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LOW LEVEL OF SEA TURTLE BYCATCH CONTINUES IN THE HAWAII LONGLINE FISHERY [1]

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Abstract

The Hawaii longline fishery has been successfully managed to greatly reduce sea turtle bycatch. This fishery was estimated from observer data to have caught from 556 to 774 sea turtles per year from 1994 through 2000 when the fishery was temporarily closed due to court mandate. Prior to closure the annual turtle bycatch per unit effort in this fishery had averaged 0.043 turtles per 10^3 hooks. Highest bycatch rates were observed for vessels using shallow-set gear to target swordfish. A regulatory definition of deep-set longlining for tuna was established which allowed the deep-set fishery sector to re-open under 20% (minimum) observer coverage, with the result that sea turtle bycatch rates in the deep-set sector averaged 0.002 turtles per 10^3 hooks from 2001through 2008. A regulatory framework to reduce sea turtle bycatch based on successful U.S. experiments with large circle hooks and fish bait allowed the shallow-set fishery for swordfish to re-open in April 2004 under 100% observer coverage. Under the new framework, sea turtle bycatch rates for the shallow-set sector averaged 0.016 turtles per 10^3 hooks from 2004-2008. Bycatch rates in the shallow-set fishery were reduced for both leatherback (average 0.004 per 10^3 hooks) and hardshell sea turtles (average 0.011 per 10^3 hooks). Viable catch rates for target fish species were maintained in both the deep-set and shallow-set sectors of the fishery. Other experiments and fishery applications to reduce sea turtle bycatch using large circle hooks and/or fish bait in shallow-set swordfish longline fisheries have succeeded, but not always as well as in the Hawaii fishery. In other fisheries the ability to detect very low rates of sea turtle bycatch may be limited by low observer coverage and the amount of fishing effort. A high rate of observer coverage is required to observe turtles in small fisheries with very low bycatch.

1 Introduction

Efforts by U.S. longline fishery managers to reduce sea turtle bycatch in the Hawaii-based longline fishery (Gilman et al., 2006) continue to be quite successful and provide information useful for other longline fisheries in the western and central Pacific Ocean (WCPO). Observers were first deployed in the fishery in 1994. Early analyses of observer data indicated that hundreds of sea turtles were being caught each year, and also indicated that shallow-set fishing for swordfish, although representing a small fraction of total fishing effort, was responsible for a large portion of the turtles caught (NMFS, 2005). Litigation and a subsequent ruling by a U.S. Federal court closed the fishery temporarily in 2000. After a regulatory definition of deep-set fishing was instituted, the deep-set sector of the fishery resumed. Shallow-set fishing in very restricted areas resumed temporarily until early 2001 when the shallow-set sector was again closed. In 2004, after conservation engineering research showed that large circle hooks and fish bait could reduce sea turtle bycatch in the U.S. shallow-set swordfish longline fishery in the N. Atlantic (Watson et al., 2005) this improved fishing method was mandated in a re-opened shallow-set fishery for swordfish in Hawaii. In combination, the regulatory definition of deep-set fishing and the mandatory improvement of shallow-set fishing methods reduced sea turtle bycatch by an order of magnitude.

2 Update

Turtle bycatch estimates for the Hawaii fishery were provided earlier (Gilman et al 2006) and are updated here through early 2009. Prior to its temporary closure in 2000 the Hawaii longline

fishery was not managed by separate deep- and shallow-set sectors. Observer coverage averaged less than 5% per year, and turtle bycatch was estimated for the entire fleet based on logbook reported effort and observed bycatch using prediction models (McCracken, 2005). The fishery was estimated to be catching between 556 and 774 sea turtles per year from 1994-2000 (NMFS 2005) including 89 to139 leatherback turtles per year (Table 1). The estimated annual bycatch per unit effort (BPUE) expressed as turtles per 10^3 hooks, was 0.043 during this period.

Table 1. Estimated sea turtle bycatch and bycatch per unit effort (BPUE in turtles per in 10^3 hooks) in the Hawaii-based longline fishery, by all fishery sectors (1994-2000), by the deep-set sector (2001-2008) and by the shallow-set sector (2004-2009). Data through 2004 from NMFS 2005. Deep-set updates from Pacific Islands Fisheries Science Center Internal Reports (IR-05-001, IR-06-006, IR-07-006, IR-08-007, and IR-09-011) and shallow-set counts from 100% observer coverage (http://www.fpir.noaa.gov/OBS/obs_qrtrly_annual_rprts.html**).**

Fishery Sector	Year	Effort (million hooks)	Turtle bycatch (and rate per 10^3 hooks)					
			Leatherback		All hardshell		All turtles	
All sectors (Shallow-, mixed-, and deep-set, Combined)	1994	12	109	(0.009)	665	(0.055)	774	(0.065)
	1995	14	99	(0.007)	544	(0.038)	643	(0.045)
	1996	14	106	(0.007)	599	(0.042)	705	(0.049)
	1997	16	89	(0.006)	485	(0.031)	574	(0.037)
	1998	17	139	(0.008)	569	(0.033)	708	(0.041)
	1999	19	132	(0.007)	568	(0.030)	700	(0.037)
	2000	20	132	(0.007)	424	(0.021)	556	(0.027)
Average of 1994-2000		16	115	(0.007)	551	(0.036)	666	(0.043)
Deep-set	2001	22	10	(0.0004)	65	(0.003)	75	(0.003)
	2002	27	5	(0.0002)	51	(0.002)	56	(0.002)
	2003	30	4	(0.0001)	14	(0.0005)	18	(0.001)
	2004	32	15	(0.0005)	51	(0.002)	66	(0.002)
	2005	34	4	(0.0001)	16	(0.000)	20	(0.001)
	2006	35	9	(0.0003)	60	(0.002)	69	(0.002)
	2007	39	4	(0.0001)	33	(0.0008)	37	(0.001)
	2008	40	11	(0.0003)	18	(0.0004)	29	(0.001)
Average of 2001-2008		32	8	(0.0002)	39	(0.001)	46	(0.002)
Shallow-set (with large circle hooks and fish bait)	2004	0.1	1	(0.009)	1	(0.009)	2	(0.018)
	2005	1.4	8	(0.006)	10	(0.007)	18	(0.013)
	2006	0.7	2	(0.003)	19	(0.027)	21	(0.030)
	2007	1.4	5	(0.004)	16	(0.012)	21	(0.015)
	2008	1.5	2	(0.001)	3	(0.002)	5	(0.003)
	2009	incomplete	7		3		10	
Average of 2004-2008		1.0	4	(0.004)	10	(0.011)	13	(0.016)

Shortly after the 2000 closure, deep-set fishing was allowed to continue under new regulations, which after some modification now specify that: 1) all float lines on board must be longer than 20 m in length, 2) a minimum of 15 branch lines must be deployed between any two floats, except for basket gear, which has a minimum of 10 branch lines between any two floats, 3) no use of light sticks (light emitting devices), and 4) no more than ten swordfish may be landed or possessed on a deep-set fishing trip (Summary of Western Pacific General Longline Fishery

Regulations at http://www.fpir.noaa.gov/SFD/SFD_regs_2.html). A number of other regulations were enacted to address seabird interactions.

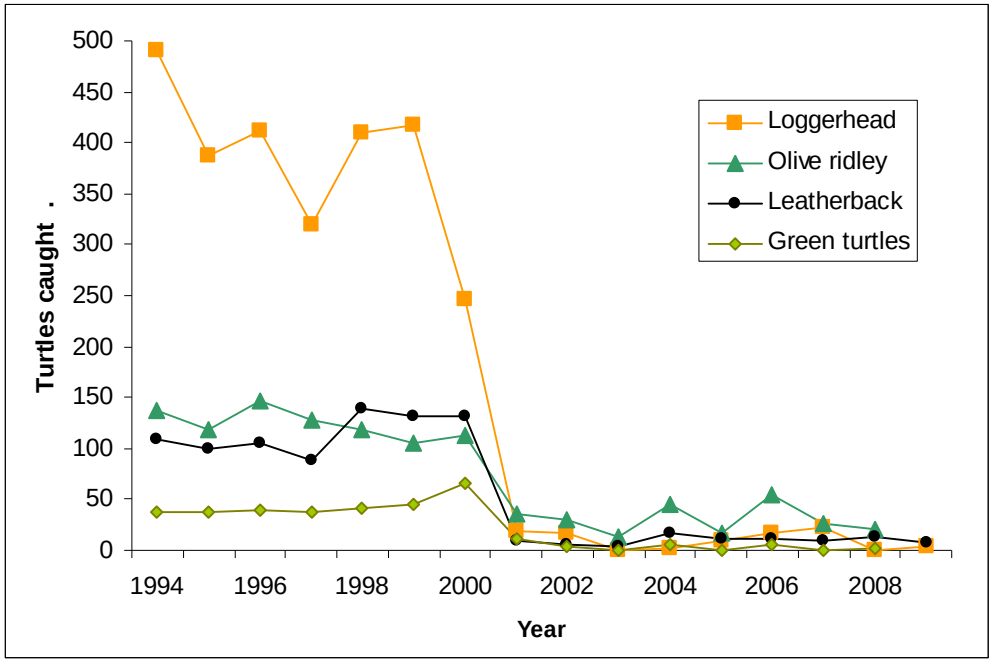

Figure 1. Estimated sea turtle bycatch in the Hawaii-based longline fishery, by all fishery sectors combined (Sources as in Table 1).

After the closure of shallow-set fishing in 2000 and the implementation of the above cited regulatory measures, sea turtle bycatch declined by an order of magnitude (Figure 1). The deep-set fishery continued from 2001 to the present with annual turtle BPUE, estimated from at least 20% observer coverage per year, averaging 0.002 turtles per 10^3 hooks (Table 1). Leatherback turtle BPUE averaged only 0.0002 turtles per 10^3 hooks.

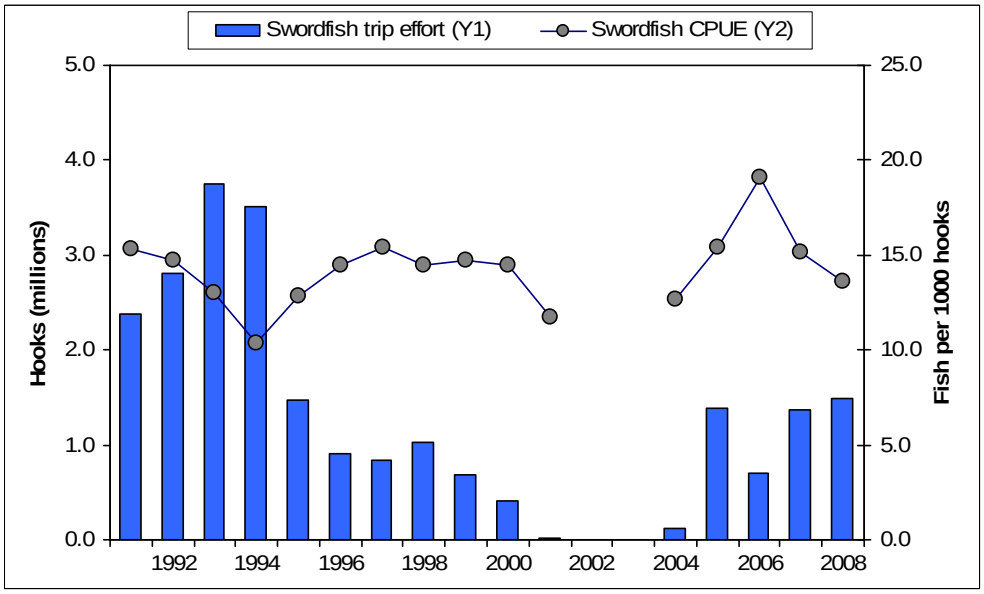

Figure 2. Annual shallow-set fishing effort and CPUE in the Hawaii fishery.

The shallow-set fishery did not re-open until April 2004 under regulations requiring the use of large (size 18/0) circle hooks (ca. 4.9 cm minimum width) and fish bait. Swordfish catch per unit effort (CPUE) in the resumed shallow-set swordfish fishery, expressed as fish per 10^3 hooks, has continued to the present at levels similar to those before regulation (Figure 2).

In addition to hook and bait type regulations, since 2004 Hawaii shallow-set fishing has been limited to 2,120 sets annually (equivalent to about 2 million hooks. This level of effort has not yet been fully utilized in any year since the fishery reopened. Regulations also specified that the shallow-set fishery could not exceed an annual bycatch limit of 17 loggerhead, or 16 leatherback turtles. The limit for loggerhead turtles was reached in March 2006 causing a shallow-set closure before the end of the calendar year. In 2004-2005 and 2007-2008 fishing was uninterrupted by turtle limits. The 2004-2008 average BPUE for leatherback and hardshell turtles was 0.004 and 0.011 turtles per 10^3 hooks, respectively. Total BPUE for all species was 0.016 turtles per 10^3 hooks (Table 1). Both the original experiments in the Atlantic (Watson et al. 2005) and the application of these methods to the Hawaii-based fishery under a management framework indicated that sea turtle catch rates could be reduced by as much as 90% with no reduction of swordfish catch rates (Gilman et al., 2006).

3 Other Studies

There have been several other experiments and applications with large circle hooks or fish bait in shallow set swordfish fisheries; these are summarized in Boggs and Swimmer (2007). Experiments in reducing loggerhead turtle bycatch in a shallow-set swordfish fishery in the Alboran Sea (Earthwatch 2006) found the use of fish instead of squid bait alone to be about 60% effective. Experiments in a swordfish fishery in the Strait of Sicily found size 16/0 circle hooks (4.4 cm minimum width) to be about 79% effective in reducing loggerhead bycatch in comparison with smaller (3.4 cm minimum width) J hooks. In the swordfish fisheries of Brazil the most recent experimental results (NOAA Fisheries, unpublished data) suggest a reduction of about 60% (n=20) and 55% (n=164) in the bycatch of leatherback and loggerhead turtles, respectively from the use of size 18/0 circle hooks as compared with size 16/0 J hooks.

Not all experiments with large circle hooks or fish bait, or their application in shallow-set swordfish fisheries, have been as successful as those cited above. Other variables and unknowns, such as changes in targeting, habitat, turtle distribution, and abundance can cause turtle catch rates to rise after hook or bait changes are implemented in a fishery, making the benefits of the change harder to detect (Epperly et al. 2009). The effectiveness of hook changes depends on the new hook size, the replaced hook size, and the size of the sea turtles in each particular fishery (Boggs and Swimmer, 2007).

4 Limits of Observation

Achievement of a 5% rate of coverage for longline fisheries was recommended by the 2nd WCPFC Science Committee as an initial goal for the Commission's observer program. When a longline fishery has a high rate of turtle bycatch (relative to WCPO fisheries), or contains a sector with a high rate of bycatch, as was the case in Hawaii in the 1990's, observer coverage of about 5% coupled with analysis looking for predictors of bycatch may provide very useful information for resource managers. However, in circumstances where the fishery is relatively small and

where the goal may be to document a very low bycatch rate, the ability to observe even a single sea turtle may be difficult or impossible with rates of observer coverage in the vicinity of 5%. In other oceans or regions where turtles are more numerous and bycatch rates are higher than they are in the WCPO this might be of less concern.

A simple illustration (Table 2), ignoring the non-normal, hyper-distributed nature of rare bycatch events, makes it clear that in fisheries with effort of several million hooks per year or less, when bycatch rates are low, a 5% observer coverage is not enough to establish what the rate of bycatch might be. And to determine variance or test hypotheses, observation of tens of turtles, not single individuals, would be needed.

Table 2. Calculated numbers of turtles observed for a given bycatch rate and size of fishery at 5% observer coverage. The shaded area shows where the calculated number would be less than one.

Turtle Bycatch (per 10^3 hooks)	Observer coverage	Number of turtles observed with 5% longline observer coverage, as a function of fishing effort (10^3 hooks, ascending from left to right)								
		100	250	500	1,000	2,500	5,000	10,000	25,000	50,000
0.0010	5%	0.01	0.01	0.03	0.05	0.13	0.25	0.50	1	2
0.0020	5%	0.01	0.03	0.05	0.10	0.25	0.50	1	2	5
0.0050	5%	0.03	0.06	0.13	0.25	0.63	1	2	6	12
0.0100	5%	0.05	0.13	0.25	0.50	1	2	5	12	25
0.0150	5%	0.08	0.19	0.38	0.75	1	3	7	18	37
0.0200	5%	0.10	0.25	0.50	1	2	5	10	25	50
0.0300	5%	0.15	0.38	0.75	1	3	7	15	37	75
0.0400	5%	0.20	0.50	1	2	5	10	20	50	100
0.0500	5%	0.25	0.63	1	2	6	12	25	62	125
0.1000	5%	0.50	1	2	5	12	25	50	125	250

Table 3. Calculated observer coverage that would encounter a turtle, at various bycatch rates. The lightly shaded area shows where no more than 1 turtle could be observed even at an increased rate.

Turtle Bycatch (per 10^3 hooks)	No. of turtles	Observer coverage greater than 5% required to observe a turtle, as a function of fishing effort (10^3 hooks, ascending from left to right)								
		100	250	500	1,000	2,500	5,000	10,000	25,000	50,000
0.0010	1				100%	40%	20%	10%		
0.0020	1			100%	50%	20%	10%			
0.0050	1		80%	40%	20%	8%				
0.0100	1	100%	40%	20%	10%					
0.0150	1	67%	27%	13%	7%					
0.0200	1	50%	20%	10%						
0.0300	1	33%	13%							
0.0400	1	25%	10%							
0.0500	1	20%								
0.1000	1	10%								

A similar illustration indicates the coverage that would result in observation of one turtle, when a rate of 5% would be insufficient (Table 3).

5 Summary

The current regulatory framework implemented in the Hawaii fishery continues to demonstrate very low rates of sea turtle bycatch while maintaining viable CPUE for target species. The turtle bycatch rates in this fishery may provide a useful comparison for other fisheries in developing management goals. It is important to note that the very low turtle bycatch rates now observed in the Hawaii fishery could be difficult to document in small fisheries with low rates of observer coverage.

6 References

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