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Seabird interaction rates in the Hawaii-based shallow and deep-set longline fisheries by vessel size as estimated from observer data (2004–2013)[1]

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Seabird interaction rates in the Hawaii-based shallow and deep-set longline fisheries by vessel size as estimated from observer data (2004–2013)

Keith A. Bigelow

Seabird interactions have occurred in both the shallow (swordfish targeting) and deep-set (tuna targeting) U.S. longline fisheries that are based in Hawaii. Incidental seabird interactions are documented by fishery observers from the Pacific Islands Regional Observer Program (http://www.fpir.noaa.gov/OBS/obs_index.html). Annual fleet-wide estimates are reported in Part 1 of the U.S. Annual Report to the WCPFC (USA 2014). The interactions in the deep-set fishery are estimated (McCracken 2014) using the probabilities that a deep-set trip notification was sampled by the National Marine Fisheries Service (NMFS) observer program. The Pacific Islands Regional Office (PIRO) of NMFS provides additional seabird information as an Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fisheries. The most recent summary (NMFS 2014) describes seabird mitigation measures for the Hawaii longline fisheries, protected species workshops, fishing effort, observer coverage and observed and estimated total numbers of interactions with Laysan (*Phoebastria immutabilis*), blackfooted (*P. nigripes*) albatrosses and other seabird species.

The shallow set fishery was closed in 2001 and subsequently reopened in April 2004 under a suite of new management measures that required new gear configurations, and specialized turtle dehooking equipment and handling procedures were put in place to reduce incidental captures of sea turtles and increase their post-hooking survival. Seabird mitigation measures were initially adopted in 2001 and subsequently amended in 2005. A summary of current seabird regulations for both the shallow and deep-set Hawaii-based longline fleet is provided in Table 1. The measures have been effective as the estimated total number of interactions with albatrosses hooked or entangled incidentally in Hawaii-based shallow and deep fisheries annually declined 89 to 99% during the period 2004 to 2011 (range: 26 to 260 seabirds) compared to an estimated 2,433 in 2000 (NMFS, 2010, 2014).

WCPFC Conservation and Management Measure (CMM) 2012-07 contain measures to mitigate the impact of fishing for highly migratory fish stocks on seabirds. In the north Pacific, the mitigation requirements apply to longline vessels 24 meters or more in overall length in the areas of the Convention Area north of 23°N. The CMM's requirements for the U.S. longline fleet are satisfied through regulations at 50 CFR 665.35 (summarized in Table 1), which apply to all longline vessels fishing to the north of 23°N (and to shallow-setting longline vessels everywhere) regardless of vessel length.

A report of seabird interaction rates and longline gear attributes in the Hawaii-based longline fisheries (Bigelow 2011) was provided to the 7th Scientific Committee (SC). The Ecosystems and Bycatch Theme at SC9 discussed seabirds and made the following recommendations (paragraph 81) in the Summary Report:

SC9 recommended the following.

a) In order to address the impacts of vessels less than 24 m that are fishing in the North Pacific (north of 23°N) without seabird mitigation, seabird bycatch rates for vessels less than 24 m, and equal to or greater than 24 m fishing with longline gear need to be investigated. The investigation is required due to the high overlap between the longline fishery in the North Pacific (north of 23°N) and North Pacific albatrosses, and the paucity of bycatch data; and that nearly 60% of longline vessels in the North Pacific are less than 24 m in length.
b) ACAP forward the seabird identification guide to the WCPFC Secretariat for circulation to all relevant national and regional observer programmes for their advice and input.
c) A pilot project assessing the utility of electronic monitoring be undertaken in the WCPFC longline fishery.

This report provides observed seabird interactions and interaction rates in the Hawaii-based longline fisheries from 2004 to 2013 summarized by calendar year of operation (longline haulback). Seabird regulations initially went into effect in June 2001. Year 2004 was chosen as a start of the analysis as the shallow-set fishery re-opened. Statistics are disaggregated by longline fishery (shallow and deep-set), vessel size (<24 m and >=24 m) and latitude (<23°N and >=23°N). The analysis addresses the SC9 recommendation (para 81(a)), requesting for a comparison of large- and small-vessel interaction rates in order to address the current lack of mitigation by small vessels. The analysis is beneficial in describing interaction rates by fishery, latitude and vessel size.

Observer coverage, interactions and interaction rates

Since 2004, annual observer coverage rates were 100% for the shallow-set fishery and ranged from 20.1 to 26.1% for the deep-set fishery. Most of the incidental interactions occur with the two albatross species (Table 2) to the north of the Hawaiian archipelago. Total observed interactions, effort and nominal catch rates depicted in Table 2 differ slightly from NMFS (2014) values because some observed effort from experimental or research longline trips was deleted in this analysis.

Interaction rates depend on latitude, fishery type (shallow or deep-set) and vessel deployment and retrieval characteristics. The annual observed interaction rate in the shallow-set fishery averaged 0.048 seabirds per 1,000 hooks (range=0.009–0.071, Table 2, Figure 1) while the deep-set fishery averaged 0.006 seabirds per 1,000 hooks (range=0.001–0.011, Table 2). The shallow-set fishery has an interaction rate that is 8.65 times greater than the deep-set fishery. The ratio was calculated by dividing the aggregate shallow-set interaction rate by the deep-set interaction rate as 8.65=(599/12,498,293)/(444/80,107,211). Interaction rates in the deep-set fishery at or north of 23ºN averaged 0.010 (range=0.001–0.016) and 0.002 (range=0–0.003) to the south of 23ºN (Figure 1). Higher albatross abundance to the north of 23°N contributes to the higher interaction rates. The analysis didn't spatially disaggregate the shallow-set fishery as very little effort occurred to the south of 23ºN. The ratio of seabird interaction rate between the shallow and deep-set fishery is 4.68 and 28.78 for deep sets at or north of 23ºN and south of 23ºN, respectively.

Annual observed interaction rates in each fishery sector were similar between vessel size categories. Interaction rates were 0.047 and 0.049 seabirds per 1000 hooks in the shallow-set fishery for the vessels >=24 m and <24 m; respectively (Figure 2).

Vessels that deep-set to the south of 23°N are not required to use seabird mitigation; however virtually all longline gear in this area has 45 gram or heavier weights attached within 1 meter of each hook. Interaction rates for deep-set to the north of 23°N are perhaps more meaningful for the comparison between vessel size (<24 m and >=24 m) and fishery. To the north of 23°N, Interaction rates were 0.009 and 0.011 seabirds per 1000 hooks in the deep-set fishery for the vessels >=24 m and <24 m; respectively (Table 2, Figure 2).

Operational characteristics of shallow and deep-set gear influencing interactions and observed mortality

The analysis indicated that the shallow-set fishery can have seabird interaction rates ranging from ~5 to ~29 times greater than the deep-set fishery depending on latitude. Shallow gear for swordfish is set by not using a line shooter and typically deploys four hooks between successive floats. For shallow gear, the observed depth of the settled deepest hook measured by time-depth recorders (TDRs) had a median value of 60m (n=333 sets, Bigelow et al. 2006). Deep gear for tuna uses a line shooter, deploys more hooks between floats (~27), and the observed median depth of the deepest hook was 248m (n = 266 sets, Bigelow et al. 2006). The retrieval of shallow gear can allow hooks to remain near the ocean surface, thereby amenable to seabird interactions. As an example, the trajectory of the deepest longline hook on a

shallow-set indicated that the hook was within 10m of the ocean surface for ~45 minutes. The TDR is actually placed on the mainline and the corresponding branchline length is added to the TDR depth value to estimate hook depth. If the branchline was shoaled then the actual hook depth would be shallower than the illustrated trajectory in Figure 3. In contrast, deep-set gear typically consists of hooks that rapidly ascend on retrieval. The trajectory of the deepest longline hook on a deep-set indicated a settled depth of 300m and retrieval with a vertical rate of 19m per minute in the upper 100m of the water (Figure 4). A rapid retrieval through the upper water column would reduce the probability of seabird interactions.

An observed seabird interaction is automatically classified as "injured" if the seabird is not "dead", and is seldom given an "alive" release code. "alive" is a rare release condition, and could only happen if a seabird were to become lightly entangled, not hooked, and freed itself without the aid of the observer. Most seabirds (96.2%) captured in the deep-set fishery were dead upon retrieval and there was only one observation of a seabird released alive (Table 3). The shallow-set fishery has a higher seabird interaction rate than the deep-set fishery, but the majority (73.8%) of seabirds captured in the shallow-set fishery were released injured. Three seabirds were released alive in the shallow-set fishery.

Recorded observer comments illustrate that the differential mortality between fisheries is related to when the longline gear is deployed and retrieved. Seabirds are unlikely to survive the interaction and gear soak period in the deep-set fishery which typically deploys gear after sunrise (~0800 hours, Bigelow 2010) when seabirds are actively feeding. Seabirds may be hooked or entangled and drown as the deep gear sinks. Deep-set gear is typically hauled prior to dusk (~1700 hours) but very few interactions occur during the retrieval as evidenced by few captures of injured or alive seabirds. In contrast, the shallow set fishery deploys gear at night and retrieves gear during the day when seabirds are actively feeding. Shallow-set gear is retrieved after sunrise (~0700 hours, Bigelow 2010) and most seabirds caught in the shallow-set fishery occur upon longline retrieval and thus are usually released injured instead of dead.

The shallow-set fishery is subject to several regulations, including choices among mitigation methods relating to stern and side-setting (Table 1). Of 18 vessels participating in the shallow-set fishery in 2012, 16 vessels chose to stern-set (NMFS 2014). The primary mitigation method in stern-setting is the requirement of night setting (begin set 1 hour after local sunset and finish 1 hour before next sunrise and keep lighting to a minimum) with the other mitigation methods (e.g. blue-dyed bait, strategic offal discharge) have less efficacy as a deterrent.

Gilman et al. (2014) analyzed seabird bycatch mitigation for the shallow-set fishery during retrieval (hauling). They fit a generalized additive regression model to observer data to determine the significance of the effect of various factors on the standardized seabird haul catch rate. Density of albatrosses attending vessels during hauling, leader length and year had largest model effects. They reviewed observer comments for each seabird capture event to determine the proportion of live caught seabird that were observed being captured: 1) on a branchline still attached to the mainline; 2) on tended branchlines; 3) on untended lines; 4) entangled in the mainline but not entangled in a branchline or hooked; or 5) was not observed or recorded. A total of 517 interactions occurred and observers recorded information on 230 records if the seabird was captured during the set or haul. Of 222 live capture events observed to have occurred during hauling, observers recorded the manner of capture for 165 records. Of the 165 records, most (81%) haul captures were on branchlines actively being retrieved suggesting that future haul mitigation research should therefore focus on reducing bird access to hooks as crew coil branchlines.

Conclusions

Seabird interaction data were updated from 2004 to 2013 and interaction rates disaggregated by fishery (shallow and deep-set) and latitude within the deep-set fishery are similar to previous values (Bigelow 2010). This study further developed interaction rates by disaggregating by vessel size.

There were no appreciable differences by vessel size (>=24 m and <24 m) in either the shallow or deep-set fishery. This indicates that using consistent seabird mitigation techniques across vessels >=24 m and <24 m resulted in similar interaction rates. Since seabird interactions are considered rare events in the Hawaii-based fisheries, there were no statistical techniques applied to ascertain if estimates were significantly different. This study doesn't analyze seabird interaction rates by small vessels not using mitigation, but the comparisons of interaction rates between small vessels and large vessels – all of which are subject to the same mitigation requirements – are informative with respect to the question of whether mitigation should be required for vessels less than 24m in length in the North Pacific Ocean.

References

Bigelow, K., Musyl, M., Poisson, F. and P. Kleiber. 2006. Pelagic longline gear depth and shoaling. Fisheries Research 77:173−183.

Bigelow, K. 2011. Seabird interaction rates estimated from observer data (2004−2011) in the Hawaii-based shallow and deep-set longline fisheries. WCPFC-SC7-2011/EB-WP10, Pohnpei, Federated States of Micronesia, 9-17 August 2011. 13 p.

Gilman E., Chaloupka M., Wiedoff B., Willson J. 2014. Mitigating seabird bycatch during hauling by pelagic longline vessels. PLoS ONE 9(1): e84499. doi:10.1371/journal.pone.0084499

McCracken, M.L. 2014. Estimation of incidental interactions with sea turtles and seabirds in the 2013 Hawaii deep-set longline fishery. NMFS Pacific Islands Fisheries Science Center Internal Report, PIFSC IR-14-022. Issued 24 June 2014. 4 p.

National Marine Fisheries Service. 2010. Annual Report on Seabird Interactions and Mitigation Efforts in Hawaii Longline Fisheries for 2009. NMFS Pacific Islands Regional Office. Honolulu, HI. 58 p.

National Marine Fisheries Service. 2014. Annual Report on Seabird Interactions and Mitigation Efforts in Hawaii Longline Fisheries for 2012. NMFS Pacific Islands Regional Office. Honolulu, HI. 16 p.

USA. 2014. Annual Report to the Commission, Part 1: Information on Fisheries, Research, and Statistics.WCPFC-SC10-2014/AR-CMM-26, Majuro, Marshall Islands 6–14 August 2014.

Tables

Table 1. Seabird bycatch mitigation methods required for the Hawaii longline fleet, effective January 18, 2006. (Source: Pacific Islands Regional Office)

1. How do you set your gear →	STERN-SETTING		SIDE-SETTING	
2. Do you shallow-set or deep-set, and where are you →	Shallow-Set Anywhere	Deep-Set North of 23° N	Shallow-Set Anywhere	Deep-Set North of 23° N
3. What you need to do ↓				
Deploy mainline from port or starboard side at least 1 m forward of stern corner			Yes	Yes
If line shooter is used, mount it at least 1 m forward from stern corner			Yes	Yes
Use a specified bird curtain aft of the setting station during the set			Yes	Yes
Deploy gear so that hooks do not resurface			Yes	Yes
Attach 45 g or heavier weights within 1 m of hook of each hook		Yes	Yes	Yes
Use a line shooter to set the mainline		Yes		
Keep two 1-pound containers of blue-dye on boat	Yes	Yes		
Use completely thawed and blue-dyed bait	Yes	Yes		
Keep fish parts and spent bait with all hooks removed for strategic offal discard	Yes	Yes		
Cut all swordfish heads in half, and use heads and livers for strategic offal discard	Yes	Yes		
Night Set - begin set 1 hour after local sunset and finish 1 hour before next sunrise and keep lighting to a minimum	Yes			

Table 2. Summary of observed seabird interactions and nominal catch rates in the Hawaii-based shallow and deep-set fisheries from 2004 to May 2013.

Year	No. Laysan albatross caught	No. black-footed albatross caught	No. shearwaters (not identified to species level)	No. other unidentified birds	Total birds observed caught	Total observed effort (hooks)	Nominal seabird catch rate (birds per 1,000 hooks)	Ratio of shallow-set catch rate to deep-set catch rate
Shallow sets								
2004	1	-	-	-	1	115,718	0.009	
2005	62	7	-	-	69	1,358,247	0.051	
2006	8	3	-	-	11	676,716	0.016	
2007	40	8	-	-	48	1,352,822	0.035	
2008	33	6	-	-	39	1,460,993	0.027	
2009	81	30	1	-	112	1,694,260	0.066	
2010	40	38	-	1	79	1,835,182	0.043	
2011	49	19	-	-	68	1,501,050	0.045	
2012	62	37	-	-	99	1,476,969	0.067	
2013	45	28	-	-	73	1,026,336	0.071	
Total	421	176	1	1	599	12,498,293	0.048	
Deep sets (all latitudes)								
2004	2	5	-	2	9	7,863,254	0.001	7.55
2005	6	11	-	1	18	6,908,497	0.003	19.50
2006	1	17	5	-	23	7,005,649	0.003	4.95
2007	7	18	-	-	25	7,720,664	0.003	10.96
2008	14	30	14	2	60	8,745,233	0.007	3.89
2009	18	23	4	-	45	7,874,307	0.006	11.57
2010	37	17	-	-	54	7,646,949	0.007	6.10
2011	32	13	-	-	45	8,320,194	0.005	8.38
2012	31	35	1	-	67	8,834,229	0.008	8.84
2013	48	50	-	-	98	9,188,235	0.011	6.67
Total	196	219	24	5	444	80,107,211	0.006	8.65

Table 2 continued. Summary of observed seabird interactions and nominal catch rates in the Hawaii-based shallow and deep-set fisheries from 2004 to May 2013.

Year	No. Laysan albatross caught	No. black-footed albatross caught	No. shearwaters (not identified to species level)	No. other unidentified birds	Total birds observed caught	Total observed effort (hooks)	Nominal seabird catch rate (birds per 1,000 hooks)
Shallow sets (>= 24 m)							
2004	1	-	-	-	1	79,222	0.013
2005	45	5	-	-	50	685,330	0.073
2006	4	-	-	-	4	345,929	0.012
2007	33	6	-	-	39	896,649	0.043
2008	29	6	-	-	35	1,047,912	0.033
2009	80	25	1	-	106	1,396,640	0.076
2010	21	20	-	1	42	1,258,636	0.033
2011	18	8	-	-	26	942,016	0.028
2012	31	24	-	-	55	921,084	0.060
2013	14	12	-	-	26	569,270	0.046
Total	276	106	1	1	384	8,142,688	0.047
Shallow sets (<24 m)							
2004	-	-	-	-	-	36,496	-
2005	17	2	-	-	19	672,917	0.028
2006	4	3	-	-	7	330,787	0.021
2007	7	2	-	-	9	456,173	0.020
2008	4	-	-	-	4	413,081	0.010
2009	1	5	-	-	6	297,620	0.020
2010	19	18	-	-	37	576,546	0.064
2011	31	11	-	-	42	559,034	0.075
2012	31	13	-	-	44	555,885	0.079
2013	31	16	-	-	47	457,066	0.103
Total	145	70			215	4,355,605	0.049

Table 2 continued. Summary of observed seabird interactions and nominal catch rates in the Hawaii-based shallow and deep-set fisheries from 2004 to May 2013.

Year	No. Laysan albatross caught	No. black-footed albatross caught	No. shearwaters (not identified to species level)	No. other unidentified birds	Total birds observed caught	Total observed effort (hooks)	Nominal seabird catch rate (birds per 1,000 hooks)	Ratio of shallow-set catch rate to deep-set catch rate
Deep sets (>= 24 m)								
2004	2	3	-	-	5	1,473,571	0.003	3.72
2005	-	-	-	-	-	1,175,212	-	-
2006	-	8	1	-	9	1,815,877	0.005	2.33
2007	3	5	-	-	8	1,865,692	0.004	10.14
2008	8	7	6	1	22	2,079,127	0.011	3.16
2009	3	3	2	-	8	1,966,104	0.004	18.65
2010	2	1	-	-	3	1,644,197	0.002	18.29
2011	11	3	-	-	14	2,021,666	0.007	3.99
2012	8	7	-	-	15	2,258,503	0.007	8.99
2013	21	8	-	-	29	2,499,554	0.012	3.94
Total	58	45	9	1	113	18,799,503	0.006	7.85
Deep sets (<24 m)								
2004	-	2	-	2	4	6,389,683	0.001	-
2005	6	11	-	1	18	5,733,285	0.003	8.99
2006	1	9	4	-	14	5,189,772	0.003	7.84
2007	4	13	-	-	17	5,854,972	0.003	6.79
2008	6	23	8	1	38	6,666,106	0.006	1.70
2009	15	20	2	-	37	5,908,203	0.006	3.22
2010	35	16	-	-	51	6,002,752	0.008	7.55
2011	21	10	-	-	31	6,298,528	0.005	15.26
2012	23	28	1	-	52	6,575,726	0.008	10.01
2013	27	42	-	-	69	6,688,681	0.010	9.97
Total	138	174	15	4	331	61,307,708	0.005	9.14

Table 2 continued. Summary of observed seabird interactions and nominal catch rates in the Hawaii-based shallow and deep-set fisheries from 2004 to May 2013.

Year	No. Laysan albatross caught	No. black-footed albatross caught	No. shearwaters (not identified to species level)	No. other unidentified birds	Total birds observed caught	Total observed effort (hooks)	Nominal seabird catch rate (birds per 1,000 hooks)	Ratio of shallow-set catch rate to deep-set catch rate
Deep sets (latitude >=23N)								
2004	-	1	-	-	1	1,270,446	0.001	10.98
2005	5	7	-	-	12	3,345,218	0.004	14.16
2006	1	9	2	-	12	2,300,566	0.005	3.12
2007	1	11	-	-	12	2,476,815	0.005	7.32
2008	14	28	14	1	57	4,926,298	0.012	2.31
2009	18	20	2	-	40	4,161,085	0.010	6.88
2010	37	17	-	-	54	3,888,479	0.014	3.10
2011	29	10	-	-	39	3,872,195	0.010	4.50
2012	30	24	-	-	54	4,525,563	0.012	5.62
2013	47	43	-	-	90	5,497,578	0.016	4.34
Total	182	170	18	1	371	36,264,243	0.010	4.68
Deep sets (latitude <23N)								
2004	2	4	-	2	8	6,592,808	0.001	7.12
2005	1	4	-	1	6	3,563,279	0.002	30.17
2006	-	8	3	-	11	4,705,083	0.002	6.95
2007	6	7	-	-	13	5,243,849	0.002	14.31
2008	-	2	-	1	3	3,818,935	0.001	33.98
2009	-	3	2	-	5	3,713,222	0.001	49.09
2010	-	-	-	-	0	3,758,470	0.000	-
2011	3	3	-	-	6	4,447,999	0.001	33.58
2012	1	11	1	-	13	4,308,666	0.003	22.22
2013	1	7	-	-	8	3,690,657	0.002	32.81
Total	14	49	6	4	73	43,842,968	0.002	28.78

Table 2 continued. Summary of observed seabird interactions and nominal catch rates in the Hawaii-based shallow and deep-set fisheries from 2004 to May 2013.

Year	No. Laysan albatross caught	No. black-footed albatross caught	No. shearwaters (not identified to species level)	No. other unidentified birds	Total birds observed caught	Total observed effort (hooks)	Nominal seabird catch rate (birds per 1,000 hooks)
Deep sets (latitude =>23N & >=24 m)							
2004	-	-	-	-	0	369,071	0.000
2005	-	-	-	-	0	703,605	0.000
2006	-	7	-	-	7	842,817	0.008
2007	-	3	-	-	3	762,488	0.004
2008	8	7	6	-	21	1,341,124	0.016
2009	3	3	2	-	8	1,230,346	0.007
2010	2	1	-	-	3	967,081	0.003
2011	10	1	-	-	11	897,524	0.012
2012	7	6	-	-	13	1,262,439	0.010
2013	21	7	-	-	28	1,793,709	0.016
Total	51	35	8	-	94	10,170,204	0.009
Deep sets (latitude =>23N & <24 m)							
2004	-	1	-	-	1	901,375	0.001
2005	5	7	-	-	12	2,641,613	0.005
2006	1	2	2	-	5	1,457,749	0.003
2007	1	8	-	-	9	1,714,327	0.005
2008	6	21	8	1	36	3,585,174	0.010
2009	15	17	-	-	32	2,930,739	0.011
2010	35	16	-	-	51	2,921,398	0.017
2011	19	9	-	-	28	2,974,671	0.009
2012	23	18	-	-	41	3,263,124	0.013
2013	26	36	-	-	62	3,703,869	0.017
Total	131	135	10	1	277	26,094,039	0.011

Table 2 continued. Summary of observed seabird interactions and nominal catch rates in the Hawaii-based shallow and deep-set fisheries from 2004 to May 2013.

Year	No. Laysan albatross caught	No. black-footed albatross caught	No. shearwaters (not identified to species level)	No. other unidentified birds	Total birds observed caught	Total observed effort (hooks)	Nominal seabird catch rate (birds per 1,000 hooks)
Deep sets (latitude <23N & >=24 m)							
2004	2	3	-	-	5	1,104,500	0.005
2005	-	-	-	-	0	471,607	0.000
2006	-	1	1	-	2	973,060	0.002
2007	3	2	-	-	5	1,103,204	0.005
2008	-	-	-	1	1	738,003	0.001
2009	-	-	-	-	0	735,758	0.000
2010	-	-	-	-	0	677,116	0.000
2011	1	2	-	-	3	1,124,142	0.003
2012	1	1	-	-	2	996,064	0.002
2013	-	1	-	-	1	705,845	0.001
Total	7	10	1	1	19	8,629,299	0.002
Deep sets (latitude <23N & <24 m)							
2004	-	1	-	2	3	5,488,308	0.001
2005	1	4	-	1	6	3,091,672	0.002
2006	-	7	2	-	9	3,732,023	0.002
2007	3	5	-	-	8	4,140,645	0.002
2008	-	2	-	-	2	3,080,932	0.001
2009	-	3	2	-	5	2,977,464	0.002
2010	-	-	-	-	0	3,081,354	0.000
2011	2	1	-	-	3	3,323,857	0.001
2012	-	10	1	-	11	3,312,602	0.003
2013	1	6	-	-	7	2,984,812	0.002
Total	7	39	5	3	54	35,213,669	0.002

Table 3. Release condition for birds observed to be captured incidentally in Hawaii-based shallow and deep-set longline fisheries from 2004 to 2013.

	Number (percentage (%))	
Condition upon gear retrieval	Shallow-set	Deep-set
Alive	3 (0.5%)	1 (0.2%)
Injured	442 (73.8%)	16 (3.6%)
Dead	154 (25.7%)	427 (96.2%)

Figures

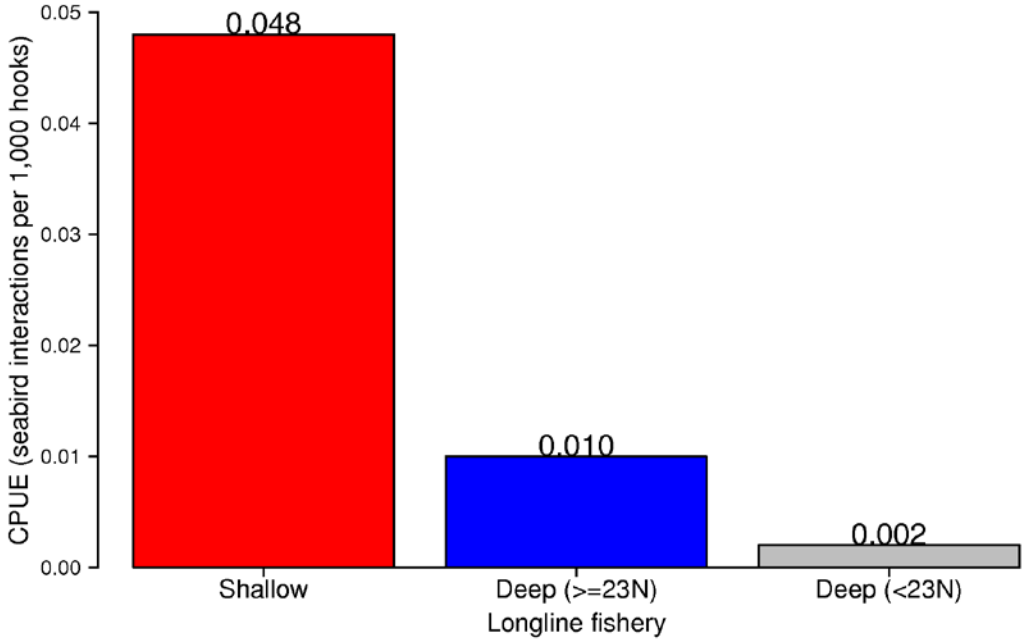

Figure 1. Seabird interaction rates in the shallow and deep-set longline fisheries based in Hawaii (2004–2013). Deep-set fishery is disaggregated in latitudes north and south of 23°N.

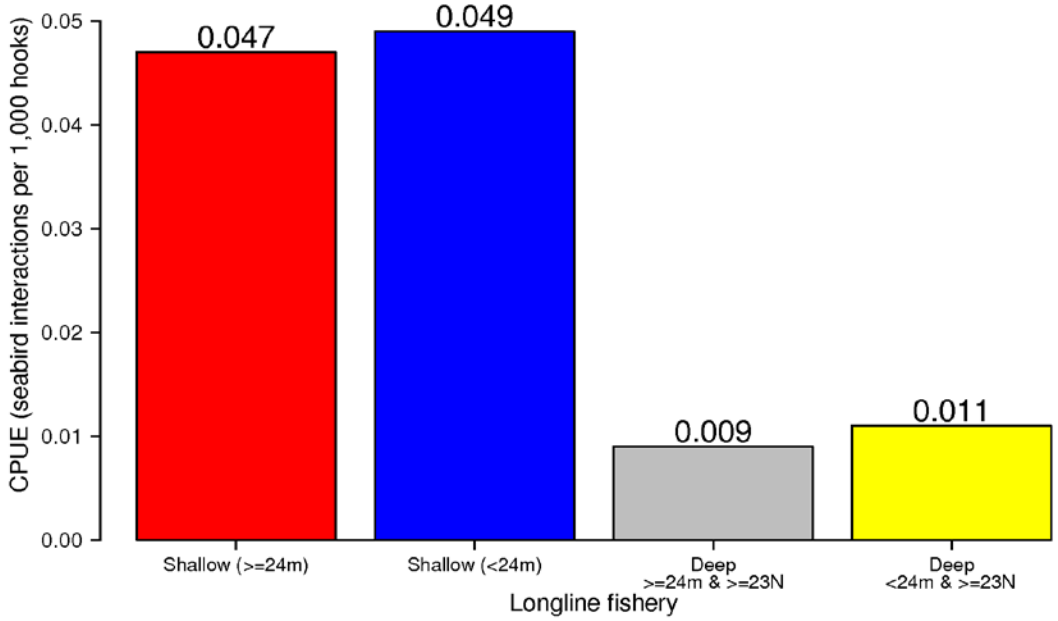

Figure 2. Seabird interaction rates by vessel size in the shallow and deep-set longline fisheries based in Hawaii (2004–2013).

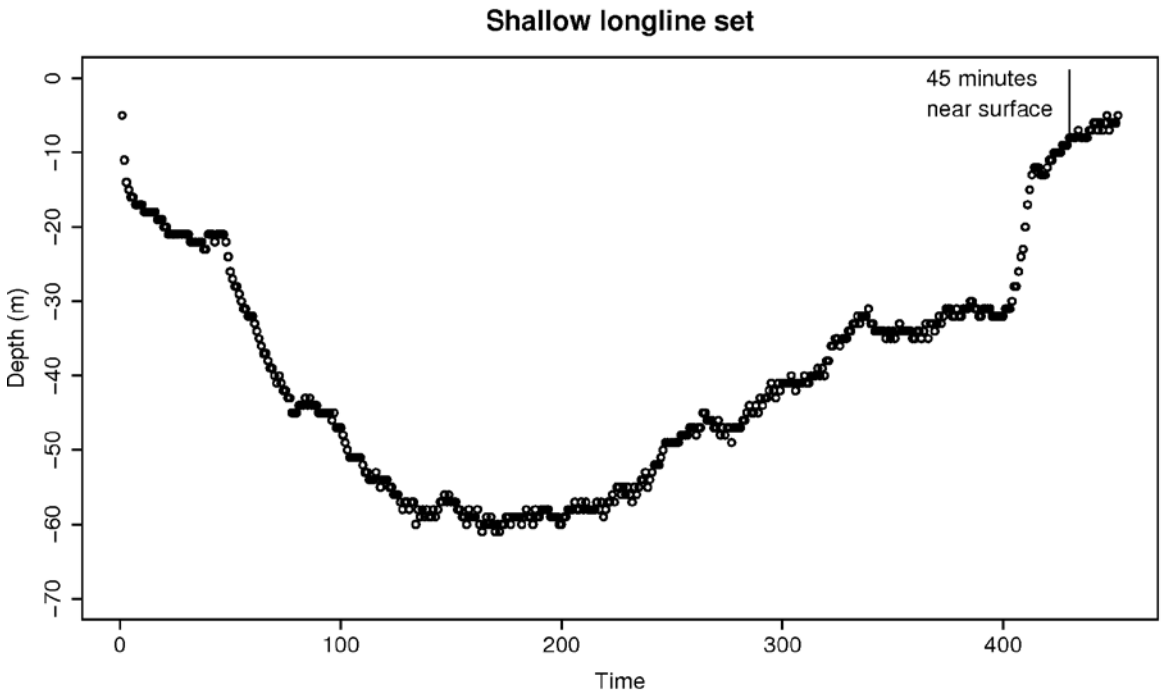

Figure 3. Trajectory of the assumed deepest longline hook monitored by a temperature-depth recorder (TDR) during a shallow-set in the Hawaii-based fishery. Points represent data collected every 128 seconds.

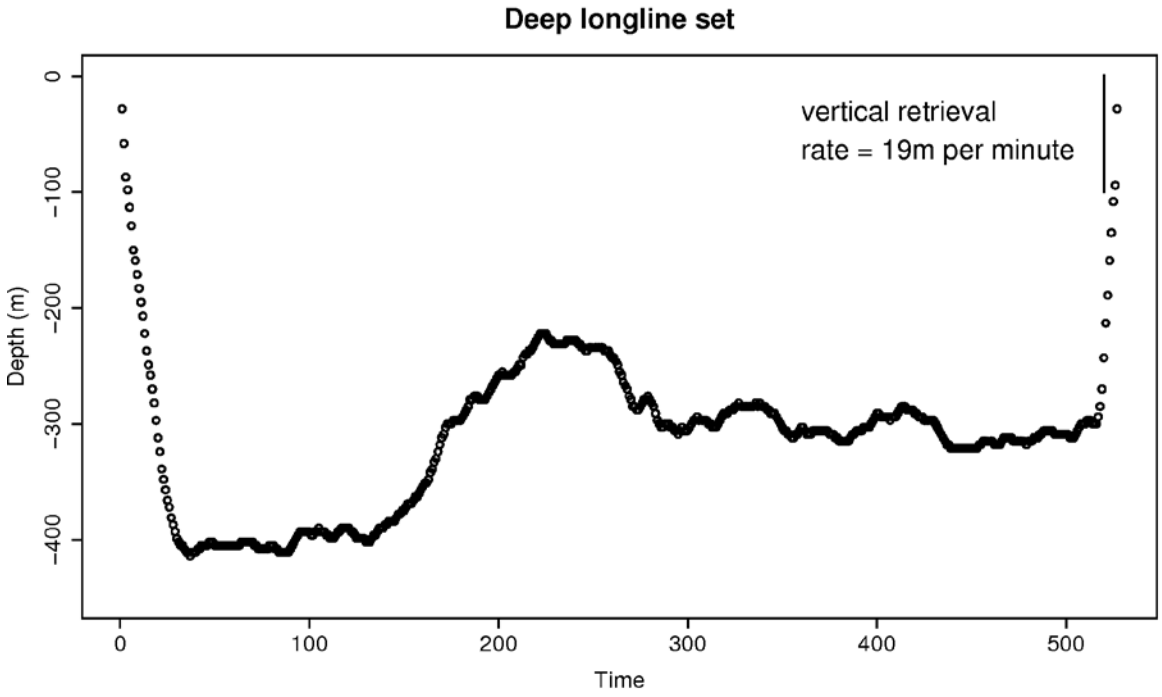

Figure 4. Trajectory of the assumed deepest longline hook monitored by a temperature-depth recorder (TDR) during a deep-set in the Hawaii-based fishery. Points represent data collected every 128 seconds.