Supporting the assessment of alternative fishing gears for replacing gillnets that cause bycatch of vaquita (*Phocoena sinus*) at the Upper Gulf of California.

Final Report for the International Whaling Commission (IWC)
Submitted by World Wildlife Fund-Mexico/Mesoamerican Reef and the National Fisheries Institute of Mexico
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I. EXECUTIVE SUMMARY

Favored by the kind contribution of IWC, INAPESCA and WWF were able to hire a non-scientific crew for of the R/V "UNICAP XVI" and assess the catch efficiency, selectivity and economic yields of alternative fishing gears; in order to find feasible options for replacing gillnets that cause bycatch of vaquita at the Upper Gulf of California.

Fishing trials were undertaken during 248 days (April - November 2012) at commercial fishing grounds from San Felipe and Puertecitos (Baja California) and Golfo de San Clara and Adair Bay (Sonora).

Experiments allowed the identification of four groups among the set of tested alternative fishing gears:

a) Collapsible multi-purpose traps, with null performance.

b) Swimming crab traps, conical and rigid fish/crab traps and tide bags with low catch efficiency (0.2-0.4 Kg of commercial catch/h) and variable selectivity (catch:bycatch ratios between 1:0.5 and 1:6).

b) Rigid fish traps, hook long lines and shrimp/fish trawls with high catch efficiency (3-8 Kg of commercial catch/h) and good selectivity (catch:bycatch ratios between 1:0 and 1:4).

In all cases vaquita bycatch was absent. Rigid traps and hook long lines offered the lowest bycatch ratios, but fish trawls had the best overall performance (up to 8 Kg/h of commercial catch, 1:1 catch to bycatch ratio and null vaquita incidence). The performance of a particular fish trawling variant ("Modified RS-INP") was particularly outstanding (234 Kg of commercial fish species and only 33 kg of bycatch) and should be tested more intensively.

II. INTRODUCTION

Fisheries are a relevant component of the economy at the Upper Gulf of California and Colorado Delta River Delta Biosphere Reserve (Mexico). There, habitats of the endangered vaquita (*Phocoena sinus*)[1] and totoaba (*Totoaba macdonaldi*) overlap with the main local fishing grounds for at least 70 species of fishes, elasmobranches, arthropods and mollusks. Today, most of the local fisheries operate drift-gillnets as standard fishing gear.

Official data from Mexico´s National Fisheries Commission reveal that the production of finfish and shrimp species has increased in recent years (Fig. 1) and that catch volumes and their related revenues have also increased (Table I). The number of artisanal fishing boats at the three fishing towns has also increased in recent years (Fig. 2). All the previous are clear evidences that the regional fishing effort has increased.

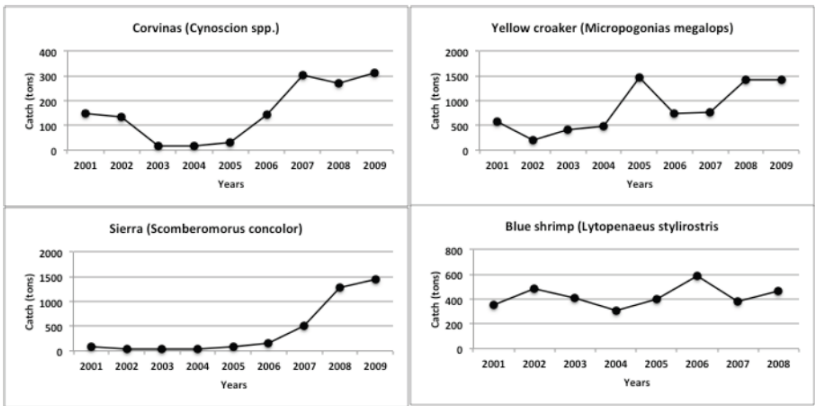


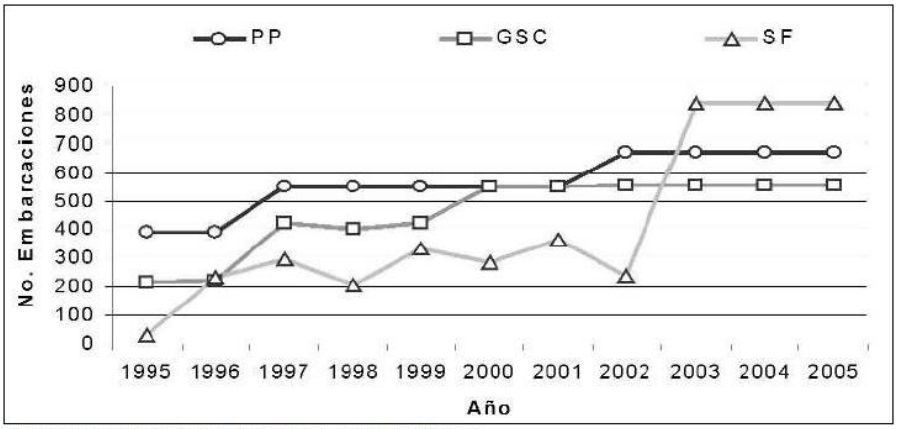
Fig. 1. Catch trends of the three main commercial finfish species and shrimp species from San Felipe (Baja California).

As of today, it is sure that at least 1000 artisanal fishing boats operate at least two drift gillnets per boat. The gillnet length is highly relevant for vaquita, since they run into nets, get accidentally snared and die by drowning. Vaquita catchability must be addressed in terms of gillnet kilometers, but there is a high uncertainty about their real dimensions (the estimated average net length is 1.3 km/artisanal fishing boat, but maximal lengths up to 2 km have been observed).

[1] Vaquita (*Phocoena sinus*) is the smallest cetacean in the World and the most extinction threatened cetacean in the planet and is endemic of the Upper Gulf of California. Its population has decreased 56% in the past 11 years due to bycatch in artisanal shrimp and finfish fisheries. Past and present work of WWF and its partners are shown at http://www.vaquitamarina.org/.

Table I. Yearly catch (tons) and revenue (millions of pesos) of the most important commercial species in San Felipe. Highlighted in blue are catches above 1,000 tons.

	Curvina		Blue Shrimp		Yellow croaker		Sierra	
Year	Catch	Revenues	Catch	Revenues	Catch	Revenues	Catch	Revenues
2001	150.33	1.14	352.72	42.58	575.16	2.29	84.69	0.62
2002	132.97	1.02	489.16	54.31	195.77	0.67	39.89	0.36
2003	18.26	0.25	413.56	43.62	403.83	2.68	40.27	0.33
2004	17.09	0.21	308.11	35	480.07	3.02	44.53	0.41
2005	29.07	0.26	397.67	49.02	1459.95	8.91	84.02	0.84
2006	141.96	1.2	589.61	62.16	731.54	4.09	157.34	1.5
2007	304.15	3.24	384.83	40.3	758.63	4.16	519.58	5.76
2008	268.91	2.51	467.16	51.93	1415.25	7.14	1280.33	15.53
2009	311.02	3.05			1417.71	8.72	1448.41	16.67



SF: San Felipe, GSC: Golfo de Santa Clara, PP: Puerto Peñasco

Fig. 2. Number of artisanal fishing boats at the three main fishing towns of the Upper Gulf of California (PP: Puerto Peñasco, GSC: Golfo de Santa Clara, SF: San Felipe. Taken from http://redalyc.uaemex.mx/pdf/417/41703205.pdf).

Experts consider that vaquita mortality associated to fishing must effectively disappear for ensuring its recovery, but cessation of fishing is not a realistic option. In response, during the past nine years Mexico´s National Fisheries Institute (INAPESCA) and WWF have identified alternative fishing gears suitable for replacing drift gillnets at the Upper Gulf. So far, we have convinced the Mexican government and the International Committee for the Vaquita Recovery about the added values of the "RS-INP-MX" shrimp trawling gear for progressively replacing shrimp gillnets[2]. The official decree stating the "RS-INP-MX" shrimp trawling gear as a legal

[2] The RS-INP-MX trawling gear was developed by INAPESCA during the past 15 years and was finalist of the 2009 International Smart Gear Contest. Its performance under different conditions at the Gulf of California was tested during 2009-

gear for artisanal shrimp fisheries in the Upper Gulf is expected to be published during the upcoming three months. WWF and Mexico´s National Commission for Protected Areas (CONANP) signed in October 2012 a collaboration agreement related to the operative coordination for the technology transfer inside the Biosphere Reserve.

Incentivized by that significant achievement related to local shrimp fisheries, INAPESCA and WWF recognize the need of prospecting additional alternative fishing gears for the rest of local fisheries and pursuit their recognition as legal options for replacing drift gillnets. As part of that, INAPESCA has brought one of its research vessels (R/V "UNICAP XVI") to the Upper Gulf for using it as experimental platform. This allows the undertaking of experiments without depending on the willingness of local fishers. Between April and November 2012, the R/V "UNICAP XVI" assessed the performance of eight alternative fishing gears, aiming to determine: a) their catch efficiency and selectivity for shrimp, crab and fish; and b) their maximal economic yield.

III. RESULTS

The effective experimental effort

Funds kindly provided by IWC allowed INAPESCA and WWF to cover consultancy fees of the non-scientific crew of the vessel (Fig. 3) and their respective life insurances; as well as hiring one logistic coordinator during 248 days of year 2012. Lead and accompanied by technical staff of INAPESCA, the crew undertook experimental fishing trials in April 10-25, May 15-30, July 30-August 11, September 2-17, October 5-20 and November 6-20.

Given the precarious situation of the North Pacific loggerhead sea turtle population[3], INAPESCA assigned the vessel to undertake similar alternative gear assessments at the Gulf of Ulloa (Southern Baja California) during June 21-July 15.

2011 (see http://cmsdevelopment.sustainablefish.org.s3.amazonaws.com/2011/10/14/WWF_Final%20Report_INAPESCA-e25e1d7d.pdf). In addition to reducing shrimp bycatch 50% and having null vaquita bycatch, the "RS-INP-MX" gear has created a new regional artisanal fishery for brown shrimp (*Farfantepenaeus californiensis*) caught at night (drift-gillnet shrimp fisheries are entirely dependent on blue shrimp (*Litopenaeus stylirostris*) and only operate with daylight).

[3] The North Pacific loggerhead sea turtle population has shown precipitous declines in nestlings over the past three generations (to fewer than 2000 turtles nesting/yr). In consequence, that population has been included into the IUCN Red List, has been classified as "endangered" by the U.S. Endangered Species Act and is recognized among the most endangered sea turtle populations worldwide according to a recent IUCN meta-analysis. The population currently fluctuates at low levels and intense drift-gillnet and hook long line-based coastal fisheries overlap with the Ulloa Gulf (west Southern Baja California) nursery hotspot. Present local bycatch rates are among the highest reported worldwide and are resulting on extremely high bycatch mortality.

Fig. 3. INAPESCA´s research vessel R/V "UNICAP XVI", docked at San Felipe (Baja California, Mexico).

The ideal operative scheme for the vessel consisted of 15 days of experimentation followed by 15 days of docking for ship and gears maintenance. Effectively, 40% of the total time spent at the Upper Gulf (223 days) was used for fishing, 26% of the time the vessel was docked due to bad weather and rough sea conditions[4], 16% of the time the vessel was commuting, 12% of the time the vessel was docked for motors and gears maintenance and 6% of the time the vessel was docked due to unexpected mechanical failures and repairs. The time spent at the Ulloa Gulf represented 10% of the total number of crew days supported by IWC.

Fishing trials[5] were performed at commercial fishing grounds used by artisanal fleets around San Felipe and Puertecitos (Baja California) and Golfo de San Clara and Adair Bay (Sonora) (Fig. 4).

[4] Mexican naval authorities prohibit the navigation at open waters with steady winds ≥ 8 knots. Windy conditions combined with strong tides (4 m-gradient between high and low tides) often result in sea conditions unsuitable for fishing.

[5] Traps were deployed at an average depth of 25 m (maximum depth: 40 m, minimum depth: 10 m). Bottom hook long lines were set at 30 m depth. Bottom trawling was performed at 9 m depth and mid-water column trawling between 6 and 8 m depth.

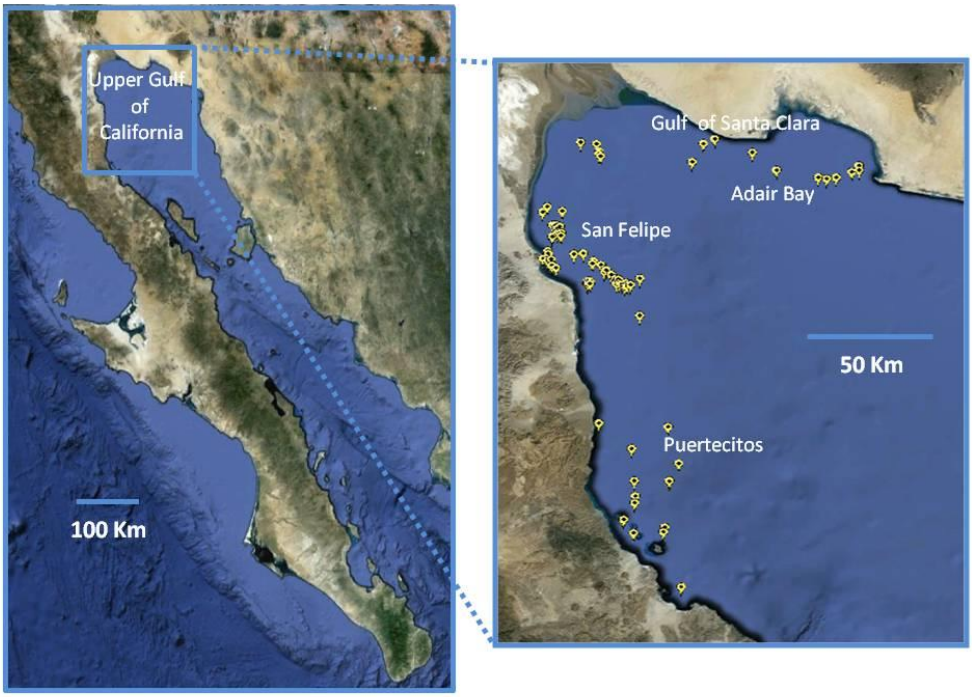


Fig. 4. Location of the fishing trials.

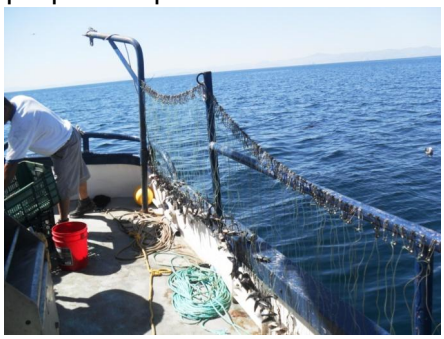
Some aspects of the field work and tested gears are shown in Fig. 5, while technical specifications of the tested gears are shown in Appendix I. Table II describes the accumulated fishing effort for each gear. The original design of the experiment included the test of squid jigs and octopus traps, but the natural availability of those resources was very low and their catch was excluded from the experiment.

Table II. Accumulated effort for each tested gear.

Fishing gear	Fishing effort
Collapsible multi-purpose traps baited with fresh sardine	10 hours 40 minutes
Conical and rigid fish/crab traps	16 hours 42 minutes
350-hook bottom hook long lines	6 hours 5 minutes
Swimming crab traps	26 hours
Tide bag	48 hours 10 minutes
Rigid fish traps baited with fresh sardine and mackerel	79 hours 13 minutes
Shrimp trawl	59 hours 53 minutes
Fish trawl	61 hours 20 minutes

Collapsible multi-purpose traps

Conical and rigid fish/crab traps



Bottom hook long lines

Swimming crab traps

Rigid fish traps

Fish trawl net

Tide bag

Fig. 5. Some aspects of the field work and tested fishing gears.

Catch efficiency and selectivity of the tested gears

We face the big challenge of identifying fishing gears capable of producing seafood in higher (or at least equal amount) than thousands of 1-Km long individual drift gillnets; but eliminating the vaquita bycatch risk.

We have detected three groups among the tested gears (Table III) and during January and February 2013 we will determine the maximal economic yield for each gear:

a) Collapsible multi-purpose traps, with null performance.

b) Swimming crab traps, tide bags and conical and rigid fish/crab traps) with low catch efficiency (0.2-0.4 Kg of commercial catch/h) and mixed selectivity (catch:bycatch ratios between 1:0.5 and 1:6).

b) Rigid fish traps, hook long lines and shrimp/fish trawls with high catch efficiency (3-8 Kg of commercial catch/h) and good selectivity (catch:bycatch ratios between 1:0 and 1:4).

In all cases vaquita bycatch was absent. Rigid traps and hook long lines offered the lowest bycatch ratios, but fish trawls had the best overall performance (up to 8 Kg/h of commercial catch, 1:1 catch to bycatch ratio and null vaquita incidence). Three variations of fish trawling were used during the experiment[6] and the "Modified RS-INP" version had an outstanding overall performance of 234 Kg of commercial fish species with only 33 kg of non commercial bycatch. That option should be tested more intensively in the near future.

[6] "Scorpio" and "Corean" differed in net geometry, but had in common a 50 ft long polyethylene net and aluminum trawl doors. "Modified RS-INP" had a 60 ft long nylon net, a bycatch excluding curtain and wood trawl doors.

Table III. Observed catch efficiency and selectivity of the tested fishing gears.

Fishing gear	Accumulated catch (Kg)		Catch:Bycatch ratio	Catch efficiency for commercial species (Kg/h)	Remarks on catch and bycatch
	Commercial species	Bycatch			
Collapsible multi-purpose traps	0	0	-	-	
Swimming crab traps	4	16	1:4	0.2	Bycatch dominated by snails
Tide bag	10	61	1:6	0.2	Catch almost equally represented by shrimp and fish.
Conical and rigid fish/crab traps	6	3	1:0.5	0.4	
Rigid fish traps baited with fresh sardine and mackerel	220.5	18.5	1:0	3	Catch composed by prime quality fish species (mostly Chano (*Menticirrhus panamensis*) and Cabrilla (*Paralabrax maculofasciatus*). Bycatch dominated by eels and skates.
350-hook bottom hook long lines	19	14	1:0.7	3.2	Catch composed by prime quality species (Cabrilla (*Paralabrax maculofasciatus*) and Baqueta). Bycatch dominated by eels.
Shrimp bottom trawl	246	1052	1:4	4.1	Catch dominated by shrimp, but also including prime quality fish species.
Mid-water column fish trawl	484	479	1:1	8	

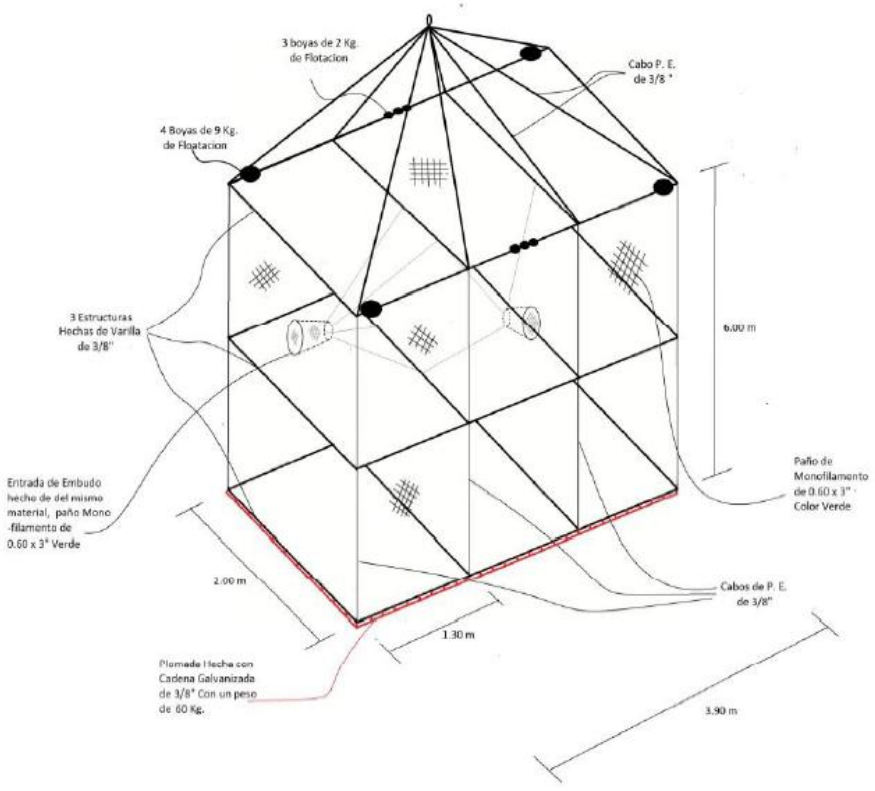
IV. FINAL FINANCIAL REPORT

ITEM	Original budget (USD)	Expenditures
WWF-personnel costs	$4,200	$2,600
Third party fees and expenses	$45,000	$49,942
Travel and coordination meeting costs	$4,800	$1,458
TOTAL BUDGET	$54,000	$54,000

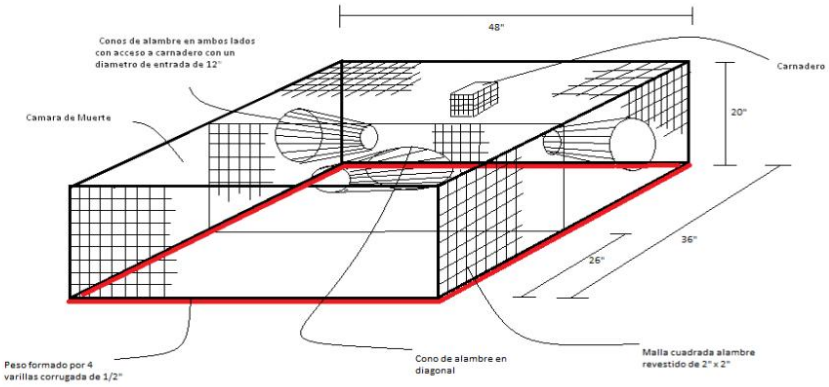
INAPESCA provided a total financial match of USD $75,742 for the project.

V. APPENDIXES

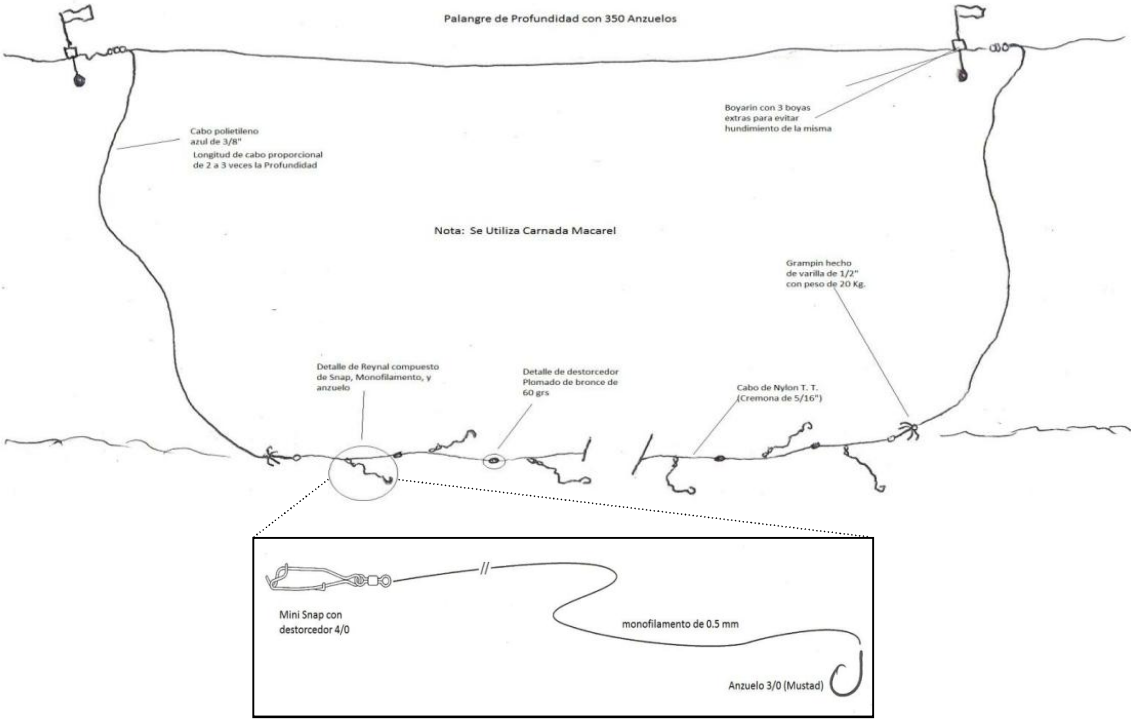
Appendix I. Technical specifications of the tested gears.



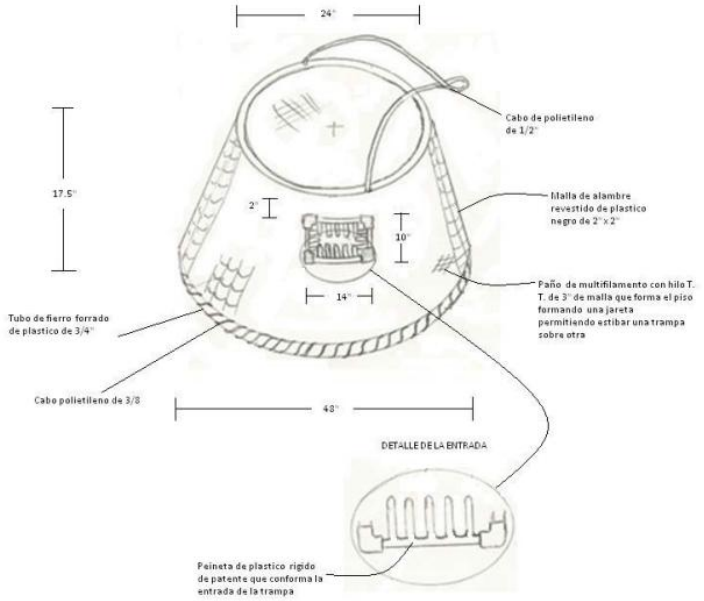
Collapsible multi-purpose traps



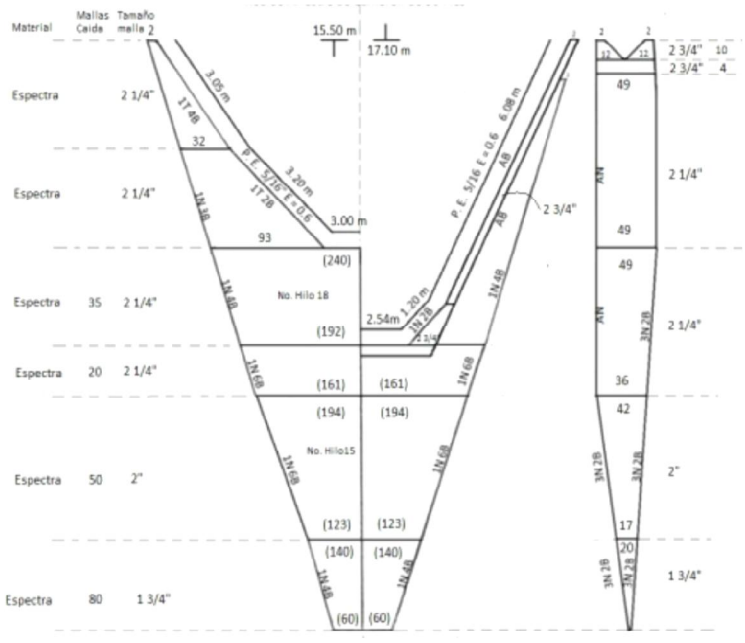
Rigid fish traps



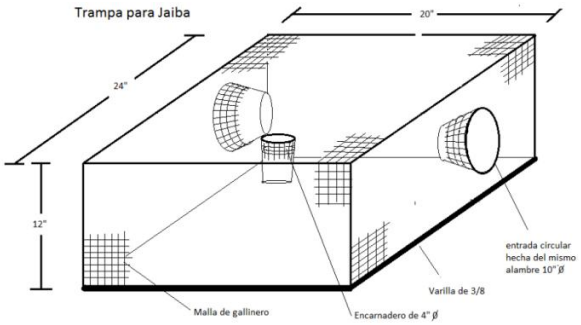
Bottom hook long lines



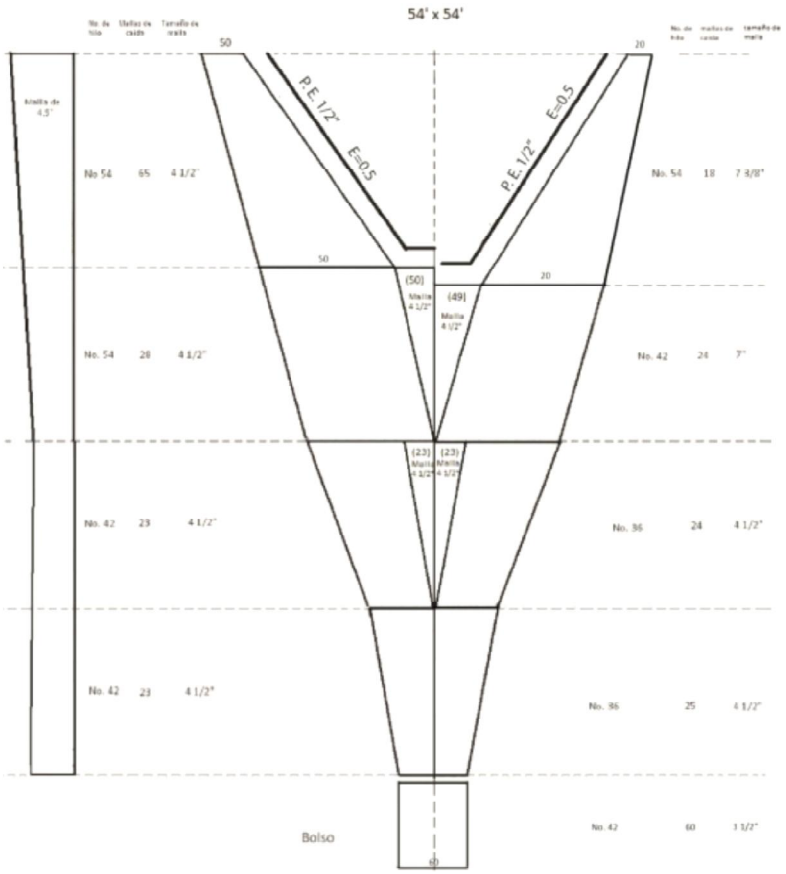
Conical and rigid fish/crab traps



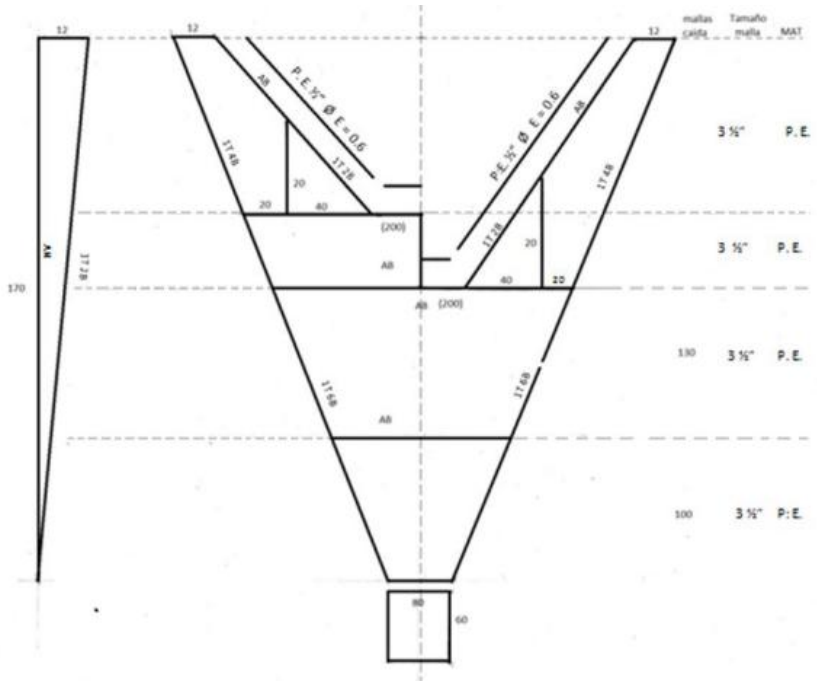
50 ft. shrimp bottom trawl ("RS-INP"



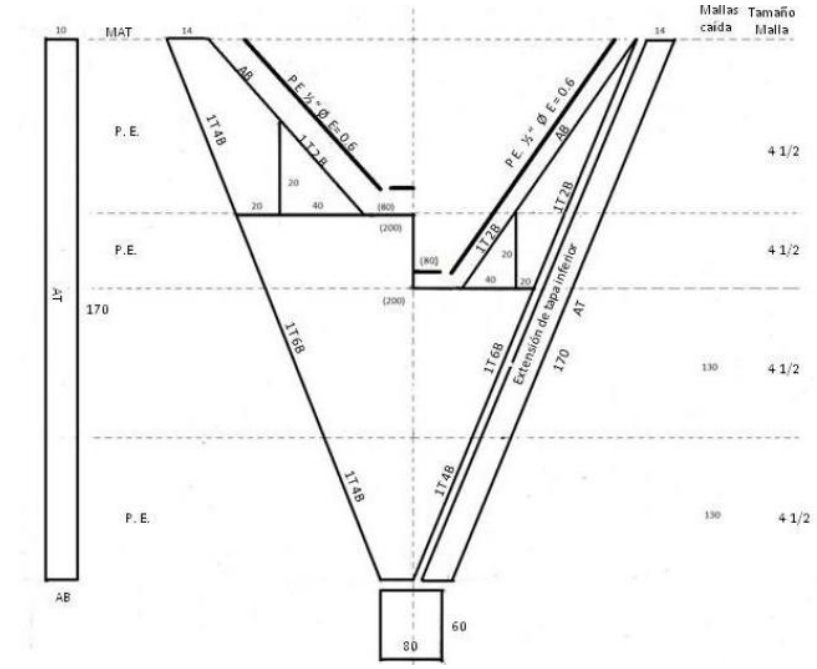
Swimming crab traps



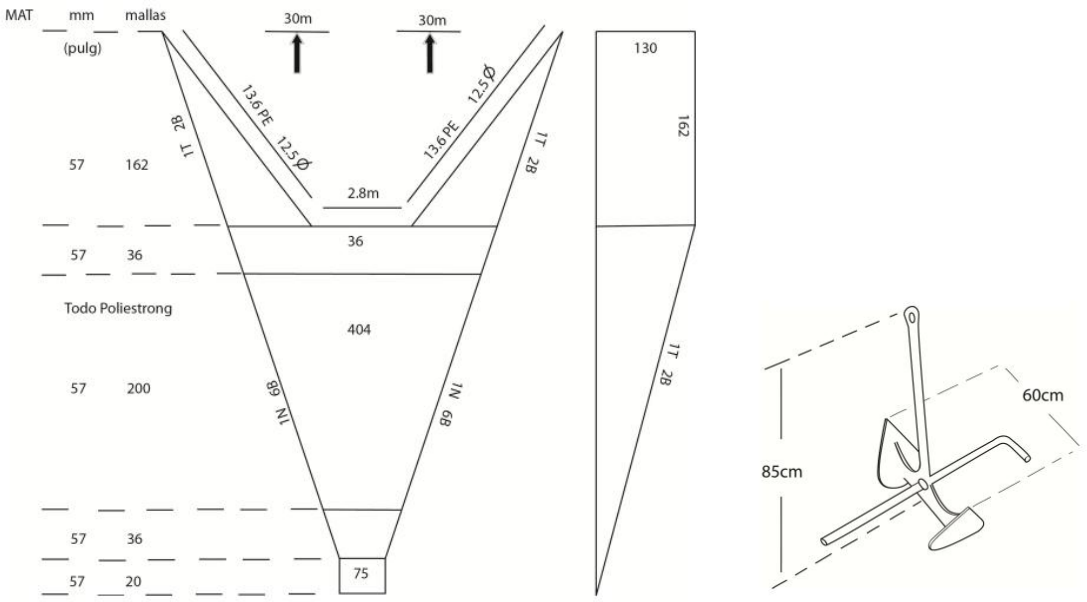
54 ft. fish trawl net (Modified "RS-INP")



“Scorpio” trawl net



“Corean” “Scorpio” trawl net



Tide bag and its anchor