1,086 archival tags have been deployed on albacore off the west coast of North America and 37 tags have been recovered. Times at liberty ranged from 25 days to 2.8 years. Detailed daily location estimates, diving behavior, and physiological information is available from the tag data (Childers-SWFSC unpublished data).

North Pacific Albacore Electronic Logbook Project. In 2005, a computer program was developed to allow albacore troll fishermen to enter their logbook data into a computer program rather than completing the traditional paper forms. The advantages of recording the data through a computer program include implementing validation rules at the point of entry thus limiting data entry errors, saving time and money on data entry costs, and making the data available in a timelier manner. Since 2006, the program has been used by 5-10 fishermen annually. The program has received positive feedback on its functionalities and ease of use. During the 2016 season, logs for 31 trips were submitted electronically. In 2015, NOAA Fisheries began developing a new, alternative electronic logbook in PDF format to upgrade the existing version and increase the use of electronic logbooks. Development is nearly complete and distribution of the new electronic logbook will begin in 2018.

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 greater than 40-year time series of recreational billfish angling catch and effort (number caught per angler fishing day), and is the only billfish survey independent of commercial fisheries in the Pacific Ocean. The main fishing areas include Hawaii, southern California, Baja California (Mexico), 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, and Commonwealth of the Northern Mariana Islands). This includes longline, skipjack pole-and-line, tropical troll, and tropical handline fisheries.

Ecological data from observer programs underpin ecosystem-based fisheries management. Data required from fisheries monitoring programs substantially expand as management authorities transition to implement elements of ecosystem-based fisheries management (EBFM). EBFM extends conventional approaches of managing single fishery effects on individual stocks of target species by taking into account the effects, within a defined ecosystem, of local to regional fisheries on biodiversity, from genotypes to ecological communities. This includes accounting for fishery effects on evolutionary processes, associated and dependent species, habitats, trophic food web processes, and functionally linked systems. Despite seemingly insurmountable constraints, through examples, this NOAA study demonstrates how data routinely collected in most observer programs and how minor and inexpensive expansions of observer data fields and collection protocols supply ecological data underpinning EBFM. Observer data enable monitoring bycatch, including catch and mortality of endangered, threatened and protected species, and assessing the performance of bycatch management measures. They provide a subset of inputs for ecological risk assessments, including productivity–susceptibility analyses and multispecies and ecosystem models. Observer data are used to monitor fishery effects on habitat and to identify and protect benthic vulnerable marine ecosystems. They enable estimating collateral sources of fishing mortality. Data from observer programs facilitate monitoring ecosystem pressure and state indicators. The examples demonstrate how even rudimentary fisheries management systems can meet the ecological data requirements of elements of EBFM (Gilman et al., 2017).

Calculation of population-level fishing mortality for single- versus multi-area models: application to models with spatial structure. Spatial considerations in stock assessment models can be used to account for differences in fish population dynamics and fleet distributions, which, if otherwise unaccounted for, could result in model misspecification leading to bias in model results. Calculating an overall fishing mortality rate (F) across spatial components is not straightforward but is often required for harvest management. This NOAA study examined effects of spatial assumptions on model results under different approaches for calculating F. The authors show that (i) F can differ by as much as 50% depending on the spatial structure of the model; (ii) for multi-area models, F changes with size of area for all but one approach; and (iii) results are sensitive to model assumptions about catchability between areas and the spatial distribution of effort and abundance. Findings suggest caution be taken when interpreting results between models with different spatial structures. When comparing single- with multi-area models, the authors recommend adding F across areas when catchability is the same between areas and either effort or abundance is proportional to area. Otherwise no single approach can be expected to be superior in all cases. The authors suggest simulation be used to evaluate the best approach to meet particular management objectives (Langseth and Schueller, 2017).

Collection and Analysis of Biological Samples to Support Stock Assessments. Given the uncertainty surrounding current growth models, stock structure, and ecosystem interactions of several tuna and tuna-like species in the North Pacific, NOAA Fisheries has been working with a range of partners to collect biological samples of otoliths, muscle, DNA fin biopsies, gonads, and stomachs from a number of species along the U.S.A. West Coast. In 2007, NOAA Fisheries and the Sportfishing Association of California initiated a sampling program to collect data on tuna and other HMS. Initially the program was focused on the Southern California Bight (SCB). Since that time the program has been expanded to include a broader geographic range and increased number of species. In 2009 scientists began working with commercial fishermen in the Northeast Pacific to collect samples from albacore off Oregon and Washington. In 2010, additional efforts were made to include central California (Monterey Bay and San Francisco) where albacore are sometimes encountered from August through November. Finally, in 2017, the program was again expanded to include opah and bigeye tuna caught by high-seas longliners landing their catch in California. Sample collection is ongoing and supports the ISC's proposed North Pacific-wide sampling program to address the uncertainties regarding biological information, notably growth models, maturity schedules, and stock structure of several tuna and tuna-like species. Samples of albacore, Pacific bluefin, yellowfin, skipjack (*Katsuwonus pelamis*), California yellowtail (*Seriola lalandi*), opah (*Lampris guttatus*), and dorado (*Coryphaena hippurus*) have been collected during NOAA research surveys and through cooperative programs with commercial passenger fishing vessels, seafood processors, the commercial fisheries operations, and recreational anglers.

Evaluation of alternative modelling approaches to account for spatial effects due to age-based movement. Spatial patterns due to age-specific movement have been a source of un-modelled process error. Modeling movement in spatially-explicit stock assessments is feasible, but hampered by a paucity of data from appropriate tagging studies. Lee et al. (2017) used simulation methods to evaluate alternative model structures that either explicitly or implicitly account for the process of age-based movement in a population dynamics model. They simulated synthetic population using a two-area stochastic population dynamics operating model. Two different states of nature governing the movement process were explored. The model that includes the correct spatial dynamic is the only one that results in unbiased and precise estimates of derived and management quantities. In a single area assessment model, using the fleets as area (FAA) approach and estimating both length-based and time-varying, age-based selectivity to implicitly account for the contact selection and annual availability may be the second best option. A FAA approach, assuming each fleet represents a combination of gear and area and adds additional observation error, performed nearly as well. Future research could evaluate which stock assessment method is robust to uncertainty in movement and is more appropriate for achieving intended management objectives.

Petition to List Pacific Bluefin Tuna as Endangered or Threatened Under the U.S.A. Endangered Species Act. In 2016 NOAA Fisheries received a petition from the Center for Biological Diversity (CBD) and 13 co-petitioners requesting that Pacific bluefin tuna, *Thunnus orientalis* (PBF), be listed as endangered or threatened under the Endangered Species Act (ESA) throughout all or a significant portion of its range. After review of the petition, NOAA Fisheries published a positive 90-day finding in the Federal Register (81 FR 70074) on October 11, 2016, concluding that the petitioned actions may be warranted and announcing that a formal status review would be conducted as required by the ESA. A Status Review Team was tasked to conduct this review. On August 8, 2017, NOAA Fisheries published a 12 month finding on this petition and determined that, based on the best scientific and commercial data available, including the status review report, and after taking into account efforts being made to protect the species, listing of the Pacific bluefin tuna was not warranted. NOAA Fisheries concluded that PBF is not an endangered species throughout all or a significant portion of its range, nor likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Information on the petition and final determination, including the status review report, may be found at: westcoast.fisheries.noaa.gov/fisheries/migratory_species/pbt_esa_status_review.html

Relevant Publications

Fisheries Research and Monitoring Division, Pacific Islands Fisheries Science Center, NOAA Fisheries. 2018. The Hawaii limited access longline logbook summary report January to December 2017. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-18-007, 10 p. https://doi.org/10.7289/V5/DR-PIFSC-18-007.

Fisheries Research and Monitoring Division, Pacific Islands Fisheries Science Center, NOAA Fisheries. 2017. PIFSC Report on the American Samoa troll fishery from 1 January to 31 December 2016. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-17-012, 18

p. https://doi.org/10.7289/V5/DR-PIFSC-17-012.

Fisheries Research and Monitoring Division, Pacific Islands Fisheries Science Center, NOAA Fisheries. 2017. PIFSC report on the American Samoa troll fishery during calendar year 2016. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-17-017, 18 p. https://doi.org/10.7289/V5/DR-PIFSC-1.

Fisheries Research and Monitoring Division, Pacific Islands Fisheries Science Center, NOAA Fisheries. 2017. PIFSC report on the American Samoa limited-access longline fishery from 1 January to 31 December 2016. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-17-013, 16 p. https://doi.org/10.7289/V5/DR-PIFSC-17-013.

Fisheries Research and Monitoring Division, Pacific Islands Fisheries Science Center, NOAA Fisheries. 2018. Submission of 2016-2017 U.S. Fishery Statistics for the Western and Central Pacific Ocean and Other Areas to the Western and Central Pacific Fisheries Commission. PIFSC Data Report, DR-18-nnn (In Press).

Gilman E, Weijerman M, Suuronen P, Link J (handling editor). 2017. Ecological data from observer programmes underpin ecosystem-based fisheries management. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsx032.

Kleiber D, Kotowicz D, Hospital J. 2018. Applying national community social vulnerability indicators to fishing communities in the Pacific Island region. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-65, 63 p. https://doi.org/10.7289/V5/TM-PIFSC-65.

Langseth BJ, Schueller AM. 2017. Calculation of population-level fishing mortality for single- versus multi-area models: application to models with spatial structure. Canadian Journal of Fisheries and Aquatic Sciences. 74:1821-1831. https://doi.org/10.1139/cjfas-2016-0295.

Lee HH, Piner KR, Maunder MN, Methot RD Jr. 2017. Evaluation of alternative modelling approaches to account for spatial effects due to age-based movement. Canadian Journal of Fisheries and Aquatic Sciences. 74:1832-1844.

Ma H, Ogawa TK, Sminkey TR, Breidt FJ, Lesser VM, Opsomer JD, Foster JR, Van Voorhees DA. 2018. Pilot surveys to improve monitoring of marine recreational fisheries in Hawaii. Fisheries Research. 204:197-208. https://doi.org/10.1016/j.fishres.2018.02.010.

McCracken M. 2017. American Samoa longline fishery marine mammal, seabirds, sea turtles, and fish bycatch for years 2014 and 2015. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-17-027, 16 p. https://doi.org/10.7289/V5/DR-PIFSC-17-027.

Olsen E, Kaplan IC, Ainsworth C, Fay G, Gaichas S, Gamble R, Girardin R, Eide CH, Ihde TF, Morzaria-Luna HN, Johnson KF, Savina-Rolland M, Townsend H, Weijerman M. 2018. Ocean futures under ocean acidification, marine protection, and changing fishing pressures explored using a worldwide suite of ecosystem models. Frontiers in Marine Science. 5:64. https://dx.doi.org/10.3389/fmars.2018.00064.

Pacific Islands Fisheries Science Center, National Marine Fisheries Service, NOAA. 2017 Annual report to the Western and Central Pacific Fisheries Commission United States of America, Part I:

Information on fisheries, research, and statistics (for 2016) Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-17-029, 46 p. https://doi.org/10.7289/V5/DR-PIFSC-17-029. DR-17-029.

Stohs S, Sippel T. 2017. Analysis of Increasing the Required VMS Ping Rate for the California Drift Gillnet Fishery. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-570.

Woodworth-Jefcoats PA. 2018. Summary report from the first annual Collaborative Climate Science Workshop 19-21 September 2017, NOAA's Inouye Regional Center Honolulu, Hawaii. Pacific Islands Fisheries Science Center, PIFSC Administrative Report, H-18-01, 31 p. https://doi.org/10.7289/V5/AR-PIFSC-H-18-01.

Research Activities

Biological and Oceanographic Research – TUNAS

Using Chemical Tracers (Stable Isotopes and Cesium-134) to Characterize Migratory Patterns of Pacific Bluefin Tuna. Understanding movement patterns of migratory marine animals is critical for effective management, but often challenging due to the cryptic habitat of pelagic migrators and the difficulty of assessing past movements. Chemical tracers can partially circumvent these challenges by reconstructing recent migration patterns. The radionucleotides released into the ocean off Japan after the 2011 tsunami provided a unique chemical tracer for animals occupying these waters, including Pacific bluefin tuna. A collaborative study with the State University of New York (SUNY) and Harvard University combined a Fukushima-derived radiotracer (^{134}Cs) with bulk tissue and amino acid stable isotope analyses of Pacific bluefin to distinguish recent migrants from residents of the EPO, and to time the migrations of juvenile bluefin as they cross the Pacific Ocean (Madigan et al. 2017b). The presence of ^{134}Cs, while detectable only until 2013, provided the opportunity to validate estimates using stable isotopes alone. Using additional samples, a more robust study was completed in 2016 (Madigan et al. 2017a). The results from this work show that the proportion of recent migrants to residents decreased in older year classes. All fish smaller than 70 cm FL were recent migrants, confirming that fish caught locally are from the western Pacific. Looking across age classes, the number of recent migrants decreased from ~ 80% for 1-2 year olds to ~30% for 2-3 year olds and ~2% for 3-4 year olds. The peak arrival time from the western Pacific is April and May. This information provides important insight into the dynamics of movements across the Pacific. By linking relative arrivals to climate variability on both sides of the Pacific, we should gain insights into the forcing mechanisms behind the high degree of variability in trans-Pacific migrations (Madigan et al. 2017a).

Ecological data and ecosystem-based fisheries management. Data required from fisheries monitoring programs substantially expand as management authorities transition to implement elements of ecosystem-based fisheries management (EBFM). EBFM extends conventional approaches of managing single fishery effects on individual stocks of target species by taking into account the effects, within a defined ecosystem, of local to regional fisheries on biodiversity, from genotypes to ecological communities. This includes accounting for fishery effects on evolutionary processes, associated and dependent species, habitats, trophic food web processes, and functionally linked systems. This NOAA study (Gilman et al. 2017) demonstrates how data routinely collected in most observer programs and how minor and inexpensive expansions of observer data fields and collection protocols supply ecological data underpinning EBFM. Observer data enable monitoring bycatch, including catch and mortality of endangered, threatened and protected species, and assessing the performance of bycatch management measures. They provide a subset of inputs for ecological risk assessments, including productivity–susceptibility analyses and multispecies and ecosystem models. Observer data are used to monitor fishery effects on habitat and to identify and protect benthic vulnerable marine ecosystems. They enable estimating collateral sources of fishing mortality. Data from observer programs facilitate monitoring ecosystem pressure and state indicators. The examples demonstrate how even rudimentary fisheries management systems can meet the ecological data requirements of elements of EBFM.

Ocean futures under ocean acidification. In this NOAA study Olsen et al. (2018) leverages the global advances in ecosystem modeling to explore common opportunities and challenges for ecosystem-based management, including changes in ocean acidification, spatial management, and fishing pressure across eight Atlantis (atlantis.cmar.csiro.au) end-to-end ecosystem models. These models represent marine ecosystems from the tropics to the arctic, varying in size, ecology, and management regimes, using a three-dimensional, spatially-explicit structure parametrized for each system. Results suggest stronger impacts from ocean acidification and marine protected areas than from altering fishing pressure, both in terms of guild-level (i.e., aggregations of similar species or groups) biomass and in terms of indicators of ecological and fishery structure. Effects of ocean acidification were typically negative (reducing biomass), while marine protected areas led to both "winners" and "losers" at the level of particular species (or functional groups). Changing fishing pressure (doubling or halving) had smaller effects on the species guilds or ecosystem indicators than either ocean acidification or marine protected areas. Compensatory effects within guilds led to weaker average effects at the guild level than the species or group level. The impacts and tradeoffs implied by these future scenarios are highly relevant as ocean governance shifts focus from single-sector objectives (e.g., sustainable levels of individual fished stocks) to taking into account competing industrial sectors' objectives (e.g., simultaneous spatial management of energy, shipping, and fishing) while at the same time grappling with compounded impacts of global climate change (e.g., ocean acidification and warming).

Climate change impacts on fisheries and aquaculture of the United States.
In the United States, commercial and recreational fisheries contribute $214 billion USD in sales to the nation's economy and support over 1.8 million jobs. Climate variability and change are impacting the living marine resources that support these fisheries. Spanning over 70 degrees of latitude and several oceans and seas, the Exclusive Economic Zone of the United States and its Territories experiences different types and magnitudes of climate-related change. Some regions are warming at a rate much higher than predicted, while others are experiencing ocean acidification as severe as, or exceeding the general projections for 100 years from now. Climate-driven regime shifts have altered the species composition of the fisheries in some areas while other regions have not yet detected significant changes. NOAA Fisheries highlights the current understanding of how climate change and variability has impacted, and will impact, fisheries and aquaculture across 6 regions of the United States Exclusive Economic Zone (Woodworth-Jefcoats 2017). With over 160 million people in the United States living within coastal communities, and fisheries and aquaculture contributing significantly to the social and economic well-being of the nation, a strong scientific understanding of how ocean ecosystems are changing, the mechanisms of these changes, and how to anticipate and account for future change is paramount to good stewardship of our living marine resources for current and future generations.

Biological Research – BILLFISHES

Blue marlin (Makaira nigricans) longevity confirmed with bomb radiocarbon. NOAA scientists are investigating the longevity parameters of blue marlin (*Makaira nigricans*) as they remain unresolved. The use of fin spines and sagittal otoliths for age reading has led to unconfirmed longevity estimates near 20 years. Age validation has been elusive because large individuals are rare and a technique that can be applied to structures that provide estimates of age was absent. Use of otolith chemical signatures has been limited by sagittal otoliths that are very small—whole otolith mass of adult blue marlin reach just 10 mg for the largest fish. Recent advances in the detection limits of radiocarbon (^{14}C) with accelerator mass spectrometry—coupled with recently acquired knowledge of marine bomb ^{14}C signals spanning the tropical Pacific Ocean—have led to an opportunity to age blue marlin from small amounts of otolith material. In this study, otoliths from a recently collected 1245 lb. (565 kg) female blue marlin at a measured 146 inches (371 cm) lower jaw fork length (LJFL) were analyzed for ^{14}C. Estimated longevity was either 17 ± 4 years or 38 ± 6 years based on ^{14}C bomb dating. Using multiple lines of evidence, it was hypothesized that the young age scenario was most likely, with evidence for an age closer to 20 years using a series of deductions in the bomb ^{14}C dating method (Andrews et al., 2018).

Just Another Bayesian Biomass Assessment. NOAA Fisheries developed new, open-source modelling software entitled 'Just Another Bayesian Biomass Assessment' (JABBA) (Winker et al., 2018). JABBA can be used for biomass dynamic stock assessment applications, and has emerged from the development of a Bayesian State-Space Surplus Production Model framework, already applied in stock assessments of sharks, tuna, and billfishes around the world. JABBA presents a unifying, flexible framework for biomass dynamic modelling, runs quickly, and generates reproducible stock status estimates and diagnostic tools. Specific emphasis has been placed on flexibility for specifying alternative scenarios, achieving high stability and improved convergence rates. Default JABBA features include: 1) an integrated state-space tool for averaging and automatically fitting multiple catch per unit effort (CPUE) time series; 2) data-weighting through estimation of additional observation variance for individual or grouped CPUE; 3) selection of Fox, Schaefer, or Pella-Tomlinson production functions; 4) options to fix or estimate process and observation variance components; 5) model diagnostic tools; 6) future projections for alternative catch regimes; and 7) a suite of inbuilt graphics illustrating model fit diagnostics and stock status results. As a case study, JABBA is applied to the 2017 assessment input data for South Atlantic swordfish (*Xiphias gladius*). The authors envision that JABBA will become a widely used, open-source stock assessment tool, readily improved and modified by the global scientific community.

Biological Research – PELAGIC SHARKS

EcoCast. Both electronic tagging data and catch data for blue sharks in the California Current have been incorporated into EcoCast, to help fishers avoid blue sharks during drift gillnet fishing activities. EcoCast is a real-time data tool to help fishers and managers allocate fishing effort to optimize the harvest of target fish while minimizing bycatch of protected species. Motivations to reduce blue sharks landings include reducing bycatch as blue sharks have no marketable value and are discarded at sea. In addition, catching blue sharks increases haul back time, reduces efficiency and can damage gear. Given that the overall viability of a fishery depends on target species catch, EcoCast combines habitat preferences for both target (swordfish) and non-target species which includes sea lions and leatherback sea turtles in addition to blue sharks. The resulting product is updated daily based on environmental conditions and can be used by fishers to identify locations where target catch is maximized and bycatch is minimized. Current efforts are focused on beta testing EcoCast with fishers.

An unusual capture of the bluntnose sixgill shark, Hexanchus griseus on a pelagic longline in the Hawaiian longline fishery. On 1 May 2016, a large, dark female shark (270 cm TL, 90.5 kg), with green eyes and six gill slits was captured in the Hawaiian longline fishery region (1900 km north east of the Big Island of Hawai‘i) at a bottom depth of over 3000 m. A longline for bigeye tuna was set 30 Apr 2016 at 0833, and based on the hook number, the depth of capture was estimated between 100 and 200 m. Retrieval started the same day at 1748 and was completed at 0508 (1 May 2016). Based on the unusual nature of the specimen, the shark was retained and frozen onboard ship, and later delivered to NOAA Fisheries. The frozen shark was evaluated on 22 Jul 2016 for 60 morphological parameters plus teeth shape and row number. There were no visible stomach or intestinal food contents, no follicles present in the ovary, and the uterus appeared thread-like. The shark was clearly an immature female. A portion of the lower jaw and skin flank tissue was deposited in the Bernice P. Bishop Museum accession number BPBM 41330. Muscle tissue was removed for later DNA species verification, and photographs were taken. Based on the six gill slits, a single dorsal fin origin posterior to the pelvic fin base, and six rows of lower jaw comb-shape teeth, the specimen was identified as *Hexanchus griseus* the bluntnose sixgill shark. The bluntnose sixgill shark (BSS), *Hexanchus griseus* (Bonnaterre, 1788) has been reported worldwide from the Atlantic, Indian, and Pacific oceans, and the Black and Mediterranean seas from the surface to 2500 m. This species is described as demersal, occurring on the continental shelves, slopes, seamounts, and submarine ridges. It typically occurs in shallow, cold temperate water and inhabits deeper depths in subtropical and tropical waters. It was suggested that the BSS moved into the subtropics and tropics via isothermic submergence (Crow et al., 2017).

Vertical distribution, diet, and reproduction of the velvet dogfish (Zameus squamulosus) in waters off Hawaii. The velvet dogfish (*Zameus squamulosus*) is a wide-ranging species of shark that is captured as bycatch in bottom and pelagic longline fisheries in the Atlantic, Pacific, and Indian oceans from near the surface to depths as great as 2000 m. This NOAA study (Crow et al., 2018) provides information on the vertical distribution, diet, and reproduction of the velvet dogfish based on examination of 21 specimens captured in Hawaiian longline fisheries. Only females (576–839 mm in total length [TL]) were captured in waters off Hawaii and this finding may indicate sexual segregation for this species. All individuals were captured in epipelagic and pelagic oceanic waters at estimated target hook depths between 24 and 400 m. Stomach and intestinal contents consisted of squid, fish, and shrimp. Females were immature at 576–729 mm TL and mature at 715–839 mm TL. Mature females contained 6–10 uterine eggs and 4–8 embryos. On the basis of results from a pregnant female (715 mm TL), the size of ovarian ova, and the width of the uteri of slightly larger individuals, female maturity was estimated to occur at 715–730 mm TL. No reproductive seasonality was detected; however, our sample size was small. Reproductive data from published records for size of near-term embryos and smallest free-swimming specimens with umbilical scars indicate that size at birth is 245–270 mm TL.

Research on Bycatch and Fishing Technology – SEA TURTLES

Sea turtle bycatch mitigation in U.S. longline fisheries. Capture of sea turtles in longline fisheries has been implicated in population declines of loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) turtles. Since 2004, United States (U.S.) longline vessels targeting swordfish and tunas in the Pacific and regions in the Atlantic Ocean have operated under extensive fisheries regulations to reduce the capture and mortality of endangered and threatened sea turtles. This NOAA study (Swimmer et al., 2017) analyzed 20+ years of longline observer data from both ocean basins during periods before and after the regulations to assess the effectiveness of the regulations. Using generalized additive mixed models (GAMMs), we investigated relationships between the probability of expected turtle interactions and operational components such as fishing location, hook type, bait type, sea surface temperature, and use of light sticks. GAMMs identified a two to three-fold lower probability of expected capture of loggerhead and leatherback turtle bycatch in the Atlantic and Pacific when circle hooks are used (vs. J hook). Use of fish bait (vs. squid) was also found to significantly reduce the capture probability of loggerheads in both ocean basins, and for leatherbacks in the Atlantic only. Capture probabilities are lowest when using a combination of circle hook and fish bait. Influences of light sticks, hook depth, geographic location, and sea surface temperature are discussed specific to species and regions. Results confirmed that in two U.S.-managed longline fisheries, rates of sea turtle bycatch significantly declined after the regulations. In the Atlantic (all regions), rates declined by 40 and 61% for leatherback and loggerhead turtles, respectively, after the regulations. Within the Northeast Distant area of the Atlantic alone, where additional restrictions include a large circle hook (18/0) and limited use of squid bait, rates declined by 64 and 55% for leatherback and loggerhead turtles, respectively. Gains were even more pronounced for the Pacific shallow set fishery, where mean bycatch rates declined by 84 and 95%, for leatherback and loggerhead turtles, respectively, for the post-regulation period. Similar management approaches could be used within regional fisheries management organizations to reduce capture of sea turtles and to promote sustainable fisheries on a global scale.

Research on Bycatch and Fishing Technology – CETACEANS

Marine mammal injuries in Hawaii and American Samoa longline fisheries.
Marine mammal interactions (i.e., hookings and entanglements) with the Hawaii and American Samoa longline fisheries observed during 2010–2014 were compiled, and the number of marine mammal deaths, serious injuries, and non-serious injuries by fishery, species, and management area were assessed (Bradford and Forney, 2017). These values form the basis of the mortality and serious injury estimates included in the stock assessment reports of stocks impacted by these fisheries. Injury determinations were made using a nationally standardized process and established criteria for distinguishing serious from non-serious injuries. In the Hawaii deep-set fishery, 46 marine mammal interactions were observed from 2010 to 2014; most involved false killer whales (54.3%), resulted in death or serious injury (78.3%), and occurred outside the U.S.A. exclusive economic zone (EEZ) (54.3%).In the Hawaii shallow-set fishery, 54 marine mammal interactions were observed from 2010 to 2014; most involved Risso's dolphins (37.0%), resulted in death or serious injury (72.2%), and occurred outside the U.S.A. EEZ (92.6%). In the American Samoa deep-set fishery, 14 marine mammal interactions were observed from 2010 to 2014; most involved rough-toothed dolphins (42.9%), resulted in death or serious injury (92.9%), and occurred within the U.S.A. EEZ (78.6%).

Unexpected patterns of global population structure in melon-headed whales (Peponocephala electra). Foraging specialization, environmental barriers, and social structure have driven the development of strong genetic differentiation within many marine species, including most of the large dolphin species commonly referred to as 'blackfish' (subfamily Globicephalinae). This NOAA study used mitochondrial sequence data (mtDNA) and genotypes from 14 nuclear microsatellite loci (nDNA) to examine patterns of genetic population structure in melon-headed whales (MHWs), poorly known members of the blackfish family for which genetic structuring is unknown. MHWs are globally distributed in tropical and subtropical waters, and have formed resident populations around oceanic islands. They frequently mass strand, suggesting strong social cohesion within groups. Based on these characteristics, the authors hypothesized that MHWs would exhibit strong regional genetic differentiation, similar to that observed in other members of the Globicephalinae subfamily. Instead we found only moderate differentiation (median mtDNA $\Phi ST = 0.204$, median nDNA $FST = 0.012$) among populations both within and between ocean basins. Our results suggest that populations of MHWs that are resident to oceanic islands maintain a higher level of genetic connectivity than is seen in most other blackfish. MHWs may be more behaviorally similar to delphinids from the Delphininae subfamily (particularly the spinner dolphin Stenella longirostris), which are known to form coastal and island-associated resident populations that maintain genetic connectivity either through occasional long-distance dispersal or gene flow with larger pelagic populations. Results suggest that differences in social organization may drive different patterns of population structure in social odontocetes (Martien et al., 2017).

Familial social structure and socially driven genetic differentiation in Hawaiian short-finned pilot whales. Social structure can have a significant impact on divergence and evolution within species, especially in the marine environment, which has few environmental boundaries to dispersal. On the other hand, genetic structure can affect social structure in many species, through an individual preference towards associating with relatives. One social species, the short-finned pilot whale (*Globicephala macrorhynchus*), has been shown to live in stable social groups for periods of at least a decade. This NOAA study (Van Cise et al., 2017) uses mitochondrial control sequences from 242 individuals and single nucleotide polymorphisms from 106 individuals to examine population structure among geographic and social groups of short-finned pilot whales in the Hawaiian Islands and to test for links between social and genetic structure. Results show that there are at least two geographic populations in the Hawaiian Islands: a Main Hawaiian Islands (MHI) population and a Northwestern Hawaiian Islands/Pelagic population (FST and ΦST $p < .001$), as well as an eastern MHI community and a western MHI community (FST $p = .009$). The authors find genetically driven social structure, or high relatedness among social units and clusters ($p < .001$), and a positive relationship between relatedness and association between individuals ($p < .0001$). Further, socially organized clusters are genetically distinct, indicating that social structure drives genetic divergence within the population, likely through restricted mate selection (FST $p = .05$). This genetic divergence among social groups can make the species less resilient to anthropogenic or ecological disturbance. Conservation of this species therefore depends on understanding links among social structure, genetic structure and ecological variability within the species.

Estimating drift of directional sonobuoys from acoustic bearings. In this NOAA study (Miller et al., 2018) a maximum likelihood method is presented for estimating drift direction and speed of a directional sonobuoy given the deployment location and a time series of acoustic bearings to a sound source at known position. The viability of this method is demonstrated by applying it to two real-world scenarios: (1) during a calibration trial where buoys were independently tracked via satellite, and (2) by applying the technique to sonobuoy recordings of a vocalizing Antarctic blue whale that was simultaneously tracked by photogrammetric methods. In both test cases, correcting for sonobuoy drift substantially increased the accuracy of acoustic locations.

Relevant Publications

Andrews AH, Humphreys RL Jr, Sampaga JD. 2018. Blue marlin (Makaira nigricans) longevity estimates confirmed with bomb radiocarbon dating. Canadian Journal of Fisheries and Aquatic Sciences. 75:17-25. https://doi.org/10.1139/cjfas-2017-0031.

Bradford AL, Forney KA. 2017. Injury determinations for marine mammals observed interacting with Hawaii and American Samoa longline fisheries during 2010--2014. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-62, 28 p. https://doi.org/10.7289/V5/TM-PIFSC-62.

Crow GL, Humphreys RL Jr, Naylor GJP, Emanuel A. 2017. An unusual capture of the bluntnose sixgill shark, Hexanchus griseus on a pelagic longline in the Hawaiian longline fishery with comments on the worldwide genetic population structure. Bishop Museum Occasional Papers. 119:23-28.

Crow GL, Wetherbee BM, Humphreys RL Jr, Young RJ. 2018. Vertical distribution, diet, and reproduction of the velvet dogfish (Zameus squamulosus) in waters off Hawaii. Fishery Bulletin. 116(2):207-214. https://doi.org/10.7755/FB.116.2.9.

Hill MC, Bradford AL, Ligon AD, U AC, Oleson EM . 2018. Cetacean monitoring in the Mariana Islands Range Complex, 2017 . Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-18-002, 28 p. https://doi.org/10.7289/V5/DR-PIFSC-18-002.

Jensen MP, Allen CD, Eguchi T, Bell IP, LaCasella EL, Hilton WA, Hof CAM, Dutton PH. 2018. Environmental warming and feminization of one of the largest sea turtle populations in the world. Current Biology. 18:154-159. http://dx.doi.org/10.1016/j.cub.2017.11.057.

Jung MR, Horgen FD, Orski SV, Rodriguez CV, Beers KL, Balazs GH, Jones TT, Work TM, Brignac KC, Royer, S-J, et al. 2018. Validation of ATR FT-IR to identify polymers of plastic marine debris, including those ingested by marine organisms. Marine Pollution Bulletin. 127:704-716. https://doi.org/10.1016/j.marpolbul.2017.12.061.

Kittle RP, McDermid KJ, Muehlstein L, Balazs GH. 2018. Effects of glyphosate herbicide on the gastrointestinal microflora of Hawaiian green turtles (Chelonia mydas) Linnaeus. Marine Pollution Bulletin. 127:170-174. https://doi.org/10.1016/j.marpolbul.2017.11.030.

Madigan D. J., Baumann, Z., Carlisle, A.B., Snodgrass, O.E., Dewar, H., Fisher, N.S. 2017a. Isotopic insights into migration patterns of Pacific bluefin tuna in the eastern Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences, 75(2): 260-270. https://doi.org/10.1139/cjfas-2016-0504

Madigan D. J., Baumann, Z., Snodgrass, O.E., Dewar, H., Berman-Kowalewski, M., Weng, K.C., Nishikawa, J., Dutton, P.H., Fisher, N.S. 2017b. Assessing Fukushima-derived radiocesium in migratory Pacific predators. Environ. Sci. Technol., 51 (16), pp 8962–8971. doi: 10.1021/acs.est.7b00680

Martien KK, Hancock-Hanser BL, Baird RW, Kiszka JJ, Aschettino JM, Oremus M, Hill MC. 2017. Unexpected patterns of global population structure in melon-headed whales (Peponocephala electra) Marine Ecology Progress Series. 577:205-220. https://doi.org/10.3354/meps12203.

Miller BS, Wotherspoon S, Rankin S, Calderan S, Leaper R, Keating JL. 2018. Estimating drift of directional sonobuoys from acoustic bearings. Journal of the Acoustical Society of America Express Letters. 143:1. EL25-EL30. https://doi.org/10.1121/1.5020621.

Olsen E, Kaplan IC, Ainsworth C, Fay G, Gaichas S, Gamble R, Girardin R, Eide CH, Ihde TF, Morzaria-Luna HN, Johnson KF, Savina-Rolland M, Townsend H, Weijerman M, et al. 2018. Ocean futures under ocean acidification, marine protection, and changing fishing pressures explored using a worldwide suite of ecosystem models. Frontiers in Marine Science. 5:64. https://dx.doi.org/10.3389/fmars.2018.00064.

Snyder, S., P. J. S. Franks, L. D. Talley, Y. Xu, and S. Kohin. 2017. Crossing the line: Tunas actively exploit submesoscale fronts to enhance foraging success. Limnol. Oceanogr., 2: 187–194. Doi:10.1002/lol2.10049

Swimmer Y, Gutierrez A, Bigelow K, Barcelo C, Schroeder B, Keene K, Shattenkirk K, Foster DG. 2017. Sea turtle bycatch mitigation in U.S. longline fisheries. Frontiers in Marine Science. 4:260. https://doi.org/10.3389/fmars.2017.00260.

Urbisci, L.C., Stohs, S., Piner, K.R. 2017. From sunrise to sunset in the California drift gillnet fishery: An examination of the effects of time and area closures on the catch and catch rates of pelagic species. Marine Fisheries Review 78(3-4):1-11. doi: 10.7755/MFR.78.3–4.1

Van Cise AM, Martien KK, Mahaffy SD, Baird RW, Webster DL, Fowler JH, Oleson EM, Morin PA. 2017. Familial social structure and socially driven genetic differentiation in Hawaiian short-finned pilot whales. Molecular Ecology. 26(23):6730-6741. https://doi.org/10.1111/mec.14397.

Winker H, Carvalho F, Kapur M. 2018. JABBA: Just Another Bayesian Biomass Assessment. Fisheries Research. 204:275-288. https://doi.org/10.1016/j.fishres.2018.03.010.

Woodworth-Jefcoats PA. 2017. Climate change impacts on fisheries and aquaculture of the United States - Pacific Islands. In: Phillips BF, Perez-Ramirez M (eds.). Climate change impacts on fisheries and aquaculture: a global analysis. Newark (NJ): John Wiley & Sons Ltd. p. 159-217. https://doi.org/10.1002/9781119154051.ch8.

Woodworth-Jefcoats P, Polovina JJ, Drazen JC. 2018. Synergy among oceanographic variability, fishery expansion, and longline catch composition in the central North Pacific Ocean. Fishery Bulletin. 116(3):228-239. https://doi.org/10.7755/FB.116.3.2