BYCATCH REDUCTION IN THE ARTISANAL LONGLINE FLEETS OF THE EASTERN PACIFIC

SUMMARY OF ACTIVITIES FOR THE REGIONAL SEA TURTLE PROGRAM JUNE 2007

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This program is the result of the support and cooperation provided by the following institutions:

World Wildlife Fund - Central America, Peru, Mexico, Colombia (WWF)
Western Pacific Regional Fishery Management Council (WPRFMC)
Inter-American Tropical Tuna Commission (IATTC)
Overseas Fishery Cooperation Foundation- Japan (OFCF)
National Oceanic and Atmospheric Administration- Hawaii, Pascagoula, and San Diego labs, Regional Offices Hawaii, Long Beach (NOAA)
The Ocean Conservancy (TOC)
Defenders of Wildlife- Mexico
and many national organizations.

Report prepared by Martin A. Hall, with contributions from all participants.

June, 2007

INTRODUCTION

The Regional Sea Turtle Program of the eastern Pacific started in late 2003, and it has turned into a major project of continental scale. In order to coordinate the activities, oversee the data collection, editing, and processing, M. Hall visits the different countries several times a year, to produce joint analyses of the data with the local scientists, to secure consistency in the data, and to produce the comparative results that are very important to integrate over the whole region.

In this report we summarize succinctly, the results up to mid-2007. A technical workshop in November will bring together most of the researchers participating in the project, and in 2008, we will publish the results for the initial years (2004-2007).

BASIC DESCRIPTION OF THE PROGRAM

Fisheries (target species):

Fisheries from Peru and Ecuador target mahi-mahi in the summer, and tuna (when there is tuna) in the winter. If tuna is not abundant, the targets are a mixture of species that include, billfishes, sharks, wahous, oilfishes, etc (TBS fishery). Very occasionally swordfish becomes available, and they all switch to this target. From Southern Peru they target sharks in the winter.

In Colombia, the longline effort targeting mahi-mahi used to be limited to a few shrimp boats during a closure period, but it has practically ceased.

From Panama to Guatemala the seasons are not so clear. In Panama for instance, the same boat may switch targets (and therefore gear) within a trip. Their options include also bottom longlining.

In Guatemala bottom longlining is prevalent from some ports. In Costa Rica pelagic longlining is the most common way of fishing, with mahi-mahi as the main target followed by sharks, tunas, billfishes.

There has been a considerable increase in longlining by small vessels based in nations adjacent to the eastern Pacific Ocean (EPO) during recent years. Sea turtles are caught incidentally by longline gear, and the populations of leatherback, loggerhead, and hawksbill turtles have been at low levels or declining in recent years. In particular, the leatherback sea turtle has experienced a steady decline for decades. The FAO and other organizations have urged the development of programs to reduce sea turtle mortality. The Association of Fish Exporters of Ecuador, together with the Subsecretaria de Recursos Pesqueros, and fish worker's organizations from that country took the initiative, and decided to search for a

solution that reduced the mortalities of sea turtles, but allowed the continuation of the fishing activities, critical to thousands of families. Some member countries from the EPO asked IATTC to help develop such a program.

In response to this, the IATTC adopted a Resolution on a Three-Year Program to Mitigate the Impact of Tuna Fishing on Sea Turtles (Resolution C-04-07) at its 72nd meeting in June 2004. It then began a program, supported by the World Wildlife Fund, the U.S. Western Pacific Regional Fisheries Management Council, the U.S. National Oceanic and Atmospheric Administration (NOAA), the U.S. State Department, the Overseas Fishery Cooperation Foundation (OFCF) of Japan, The Ocean Conservancy, Defenders of Wildlife (Mexico), and several national conservation, industry, and fishworker's organizations of the coastal countries of the EPO, to seek ways to reduce this mortality by:

(1) reducing the catches of sea turtles and
(2) reducing the mortalities of sea turtles that are caught.

A program was begun in Ecuador in 2003, and expanded to other countries bordering the EPO. By June 2007, the program was (1) very active in Costa Rica, Ecuador, El Salvador, Guatemala, Panama, and Peru and (2) under development in Mexico and Nicaragua. In Colombia, the longline effort has been substantially reduced in recent years.

REDUCING THE CATCHES OF SEA TURTLES BY LONGLINE GEAR

In the eastern Pacific region, there are two categories of vessel size that we should be aware of: the "fibras", small vessels of less than 7.5 mts in length, and larger vessels (usually 15 mt – 28 mt long). Most of the vessels fishing off South America, and a proportion of those fishing off Central America use "J-hooks," a category in which we include straight J hooks (with a straight shank), and Japanese style tuna hooks (with a bent shank). In parts of Central America, the use ofcircle hooks was already widespread, but here were still many vessels using J hooks.

It has been found in experiments performed in other areas that the use of "circle hooks" tends to decrease the catches of sea turtles without affecting those of the target species. These results might not apply to the countries bordering the EPO, however, so an experimental hook exchange program was begun in 2004. Fishers are asked to test the circle hooks in their normal fishing conditions, and on a voluntary basis. Circle hooks are exchanged one to one for J hooks currently on the line. They are exchanged following an alternating design (one J, one C, one J, one C)

to eliminate biases during the fishing operations. Observers are placed aboard those vessels to record the results.

As we mentioned earlier, there are two principal longline fisheries conducted by small vessels in the EPO, one directed at tunas, billfishes, and sharks (called the TBS fishery) and the other directed at mahi-mahi, *Coryphaena hippurus* (called the mahi-mahi fishery). Most of the vessels in Ecuador and Peru have two sets of gear, one with larger hooks for the TBS fishery and the other with smaller hooks for the mahi-mahi fishery. In Central America, however, many vessels use the same gear, regardless of the species toward which they are directing their effort.

In the TBS fishery, J hooks, or Japanese tuna hooks, were initially replaced by C16/0 and C18/0 circle hooks in Ecuador, but the C18/0 hooks proved to be too large, so the J hooks were replaced only by C16/0 hooks after 2004. In Central America some of the vessels were already using C14/0 and C15/0 hooks, and some of the fishermen expressed interest in testing C16/0 hooks, so some of the C14/0 and C15/0 were replaced by larger circle hooks.

Gear Used:
Southern Peru: very large J hooks (sizes 1 and 2 from A Poutada catalog) for sharks.
Rest of Peru and Ecuador: J hooks and Tuna hooks sizes for the fisheries shown below (Photo by T. Mituhasi)

Central America: Vessels either using the same J hooks as shown above (Nr 38) or already using circle hooks sizes 14/0 or 15/0.

SAMPLING EFFORT

Tables 1 to 4 summarize the sampling effort in number of hooks observed for the whole region, and also stratified by each major type of fishery, location, and hook type and size.

Table 1.

Fishery	Fishery	Hooks	Year	Nr First hook	Nr 2nd hook	Total 1st hook	Total 2nd hook
Surface	Mahi-mahi	J - C16	2004-2005	3,200	3,193		
Surface	Mahi-mahi	J - C16	2005-2006	41,964	42,495		
Surface	Mahi-mahi	J - C16	2006-2007	26,516	25,515		
		J - C16				71,680	71,203
Surface	Mahi-mahi	J - C15	2004-2005	15,910	15,034		
Surface	Mahi-mahi	J - C15	2005-2006	25,062	27,597		
Surface	Mahi-mahi	J - C15	2006-2007	3,120	3,330		
		J - C15				44,092	45,961
Surface	Mahi-mahi	J - C14	2004-2005	15,506	15,105		
Surface	Mahi-mahi	J - C14	2005-2006	22,004	20,685		
Surface	Mahi-mahi	J - C14	2006-2007	11,355	10,809		
		J - C14				48,865	46,599
Surface	Mahi-mahi	J - C13	2005-2006	15,995	15,905		
Surface	Mahi-mahi	J - C13	2006-2007	930	918		
		J - C13				16,925	16,823
Surface	Mahi-mahi	J - C12	2005-2006	13,821	13,731		
		J - C12				13,821	13,731
Surface	Mahi-mahi	C16 - C15	2004-2005	1,028	1,204		
Surface	Mahi-mahi	C16 - C15	2005-2006	52,921	62,777		
Surface	Mahi-mahi	C16 - C15	2006-2007	12,379	13,556		
		C16 - C15				66,328	77,537
Surface	Mahi-mahi	C15 - C14	2004-2005	14,494	14,887		
Surface	Mahi-mahi	C15 - C14	2005-2006	46,910	46,968		
Surface	Mahi-mahi	C15 - C14	2006-2007	61,235	52,745		
		C15 - C14				122,639	114,600
Surface	Mahi-mahi	C15 - C13	2006-2007	12,960	8,142		
Surface	Mahi-mahi	C15 - C13	2007	2,409	1,379		
		C15 - C13				15,369	9,521
Surface	Mahi-mahi	C14 - C13	2005-2006	1,049	837		
Surface	Mahi-mahi	C14 - C13	2006-2007	10,666	11,841		
Surface	Mahi-mahi	C14 - C13	2007	1,000	1,379		
		C14 - C13				12,715	14,057
Surface	Mahi-mahi	C13 - C12	2005-2006	14,386	14,395		
		C13 - C12				14,386	14,395
			TOTALS	426,820	424,427		

Table 2.

Fishery	Fishery	Hooks	Year	Nr First hook	Nr 2nd hook	Total 1st hook	Total 2nd hook
Surface	TBS	J - C18	2004	6,677	6,070		
Surface	TBS	J - C18	2005	13,251	12,580		
Surface	TBS	J - C18	2006	2,118	3,800		
		J - C18				22,046	22,450
Surface	TBS	J - C16	2004	8,084	7,614		
Surface	TBS	J - C16	2005	113,573	104,931		
Surface	TBS	J - C16	2006	63,071	62,485		
Surface	TBS	J - C16	2006-2007	1,450	1,450		
Surface	TBS	J - C16	2007	39,355	38,935		
		J - C16				225,533	215,415
Surface	TBS	J - C15	2006	83	121		
Surface	TBS	J - C15	2007	4,238	4,578		
		J - C15				4,321	4,699
Surface	TBS	J - C14	2005	2,075	2,740		
		J - C14				2,075	2,740
Surface	TBS	C18 - C16	2004	6,232	5,986		
Surface	TBS	C18 - C16	2005	4,766	5,345		
		C18 - C16				10,998	11,331
Surface	TBS	C18 - C15	2006	200	121		
		C18 - C15				200	121
Surface	TBS	C16 - C15	2005	39,650	39,694		
Surface	TBS	C16 - C15	2006-2007	1,034	1,083		
Surface	TBS	C16 - C15	2007	7,673	4,517		
		C16 - C15				48,357	45,294
Surface	TBS	C16 - C14	2005	2,006	2,740		
		C16 - C14				2,006	2740
Surface	TBS	C15 - C14	2006	473	475		
Surface	TBS	C15 - C14	2007	1,006	1,010		
		C15 - C14				1,479	1,485
			TOTALS	317,015	306,275		

Table 3.

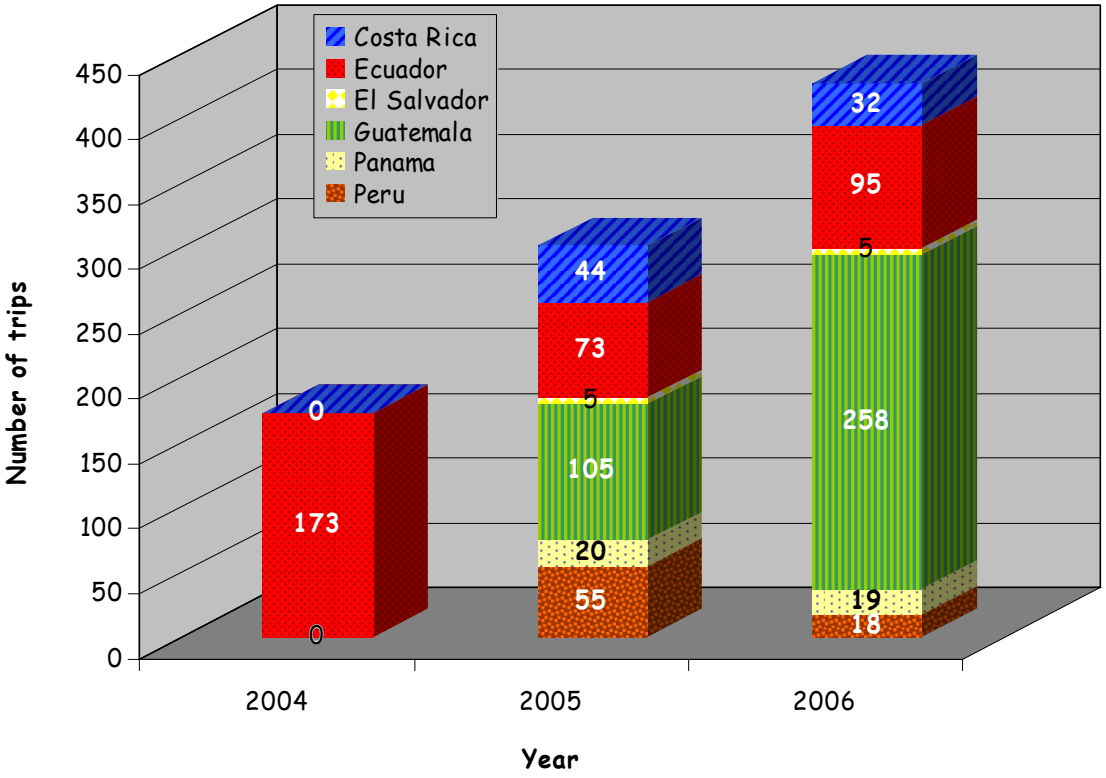
Fishery	Fishery	Hooks	Year	Nr First hook	Nr 2nd hook	Total 1st hook	Total 2nd hook
Bottom	Shark	J - C16	2006	561	321		
Bottom	Shark	J - C16	2007	592	587		
		J - C16				1,153	908
Bottom	Catfish	J - C15	2006	2,000	1,000		
Bottom	Grouper	J - C15	2005	8,266	5,595		
Bottom	Grouper	J - C15	2006	19,373	11,213		
		J - C15				29,639	17,808
Bottom	Catfish	J - C14	2005	1,260	1,260		
Bottom	Catfish	J - C14	2006	16,833	15,833		
Bottom	Grouper	J - C14	2005	8,526	5,915		
Bottom	Grouper	J - C14	2006	18,306	10,137		
Bottom	Shark	J - C14	2006	561	348		
		J - C14				45,486	33,493
Bottom	Catfish	J - C13	2005	1,260	1,260		
Bottom	Catfish	J - C13	2006	5,460	5,260		
		J - C13				6,720	6,520
Bottom	Shark	C16 - C14	2006	321	348		
		C16 - C14				321	348
Bottom	Catfish	C15 - C14	2006	1,000	1,000		
Bottom	Grouper	C15 - C14	2005	5,813	5,725		
Bottom	Grouper	C15 - C14	2006	11,436	11,442		
Bottom	Grouper	C15 - C14	2006-2007	204	106		
		C15 - C14				18,453	18,273
Bottom	Grouper	C15 - C13	2006-2007	460	257		
Bottom	Shark	C15 - C13	2006-2007	495	270		
		C15 - C13				955	527
Bottom	Catfish	C14 - C13	2005	1,260	1,260		
Bottom	Catfish	C14 - C13	2006	8,540	8,340		
Bottom	Catfish	C14 - C13	2006-2007	203	243		
Bottom	Catfish	C14 - C13	2007	280	280		
Bottom	Grouper	C14 - C13	2006-2007	213	257		
Bottom	Shark	C14 - C13	2006	280	280		
Bottom	Shark	C14 - C13	2006-2007	221	270		
		C14 - C13				10,997	10,930
			TOTALS	113,724	88,807		

Table 4.

Year	Vessels sampled	J Hooks sampled	C Hooks sampled	Total hooks	Trips observed	Obs. Effort (days)	Observed sets	
2005	17	54,314	197,738	252,052	46	856	507	Costa Rica
2006	17	102,530	177,276	279,806	42	745	397	Costa Rica
2007	6	13,972	36,358	50,330	16	202	124	Costa Rica
2004	69	16,858	30,625	47,483	173	2,461	362	Ecuador
2005	31	32,410	37,871	70,281	73	1,069	483	Ecuador
2006	49	36,450	67,331	103,781	95	1,281	549	Ecuador
2005	3	1,260	2,520	3,780	5	10	10	El Salvador
2006	3	1,400	2,800	4,200	5	9	9	El Salvador
2005	26	19,267	62,798	82,065	105	290	274	Guatemala
2006	32	55,723	201,611	257,334	325	947	810	Guatemala
2007	7	0	5,971	5,971	10	32	19	Guatemala
2005	5	71,010	162,315	233,325	20	291	221	Panamá
2006	3	10,503	142,852	153,355	23	313	243	Panamá
2007	6	29,321	93,342	122,663	18	235	171	Panamá
2005	7	21,905	23,852	45,757	31	422	210	Perú S
2005	9	9,534	18,637	28,171	13	214	105	Perú C
2006	8	10,906	10,875	21,781	9	121	68	Perú C
2007	5	5,299	5,275	10,574	6	77	45	Perú C
2005	9	43,238	32,259	75,497	11	177	96	Perú N
2006	6	25,243	26,770	52,013	17	246	126	Perú N
2007	6	14,943	12,352	27,295	12	161	80	Perú N
	324	576,086	1,351,428	1,927,514	1,055	10,159	4,909	

The evolution of the program is shown in the description of observed trips per year, Fig. 1:

Fig. 1: Number of observed longline trips per year



The spatial distribution of the effort is shown in Fig. 2a and 2b:
Fig. 2a:

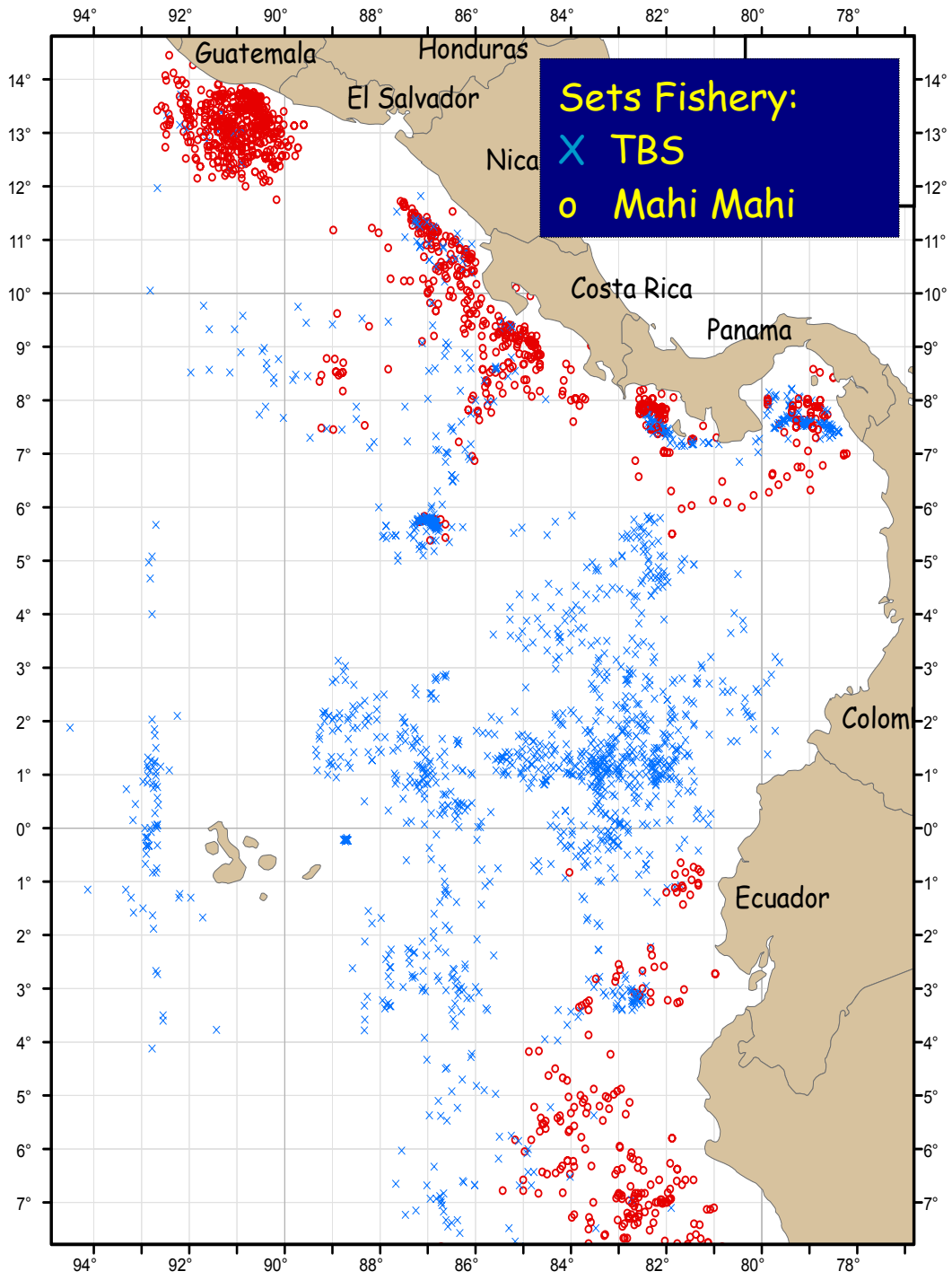


Fig. 2b:

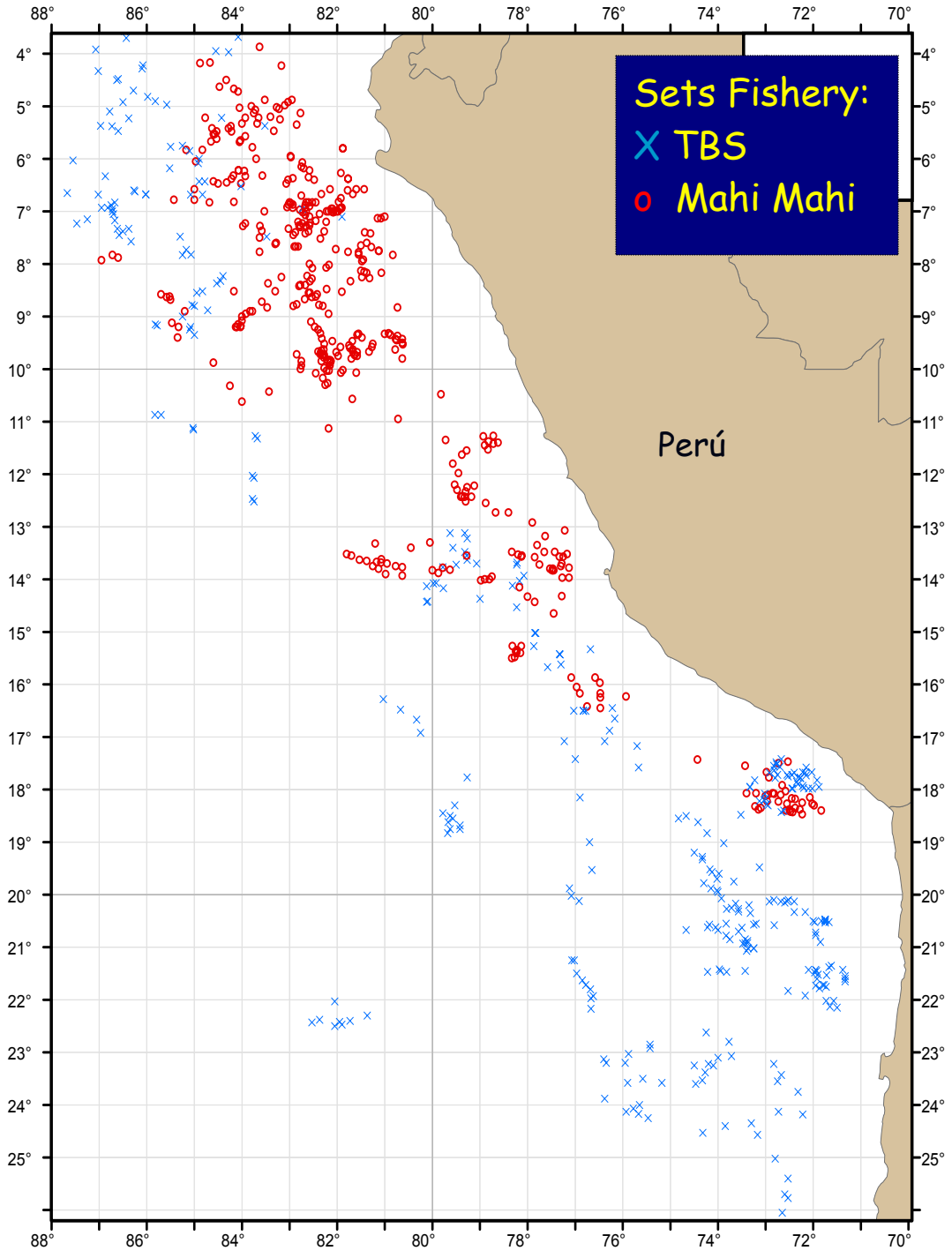
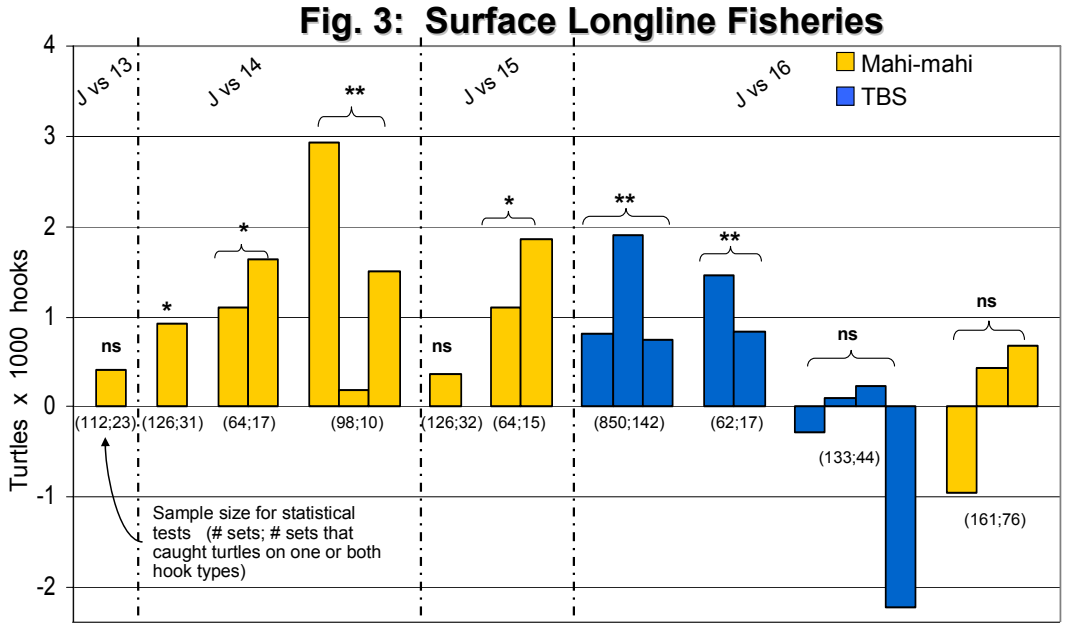


Fig. 2a and 2b: Spatial distribution of observed sets by fishery: blue crosses are sets on tunas, billfishes, and sharks; red circles are sets on mahi-mahi. Period 2003 – 2006.

STATISTICAL COMPARISONS OF SEA TURTLE HOOKING RATES

Preliminary results for the differences in hooking rates between J hooks and circle hooks are shown in Fig. 3:



Difference in overall hooking rates between J hooks and four types of circle hooks (*i.e.*, {[# turtles hooked on J hooks / # J hooks] – [# turtles hooked on C hooks / # C hooks]} x 1000), by fishing year, grouped according to fishery and port. 'TBS' indicates tuna, billfish and shark fisheries. Only those fisheries and ports with sufficient data for statistical tests of the difference in hook performance are shown. p-values associated with two-tailed tests of the null hypothesis of no difference in hook performance, by fishery and port, are indicated as follows: 'ns' – p-value > 0.10; '*' – p-value ≤0.10 but > 0.01; '**' – p-value ≤ 0.01. Statistical tests are described below.

Each vertical bar represents a port-year combination, and each group of bars represents the years a port has been sampled. The names of the ports have been omitted because they were not needed to make the point . The values on the y-axis represent the difference in hooking rates (rate for J hooks versus rate for circle hooks). If they are positive (over the 0 (zero) line), it means that the J-hooks had higher hooking rates than the circle hooks. For instance, a value of +2.0 means that by replacing the J hooks by the circle hook tested in that case, reduces turtle entanglements by 2 individuals per 1000 hooks, or 2000 turtles per million hooks.

The y-axis shows the difference in overall hooking rates between J hooks and four types of circle hooks (i.e., {[# turtles hooked on J hooks / # J hooks] – [# turtles hooked on C hooks / # C hooks]} x 1000), by fishing year, grouped according to fishery and port. 'TBS' indicates tuna, billfish and shark fisheries. Only those fisheries and ports with sufficient data for statistical tests of the difference in hook performance are shown. p-values associated with two-tailed tests of the null

hypothesis of no difference in hook performance, by fishery and port, are indicated as follows: 'ns' – p-value > 0.10; '*' – p-value ≥ 0.10 but < 0.01; '**' – p-value ≤ 0.01. Statistical tests are described below.

The asterisks show that most of the values are significant with a conservative test. For some locations however, the results are less positive than for others, and there is a need to continue exploring alternatives.
Tests for differences in the performance of the different hook types (J versus 'C') were conducted as follows.

- Testing was done by fishery within ports. Tests were performed only when sufficient data were available (10 or more sets caught turtles). Data differed among ports and fisheries in terms of line characteristics, number of years of data available for analysis, and bait types.

- The main test of hook performance was based on the paired differences in the per-line hooking rates.
For most fisheries and ports, many sets did not catch turtles. Thus, data used in this analysis were limited to lines that caught turtles on one or both types of hooks. This restriction was used because zero values for paired differences can arise in two ways: no turtles being caught at all on the line, or the same per-line hooking rate for the two hook types. When no turtles were caught on the line, it is not known whether no turtles were in the area (i.e., effectively no experiment was performed) or whether turtles were in the area but none were hooked.

- To test the null hypothesis of no difference in hooking rates between the two types of hooks, it was assumed that the mean difference in hooking rates could be modeled by an overall constant, and, when appropriate, a year effect and/or an 'other' hook effect (to account for any effect of multiple 'C' hooks). In addition, because of differences in mother line length between sets, which appeared to affect variability in hooking rates, it was assumed that the variance of the paired differences in hooking rates was an approximately linear function of line length. This model was fitted to the data, using generalized estimating equations (geese of geepack in the R statistical software package). P-values for a test of the null hypothesis of no difference in hook performance were based on the Wald test (twotailed test).

- Because the analysis of paired differences excluded lines that caught no turtles, which may exclude useful information, a second test of differences in hooking rates was also performed using logistic regression to model the log of the odds that a hook caught a turtle (year and 'other' hook effects included, as appropriate). Tests of the null hypothesis were based on a t statistic (two-tailed test).

Although results of this analysis were consistent with those of the tests of the paired differences in hooking rates, the logistic regression model used in these preliminary analyses has the shortcoming that it does not explicitly take into account the pairing of hooks on the line, nor any effect of main line length on variability in the data. Future work will explore modeling these data with zero-inflated mixed-effect models.

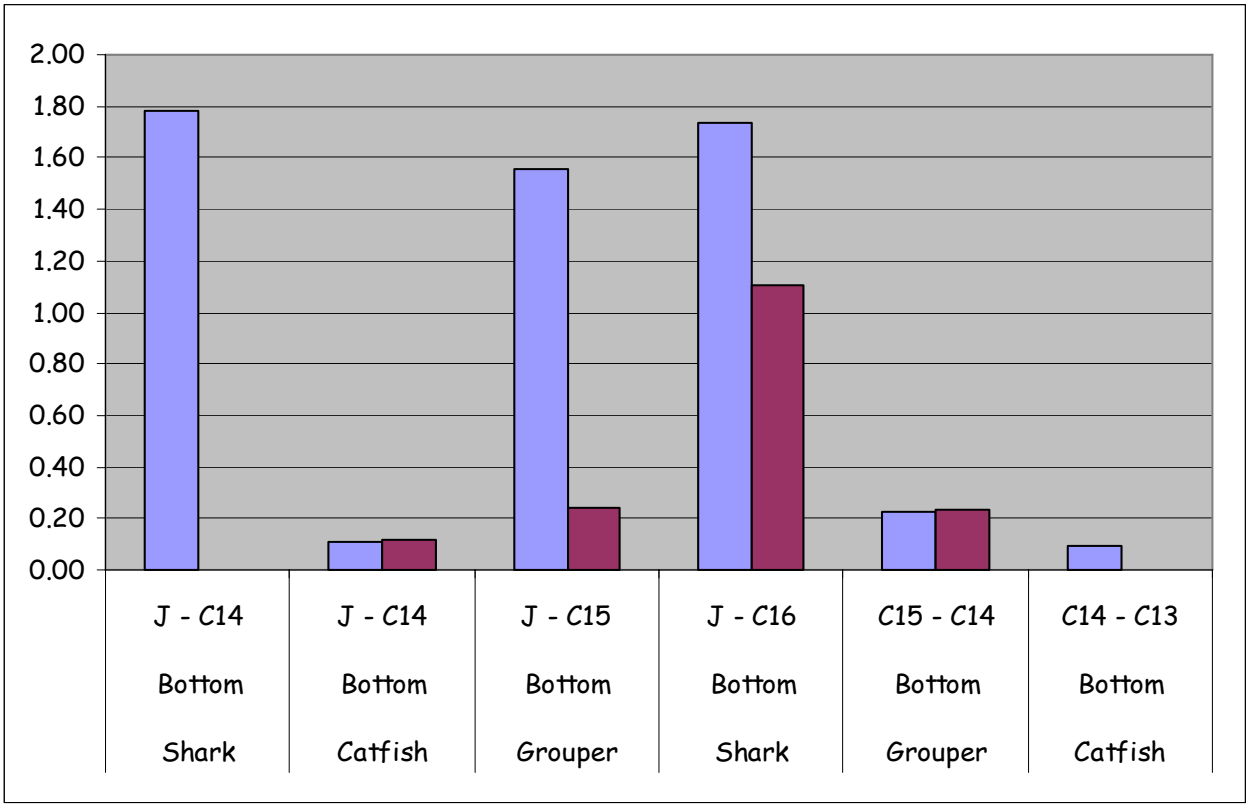
- Neither analyses above accounts for any effects of bait on hook performance, nor does either account for the grouping of sets within trips and vessels. Accounting for bait effects is made difficult because the proportions of the different baits were not known when several bait types were used. To address this issue, the above analyses were repeated for sets that only used squid bait. This could only be done for a few ports and fisheries. However, the results were consistent with those of the analyses performed on the larger data sets. Accounting for the grouping of sets within trips and vessels was not done in these preliminary analyses because not all trips/vessels were represented in the data by more than one set. Of the two, it is believed that vessel effects may be more important, and this will be explored in the future.

- For the reasons stated in the previous paragraphs, because of the diversity and variability of the fisheries involved, and because of the number of variables (not always controlled) that appear to have the potential to affect the results, these should be considered very promising, but still preliminary.

BOTTOM LONGLINE COMPARISONS

The hooking rates in J hooks and in Circle hooks for the different comparisons available in bottom longline fisheries are shown in Figure 4 below. Even in these fisheries there is a considerable reduction in hooking rates with the circle hooks. The data for this figure comes mostly from the Guatemala and Panama databases, so it is considered representative of Central American fisheries.

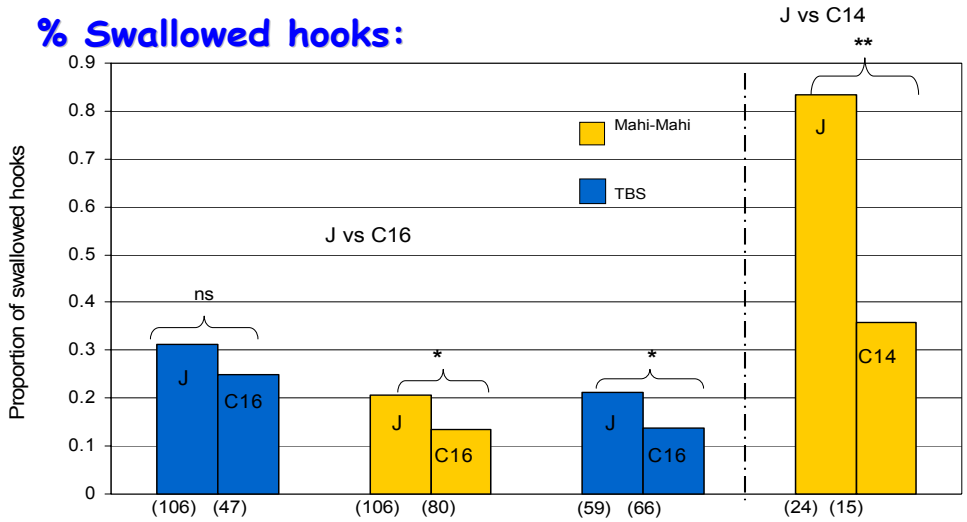
Fig. 4: Sea turtle hooking rates for different bottom longline fisheries from Central America (J hooks, or first listed circle hook in blue)



PROPORTION OF HOOKS SWALLOWED

Circle hooks also reduce the proportion of hooks swallowed deeply by the turtles which may lead to additional mortality. In this case, the statistical tests are performed after pooling years, since there is no reason to expect interannual effects in what basically is a physical process. Figure 5 summarizes the results for comparisons of J hooks versus C16 hooks in some cases, and versus C14 in another case.

Fig. 5: Proportion of hooked turtles that swallowed the hook, by fishery and port (data pooled over years), for J hooks and two types of circle hooks ('C').



Proportion of hooked turtles that swallowed the hook, by fishery and port (data pooled over years), for J hooks and two types of circle hooks ('C'). 'TBS' indicates tuna, billfish and shark fisheries. Only those fisheries and ports with sufficient data are shown. p-values associated with two-tailed tests of a 'hook-type effect,' by fishery and port, are as follows: 'ns' – p-value > 0.10; '*' – p-value ≥ 0.10 but < 0.01; '' – p-value ≤ 0.01. Sample sizes for statistical tests (# turtles) are shown in parentheses. Statistical tests are described below.**

Notes: 'TBS' indicates tuna, billfish and shark fisheries. Only those fisheries and ports with sufficient data are shown. p-values associated with two-tailed tests of a 'hook-type effect,' by fishery and port, are as follows: 'ns' – p-value > 0.10; '*' – p-value ≥ 0.10 but < 0.01; '**' – p-value ≤ 0.01. Sample sizes for statistical tests (# turtles) are shown in parentheses.

CHANGES IN HOOKING LOCATION BY HOOK TYPE AND SIZE

Besides the proportion of hooks swallowed, it was of interest to explore the distribution of hooking locations for different types and sizes of hooks. Figures 6 to 12 show the observed distributions for several paired comparisons:

This is just a preliminary look at this subject; models including vessel and bait effects, etc., must be considered to interpret the results.

1) Comparisons J hooks versus Circle hooks:

Fig .6: Comparisons J hooks versus Circle hooks C16/0

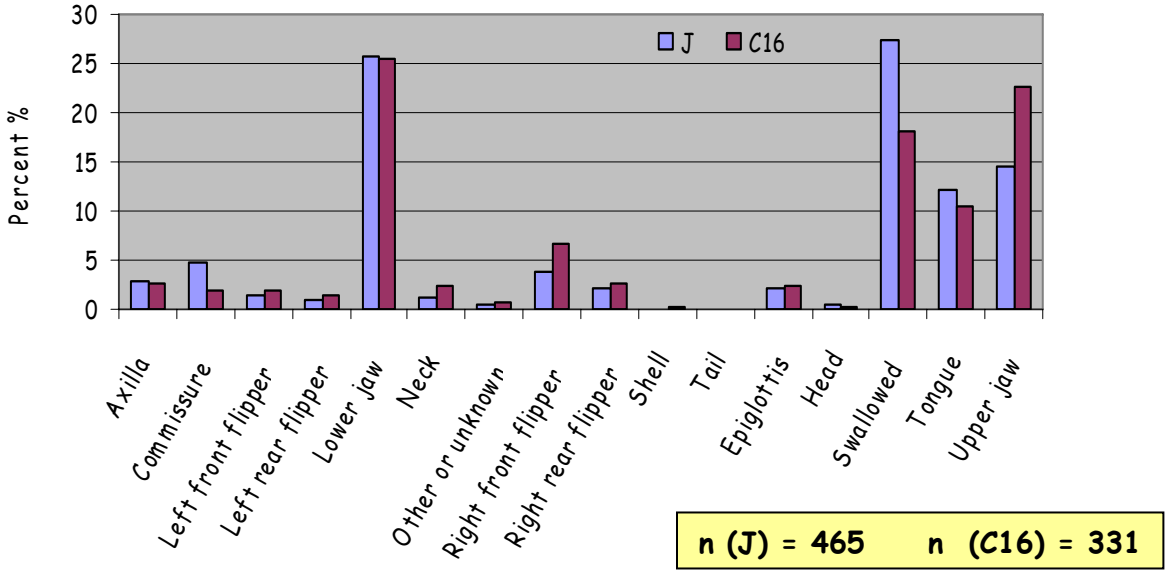


Fig. 7: Comparisons J hooks versus Circle hooks C15/0

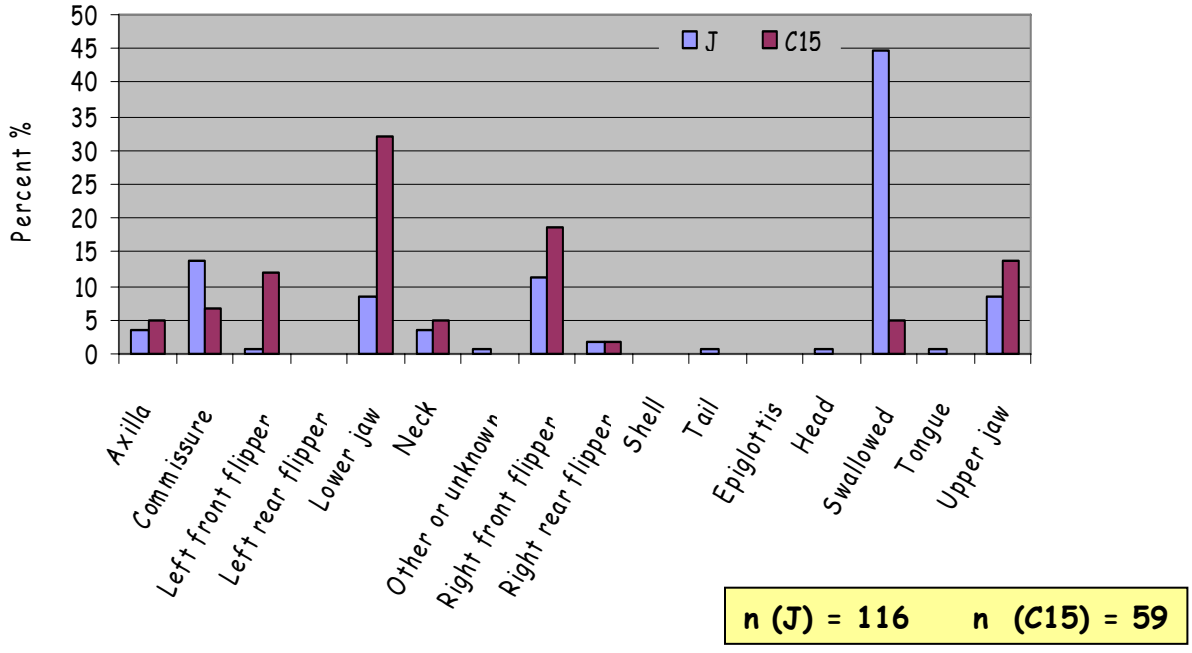
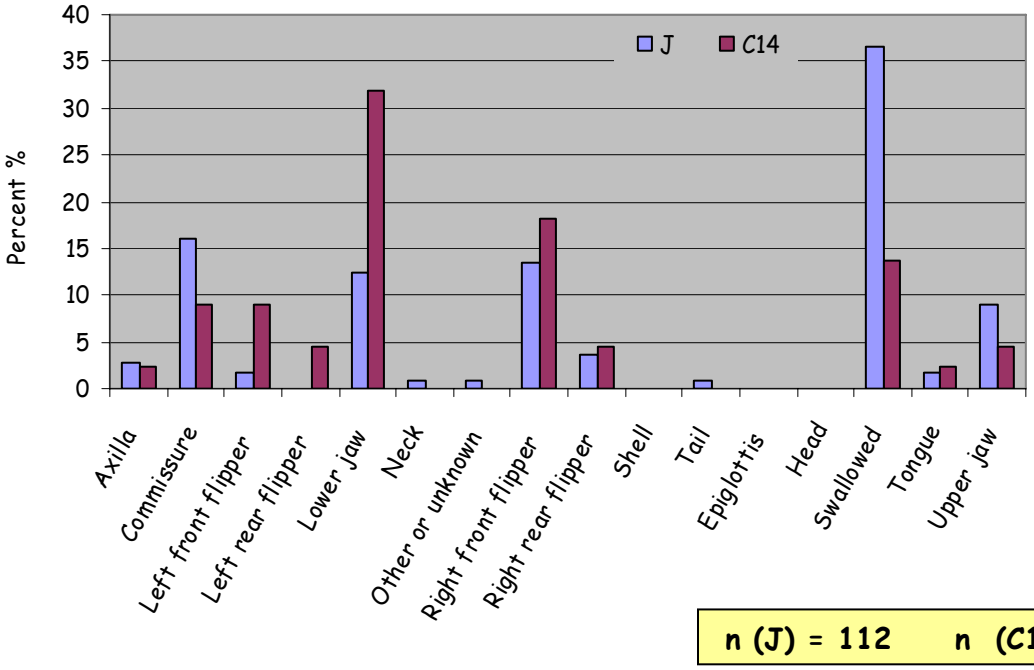
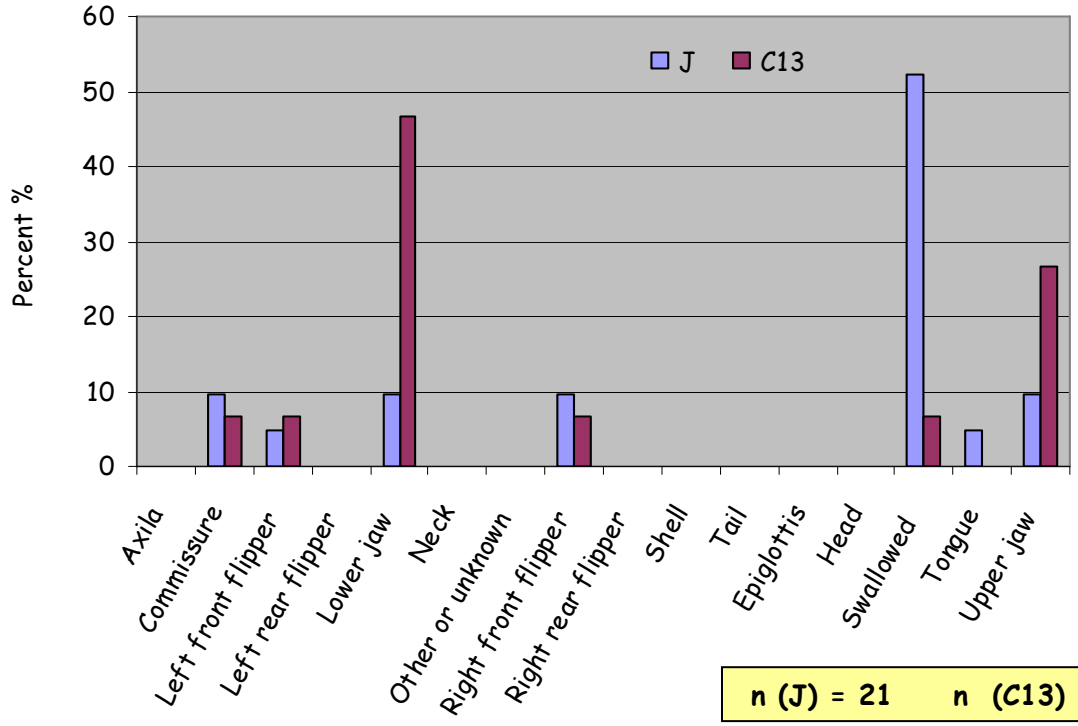


Fig. 8: Comparisons J hooks versus Circle hooks C14/0



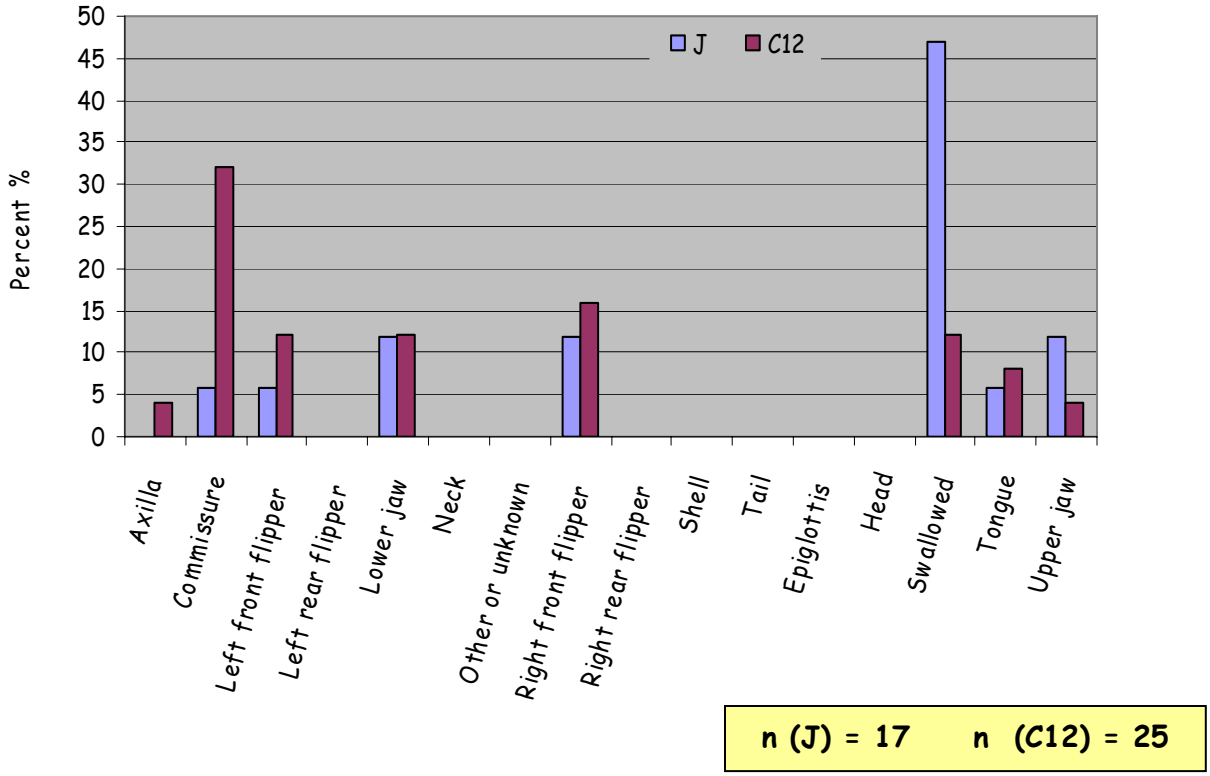
n (J) = 112 n (C14) = 44

Fig. 9: Comparisons J hooks versus Circle hooks C13/0



n (J) = 21 n (C13) = 15

Fig. 10: Comparisons J hooks versus Circle hooks C12/0



In must cases, the reduction in proportion of swallowed hooks between the control J hooks and the Circle hooks is the most visible difference. This difference remains even for the smallest circle hooks tasted. Many of these hooks may end up in the jaws.

Fig. 11: Comparisons Circle hooks C16/0 versus Circle hooks C15/0

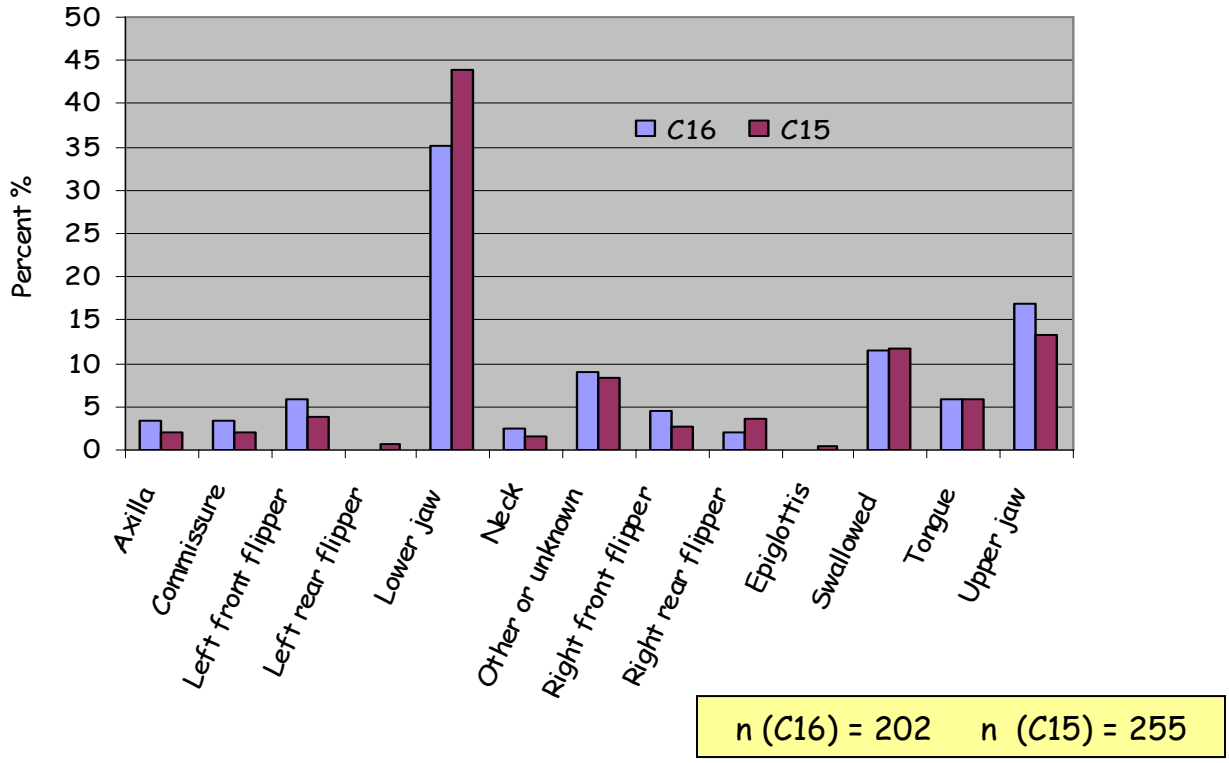
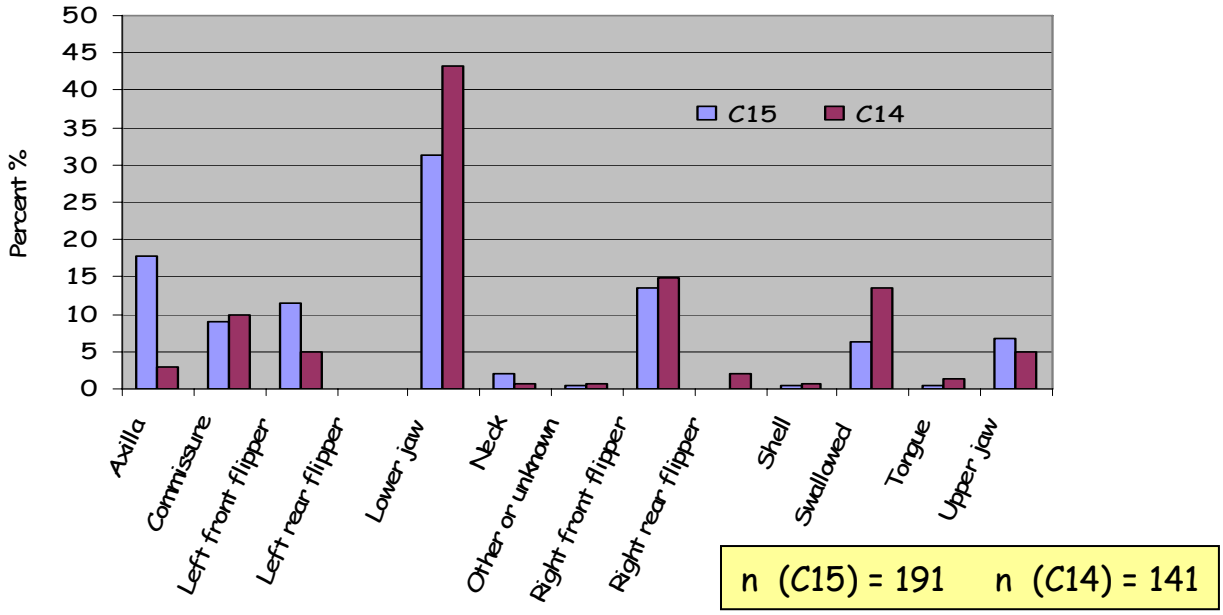


Fig. 12: Comparisons Circle hooks C15/0 versus Circle hooks C14/0



The clearest difference is almost always on the proportion swallowed

PRELIMINARY RESULTS ON HOOK TYPE AND SIZE ISSUES:

Different types and sizes of hooks have been tested in the eastern Pacific fisheries. Statistical analyses have only been performed on the cases with the most abundant data. Here we report on some comparisons that have not been tested yet, but that help understand the evolution of the program, and show potential for improvements, and limits not to be exceeded.

As the mahi-mahi fisheries from South America were showing lower catch rates when we tested C14/0 and C15/0 circle hooks, a limited test was performed using smaller circle hooks, sizes C13/0 and C12/0. The hooking rates below (Fig. 13) show that there is not any gain when using C12/0, so C13/0 seems to be the smalles size that can have a positive impact, lowering sea turtle hooking rates. Unless the hook designs are modified in some manner (e.g. by the additionof wires, etc.) we will not continue testing hook sizes below C13/0.

Circle hooks sizes C14/0 and C15/0 in general show considerable reductions in sea turtle hoooking rates (Figure 14), although not in the order expected (larger C15/0 hooks were expected to reduce rates more than C14/0 hooks.)

Fig. 13: Sea Turtle Hooking rates
Comparison J -- C13/0 -- C12/0
Mahi-mahi - Manta

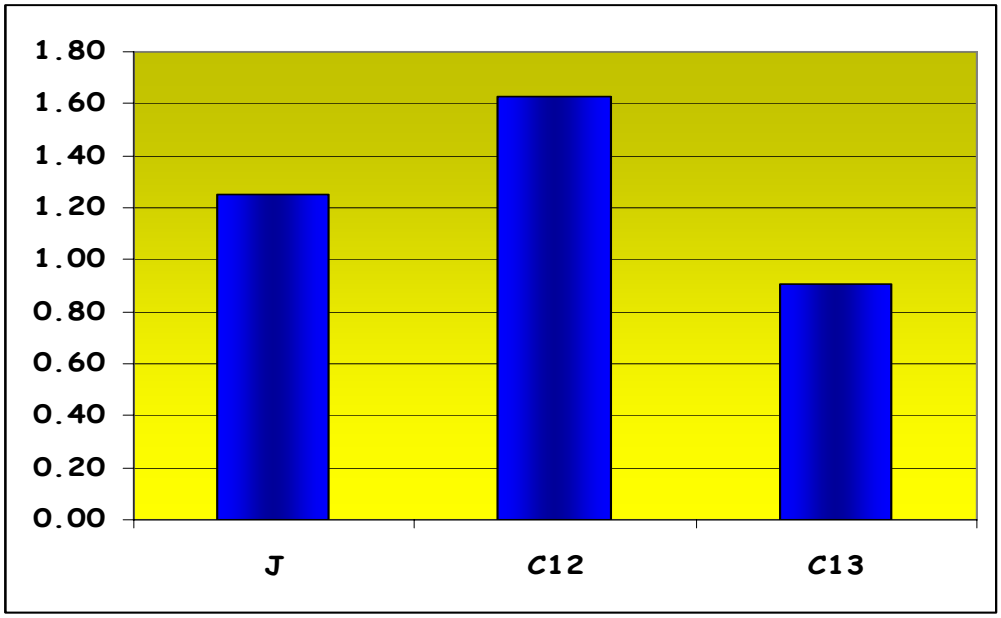
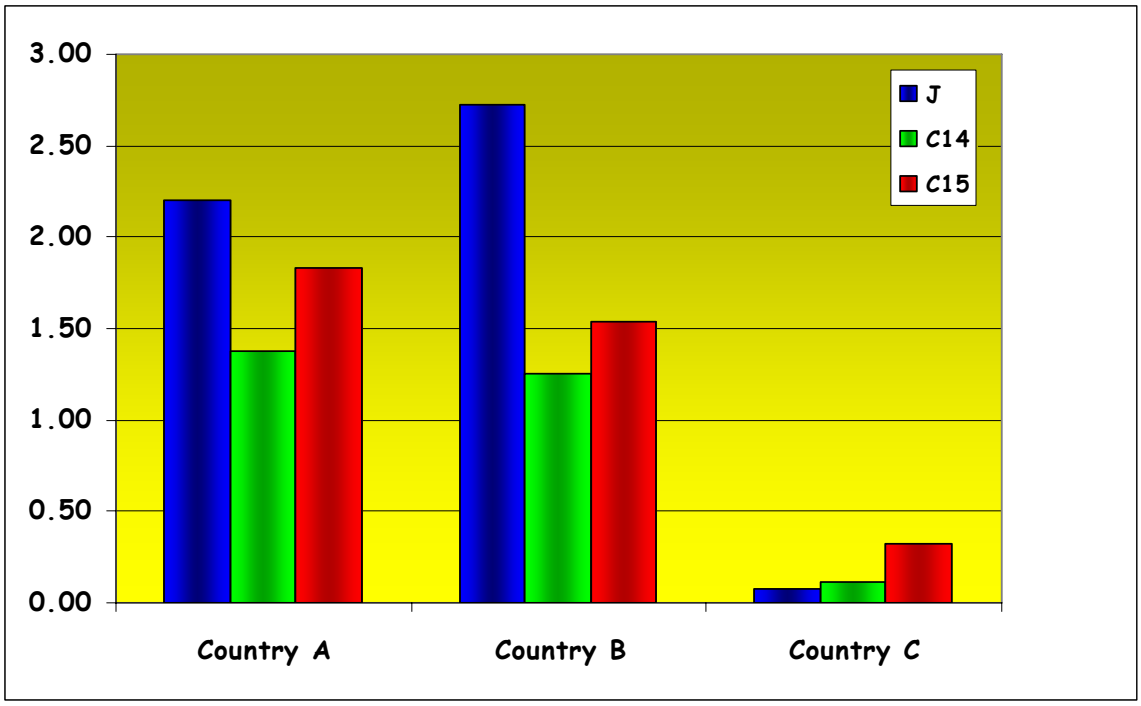
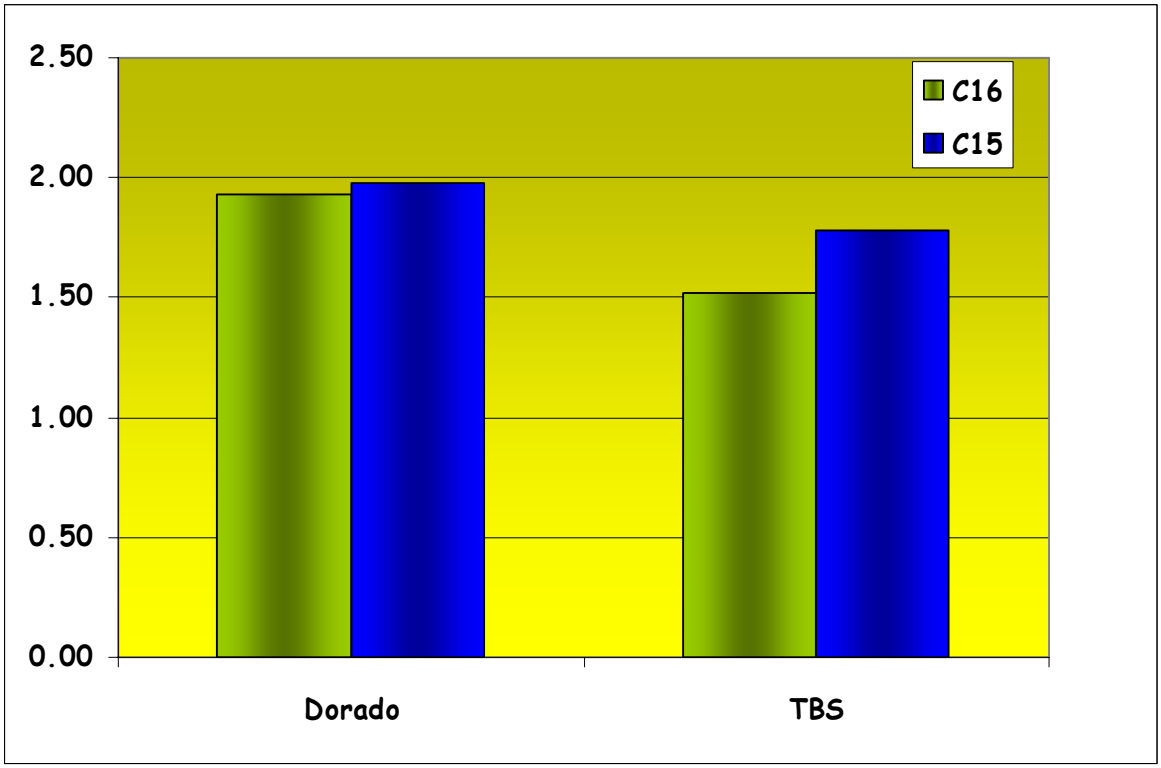


Fig. 14: Sea Turtle Hooking rates
Comparison J -- C15/0 -- C14/0
Mahi-mahi fisheries



In other cases, there was interest on the part of fishers to test C16/0 instead of C15/0 hooks. The results show much smaller differences in the mahi-mahi fisheries that use these hooks (mostly in Central America), and a more interesting 15% reduction in the TBS fisheries.

Fig. 15: Sea Turtle Hooking rates
Comparison C15/0 vs C16/0
Puntarenas - Costa Rica



In the year 2006, tests of C16/0 hooks with a ring in the eye were performed in Ecuador. The results show a good reduction in sea turtle hooking rate (- 55%), and an interesting increase in the target hooking rate (+25%). This may help make the circle hooks acceptable for the fishers.

Fig. 16: TBS 2006 Ecuador
Tests of rings
J vs C16 R

	J	C16 + R		Effect of Ring
Sample size (Nr Hooks)	17950	17897		
Sea turtle hooking rate	2	0.9		55 % down
Target Hooking rate	23.2	29.5		25 % up

Another small test was performed to compare the same size of hook, but with and without ring in the eye. The results show that the presence of the ring increases the sea turtle catch rates, at the same time as it increases the target catch rates. More tests are needed to verify this result.

Fig. 17: TBS 2006 Ecuador
Tests of rings
C16 R vs C16 No R

	C16 R	C16 NoR	Effect of Ring
Sample size (Nr Hooks)	8124	7709	
Sea turtle hooking rate	1	0.5	Doubles
Target Hooking rate	27.8	22.2	25 % up

CATCH RATES FOR THE TARGET SPECIES

In the mahi-mahi fishery based in Peru and Ecuador, however, the catch rates were lower with circle hooks (Fig. 18), which is hampering the exchange of hooks. We have began testing hooks with an added wire in the side opposite the point as an additional option to reduce deep hookings. Catch rates for control J hooks are shown paired with the experimental circle hooks, for each country-year combination.

The catch rates for the target species were about the same for the large J hooks and the C16/0 hooks in the TBS fisheries (Fig. 19, aggregated by country).

In bottom longlines, the catch rates are quite similar, or the circle hooks are higher, except for 2 clear exception. More data will help clarify these differences.

Fig. 18: Target hooking rates
Mahi-mahi fisheries (fish per 1000 hooks)

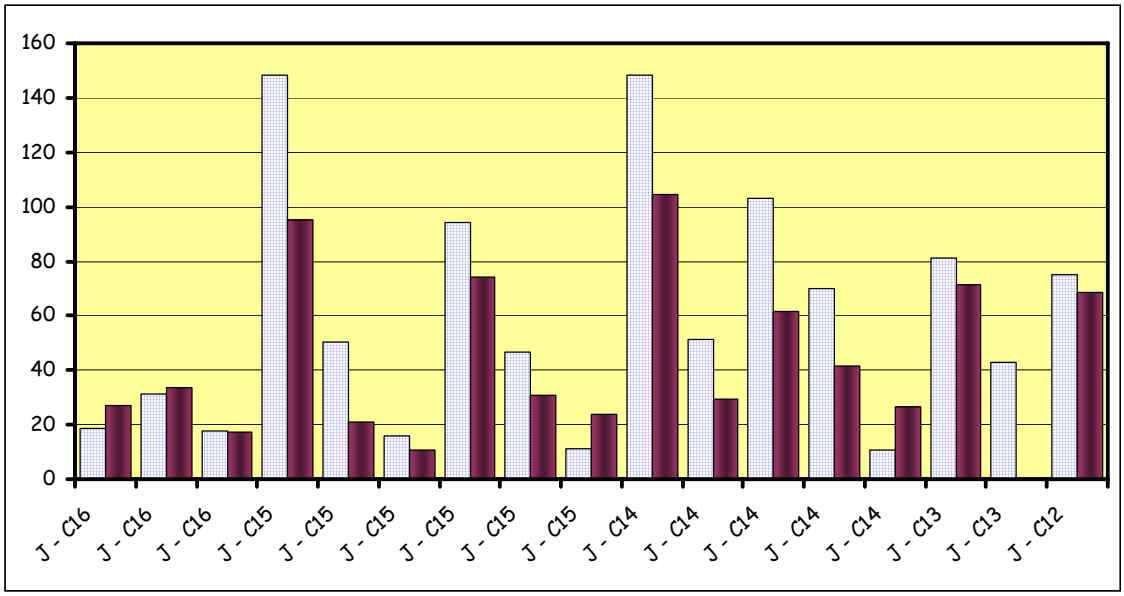


Fig. 19: Target hooking rates
TBS fisheries (fish per 1000 hooks)

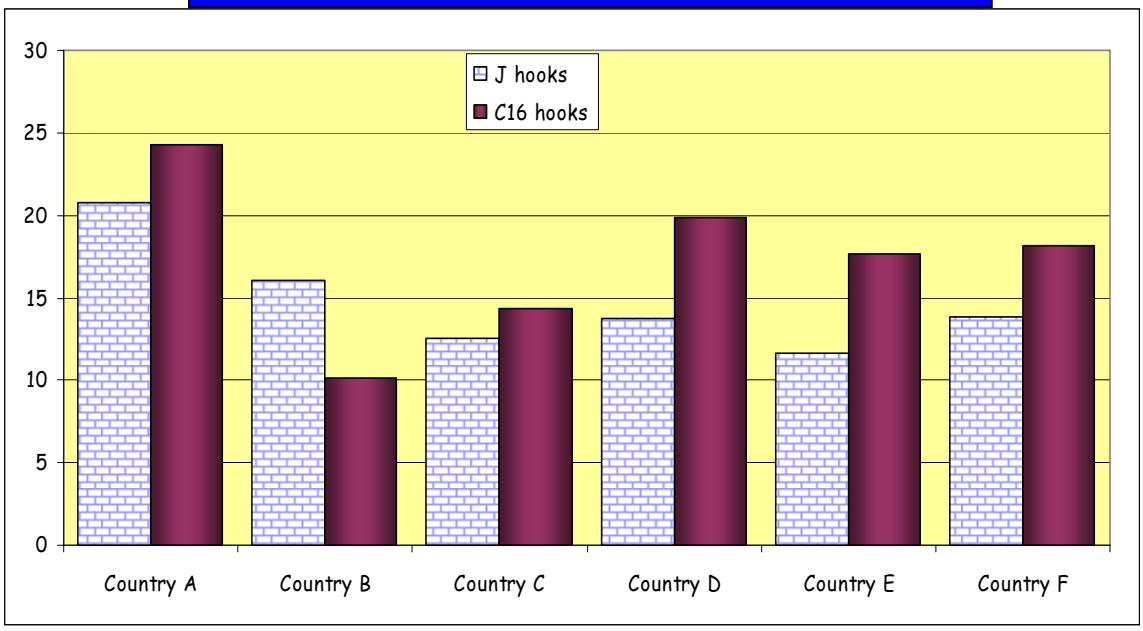
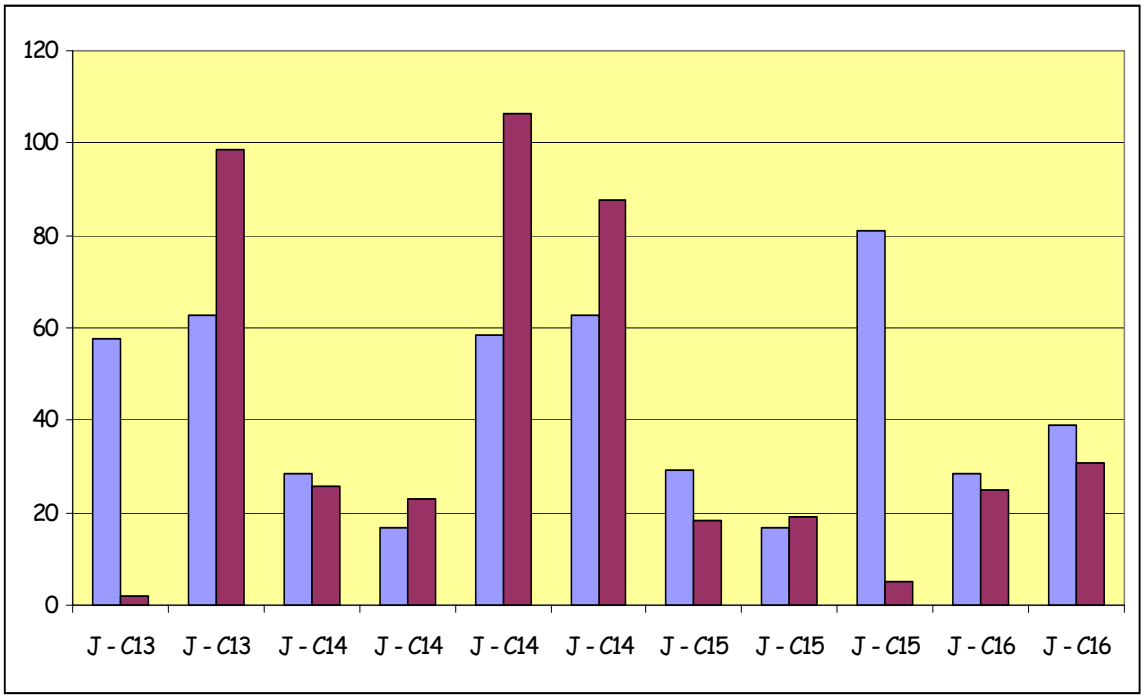


Fig. 20: Target hooking rates
Bottom longline fisheries (fish per 1000 hooks)



HANDLING OF HOOKED SEA TURTLES

"Dehookers," which make it easier and less traumatizing to remove the hooks from the turtles, have been distributed to fishermen, including those who have not had observers aboard their vessels, and they have been instructed in their use. In a recent experiment sponsored by the OFCF, a veterinarian was invited to accompany the fishing trip, to examine the procedures used, and the impacts on the turtles of the hooks and of the dehooking process.

She had an opportunity to interact with observers and fishers, discuss the techniques they used, compare the different instruments available, and help us identify the best options, given the constraints of the work in the boats. Turtles were brought to the main boat with the hook, and all the removal process took place on the deck, documenting with photographs the procedures, and the injuries left after removal. Some anatomic characteristics of the turtles, such as the the nature of the esophagus play a major role in reducing the injuries sustained during hooking and removal. Yet, there are ways to handle the turtles, and instruments, that can help them, and it is necessary to identify and communicate these procedures.

This knowledge will be used to improve the guidelines given to observers and fishers to retrieve the hooks.

ESTABLISHMENT OF AN OBSERVER DATA BASE AND QUALITY CONTROL OF THE DATA

The observer database has been continuously improved to reflect our increasing knowledge and understanding of the conditions prevailing in the fishery and of the factors that are relevant to the analysis of causes of hookings or entanglements. The database has been standardized throughout the region, and they are also completely consistent. Summaries of the data have been prepared, and the results have been discussed with the participants in each country. Especially important is the understanding of the similarities and differences among fisheries with respect to gear, mode of operation, etc.

FUTURE DEVELOPMENTS

The bottom-up approach to change, trying to convince fishermen to fish sustainably and increase the selectivity of their fishing operations is proving successful. The model shows real life evidence, coming from fishermen's own fishing trips, of the benefits of the gear substitution and best practices for the turtles, and also the absence of negative impacts on the target catches. This approach seems to match fishers' own cultural and social learning process and the way they adopt innovations in gear and techniques. Based on this assessment, the future of the program is projected along the same methodological and "philosophical" lines, building on the trust developed over the initial years, on the voluntary basis that has prevailed, and on the basic premises that give us a common ground.

- From the scientific point of view, there are many improvements that should be made to the data collection process, going from observer training to variable definition. In future data exploration, analysis, and experimental design we need to pay special attention to issues such as hook type (variations within the broad types of circle hooks, J and Japanese tuna hooks, affecting size and shape), and try to improve the handling of some variables of obvious importance but very difficult to control and track (bait type, size).

- Explore other models that account for differences in variance associated with length of fishing gear.

- Adding a wire to a hook on the side opposite the tip, with an angle of around 45 degrees from the shank, makes the hook wider without affecting the biting end. This has reduced gut hooking in fishes, and it may help also to reduce deep hooking in sea turtles. As the initial experiments were promising, the exploration of hooks with added wires, will continue.

- Continue the study of sea turtle entanglements, and their mitigation options, especially the replacement of line materials in the sections near the floats.
- Integrate new on-board turtle handling techniques with recommendations obtained from wildlife veterinarians.

- Commence the planning for full implementation of the changes already tested in some fishing locations, as a pilot project for the general change at the regional level.

PARTICIPATING AND COOPERATING INSTITUTIONS

PERU: IATTC – WWF (Peru)

Timeline: Peru joined the regional sea turtle program in 2004. We started with 3 bases in Paita , Pucusana and Ilo, and NGOs or WWF-contractors covering each of them. Participant organizations include WWF Peru, ACOREMA, and APECO. Another valuable participant is the Frente Integrado Unido Pescadores Artesanales del Peru (FIUPAP), the national federation of fishers. They have accompanied us in several workshops, made contacts for many others, and helped in many ways. Contacts on the Govt. management side, at the Ministry of Foreign Affairs the Focal Point for the InterAmerican Sea Turtle Convention, at the Ministerio de la Produccion (PRODUCE,), and on the research side Instituto del Mar del Peru (IMARPE). An important institution is the Centro de Entrenamiento Pesquero de Paita, organizers of an international training course on longlining for fishers of the continent, where we have participated regularly.

ECUADOR: IATTC – OFCF –WWF – WPRFMC

The program was started following a request of Ingro G. Moran (technical advisor to the Association of Exporters ASOEXPEBLA), to the then Subsecretaria de Recursos Pesqueros (Lucia de De Genna), who transmitted the request to IATTC to develop a program to mitigate sea turtle mortality. The initial round of workshops included IATTC and NOAA staff (Swimmer, Mitchell, Bergmann). Other important participants include: ASOEXPEBLA (Asociacion de Exportadores de Pesca Blanca), Escuela de Pesca del Pacifico Oriental, ESPOL (Escuela Politecnica del Litoral), PROBECUADOR, Camara de Pesqueria, and the Ecuadorian Federation of Artisanal Fishers, FENACOPEC.

PANAMA: IATTC – OFCF – WWF – NOAA
The program is coordinated with the Aquatic Resources Authority of Panama, and the Maritime Authority of Panama.

COSTA RICA: WWF (Central America) – IATTC
Partners in Government: INCOPESCA (Instituto Costarricense de Pesca y Acuacultura), in Industry: CNIP (Camara Nacional de la Industria Palangrera), CANEPP (Camara Nacional de Exportadores de Productos Pesqueros), CAPAP (Camara de Pescadores Artesanales de Puntarenas, FENASPES (Federacion Nacional de Pescadores).

EL SALVADOR: WWF (Central America) – IATTC - CENDEPESCA
Partners in Government: CENDEPESCA y CCCNPESCA (Consejo Consultivo Cientifico Nacional de Pesca y Acuacultura), and several fishers cooperatives.

GUATEMALA: WWF (Central America) – IATTC – UNIPESCA (Unidad de Pesca y Acuacultura) - PROBIOMA (M. Jolon, R. Sanchez).
Partners in Industry: APASJO (Asociacion de Pescadores del Puerto de San Jose), FENAPESCA (Federacion Nacional de Pescadores), ASOCHAMP (Asociacion de Pescadores de Champerico).

MEXICO: WWF (Mexico) – IATTC – Defenders of Wildlife (Mexico) – CONAPESCA (Comision Nacional de Acuicultura y Pesca) – INP (instituto Nacional de la Pesca) – PROFEPA (Procuraduria Federal de Protecction del Ambiente)
Many local partners, including the different Centros Regionales de Investigacion Pesquera (from INP), Centro Mexicano de la Tortuga, Univ. Autonoma de Sinaloa, etc.

EXPERIMENTS

Over the past 3 years, the following experiments have been performed:

Hook Comparisons:

The following hook comparisons are being/have been studied in the eastern Pacific, surface longline fisheries using observers in commercial fishing operations:

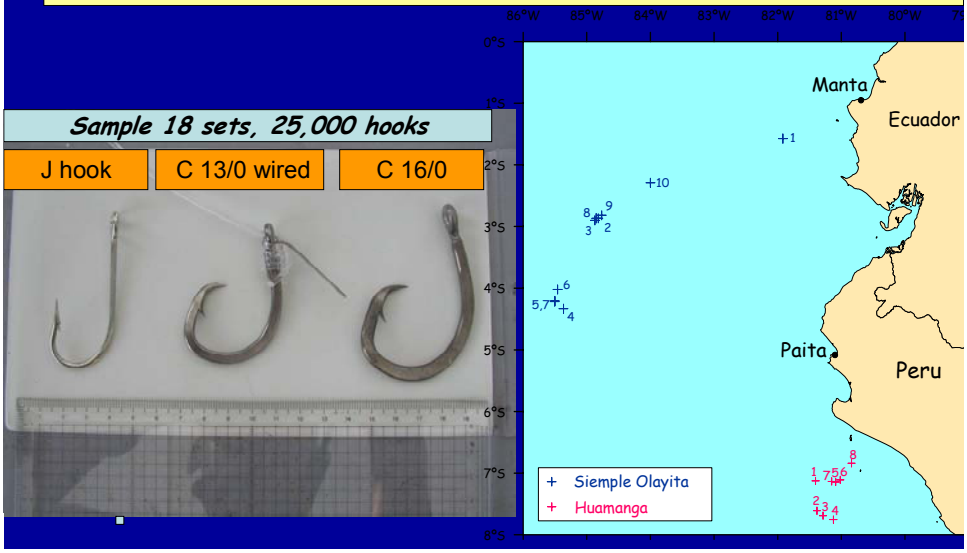
		Hook1	Hook2
TBS	J - C14	2,075	2,740
TBS	J - C15	4,238	4,578
TBS	J - C16	220,689	210,503
TBS	J - C18	22,046	22,450
TBS	C18 - C16	10,998	11,331
TBS	C16 - C15	48,357	45,294
TBS	C16 - C14	2,006	2,740

TBS	C15 - C14	1,479	1,485
Mahi-mahi	J - C16	71,680	71,203
Mahi-mahi	J - C15	44,092	45,961
Mahi-mahi	J - C14	48,865	46,599
Mahi-mahi	J - C13	16,925	16,823
Mahi-mahi	J - C12	13,821	13,731
Mahi-mahi	C16 - C15	66,328	77,537
Mahi-mahi	C15 - C14	122,639	114,600
Mahi-mahi	C15 - C13	15,369	9,521
Mahi-mahi	C14 - C13	12,715	14,057
Mahi-mahi	C13 - C12	14,386	14,395

Experiments with wired hooks:

Experiment 1 (from Peru, Ecuador): Comparison of J hooks, C13/0 with wire and C16/0

Fig. 21 Research project authors:
Takahisa Mituhasi, Charles Bergmann,
Manuel Parrales, Jairo Calderon, Martin Hall



Experiment 2 (from Ecuador): J hooks, J with wire, and C13/0
Analyses in progress

Fig. 22 Research project authors: Takahisa Mituhasi, Yoshiro Hara, Manuel Parrales, Liliana Rendon, Jorge Villavicencio

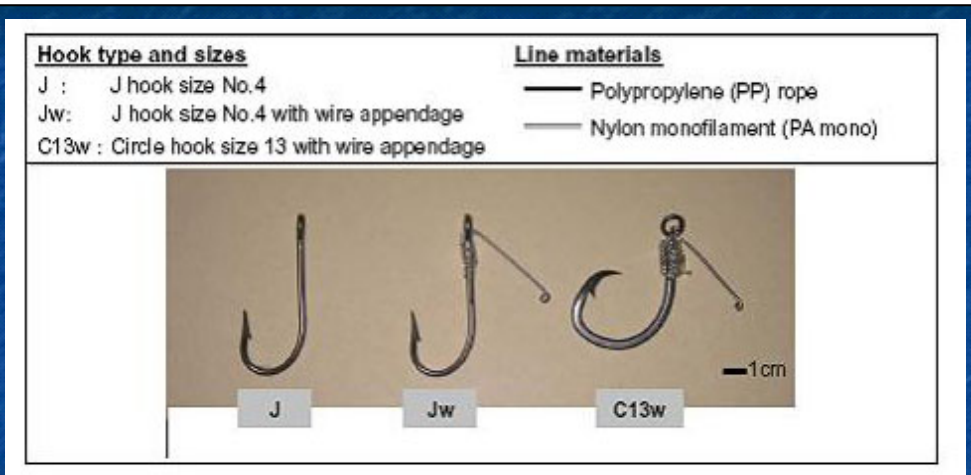


Figure by T. Mituhasi

Entanglement experiments

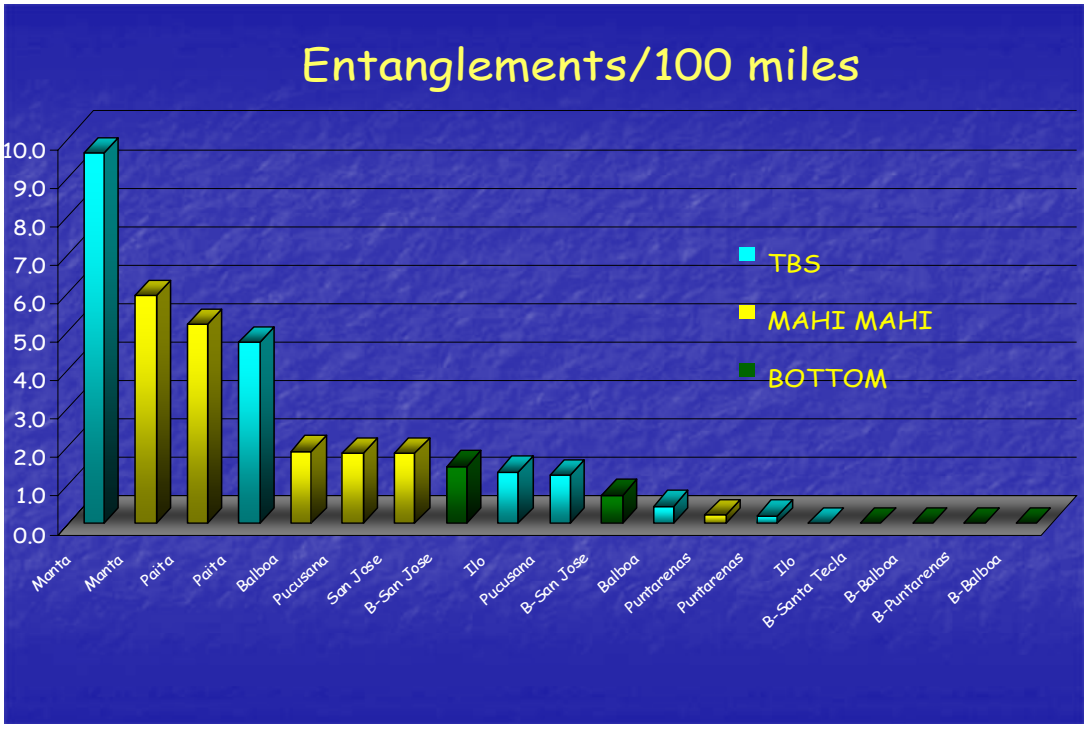
A statistical comparison (Fig. 23) showed clearly that the type of lines used in Ecuador and Peru had much higher entanglement rates than those used in other regions.

Entanglements can be a problem if the turtle is left with gear on, or if the turtle is injured in the process of attempting to disentangle. Polypropilene lines are prevalent in Ecuador and Peru, and this material has a tendency to float. In other regions, the monofilament lines sink, and therefore spend a lot less time on the surface of the water, with a much lower chance of a turtle becoming entangled.

After the comparison, it was decided to run a series of experiments looking for ways to mitigate the problem that sometimes leads to mortality.

Fig. 23:

Polypropilene Lines	7.8 entanglements/100 miles
Monofilament Lines	0.85 entanglements/100 miles



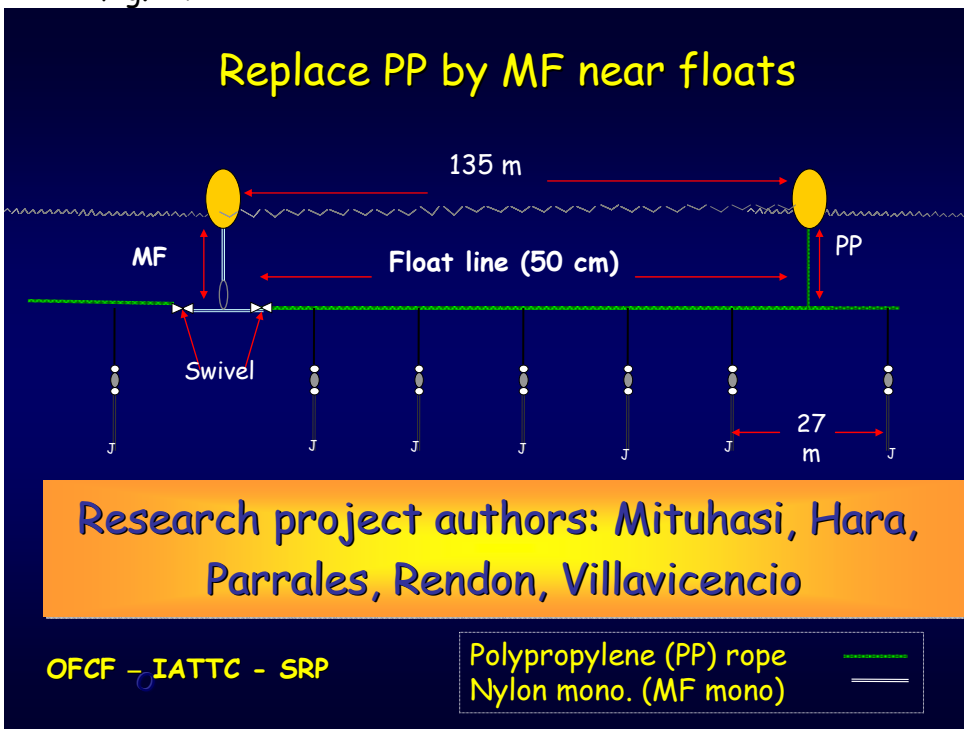
Experiment and analyses:

At the technical meeting of our regional program last year, a number of possible approaches were suggested and discussed by the attendees. Among them:

a) Replace the portion of the line closer to the float with monofilament fig. 24

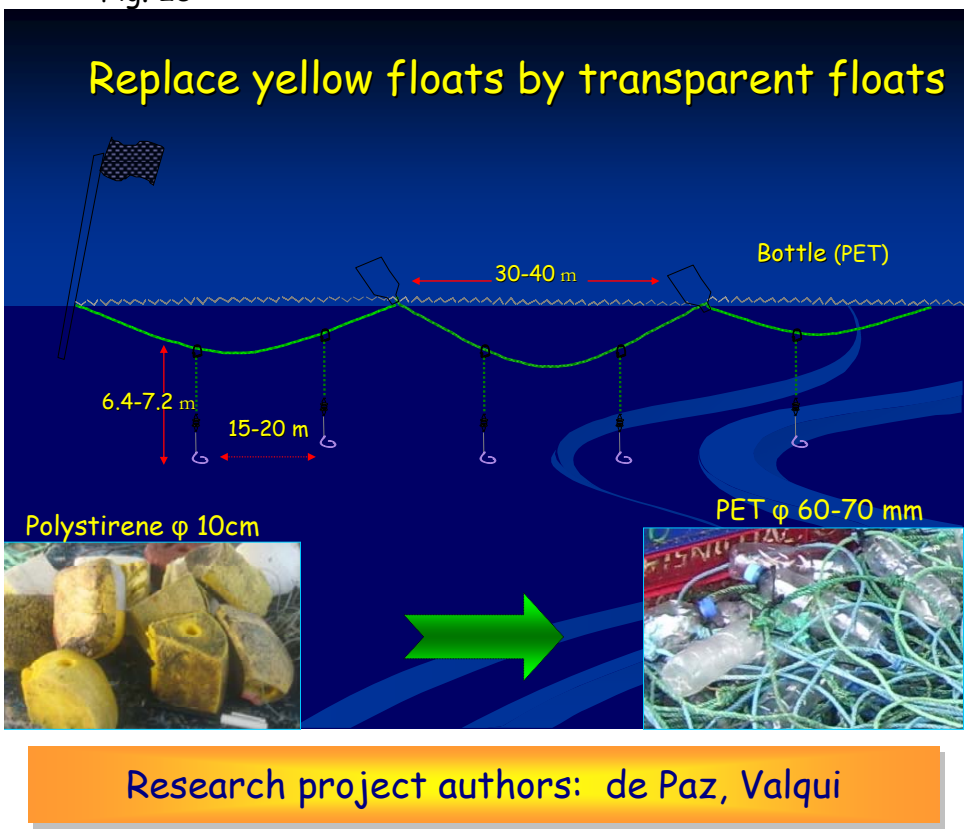
Treatments: Polypropylene line (PP)
Monofilament line (MF)
PP line with MF floatline

Fig. 24:



b) Replace floats by less attractive floats

Fig. 25:



Final summary

- Circle hooks better or equal to J hooks to catch fish in all Central American fisheries, and in TBS fisheries from Peru and Ecuador, but significantly fewer sea turtle hookings.
- In fisheries capturing small mahi-mahi, J hooks do better for targets, but still circle hooks reduce sea turtle hooking rates.
- Fewer hooks swallowed when using circle hooks.
- Wires show potential, but still more testing needed.
- Entanglements are much more common in polypropylene lines.
- Replacing PP floatline by MF reduces entanglement rates.

First Technical Workshop
Regional Sea Turtle Project of the Eastern Pacific Coast
Puntarenas, Costa Rica. June 12-17, 2006