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CONCILIATING ARTISANAL AND RECREATIONAL FISHERIES IN ANEGADA BAY, ARGENTINA
Fisheries Research

Dear Dr. Llompart,

I can now inform you that the Editorial Board has evaluated the manuscript FISH6866: CONCILIATING ARTISANAL AND RECREATIONAL FISHERIES IN ANEGADA BAY, ARGENTINA.

The Editor has advised that the manuscript is acceptable subject to satisfactory moderate revision.

The comments below should be taken into account when revising the manuscript. Along with your revised manuscript, you will need to supply revision notes in which you list all the changes you have made to the manuscript, and in which you detail your responses to all the comments passed by the reviewer(s) and the Editor. Should you disagree with any comment(s), please explain why.

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Kind regards,

Sharmila Vadivelan
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Dear Mr. Editor-in-Chief

G.A. Rose

We are sending the revised manuscript entitled "**CONCILIATING ARTISANAL AND RECREATIONAL FISHERIES IN ANEGADA BAY, ARGENTINA**"authors (FM Llompart, DC Colautti and CRM Baigún) having considered the comments and suggestions.

With compliments,

Dr. Facundo Llompart

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Editor comments: *The Ms requires a language editing*

The Ms was copyedited and proofread in accordance with the rules and the nuances of the British English languages by **PRS** (Proof Reading Service London England). However, if the editor still considers that the Ms needs to be improved we can ask this service to do a new revision

Reviewer 1:

a. Also in the abstract (i.e. the necessity to implement a true integrated management plan that considers all fisheries (AF, RF and trawl: "To 34 resolved conflicts, a co-management including AF, RF and industrial (trawl) stakeholders and non-fishing community is suggested".

We included in line 34 the industrial (trawl) fishery as requested and also added a paragraph in the Discussion section (lines 507-512).

b. *Authors state that they have used now several studies cases around the word to compare and expanded their findings in the discussion section. But they need to incorporate in the discussion the latest ms published on the same topic in Australia, which has just appeared in Marine Policy (Brown, 2016, see reference below). This new article reinforces the idea presented by the authors and therefore should be used to support their conclusions.*

We agree that this new paper needs to be mentioned and used it for supporting the study conclusions

Reviewer 4:

c. The discussion section could be improved by adding a new paragraph on possible regulations/tools to protect the most vulnerable target species (both AF/RF). Line 404-405. "This situation demands the urgent implementation of conservation policies in order to protect the most vulnerable target species". Discuss these please.

We adapted the idea provided by the reviewer related to proposed tools for the most vulnerable species conservation.

Elsevier Editorial System(tm) for Fisheries Research
Manuscript Draft

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Title: CONCILIATING ARTISANAL AND RECREATIONAL FISHERIES IN ANEGADA BAY, ARGENTINA

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Order of Authors: Facundo Llompart; Darío Colautti, Doctor; Claudio Baigún, Doctor

Manuscript Region of Origin: ARGENTINA

A final reviewed of the entire manuscript and figures files was done and now is prepared to final production. Also, a list of five bullet points was included in a separate word file called "Highlights".

- An error was fixed in the abstract section of the Ms: This phrase "However, the vulnerability index of AF landings resulted in higher values than the <u>AF</u>" was replaced by "However, the vulnerability index of AF landings resulted in higher values than the RF".

Highlights:

- The spatio-temporal overlap between artisanal and recreational fisheries was analyzed
- Temporal overlap was detected during one month but shared a 40% of the fishing areas
- Recreational catch exceeded the artisanal but together were considered low regionally
- The artisanal fisheries caught mostly adult *M. schmitti*, species without sport value
- Artisanal fishery banned is poorly justified and co-governance can resolve conflicts

CONCILIATING ARTISANAL AND RECREATIONAL FISHERIES IN ANEGADA BAY, ARGENTINA

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Abstract

Recreational and artisanal fisheries are common activities in Latin America often interpreted as competitors due to the use of common-pool resources in coastal areas. Conflicts between the (historical) artisanal fisheries (AF) and (emerging) recreational fisheries (RF) in Anegada Bay resulted in the prohibition of the former. This study address key fisheries characteristics to detect the degree of spatio-temporal overlap between them considering the annual dynamic of the coastal fish assemblage and proposed management alternatives. Both fisheries exerted different fishing effort coinciding with the dynamics of the fish assemblages but partial temporal and spatial overlap where apparent especially during one month. However, both fisheries focused their catches on different targets species thus greatly reducing the overlap in resource usage. Moreover, the low proportion of juveniles caught, limited fishing effort using selective bottom gillnets and scarce total harvest (168 tons/years) for AF compared with those of RF harvest (631 tons/years) in Anegada Bay poorly justified the actual prohibition. However, the vulnerability index of AF landings resulted in higher values than the RF. To resolved conflicts, a co-management including AF, RF and industrial (trawl) stakeholders and non-fishing community is suggested. Because of the economic importance of fishing for local people, an efficient inter and intra-sector communications process and new fisheries guidelines are urgent for the equitable use of fish resource without compromising the goals of a protected area.

Key words: coastal fisheries, Anegada Bay, fisheries conflicts, common-pool resources, sea management.

1. Introduction

Fisheries and coastal systems are intrinsically diverse, complex and dynamic (Jentoft and Chuenpagdee 2009). Moreover, an ongoing coastal area migration is happening in many parts of the world (Pauly 2006) which is adding pressure onto the resources, and consequently, is increasing competition among the numerous users of these limited resources (Jentoft 2000). The demands of new actors in coastal areas (recreational fishers, conservation organisations, scuba divers, tourist operators, among others) and the consequent diversity of usages have added a complexity to the interactions thereon. They are creating new governability challenges that are ultimately aimed towards a shared and rational use of coastal marine resources. However, in finding practical management solutions about resource sharing have proved to be very difficult, since human dimensions are involved on multiple levels, horizontally between the users and vertically between the users, managers, scientists, politicians, and the public at large (Arlinghaus 2005).

In the last few years, there has been an international increment of concern about the roles that are played by artisanal and recreational fishing in global catches and in local economies (Coleman et al. 2004, Bené 2006, Chuenpagdee et al. 2006, Cooke and Cowx 2006, Teh and Sumalia 2013). For example, the artisanal fisheries sector involves 450 million people (Berkes et al. 2001). They harvest an estimated 21 million tonnes per year in marine environments (Chuenpagdee et al. 2006) and they represent a huge socio-economic relevance for many coastal populations (Allison and Ellis 2001, Berkes et al. 2001, Andrew et al. 2007, Zeller et al. 2007). For the case of recreational fisheries, approximately 11.5% of the world's population is involved in capturing 12% of the total global catch (Cooke and Cowx 2004). This produces high revenues for both developed and developing countries (Pitcher and Hollingworth 2002). These values rearrange these fisheries into the foreground and they show the need to improve our knowledge about artisanal and recreational fisheries in coastal zones, in order to secure their sustainable development (Salas et al. 2007, Chuenpagdee 2011).

Evaluations that try to account for the conflicts between the fishery sectors and to quantify their reduction under alternative policies are still preliminary (Pitcher and Hollingworth 2002). The understanding of conflicts is a prerequisite for the planned sustainability actions (Renae 2006). Intra-sectoral conflicts, especially between the artisanal and recreational fisheries, may be due to several reasons, such as: i) the current increment of recreational fisher's participation rates, together with the improved areas of accessibility to previously remote fishing areas (Arlingahus 2005); ii) a spatiotemporal overlap, since fishing is practised and is restricted to within a few nautical miles from the coastline, due to the seasonal nature of available resources, especially in temperate environments; iii) a mutual mistrust about fishing practices or their impacts; and iv) different views and priorities about the guidelines for the sustainable use of resources which are not based on knowledge as much as they are on one's own values and interests (Jentoft and Chuenpagdee 2009). Besides, intra-sectoral conflicts can be more severe when two fisheries share the same targets species whereas inter-sectoral conflicts with non-fishing stakeholders, governance institutions, and citizens in general, can drive up the expense of fishery management (Arlinghaus 2005).

Recreational and artisanal fisheries are frequent coastal activities in many parts of the world, including the Latin American countries (FAO 2012, Defeo 2014). Argentina, for instance, has an extended marine shoreline (5000 km) where artisanal fishing is becoming a permanent livelihood for many people (Elías et al. 2011). In Anegada Bay, in the Northern Argentinean Patagonia, artisanal fisheries have been taking place for more than 100 years. Such fisheries provided a major source of food, employment, and economic benefits to the ancient inhabitants of Anegada Bay showing a temporal increase between 1939 and 1945, due to the demands of shark-oil from the school shark [*Galeorhinus galeus* (Linnaeus, 1758)] and then the fishing efforts decreased (Lasta et al. 2001). Until 2007, artisanal fishing was developed by following the fishing regulations imposed by the enforcement authority (Dirección Provincial de Pesca, Provincia de Buenos Aires http://www.maa.gba.gov.ar/pesca), but after was banned.

On the other hand, in Anegada Bay, the beginnings of the recreational fisheries took place 6 decades ago, but there is evidence of an abrupt increment over the last 15 years. Previous results on recreational fisheries have shown the current relevance of this activity, in terms of attracting tourism (39,649 ± 9320 people per year for the last ten years), the employment demands, and the incomes that this produces (Llompart et al. 2012). Over time, however, the conflicts involved in these two fishery sectors and including the local non-fishing stakeholders, have led to a prohibition of artisanal fishing in the bay. Even though, such a decision was not based on an integral evaluation. To partially address this gap of information, the objective of this study was to obtain a comprehensive framework for both artisanal and recreational fisheries in the bay and then to analyse to what extent such activities were overlapped on a spatiotemporal basis, regarding the amount and the types of fish caught. The main reasons for the conflicts and the governance constraints are also analysed, in order to propose sustainable management alternatives to enhance the fish and the conservation of the fisheries in the marine protected area of Anegada Bay.

2. Materials and Methods

2.1. Study area

Anegada Bay is located along the southern coastline of the Buenos Aires Province, Argentina (Fig. 1). This zone is a protected nature area of multiple uses, being considered as part of North Patagonia. The area protects several types of coastal environments, e.g., marshes, tidal plains, and sandy beaches (Penchaszadeh et al. 2003). The bay comprises of small islands and banks that are connected by a diffuse network of channels with depths ranging from 10m to 24m in the main channel (Lucifora 2003). The tidal regime is predominantly a mixed semidiurnal, with a maximum amplitude of 2.56m and a minimum of 1.73m (SHN 2009). The water temperature ranges from 6.8°C in winter to 19.2°C in summer, while the salinity varies between 32.5 and 35.0 PSU (Borges 1997, 2006). The climate is dry (300 mm/year of precipitation) and the prevailing winds are from the northwest.

2.2.1. Recreational fishery

The main recreational fisheries (RF) take place in San Blas Bay, both from the shoreline and from boats (Fig. 1). The shore-based RF (SRF) are carried out along 4km of the village’s coastline, on a steeply sloping pebble and gravel beach, and for 4.4 km on a gently sloped sandy beach, located to the south of the village. For the purposes of this study, the fishing information from these two sites is presented together, as both being SRF.

For the assessment of RF, we developed a two-stage stratified sampling design. The two variables that were considered were the fishing place (shore-based and boat-based) and the fishing efforts over time [i.e., months and also weekdays and weekend days (Malvestuto and Knight 1991)]. We conducted a roving-creel survey (Robson 1991, Pollock et al. 1994, Sullivan et al. 2006) during 108 days of field work between April 2009 and April 2010 (except for May and August of 2009) and we used a semi-structured questionnaire (Sudman and Bradburn 1982) in order to obtain information about the anglers preferences and their fishing trips. After each angler's interview, the species composition and the number and the length of fish caught were recorded and compared with minimum legal catch size and length at first maturity. Their total weight was calculated from the length-weight relationships for each species and that was estimated in the study area (Llompart unpublished data). The basic catch and effort statistics were calculated following the procedure of Pollock et al. (1994). The details about the formulas employed and the sampling design can be found in Llompart et al. (2012). For the case of the SRF, two daily instantaneous counts of the anglers were made.

Since the particular dynamics of boat-based recreational fishery (BRF) prevented the implementation of access point surveys (Pollock et. al. 1994), their catch estimation was carried out in a different way. In order to get an estimated of the amount of catches, the total number of boats available to rent (between 35 and 40), the number of BRF anglers per year (11,430), the mean duration of the fishing trip (4 hours) and total number of fishing trip per month (2321 per season) were registered and contrasted with official records. In the landing port, the catch amount and composition (in percentages) were recorded (N = 130 records) during all months of the 2009-2010 fishing season and validated in fillets plants (N = 50 samples). This information was supplemented by the records of the daily catches of one boat randomly sampled considered to be representative of the others and also supported by more than 30 BRF fishing trips in every month of the season and in at least 10 different sites within the bay. The number of daily fishing trips made by all of the boats during each month of the year was provided by the coastal guard placed in San Blas Bay. The BRF catch per unit effort (CPUE) was estimates from the total catch of species during a mean fishing trip time and then expanded to the total fishing monthly time to obtained the total catch along the year. These values were contrasted with the CPUE expressed for the fishing guides during interviews (N = 28) and then expanded for the same total monthly fishing time. Since very similar values were obtained this result is not show in this paper (but see Llompart 2011).

For both types of recreational fisheries, catch data reflect the total once since locally catch and release of any species or size is negligible, except for mandatory release of coastal large sharks. This fishery is an off-shore specialized recreational activity oriented to the exclusive catch of large size sharks (*Carcarhinus brachyurus, Galeorhinus galeus, Notorynchus cepedianus* and *Carcharias taurus*) that takes also place in the outer side of the bay (Lucifora 2003). However, such fishery does not present any interference and overlapping with the AF, SRF and BRF it is excluded from the present study.

2.2.2. Artisanal fisheries

This traditional activity operated with small boats and within the first 3 to 5 nautical miles from the shoreline and takes places between October 15 and December 15 of each year. This fishery had a daily pattern, setting the bottom gillnets in the afternoon and then picking them up the next morning. The fishing gear was regulated by the provincial authority which dictated that there were to be no more than seven bottom gillnets in each boat, with each one having a maximum length of 50 m and a minimum mesh size of 105 mm between the opposite knots.

The captures from the artisanal fishery were assessed for 2003–2007 from the official landings records of the Ministerio de Asuntos Agrarios de la Provincia de Buenos Aires. The landings records included targets and by-catch species in weight, but there were no data available about poaching or illegal catch. In addition, during 2007, three random fisher folks were selected during four fishing trips and samples catches were analysed to obtain the fish-length-frequency distribution. Supplementary data to assess the AF activity, such as the composition of the catch species, the harvest, and the CPUE in kg h^{-1}, was re-analysed from Colautti et al. (2010). Finally, fishermen was interviewed (N = 11) to obtained a socio-economic perspective.

Based on data provided by fishers in the proposed management plan of San Blas Bay (Zalba et al. 2008) the distribution of AF and RF areas were mapped and potential spatial overlapping measured by mean of GIS software.

The intrinsic vulnerability index (Cheung et al. 2007) for landings of RF and AF was calculated from the intrinsic vulnerability index of the main target species available in FishBase (Froese and Pauly 2016), and weighted by their annual catch.

3. Results

3.1. Spatio-temporal distribution of fishing efforts and fisheries characterization

The SRF is an annual activity employing 304,532 fishing hours per year. The SRF effort exhibited a considerable increase during spring and in the summer months (named the fishing season), especially during January (Fig. 2).
Comparatively, the BRF fishing season started later in October and finished during the middle of April, involving approximately 45,000 fishing hours per fishing season. The boats available to rent were entirely built after the 2000 year and 80% are construct by fiberglass ranging from 12 to 5.8 meters in length (mean 7.3 m ± 1.3 m) with engines horsepower between 205 ± 65 and remodeled to provide comfort to anglers (poses-rods, seats, etc.). It had an average value of 45,000 dollars. It realized an average of 1.3 daily fishing trips and the transport capacity was between 19 and 7 anglers (mean 10.2 ± 3.2) who paid 30 dollars (in 2010) per fishing trip. BRF guides interviewed come from the Buenos Aires province (85%) where they were employed in traditional areas and only a 10% was always linked to fishing.
In contrast with the RF, the AF season was shorter and was concentrated only in the two spring months, when 95% of the fishing effort was detected, and thus, showed a clear accomplishment of the norm (Fig. 2). According to the fishing license provided by Provincial Fisheries Division only 7 fishermen in 2003 and 14 for the rest of the study period possessed legal licenses to fishing in Anegada Bay. All of the fishermen interviewed were Argentinean resident

with at least 25 years of local experience in artisanal fishing. Three of them had wooden boats of 11.65 m ± 1.3 m in length with internal motors and a maximum load capacity between 200-300 boxes of fish (about 35 kilograms of fish in each one). The others had boats composed by fiberglass averaging 6.5 m in length ± 0.7 m, driven by outboard motors of 47 horsepower and have an average maximum load capacity of 40 ±10 fish boxes. The catch was sold fresh or filleted locally in villages, closed towns or exported. Artisanal fishermen as well as fishing guides declared that fishing was the most relevant economic income for their livelihoods.

Spatial distribution of fishing activity strongly differed according to fisheries types. Whereas the SRF occupied only a small sector almost limited to San Blas village neighbors, the BRF extended on a larger area that include also outside reserve areas. In turn, the AF selected fishing ground patches located at the north part of the bay. The distribution of SRF and BRF did not show any spatial interaction but this was apparent between the AF and the BRF. In this case, the AF fishery shared almost 40% of its fishing areas whereas only 15% of the BRF was allocated in common area with the AF (Fig. 3).

3.2 CPUE, monthly catches, vulnerability and the total harvest

The CPUE values in the SRF increased during the spring months and reached a maximum during December, when the angler's catch rate was estimated as being 1.8 fish h^{-1} (Fig. 4). In turn, the BRF, the mean season´s CPUE values were estimated as being 6.8 fish h^{-1}.

For the AF, the CPUE values varied among years but were similar on average in October (18 ± 4.4 kg fish h^{-1}) and November (15.5 ± 7.1 kg fish h^{-1}) (Table 1).

Catch composition analysis showed that RF was based on few species. Indeed, the most prevalent species in the SRF were *Cynoscion guatucupa* (Cuvier, 1830), followed by *Micropogonias furnieri* (Desmarest, 1823), together accounting for 74% in weight of the total catch, whereas the *Mustelus schmitti* (Springer, 1939) represented only 9.2% (Figure 4). The monthly distribution of the SRF catch showed higher yields during December and with similar values during November and January.

The catch estimated for the BRF exhibited the same trend as did the SRF, where 89% of the total catch was accounted for by *M. furnieri* and *C. guatucupa*, followed by *M. schmitti*, which represented only 7.9% of the total harvest in weight (Fig. 5). January was the month with the largest number of catches, followed by December and November.

The two main target species of RF showed intrinsic vulnerability values of 40 for SRF and 32 for BRF (i.e. an average value between low to moderate vulnerability), but the rays extracted by the same fishery reached intrinsic vulnerability values above 70 (high to very high intrinsic vulnerability). The average intrinsic vulnerability for RF landings was 36.25 (out of 100), a level considered as moderate to high.

On the other hand, the AF captures were strongly dominated by *M. schmitti* (96%), which indicates that this activity was almost mono-specific. A similar monthly yield trend was apparent in the AF among years where 42% of the total catch was recorded during October and 57.7% during November, while only 0.3% was corresponded to December (Table 1). For *M.* s*chmitti* an intrinsic vulnerability value of 58 (high vulnerability) was estimated. The AF intrinsic vulnerability of landings was 57.6 due to the almost monospecific extraction. The RF annual total harvest (SRF + BRF) was estimated as being 462 tonnes whereas the AF annual harvest varied between 108 tonnes and 254.3 tonnes (Table 1). In any case, the AF mean across the years (169.7 ± 61.8 tons) was a figure 2.7 times smaller when in respect to the total annual harvest of the RF.

3.3 Fish lengths and angler´s preferences

The average total length (TL) recorded for the captures of *M. schmitti* in the RF (53.8 ± 7.1 cm) was shorter than the minimum legal size (60 cm, Provincial Fisheries Authority) and also for their length at first maturity estimated for this species in Anegada Bay [♀ = 56.3 cm, and ♂= 54.6cm, (Colautti et. al 2010)]. In contrast, the AF captures of *M. schmitti* had a size distribution that ranged from 44 cm to 87 cm TL, with a well-defined modal value at 64 cm. Although this distribution included both sexes, it was noted that only 3.3 % of the captured female were below the length at first maturity while this was 7.6 % for males. Also, 15% of the captured AF fish corresponded to fish below the RF minimum legal size (Fig. 6).

In turn, the average TL of the RF catches for *M. furnieri* and *C. guatucupa* were 53.4 cm and 43.2 cm, respectively, with both of these lengths being greater than the lengths at first maturity (♀ = 36 cm and ♂= 34 cm, ♀ =35cm and ♂= 30 cm) and larger than the minimum legal size (35 cm and 30 cm), respectively (Cosseau and Perrota 2000; Provincial Fisheries Authority).

The angler´s interviews (n = 856) came from 12 different provinces of the country and half of them had travelled more than 900 kilometres for fishing in Anegada Bay. Among them, 73% believed that this bay was the best place for marine coastal fishing in Argentina. The monthly fishing quality, as reflected by the angler's opinions, was felt to be more positive during December, followed by November and October, in a descendent order. With respect to the targeted species, *M. furnieri* were selected by the anglers (47%) as their preferred fish and *C. guatucupa* was the second-most preferred species (16%) while any angler mentions a preference to catch *M. schmitti*.

4. Discussion and conclusions

This study has represented a first attempt to examine the main management problems that have been identified in the most relevant marine recreational fisheries of North Patagonia, and thus, have provided clues in order to understand the various conflicts and the governance limitations. Traditionally, main reasons for the conflicts in Anegada Bay have been related to the perception that the (ancient) AF can impact strongly on local fish assemblage and could also affect the (emerging) RF quality. However, Brown et al. (2016) recently demonstrated that the closure of net fisheries not produced an improvement of Queensland's recreational fisheries performance. Stakeholders have promoted the wrong idea when viewing artisanal fishing in the bay as a lucrative activity that uses fishing gear (nets) for the massive extraction of fish, with a high environmental cost, while recreational fishing has been conceived as a public and sporadic activity that is being realised only for fun and for being environmental friendly and without visible impact on fish resources (however, see Lewin et al. 2006). Even more, there is an increasing evidence showing that recreational fisheries could strongly affected threatened and overfished species and promoting biological changes on stocks similar to commercial fisheries (e.g. Schroeder and Love 2002, Post et al. 2002, Coleman et al. 2004, Cook and Cowx 2004).

4.1. Disentangling temporal and spatial fishing patterns

Fishing efforts and performances are strongly associated with the fish species dynamics, and thus, they represent key factors that are needed to understand the recreational and artisanal activities. Although the SRF is practised throughout the year, this fishery type along with BRF shows clear different peaks of fishing efforts during November to March as also displayed by monthly catches and CPUE maximum values. This can be related to a seasonally increase in the abundance of their main target species according to the rise in sea water temperatures and due to their reproductive migration patterns (Llompart et al. 2010, Llompart 2011, Llompart et al. 2013a). In contrast, the AF had a very limited fishing season of only two months per year, but with similar efforts and harvest rates during October and November (except when the AF operated only once in December 2006, solely catching 1.3% of the mean total harvest). This short fishing season obeyed not only to the temporal regulatory constraints made by the fishery authorities, but also because it is during these months when the adult population fraction of their target species inhabits the coastal areas of the bay (Colautti et al. 2010). According to these fishing patterns, only a partial level of temporal overlapping between both fisheries sectors existed during November. Indeed, October appears to be an important for the AF, but much less relevant for the

SRF and the BRF, since only 7% and 3% for the total efforts and 8% and 3% for the total catch, respectively take place during this month. However, during November, the AF obtained nearly half of the total catch, coinciding when the SRF and the BRF had already increased their activities (13% and 15% for the total effort and 15% and 14% for the total catch, respectively). During December, the AF mostly did not operate, while such a month was better for the SRF in terms of the CPUE, the catch, and the angler’s preferences. The higher fishing efforts for the SRF and the maximum monthly catch for the BRF were registered during January, when the AF had ended their fishing season.

Artisanal and recreational fisheries exhibited different spatial distribution patterns. Whereas the SRF does not overlapped with the AF, the BRF occupied by far the most extensive area which includes at least 40% of AF fishing grounds. Such overlapping could be relevant and promote conflicts especially during November, even when both fisheries almost not share the main target species. Nonetheless, conflicts regarding the competition for the space can take place as was found in others fisheries (Pawson et al. 2007, Lloret et al. 2008). Field experiences indicated that anglers have not good predisposition to observe fishing nets in "their" fishing areas due to a potential decline in the recreational fishing quality. Prioritizing agreed fishing areas between resource users along with independent and distant ports of landings could decrease the visual contact between fisheries sectors and thus reduce the spatial conflict. In addition, as was successfully implemented in many coastal areas around the world, diversification from traditional fishing into others activity such as ecotourism within the marine protected area could represent a sustainable and alternative way to acquire economic benefit.

Intrasectoral conflicts are alleviated due to difference in the target species. The SRF and the BRF greatly focused their catches on *C. guatucupa* and *M. furnieri*, which together accounted for three quarters of their total harvest in weight. For the AF, *M. schmitti* were nearly the single species captured, with negligible captures of *C. guatucupa* and *M. furnieri* as by-catch. Moreover, *M. schmitti* was not even mentioned as being preferable for the recreational anglers, and therefore, their captures were produced involuntarily.

The average intrinsic vulnerability for by the RF fish catches reached a value lower than the average vulnerability of all world-wide exploited coastal fish species (48 out of 100) (Cheung et al. 2007). On the other hand, the average intrinsic vulnerability of AF catch was higher than the previous reference value. These results are consequence of the biological characteristic for the main target species. In this sense, AF clearly exerts its fishing pressure on a more vulnerable species, particularly when the adult population fraction enter into the bay for birth and mating purposes. The extraction of large individuals by AF could adversely affect the reproductive potential of *M. schmitti* populations, particularly if it is considered that larger females are proportionally more fecund (Oddone et. al 2005). Despite the RF had an intrinsic vulnerability of catch lower than AF its extractions not only include *M. schmitti* but also two rays species (*Sympterigia bonapartii* and *S. acuta*) that showed high intrinsic vulnerability status (Cheung et al. 2007). This situation demands the urgent implementation of conservation policies for AF and RF, in order to protect the most vulnerable target species.

4.2. Comparison of catch lengths and the total harvest between the fisheries

The target species captured by the RF (*M. furnieri* and *C. guatucupa*) were above the minimum legal size and their length at first maturity. However, the capturing of *M. schmitti*, although represent a lower percentage of the total catch, was below the minimum legal size for the species. Such features can be related to the presence of juveniles during the autumn and winter months in the area, when they are caught by unselective baited-hooks and rigs. In contrast, since the AF operated only with selective bottom gillnets, and only when the adult population fraction migrated into the bay, a small percentage of the sharks captured were above the legal size. Moreover, the AF captures were identified as being comprised of 1% juveniles (less than 50 cm TL) and

27.7% of young adults (less than 62.5 cm TL), according to the categories suggested by Colautti et al. (2010).

A main characteristic of both fisheries is that they can be considered selective due they are concentrated on only few species. These issues preclude applying a more balanced fishing approach that distributes the effort among different species. Selective fishing can results in target and non-target species being killed disproportionately to their abundances, modifying their roles in natural assemblages, and intrinsic capacities to sustain impacts (Zhou et al. 2010). However, the dominant species of the Anegada Bay fish assemblage are *C. guatucupa, M. furnieri* and *M. schmitti* (Llompart et al. 2013a) which were also identified as the most typical ones for the inner coastal assemblage of Argentina (Jaureguizar et al. 2006). Therefore, both fisheries are based on the most abundant species into the bay. The diversification of AF catches could be possible towards *Odontesthes argentinesis* species (see Llompart et al 2013b). In addition, new regulations especially for vulnerable species in Anegada Bay need to focus on catch lengths regulations more than in total harvest. In this sense, size selection of *M. schmitti* population appears to be happened in Anegada Bay. The RF affects the juvenile and young-adult population fraction while AF extracted the larger size individuals. Oddone et al. (2005) found that the litter size of *M. schmitti* appears to be linearly related to the pregnant female's length. This is why selective catching large size favours genotypes with slower growth producing evolutionary changes with time. Meanwhile, target size below the first length at maturity have impacts on the reproductive potential of the stock (Lloret et al. 2012). To acquire sustainability, a mandatory catch and release fishing for RF was proposed for juveniles of *M. schmitii* that not have sport nor monetary value (Llompart et al. 2012). The same regulation should be implemented on other target and non-target species with high vulnerability index such as chondricthyans. For example, RF catches are directed to other vulnerable species such as *Myliobatis* spp. and *Atlantoraja castelnaui* but only during tournaments by weight (Llompart 2011) while rays are frequent SRF and BRF by-catch species. Since fish mortality rates after release depends strongly on the fishing tackle used and angler behavior (see the Special Issue: The Science and Practice of Catch-and-Release Angling, published in Fisheries Research, volume 186, 2017) educate anglers in science-based best angling practices is relevant to minimize negative impacts. Finally, to decrease the proportion of large size *M. schmitti* in the AF catch, a length frequency distribution analysis but using experimental gill nets containing smaller mesh size between opposite notes (100 mm) could be useful to tested and implement. Also, a continuous monitoring program to acquire fishery-independent information to evaluate catch lengths, by-catch levels and fishing effort should be performed.

The results from the total harvest of the RF sector proved to be almost three times that of the AF, being the SRF largely more important than the BRF in terms of anglers involved and fishing effort. This is in agreement with different studies that have reported that catches by the recreational fisheries when compared to the commercial harvest (Schroeder and Love 2002, Pawson et al. 2008) and this highlights the potential impacts of this activity. However, both coastal fisheries in Anegada Bay appear to be having a low impact on a regional scale. When the species is considered at a broader geographical area is this important to note that outside of the marine reserve area (in the el Rincón area), a multi-specific commercial bottom trawling fishery industry (practiced mostly by vessels between 18 m and 39 m in length), capture about 20,000 tonnes of fish per year (Aráoz and Carozza 2014), of which 3,000 tonnes correspond to the *M. schmitti* (total of 8500 ± 2267 tons at national level between the 1990-2015 period). This has reduced their biomass by 50% between 1994 and 2003 (Massa and Hozborn 2003, Massa et al. 2004) and actually *M. schmitti* is categorized as endangered species by UICN (Massa et al. 2006). Species with high intrinsic vulnerability to exploitation and intensively fished are more prone to have high risk of population depletion and extinction (Cheung et al. 2005). Conversely, in Anegada Bay a total harvest of nearly 631 tonnes annually (RF + AF) of which 208 tonnes correspond to *M. schmitti* is sufficient to support the local population of nearly 800 residents and thousands of tourists per year. Such numbers highlights that a well administered small scale fishery, particularly in developing countries, could represent the best option for the sustainable utilisation of coastal resources, especially if they meet most of the criteria that are required for an enlightened fisheries policy, in terms of supporting employment, livelihood, and food security (Pauly 2006).

4.3. Fishery management directions

Conflicts between artisanal and recreational fisheries have been addressed for different marines fisheries elsewhere (e.g. Kearney 2002, Morales-Nin et al. 2005, Lloret et al. 2008, Veiga et al. 2010, Brown et al. 2016). Most of such examples corresponded to fisheries managed under command-control and centralized approaches that do not emphasize the need to find win-win solutions for both sectors. While fisheries management objective need to be shifted toward preserving the integrity of the ecosystems and biological diversities as well as assuring social sustainability, it is critical to move from such conventional approaches that fail to ensure equity benefits and solve multi-stakeholder conflicts.

Problems and management constraints in Anegada Bay align also with common limitations observed in different Latin American fisheries where poor institutional structures, ineffective control of fishing efforts, poor enforcement of their policies and weak frameworks to integrate social, bio-ecological, and economic aspects promote recurrent conflicts (Salas et. al 2007, Arlinghaus 2008). For example, although the management plans for the multiple-use of the natural reserves in the San Blas Bay promoted the development of artisanal fisheries in a sustainable way, considering their historical and cultural value (Zalba et al. 2008), anyway it was banned. The absence of consistency in management propositions reduces the mutual credibility for future cooperative actions. Appropriate incentives that are offered by the management system, primarily to the fishermen (but also to managers, scientists, and other stakeholders), may be the only alternative to achieve compliance (Oresanz et al. 2005).

To resolve intra-sectoral conflicts in the long term, an efficient communication process between the fishery sectors is requested (Newton and Elliot 2016). The actual barriers that impair a good communication between the sectors, such as a lack of rigorous scientific information, need to be overcome and transferred from the researchers to the fishers and the managers by promoting better mechanisms and collective efforts to focus on effective participatory management and conservation guidelines. A fear from the fishermen of management actions, which could limit their fishing opportunities, together with the fisher’s suspicions of science, is a prerequisite solution to improve the collaboration and to find robust management actions, for the equitable and the optimal use of common-pool resources by coastal fisheries (Dedual et al. 2013).

Moreover, since the migratory behaviour of the main target species for AF and RF fisheries in Anegada Bay (Llompart et al. 2013) belong to the same stock exploited by the industrial trawl fisheries that operate in El Rincón area (Jaureguizar et al. 2006), a more comprehensive management plan must be implemented at a regional scale (Colautti et al. 2010). Only from this integrative perspective it is possible to achieve a comprehensive picture of the current status of the stocks health, their potential change for recovery and to find a balance between risks and opportunities offered by each fishery.

However, fishery sustainability is dependent not only from a fishing perspective but should also encompass other equally important dimensions (Charles 2001). Inter-sectoral conflicts with no-fishing stakeholders, conservationist demands, and wildlife watchers should be considered as well.

The nature of the multiple uses of common pool resources in Anegada Bay by local residents, fishers, and tourists in general, dictate that these activities can no longer be treated in isolation and requires more comprehensive governance guidelines. Recovering of artisanal fishery activity could be difficult without changing management paradigms. An adaptive co-management approach for small scale fisheries is emerging in Latin America as a potential solution to enhance the capability of the governing system (Castrejón and Defeo 2015, Trimble and Berkes 2015). In this context, the promotion of recreational fisheries at the expense of, or in conjunction with the artisanal fisheries, together with a transformation of the conflictive relationships, to one of collaboration, constitutes a governability challenge that is ultimately reliant on self-regulated systems, with only a slight intervention by the public hand (Berkes 2003).

The fact that the recreational and artisanal fisheries exhibit a weak temporal overlapping and because anglers prefer *M*. *furnieri* and *C*. *guatucupa* as target species while AF is directed to *M*. *schmiiti*, represents an advantage to reduce the conflicts of a common use of coastal resources in Anegada Bay. Moreover, during November when both sectors share a proportion of common fishing grounds areas, a situation-specific Territorial Use Right in Fisheries strategy could be appropriate to ameliorate potential conflicts as was implemented in other Latin American small-scale fisheries (Defeo et al. 2016). In Anegada Bay, such strategy implies allocating exclusive rights for artisanal fishers in certain areas especially during November. As RF occupies larger extensions, but main activity take place during summer months, such a measure would not impact on their performance nor reduce angler expectative and satisfaction. Future directions also should be complemented with regular and improve monitoring of both fisheries addressing the potential for catches underreports, miss reported landings and illegal catch selling and poaching. Further, in this study, fisheries data from BRF did not arrive from specific technique as was for the SRF, thus requiring some caution with data comparison and interpretation.

There is an urgent need to evaluate not only the potential impact that the different types of fishing activities and their effects on the sustainability of coastal resources and on the general functioning of coastal ecosystems, but also on supporting livelihoods for local people. Close a net fishery is only likely to increase recreational harvest if net harvest is larger relative to recreational harvest (Brown et al. 2016), however this was not the case in Anegada Bay. Indeed, this study provided strong evidences that limited total harvest of both fisheries, their slight overlap in temporal and spatial scales, along with different targeted species due the selectivity of the gear uses and the angler’s preferences provide favourable conditions for reconciliation. Instead of considering as direct “competitors” AF and RF should allow for a sustainable co-existence in the bay, without compromising the conservational goals pursued by the natural protected area.

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Table 1

Table 1. The catch per unit effort (Kg fish h^{-1}), the monthly catch (tonnes) discriminated by year and months, and the total yearly catch (in tonnes) by the artisanal fisheries in Anegada Bay, according to the log books. * During 2004 and after 2008, the artisanal fisheries were banned due to conflicts.

Year	Months	CPUE	Catch	Total
2003	10	17.9	49.4	108
	11	25.3	58.5	
2005	10	12.6	56.3	254.3
	11	14.1	198	
2006	10	18.1	107.6	169.6
	11	8	59.7	
	12	2.9	2.29	
2007	10	23.4	71.2	146.7
	11	14.8	75.5	

Figure 1

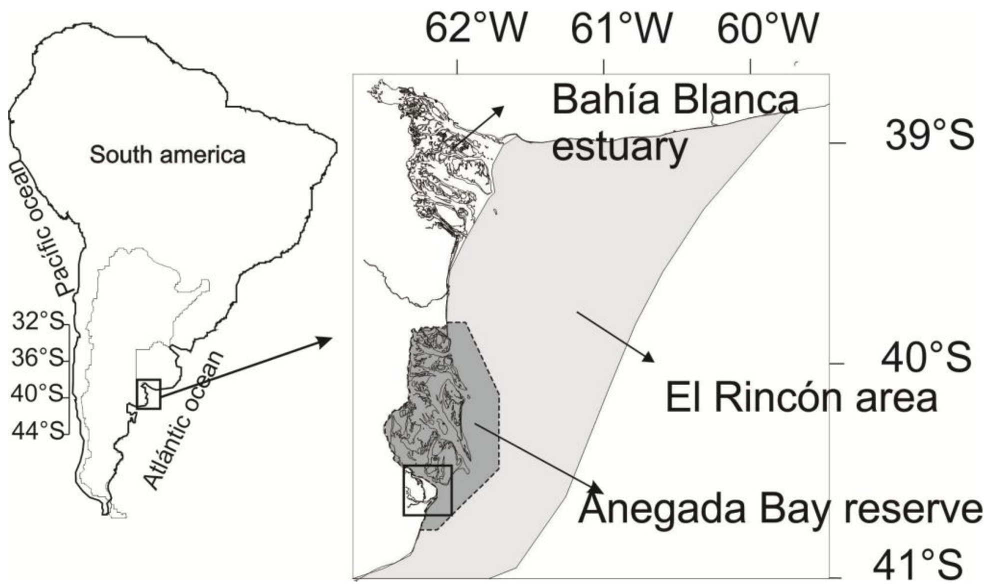

Figure 1. Geographic location of study area. Dotted line showed the boundary of the Anegada Bay protected area.

Figure 2

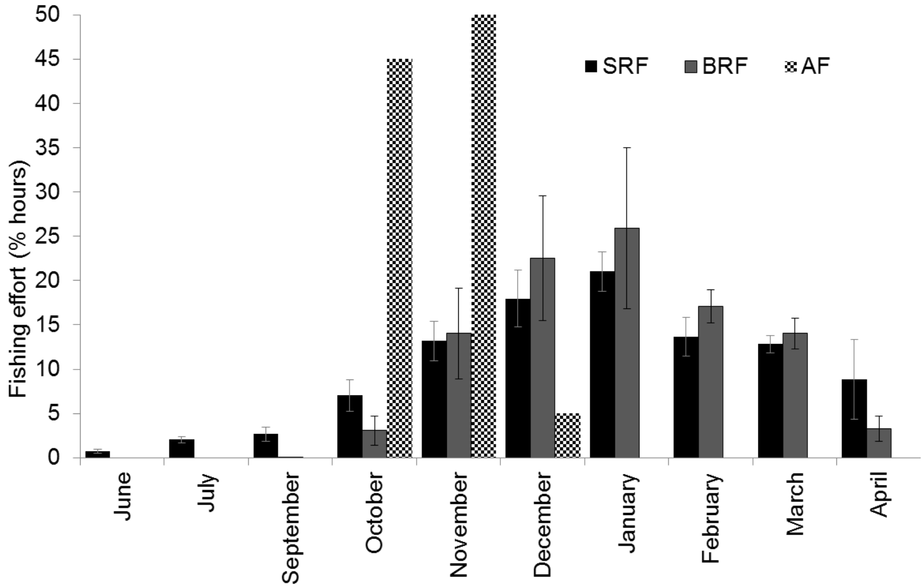

Figure 2. The percentage monthly distribution of the fishing efforts for the recreational fishery (RF) that was performed from the shoreline (Sh, black bars) and from boats (Bo, grey bars), in comparison with the artisanal fishery (AF, dotted black and white).

Figure 3

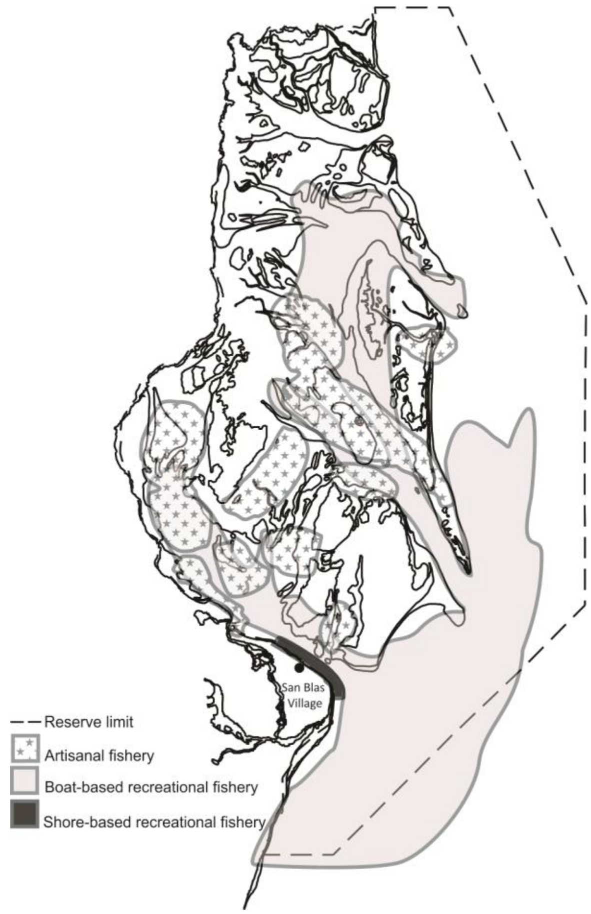

Figure 3. Spatial distribution of recreational and artisanal fisheries in Anegada Bay.

Figure 4

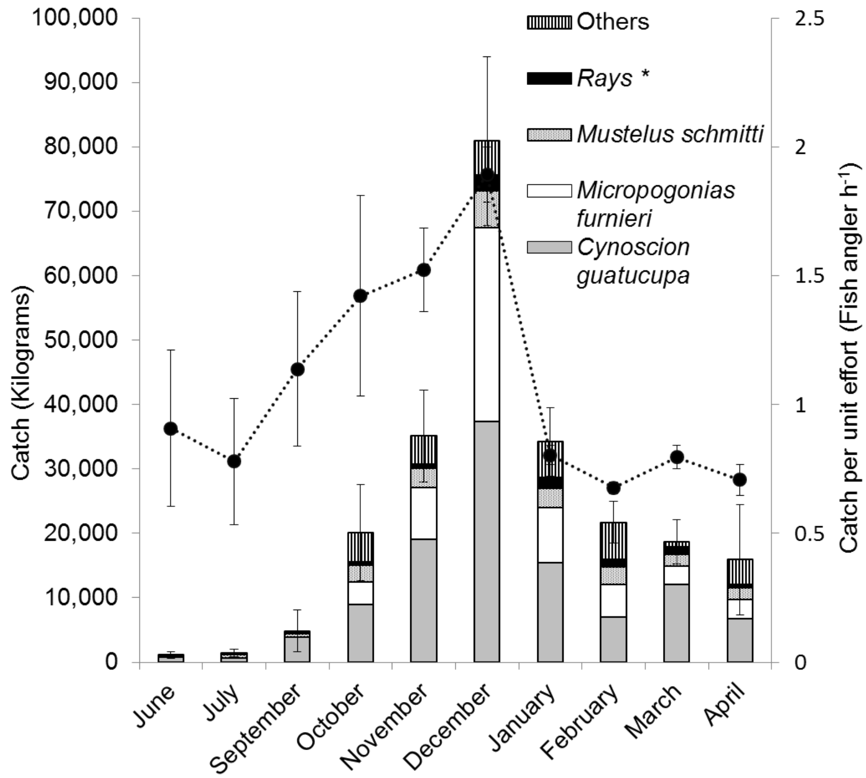

Figure 4. Total monthly catches in kilogrammes (Kg.) and their SE (vertical line) for the prevalent target species in the recreational shoreline fishery of Anegada Bay. *Rays correspond to *Sympterygia bonapartii* + *S. acuta* species. The dotted line corresponds to the capture per unit effort (CPUE).

Figure 5

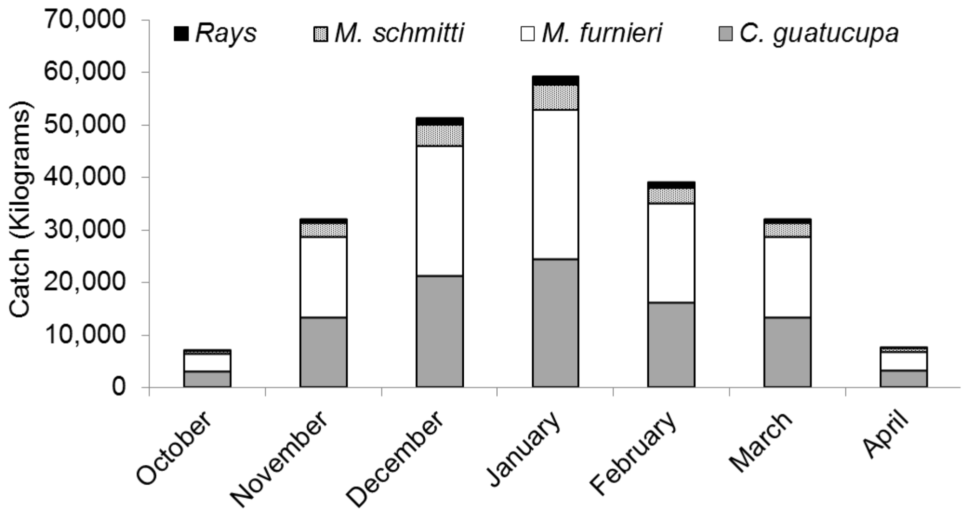

Figure 5. Total monthly catch in kilogrammes for the prevalent target species in the recreational boat-based fishery of Anegada Bay. *Rays correspond to the *Sympterygia bonapartii* + *S. acuta* species.

Figure 6

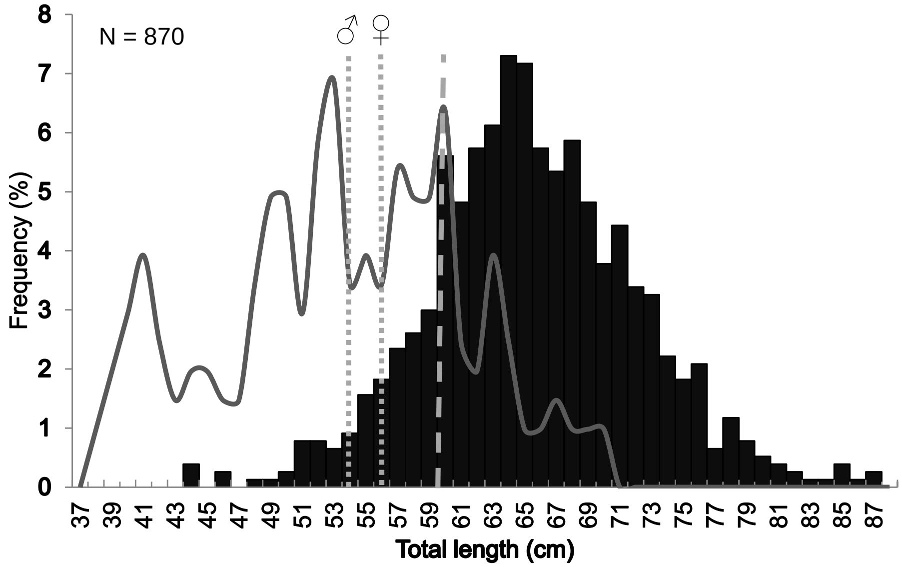

Figure 6. Total length-frequency-distribution for the landing of *Mustelus schmitti* obtained by the bottom gillnets of the artisanal (black bars) and the recreational fisheries (continue grey line) of Anegada Bay. The vertical grey lines show the length at first maturity for the males and the females (dotted) and the minimum legal size required by the Provincial Fishery Authority (stripe).