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ARTICLE

Using opportunistic records from a recreational fishing magazine to assess population trends of sharks

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Abstract: Detecting and determining changes in the occurrence and abundance of species is a priority for effective management of resources and for conservation of biodiversity. In the absence of long-term monitoring data, potential population declines may be very difficult to establish. Therefore, alternative information on occurrence of species to infer population trends is highly valued. Records of sharks (i.e., *Notorynchus cepedianus*, *Carcharias taurus*, *Galeorhinus galeus*, and *Carcharhinus brachyurus*) off northern Argentina from a recreational fishing magazine (Weekend), between 1973 and 2008, were reviewed with the aim of evaluating population trends with opportunistic data sources. For each shark species, the number of occurrences per year in the magazine was registered. Our analyses were based on a nonprobabilistic method (McPherson and Myers' approach) designed to determine population trends with opportunistic sighting records. In this approach we included the number of classified ads offering fishing guide services published per year in the magazine as a measure of observation effort. For each species, we fitted generalized linear models with a Poisson error structure and a log link, where the response variable was the number of occurrences per year, the explanatory variable was the year, and the logarithm of the number of fishing guide ads was specified as an offset in each model. For both approaches, the models estimated that populations of the four shark species have suffered declines. Estimates produced by these models will help to determine the magnitude of population changes where a paucity of data prevents more precise analysis.

Résumé : La détection et la détermination des variations de la présence et de l'abondance des espèces sont des composantes prioritaires d'une gestion efficace des ressources et de la conservation de la biodiversité. En l'absence de données de surveillance à long terme, il peut être très difficile de déceler d'éventuelles diminutions des populations. D'autres types de données sur la présence d'espèces permettant d'inférer les tendances de populations revêtent donc une grande valeur. Les signalements de requins (c.-à-d. *Notorynchus cepedianus*, *Carcharias taurus*, *Galeorhinus galeus* et *Carcharhinus brachyurus*) au large de l'Argentine dans un magazine de pêche sportive (Weekend), de 1973 à 2008, ont été examinés dans le but d'évaluer les tendances des populations à l'aide de sources de données opportunistes. Pour chaque espèce de requin, le nombre de mentions par année dans le magazine a été noté. Nos analyses reposaient sur une méthode non probabiliste (l'approche de McPherson et Myers) conçue pour déterminer les tendances de population à partir de registres de signalements opportunistes. Nous avons inclus dans cette approche le nombre d'annonces classées offrant des services de guide de pêche publiées annuellement dans le magazine comme mesure de l'effort d'observation. Pour chaque espèce, nous avons calé les données sur des modèles linéaires généralisés supposant une structure d'erreur de Poisson et un lien logarithmique, où la variable dépendante était le nombre de mentions par année, la variable indépendante était l'année et le logarithme du nombre d'annonces de guide de pêche était inclus comme écart dans chaque modèle. Pour les deux approches, les modèles ont estimé que les populations des quatre espèces de requin ont connu des diminutions. Les estimations produites par ces modèles aideront à déterminer l'ampleur des variations de populations dans les cas où la rareté des données ne permet pas une analyse plus précise. [Traduit par la Rédaction]

Introduction

Sharks face multiple threats from fisheries, habitat degradation, and pollution (Ferretti et al. 2010; Dulvy et al. 2014). Detecting population changes that may result from these threats is essential to direct conservation efforts. Many sharks play important functional roles in the top-down control of the structure and function of marine communities; therefore, the removal of these predators can result in cascading effects (Heithaus et al. 2008; Ferretti et al. 2010). In particular, the negative impacts of target and nontarget shark fisheries have led to strong abundance declines of many species, because sharks are particularly vulnerable to over-exploitation (Stevens et al. 2000; Hutchings et al. 2012). Thus, there is evidence suggesting that some populations of large sharks have declined regionally by as much as 90% or more (Baum et al. 2003; Baum and Myers 2004; Myers et al. 2007).

Estimates of abundance and identification of population trends through time are an important first step for assigning conservation status to a species and prioritizing conservation effort. But, for many species, to quantify temporal trends is complicated by the lack of information on occurrence and abundance. Histori-

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cally, shark species have received less attention than economically more valuable teleost fish species; therefore, many sharks are not recorded in fisheries statistics (Ferretti et al. 2010). Thus, the scarcity of information precludes the estimation of the magnitude of change in abundance of many shark species.

Analyses based on nontraditional data sources, as scientific specimen collections, explorers' notes, fishers' logbooks, photographs of trophy fish caught, and records of species from books and journals, can provide information on the species composition, distribution, and population trends where no quantitative fisheries catch data are available (Sáenz-Arroyo et al. 2005; McClenachan 2009; McPherson and Myers 2009; Baisre 2013). Thus, use of incidental captures and (or) sightings (i.e., opportunistic records) can help to determine the relative and approximate magnitude of population changes (McPherson and Myers 2009).

In Argentinean coastal waters, chondrichthyan fishes (i.e., sharks, skates, rays, and chimaeras) have been traditionally caught by recreational fishermen for many decades (Cedrola et al. 2011). Specially, large sharks are coveted trophies for fishermen; however, there are no catch data to evaluate this fishery (Cedrola et al. 2011). Therefore, historical occurrences of shark catches that have been targeted by recreational fishing and published in specific magazines can provide valuable insights on population trends.

Off northern Argentina, four species of large sharks are commonly found: the broadnose sevengill shark (*Notorynchus cepedianus*), the sand tiger shark (*Carcharias taurus*), the school shark (*Galeorhinus galeus*), and the copper shark (*Carcharhinus brachyurus*) (Lucifora et al. 2002, 2004, 2005*a*, 2005*b*). This region is the major coastal recreational fishing ground located in the southwestern Atlantic Ocean (Llompart et al. 2012). These shark species have been targeted by recreational fishermen for many years. The use of opportunistic observations can be very useful to evaluate sharks from this region, because there are no long-term data on shark catches in the Southwest Atlantic.

Previous assessments of large sharks from the Southwest Atlantic show declines of the few populations that could be assessed. The species with the most information is *G. galeus*. This species was subject to intense fishing between 1940 and 1950 off Argentina and Uruguay (Chiaramonte 1998). The exploitation of this species at that time, known as the "shark fever", was so lucrative that it accelerated the development of industrial fishing in Argentina (Mateo 2006). Although there is no formal assessment of the population decline, several lines of evidence, such as declines in catch per unit effort, local depletion, and increased travel times of fishing vessels, indicate a large decline in the abundance of *G. galeus*, which lead to one of the first attempts to regulate a marine fishery in Argentina (Mateo 2006). Something similar happened in Uruguay, where catches of up to 24 000 coastal sharks per year (mostly *G. galeus*) where reported in the 1940s (Nion 1999). Off southern Brazil, *G. galeus* started to be exploited in the 1970s, and by the 1980s "drastic declines" were already observed (Lessa et al. 1999). Although at lower rates of exploitation, *G. galeus* continued to be exploited through the 1980s and 1990s off Uruguay and Argentina (Chiaramonte 1998; Nion 1999). A decline rate of 6.7%–12.8% per year was estimated for *G. galeus* using stage-based matrix models (Lucifora 2003). The available data for *C. taurus* and *C. brachyurus* are less complete than that for *G. galeus*. It is likely that *C. taurus* and *C. brachyurus* constituted a small fraction of the shark catch during the "shark fever" years (Nion 1999). Afterwards, both species have been exploited throughout their range off southern Brazil, Uruguay, and Argentina (Chiaramonte 1998; Lessa et al. 1999; Nion 1999). In fact, *C. taurus* has become locally extinct in some parts of the southern Brazilian coast (Vooren et al. 2005). Both species were found to be declining at annual rates of 11% and 3%–13%, respectively (Lucifora 2003). *Notorynchus cepedianus* is the species with the least available data. It is known to be commonly caught in recreational fisheries during spring and autumn (Lucifora et al. 2005*a*; Cedrola et al. 2009). As age cannot be estimated from vertebral centra of this species, population projections using matrix models or life tables cannot be used (Barnett et al. 2012). Consequently, population trends for *N. cepedianus* in the Southwest Atlantic are unknown. In fact, *N. cepedianus* is one of the less known species of large shark in the world, and data on population status are lacking at a global scale (Barnett et al. 2012).

Currently, conservation status by the International Union for Conservation of Nature (IUCN) varies among these shark species. *Galeorhinus galeus and C. brachyurus* are respectively listed as Vulnerable and Near Threatened globally (Duffy and Gordon 2003; Walker et al. 2006). The Southwest Atlantic population of *C. taurus* is classified as Critically Endangered (Chiaramonte et al. 2007). On the other hand, *N. cepedianus* is listed as Data Deficient because fisheries data are insufficient to assess their conservation status (Compagno 2005). In the Southwest Atlantic, effective conservation measures on these shark species are scarce. In Brazilian waters, *G. galeus* is a protected species where its catch is prohibited (Ministério do Meio Ambiente, Brazil 2004). Since 2007, all medium to large coastal sharks caught in recreational fisheries off northern Argentina must be released to minimize fishing mortality (Ministerio de Asuntos Agrarios de la Provincia de Buenos Aires, Argentina 2007).

In Argentina, basic information on long-term monitoring is lacking for large shark species. Therefore, considering the conservation concern of these species and the lack of data on them, analyses based on nontraditional data sources provide valuable insights on long-term abundance. In this paper we examine temporal trends of the four large coastal sharks off the north coast of Argentina using opportunistic records obtained from a recreational fishing magazine.

Materials and methods

Data collection

Opportunistic sighting records were obtained from a recreational fishing magazine from Argentina called "Weekend" (Editorial Perfil, Buenos Aires). This fishing magazine is one of the most popular and traditional magazines among Argentinean recreational fishermen; it is published monthly since October 1972. Compared with other fishing magazines, this has the longest time series. The search for historical issues of this fishing magazine was performed at the public library "Leopoldo Marechal" (Mar del Plata), the library of the "Club de Pescadores Buenos Aires" (Buenos Aires), and individual fishermen's private libraries. Other magazines were also searched, but only scattered issues could be obtained and no consistent historical record was found.

For each shark species (i.e., *N. cepedianus*, *C. taurus*, *G. galeus*, and *C. brachyurus*), the number of occurrences per year in the magazine was recorded. A visible piece of evidence (i.e., photographs) of any individual shark that appeared in the magazine was considered as an occurrence. This way, we were able to identify each occurrence to the species level. Historical records collected between January 1973 and December 2008 were used in this study. Each sighting record typically included location of catch; therefore, the study region was defined as the coastal waters of the Buenos Aires province, between San Clemente del Tuyú (36°22′S, 56°44′W) and Bahía San Blas (40°33′S, 62°13′W) (Fig. 1). Also, we recorded the number of classified ads offering fishing guide services in this region published in the magazine per year as a measure of observation effort. Clearly, from the ad's contact details, each ad published was related to one operator. Although classified ads have some uncertainty, we checked the assumption that classified ads are a good indicator of observation effort by comparing the values of recent (i.e., 1999, 2000, and 2001) quantifications of fishing effort directed at sharks with historical (i.e., before 1976) values. The number of boats that went fishing for sharks was recorded on a daily basis at the port of Bahía San Blas during 24, 46, and 44 days during the peak of the shark fishing season (i.e., January,

Fig. 1. Map showing the study region along the northern Argentinean coast. The rectangle in the inset represents the study region in South America.

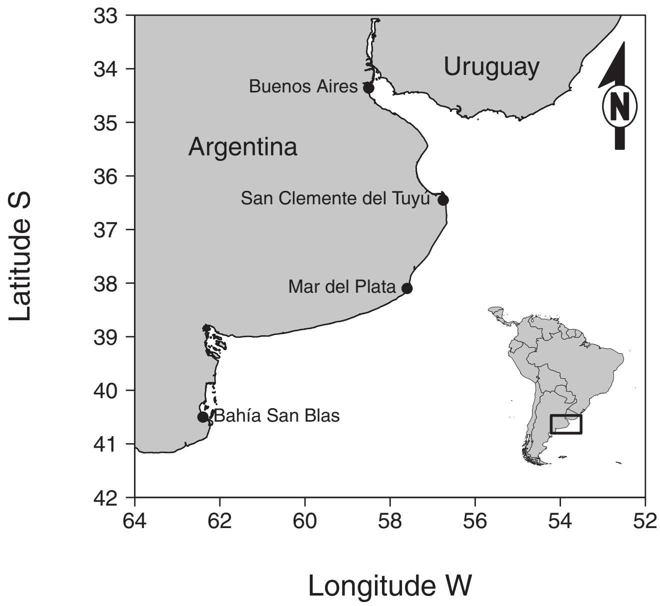
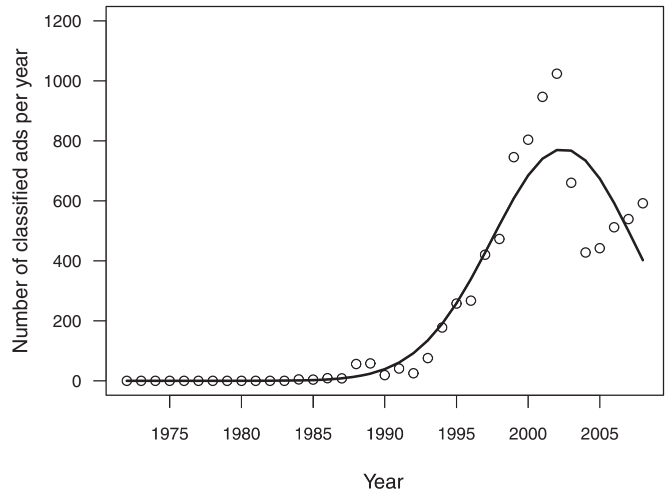


Fig. 2. Changes in the number of classified ads offering fishing guide services of an Argentinean fishing magazine (Weekend) per year estimated by a generalized linear model. The model had a negative binomial error structure and a log link.



February, and March) of 1999, 2000, and 2001, respectively. We compared the mean number of daily fishing trips made by recreational boat operators in these recent years with the values reported by Yaniz (1976) for the port of Bahía San Blas, the main recreational shark-fishing area in Argentina (Chiaramonte 1998; Lucifora 2003).

Data analysis

To determine population trends from opportunistic sighting records for these four shark species, we used a nonprobabilistic approach developed by McPherson and Myers (2009). This method extracts the relative magnitude of population change in the number of reported sightings by fitting a series of generalized linear models (GLMs) to the difference in the count data between any reference date and the most recent point with data using a Poisson distribution. Values larger than 1 suggest a declining trend; values equal to or less than 1 suggest a stable or increasing population. This approach enables to simulate various scenarios for proportional change in the observation effort. Therefore, estimates of population trends were conducted assuming changes in the observation effort as indicated by the number of classified ads offering fishing guide services per year. The proportional change in effort for each year was estimated using GLMs, where the response variable was the number of classified ads offering fishing guide services and the independent variable was the year, with a Poisson error structure and a log link (Crawley 2005). Then, these estimates were included in each trend model. To test the robustness of the population trends, we conducted a sensitivity analysis by calculating the relative change in abundance for different series of reference periods (i.e., changes in the length of the time series).

Whenever possible, historical data should be analyzed by different methods to provide sound estimates of species declines (Roberts and Kitchener 2006; Luiz and Edwards 2011). Therefore, to estimate trends from opportunistic sighting records for each shark species, we also fitted GLMs with a negative binomial error structure and a log link (Crawley 2005). The response variable was the number of occurrences per year, the explanatory variable was the year, and the predicted number of fishing guide ads (p) was specified as an offset term in each model. The structure of the models was as follows:

$$N = \alpha + \beta y + \log(p)$$

where N is the number of occurrences per year, α and β are coefficients estimated by GLMs, y is the year, and p is a known value treated as an offset. Because the variance of the number of occurrences per year for *G. galeus* is less than the mean, we fitted a GLM assuming a binomial error structure and a logit link (Crawley 2005). For this species, the number of occurrences (i.e., count data) was changed to presence–absence per year. Then, the response variable was the presence–absence per year, the explanatory variable was the year, and p was treated as an offset. We used an offset term in each model to account for variation in the number of classified ads among years when counting the number of occurrences. Operatively in the fit of the models, adding an offset term is the way to correct the response variable with respect to effort in rate models (i.e., it provides the denominator of the response). Then, as some years had absence of classified ads, we estimated p for each year to avoid the problem of having 0 values for log(p). Thus, p is an estimation for each year from a GLM fitted between the number of classified ads offering fishing guide services and year, with a negative binomial error structure and a log link. This model was as follows:

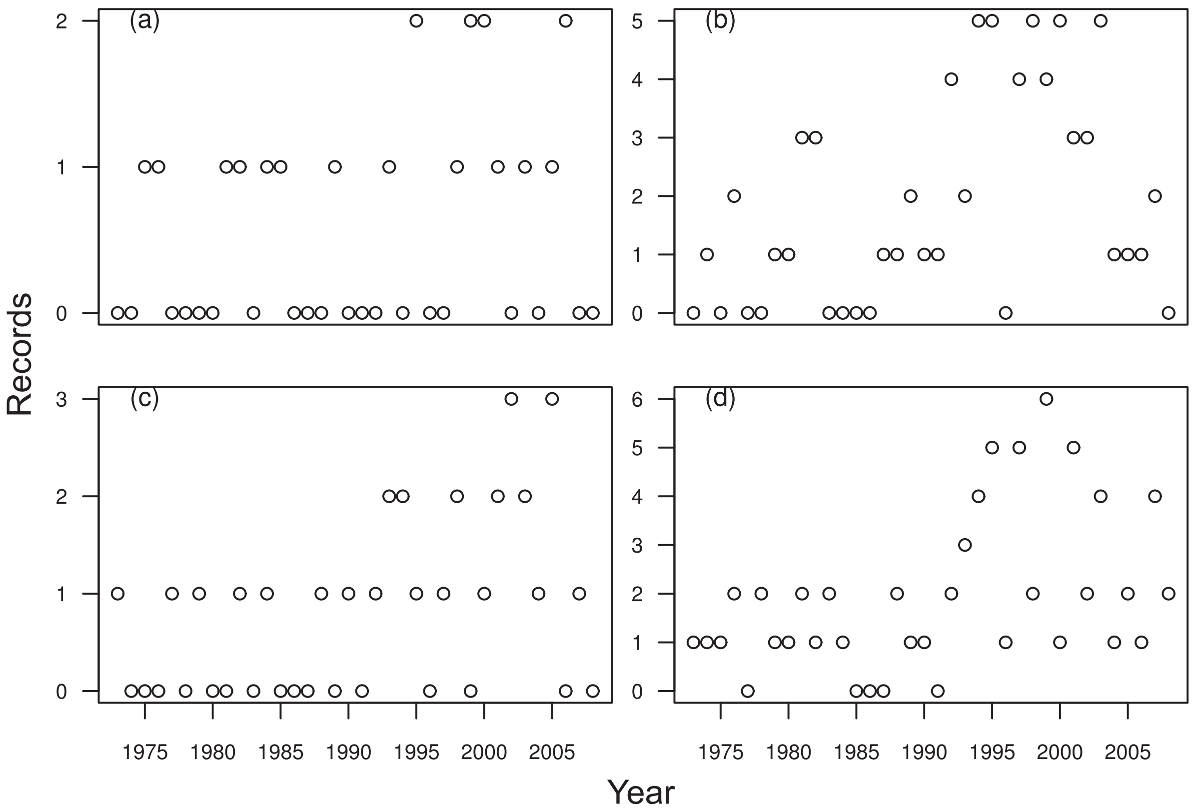
$$f = -4.151 \times 10^5 + 592.3y - 0.2810y^2 + 4.432 \times 10^{-5}y^3$$

where f is the number of classified ads offering fishing guide services, and y is the year. The prediction of this model is $p = \exp(f)$. This model fit very closely the data, but without producing any 0 value (Fig. 2). We examined the Pearson residuals plotted against model predictions and year to check the adequacy of the assumptions that support the GLMs (Faraway 2006). All statistical analyses were conducted with the statistical software R version 3.1.0 (R Development Core Team; www.r-project.org).

Results

We documented a total of 185 opportunistic sighting records during the period 1973–2008 in 403 issues of the Weekend magazine. Of these, 20 records were of *N. cepedianus*, 67 of *C. taurus*, 29 of *G. galeus*, and 69 of *C. brachyurus* (Fig. 3). The number of classified

Fig. 3. Number of occurrences reported per year in a recreational fishing magazine (Weekend) between 1973 and 2008 for (*a*) *Notorynchus cepedianus*, (*b*) *Carcharias taurus*, (*c*) *Galeorhinus galeus*, and (*d*) *Carcharhinus brachyurus* along the northern Argentinean coast.



ads offering fishing guide services in each issue of the magazine and each year ranged between 0 and 90 and between 0 and 1024, respectively, increased sharply between 1984 and 2002, decreased suddenly in 2003, and started to increase in 2004 (Fig. 2). A similar trend was found for the mean daily number of trips aimed at shark fishing in Bahía San Blas. Yaniz (1976) reported that, at least until 1976, there were no boats conducting shark fishing trips in Bahía San Blas. In fact, in his book describing recreational shark fishing in Argentina, Yaniz (1976, p. 194) states that, would it have a port, Bahía San Blas would have become a commercial fishing hub and that the lack of a port made it impossible for early recreational fishermen to have boats available to fish for sharks beyond the islands located in front of Bahía San Blas. This situation contrasted markedly with that observed in 1999, 2000, and 2001, when a fleet of 23 boats were based in Bahía San Blas with the sole aim of offering chartered fishing trips to recreational fishermen. Of these boats, 12 were able to conduct shark-fishing trips beyond the islands in front of the town. These 12 boats conducted a mean (with standard deviation) of 3.5 (2.52), 2.98 (1.92), and 2.5 (1.38) daily fishing trips targeting sharks in 1999, 2000, and 2001, respectively.

For the McPherson and Myers' (2009) approach, we treated the years between 1984 and 1988 as missing values, because we did not have access to all issues of the magazine in these years. For the estimation of proportional change in effort for each year, we divided these in three groups: 1973–1983, 1989–2002, and 2003–2008. Between 1973 and 1983 the change in effort was 0, because in this period no fishing guide service ads were published. The changes in the percentage of observation effort estimated were 229.03% between 1989 and 2002 and 200.34% between 2003 and 2008. In general, the results of McPherson and Myers' (2009) approach showed that the four shark species had estimates of relative decline in abundance larger than 1, which indicates some degree of decline (Fig. 4). The four shark species showed values approaching 1 between 1973 and 1984, suggesting that the species could have been stable at the start of the sighting period. *Notorynchus cepedianus*, *C. taurus*, and *G. galeus* presented values larger than 1 by the end of the sighting period, reaffirming the tendency of decline. *Carcharhinus brachyurus* could have been stable or with a minor decline in relative abundance by the end of the study period. For the four species, the 95% confidence intervals are large, ranging from values that drop below 1 to very large values. However, when examining different series of reference periods, the resulting trend was similar. Therefore, the sensitivity analysis determined that the trend estimated for each species was robust (see online supplementary material, Fig. S1[1]).

GLMs fitted between the number of occurrences per year of *N. cepedianus*, *C. taurus*, and *C. brachyurus* and presence–absence of *G. galeus* and year are shown in Table 1. All models had negative coefficients for the variable year, indicating a decline in the trends. These models estimated annual rates of decrease of 27.53%, 27.24%, 28.68%, and 29.03% for *N. cepedianus*, *C. taurus*, *G. galeus*, and *C. brachyurus*, respectively. Residual analyses indicated that the assumptions of the models were justified (Fig. S2[1]).

Discussion

Taking into account the results of the two methodological approaches, we can conclude that these four shark species have suffered some degree of population decline. In the case of McPherson

[1]Supplementary data are available with the article through the journal Web site at http://nrcresearchpress.com/doi/suppl/10.1139/cjfas-2015-0087.

Fig. 4. Estimates of relative decline in abundance (dots) with 95% confidence bounds (lines) for any reference year betwenn 1973 and 2008 for (*a*) *Notorynchus cepedianus*, (*b*) *Carcharias taurus*, (*c*) *Galeorhinus galeus*, and (*d*) *Carcharhinus brachyurus*. Magnitude of observation effort changes were as follows: 1973–1983 = 0%, 1989–2002 = 229.03%, and 2003–2008 = 200.34%.

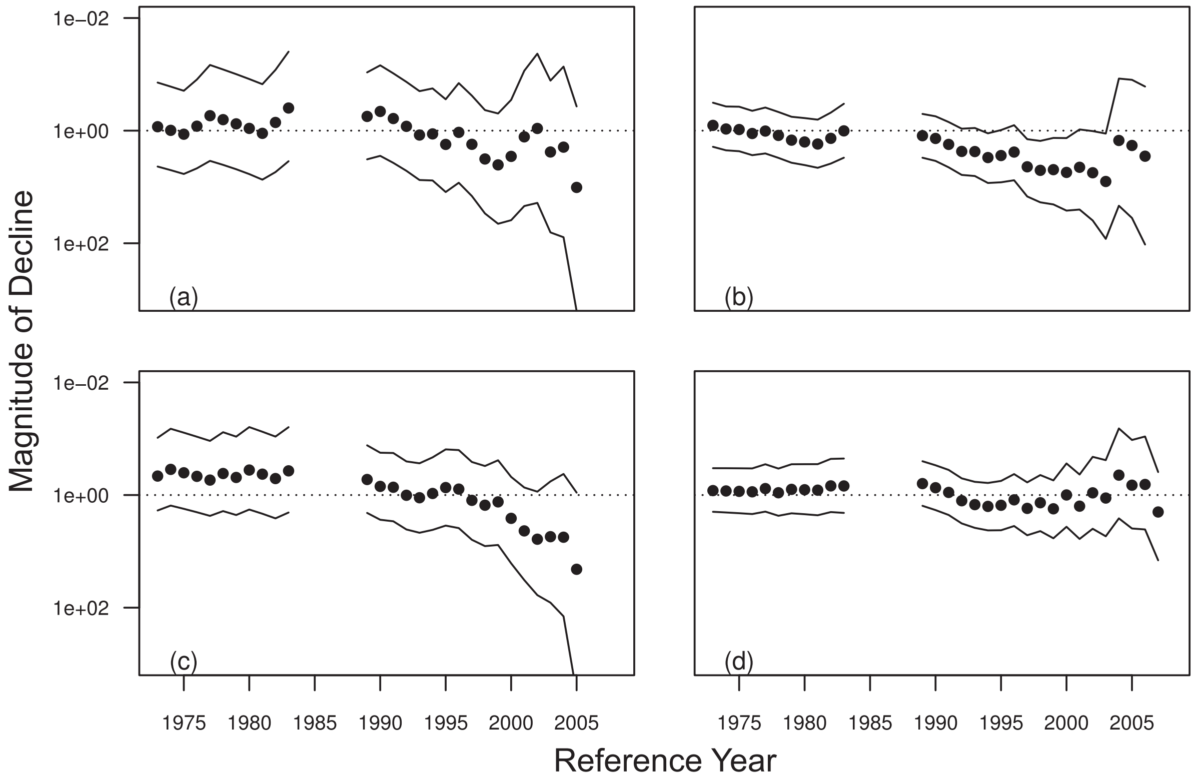


Table 1. Models used to explain the trends from opportunistic sighted records between 1973 and 2008 using generalized linear models.

Species	Model	Error structure
Notorynchus cepedianus	637.593 – 0.322 year + offset[log(*p*)]	Negative binomial
Carcharias taurus	631.659 – 0.318 year + offset[log(*p*)]	Negative binomial
Galeorhinus galeus	671.659 – 0.338 year + offset[log(*p*)]	Binomial
Carcharhinus brachyurus	382.325 – 0.343 year + offset[log(*p*)]	Negative binomial

Note: *p* is prediction of the number of fishing guide ads per year estimated from a generalized linear model with a negative binomial error structure and a log link.

and Myers' (2009) approach, the results indicate an evident decline in the sighting records of *N. cepedianus*, *C. taurus*, and *G. galeus* and an apparent stability or minor decline for *C. brachyurus*. GLMs identified significant declines in sighting records for the four shark species. These results help to determine the approximate magnitude of population changes where a paucity of data prevents more precise analysis, as is the case for large coastal sharks in Southwest Atlantic waters.

A decline in abundance of a species could be reflected in a decline in the number of sighting records through time (McCarthy 1998). As in this work, patterns of population trends based on historic sighting records were reported for sharks of the genus *Carcharhinus* in the Archipelago of Saint Paul's Rocks (equatorial Atlantic) showing a sharp decline in abundance (Luiz and Edwards 2011). For the great white shark (*Carcharodon carcharias*) in the Northwest Atlantic, abundance trends support a significant decline in the 1970s and 1980s, but with an apparent increase in abundance since the 1990s (Curtis et al. 2014). In the Northwest Pacific, population trends of *C. carcharias* indicated evidence of a minor decline since 2002 (Christiansen et al. 2014). When population information is sparse and limited, these alternative approaches are valuable to determine conservation status and prevent further losses, especially for highly vulnerable and critically endangered taxa.

The lack of historical monitoring of fishing effort in recreational fishing along the coast of Argentina retarded our ability to understand the impact of this fishery. Therefore, quantification of the fishing effort from the recreational fishery should be performed in the future. For example, in Bahía San Blas, the major shore-based marine recreational fishery in the region, the fishing effort estimated from two seasons was very high compared with other recreational fisheries of the Southern Hemisphere (Llompart et al. 2012). These results raise the need to determine fishing effort to conserve particularly vulnerable species, such as large sharks. In the context of the paucity of fishing effort data, we considered the number of classified ads offering fishing guide services as an indirect measure to quantify fishing effort, which seems to be valid given the similar trend observed in the comparison of actual effort data for different periods. Although undoubtedly limited given the scarcity of data, a pattern of no effort to regular and steady effort to catch sharks by recreational fishermen is apparent, corresponding with the pattern of classified ads. Thus, since 1989 the number of classified ads offering fishing guide services in the Weekend magazine has increased strongly. This pattern could be an indicator of a strong increase in the catch of sharks by recreational fishing in northern Argentina. The abrupt drop of fishing guide service ads that occurred in 2002 is possibly associated to the late 2001 economic crisis in Argentina. Since 2003, fishing guide service ads have been increasing steadily. This relationship of fishing ads with major economic drivers is an indicator that fishing ads may be a good proxy for fishing effort, since recreational fishing is mostly a tourist-related activity along the northern Argentinean coast.

We believe that fishing ads may be a good proxy for fishing effort; however, the rate of increase in effort over time might be underestimated. For example, it is possible that over time operators may have started to use more than one boat as their business grew, but still using just one ad to advertise the fishing service. Further, changes in the fishing ads and number of occurrences could be influenced by other trends. Some hypothetical scenarios are that changes in the trends of fishing ads or occurrences could be influenced by the editorial focus of the fishing magazine. For these reasons, pursuing a standardized quantification of the fishing effort and catches from the recreational fishery is of great importance.

The annual rates of decline estimated by our GLM approach were higher than the only previous decline rates estimated through matrix models. Estimations of percent annual decline of *C. taurus*, *G. galeus*, and *C. brachyurus* differ by about 15% compared with previous estimates. Despite these differences in magnitude, the observation that a similar trend of population decline has been reached through very different methods and data adds evidence for a general declining trend of these three species in the Southwest Atlantic.

Notorynchus cepedianus is the least known of the four species dealt with in this study. The only known population assessment of *N. cepedianus* is for New South Wales, Australia, where it is the only species with increasing catch per unit effort of all sharks caught in the New South Wales Protective Beach Meshing Program (Reid et al. 2011). This trend has been hypothesized to result from the declines in the same area of other large sharks (especially *C. carcharias* and *Galeocerdo cuvier*) and the filling of the vacated niche by *N. cepedianus* (Reid et al. 2011). In our study, both methodological approaches produced negative trends for *N. cepedianus*. Unfortunately, a combination of lack of data and human exploitation occurs in most of the global range of *N. cepedianus* (Barnett et al. 2012). In this sense, our result should be taken as a precautionary note for other regions.

Overfishing is the primary threat to shark populations in the world (Ferretti et al. 2010). In the Southwest Atlantic, shark species are caught in commercial fisheries, as target or bycatch of industrial and artisanal fisheries, and in recreational fisheries in their entire area of distribution for many years (Chiaramonte 1998; Nion 1999; Vooren and Klippel 2005; Bornatowski et al. 2014). Because sharks are highly vulnerable to over-exploitation, a continuous fishing effort should have a negative impact on large shark populations, as our analysis of sighting record trends showed. These results are supported by other observations with strong evidence of decline in abundance in the region, especially for *G. galeus* and *C. taurus*. For example, off South Brazil and Uruguay, the population of *G. galeus* was reduced by more than 85% in 1997 owing to intensive commercial fishing (Miranda and Vooren 2003). Captures of *C. taurus* off Uruguay have decreased drastically between 1977 and 1997 (Nion 1999), and off Rio Grande do Sul, Brazil, this species is now considered rare (Vooren et al. 2005). Therefore, *C. taurus* is categorized as Critically Endangered by the IUCN in this region (Chiaramonte et al. 2007). Even though the Argentine Sea is characterized by a heavy fishing effort (Tyedmers et al. 2005; Campagna et al. 2006), to date there has been no quantitative assessment of the large shark populations in this country.

Along the Argentinean coast, recreational fisheries for sharks have been traditional for over 70 years (Chiaramonte 1998; Lucifora 2003; Cedrola et al. 2011). Despite the economic and social importance of recreational fisheries for sharks in Argentina, there have been no quantitative and systematic studies and estimation of shark catches. The effect of recreational fisheries on the abundance of marine populations is little known, but in the case of sharks this effect can be similar and even larger than that of artisanal and industrial fisheries (Smith and Abramson 1990; Pollard et al. 1996; Lucifora 2003). For example, in only one place of the Argentinean coast, Bahía San Blas, between 123 and 453 individuals of *C. taurus* and between 327 and 471 individuals of *C. brachyurus* were landed each summer season between 1999 and 2001 (Lucifora 2003), which is comparable or even larger than the landings of commercial fisheries (Chiaramonte 1998; Nion 1999). Thus, we can consider recreational fisheries as a potential threat for shark populations.

The methodological approaches used in the present study detected negative population trends. Despite the limitations of opportunistic sighting records, mainly because uncertainty over observation effort, these population trends help to identify species in serious need of conservation attention (McPherson and Myers 2009). Because the use of historical data provides very important baseline data to reconstruct the past abundance of marine species (Lotze and Worm 2009), we believe in the need to take measures of strong protection of the populations of large sharks to prevent further declines in the abundance. Finally, future conservation efforts for these vulnerable shark species should focus on a constant monitoring of the populations to obtain a more accurate assessment of the conservation status in this region.

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