Upgrading the status (taxonomy, fisheries and conservation) of the school shark *Galeorhinus galeus* (Elasmobranchii: Triakidae) in Patagonian waters, South West Atlantic Ocean

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This work summarily reviews the evidence of the existence of different populations of school shark *Galeorhinus galeus* globally; it updates the taxonomy of the species as well as discussing the theoretical pertinence of a single population in the South West Atlantic ocean. It summarizes the conservation status of the species in the area and reports for the first time the collapse of school shark fishing in Argentinian waters. Finally, it extends the latitudinal range of the distribution by two degrees south and discusses the potential impact of climate change in the southward extension of the distribution of the species.

**Key words:** Vitamin shark, recreational fishing, distribution, climate change.

The triakid shark *Galeorhinus galeus* (Linnaeus 1758) —known in Argentina and Uruguay as “tiburón vitamínico” (vitamin shark), “cazón” (dogfish) or “trompa de cristal” (nose-glass shark)— is a cosmopolitan, abundant, active, strong-swimming, coastal-pelagic shark of temperate continental and insular waters; although it has several characteristic features of oceanic-pelagic species, including the occurrence of individual animals well off the continental shelf (Stevens & Wayte 1999) and long oceanic movements (Walker et al. 2008). It is known in the Western South Atlantic: Southern Brazil to Argentina. Eastern Atlantic: Iceland, Norway, Faroe Islands, British Isles to Mediterranean and Senegal, ? Ivory Coast, ? Nigeria, ? Gabon to Zaire, Namibia to South Africa. Western Indian Ocean: South Africa. Western South Pacific: Australia (Western and South Australia, Victoria, Tasmania, New South Wales, southern Queensland), Lord Howe Islands, Chatham Islands, ? New Zealand, Central Pacific: Laysan Islands. Eastern Pacific: British Columbia to southern Baja California, Gulf of California; Peru and Chile (Compagno 1984).

In his remarks on genus *Galeorhinus* Blainville 1816, Compagno (1984) included all nominal species of this genus in the epithet *Galeorhinus*...
galeus. He also suggested that, due to the great dispersion of its populations, G. galeus could be subdivided into subspecies. But so far, there have not been detailed comparative morphological studies among Galeorhinus populations as a means to elevate some of the latter to a subspecific level.

From the field of genetics, a pioneer work comprising allozyme allele frequencies concluded that “school sharks from sites as distant as the North Atlantic (UK), South Africa, Australia, and New Zealand do in fact represent a single globally-distributed species is inescapable” (Ward & Gardner 2003). More recently, Chabot & Allen (2009) working with samples taken in six dispersed locations around the globe (Australia, North America, South Africa, South America [Argentina and Peru] and Great Britain), analyzed the control region of mitochondrial DNA to assess gene flow between populations of the nominal species. These authors argued that although a single population of G. galeus may exist in the southwestern Atlantic, since the sample sizes from South America were extremely small (Argentina n = 1; Peru n = 11) their study failed to detect a unique haplotype from this region. Their results also suggest a large isolation of the populations and a low or non-existing gene flow between the North American and South American populations. With similar studies, Hernández et al. (2015) reached analogous conclusions concerning the isolation among populations of Australasia (Australia and New Zealand) and the Southeast Pacific coast off Chile. In neither case did the authors consider elevating the involved populations to subspecific level.


In her studies of the vitamin shark, Siccardi (1950) calls this species G. galeus with certain reservations. Finally Sadowsky (1977), in a brief communication, sets G. vitaminicus de Buen 1950 in synonymy with G. galeus (Linnaeus 1758). The latter name was used thereafter in all citations of this shark in southern South America: Menni (1986), Cousseau & Denegri (1997), Chiaramonte (1998), Cousseau & Perrota (2000), Elias et al. (2005) and Lucifora et al. (2004), among others.

For the south western Atlantic (SWA), Bellisio et al. (1979) and Cousseau & Perrota (2000) updated the distribution of the species in the continental shelf setting the northern and southern limits at the coast of Rio Grande do Sul (28° s, Brazil; Fig. 1) and San Jorge Gulf 47° s (Patagonia; Fig. 1), respectively. Although South American biologists agree that the SWA G. galeus population is a single one that could migrate by reproductive needs between southern Brazil and north Patagonia in Argentina (Chiaramonte 2015), tagging experiments were recently performed in the area in order to elucidate the migration pattern of the SWA stock (Cuevas et al. 2014). Supporting the aforementioned agreement, some additional evidences have been put forward: during spring and summer, when the breeding females leave their offsprings, the species called “Winter migrant” by Vooren (1997) disappears in southern Brazilian waters, whilst at the same time, it is heavily fished in Uruguay.

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and Argentina for a short time (de Buen 1952, Chiaramonte 1998). In this way, Nion (1999) reported another peak in the Uruguayan fishery during autumn, when gravid females arrive to the coast. Finally, Bovcon et al. (2012) estimated that the parturition in Bahía Engaño (Puerto Rawson, Fig. 1) occurs between December and February, a fact that reinforces the assumption of a single population with nursery areas in the southern part of its distribution.

To assess the conservation status of the *G. galeus* population in the SWA and by a matrix population model with data collected at Bahía San Blas (Fig. 1), Lucifora (2003) found a decrease in the population at an average annual rate of 6.7% to 12.8%. More recently, while within a global scope, *G. galeus* was assessed as VU (Vulnerable) (Red List of IUCN 2007), in the SWA it was classified as CR (Critically Endangered) (Walker et al. 2006, Chiaramonte & Di Giàcomo 2008). These figures contrast with those presented by the National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks 2009): citing Otero et al. (1982) and Massa et al. (2004). The NPOA report presented an estimated abundance of *G. galeus* during spring in Buenos Aires and Uruguayan coastal region with numerals of 16 000 t in 1978, 7 332 t in 1994, 17 826 t in 1998 and 61 090 t in 1999. In this context of peril for the SWA population, although there are no-specific fishing regulation established for *G. galeus* in Argentina, some of the norms of Buenos Aires, Chubut and Santa Cruz provinces encompass the angling for the species (NPOA-Sharks 2009, Cedrola et al. 2011).

Nevertheless, the efficiency of these norms for the conservation of the species is still object of dispute (Cedrola et al. 2012, Cuevas et al. in prep).

Due to zoogeographic and demographic factors (historically the ports and cities were mainly focused at the northern area of the line coast of the country near the Pampas fields which concentrated the workforce since the Spanish colonization), the traditional fisheries in Argentina take place in the south central coasts of Buenos Aires province and in northern Patagonia. From south to north, the main fishing ports during the mid 1950’s were Rawson, Carmen de Patagones, Necochea (= Puerto Quequén) and Mar del Plata (Fig. 1). Between 1943 and 1952 these fishing harbours played a predominant role in the commercial exploitation of *G. galeus*, with 44 397 tons of the species (whole mass) being landed (90% between 1944 and 1949 according to López 1954, fide Mateo 2006). The landings in the early 1950’s were Rawson (6 501 t), Carmen de Patagones (5 846 t), Necochea (5 862 t) and Mar del Plata (17 497 t). Also, Bahía Blanca (2 342 t) and Puerto Madryn (1 919 t; Figs. 1 and 2. López 1954, fide Mateo 2006) had some relevance. According to Cordini (1963), in 1955 and 1956 Puerto Rawson produced 24% of the total shark landing (as salted fish and liver oil) in Argentina. Between 1957 and 1960, the northern harbours, mainly Mar del Plata and Necochea, increased their importance in shark production. During the following two decades (1960’s and 1970’s) the school shark landings were kept at low levels, whilst during the 1980’s, the school shark became an important resource for coastal fisheries as the target of the shark fisheries in the SWA (Compagno 1984, Bonfil 1994, Chiaramonte 1998), reaching 40.35% of the total landings of cartilaginous fish (whole mass). This activity finally collapsed at the end of the last century (Chiaramonte 2015), and the landings decreased down to less than 5% of the total of cartilaginous fish landed in subsequent years, with a minimum.
of 2.17% in 2008 (Fig. 3). Nowadays, some school sharks are still landed as bycatch of several fisheries. It should be noted that in the national fishery statistics, the school sharks landing records (whole mass) were declared both as “shark nei” and “school shark”. These two items were attributed to *G. galeus* in the fishery statistics by Chiaramonte (1998) based on the results of interviews to fishermen conducted by Dr. Terence I. Walker, during the preparation of FAO Fisheries Technical Paper 378 (Walker 1999). The interviews were conducted along the Argentinian coast, between San Clemente del Tuyú and Rawson (Fig. 1), on September-October 1997. All the interviewed fishermen named *G. galeus* indistinctly as “tiburón” (shark) or “cazón” (local name for school shark), doing likewise in their log books. Prefectura Naval Argentina (local Maritime Authority) also reported the name “salida a tiburón” for fishing boats sailing for *G. galeus*. It should be also noted that these figures probably have changed since the end of the school shark directed fishery in 1998 (Chiaramonte 2015). Nevertheless, the declared values have not recovered to the levels recorded at the time of the directed fishery (Fig. 3).

Recent reported captures expand significantly their southern distribution limit of the species in the SWA by two latitudinal degrees. Three females (125, 128, and 130 cm in total length [TL]), were captured on January 7, 2008 on the “Los Instalados” beach (49°23’15” s - 67°39’14” w, at Península San Julián, Santa Cruz, Fig.1). Subsequently, on February 3, 2008, Mr Rubén Ricci captured another female 117 cm TL (Fig. 4), which was tagged with brand spaghetti type
(dart tag MACN-18017) and returned to the sea in good condition. Finally at the same location, in January 27, 2013 another female 113 cm TL was captured.

Although the geographical references of *G. galeus* in the SWA almost always came from information coming from commercial fisheries, in recent years monitoring effort on coastal and embarked recreational fishing has increased (Cedrola *et al.* 2011). This fact could represent

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7. [Link to MACN website](http://www.macn.secyt.gov.ar/investigacion/proyectos/vertebrados/ictiologia/pro_tiburones.php)
an amendment of the biases in historical records, and not an enlargement of the distribution as presented here. Moreover, anglers from Península de San Julián informed that catches of *G. galeus* are frequent during the summer recreational fishing season.

An alternative view is that the extension of the latitudinal range could be caused by oceanographic changes in response to global climate change. But a further analysis of this hypothesis however could lead to the conclusion that the southward expansion could be driven by the presence of cooler water masses than those of preceding decades and not by global warming as the common sense would suggest.

For the South Atlantic region, Wainer & Venegas (2002) found oscillations of a 25-30 year period in the sea surface temperature (SST) at SWA and that an “anomalous advection of cold waters northward (warm waters southward), owing to a strong (weak) Malvinas Current, is responsible for sea surface temperature anomalies in the subtropical western South Atlantic”. In another study of the SST focused at the Antarctic Peninsula and adjacent area (including Patagonian coasts), Meredith & King (2005) found a warming process since 1965: decadal sea surface temperature anomalies reveals a large cold anomaly during 1955-64 replaced successively by warmer waters until 1994. This process for the SST is somewhat less obvious at 20 m depth and far less evident at 50 m depth (Meredith & King 2005). But in recent years (2007 to 2010) the surface waters in the area tended to be colder than on average (Dehnhard *et al.* 2013). This scenario, far from clarifying it, makes this picture more complex since the occurrence of species associated with warmer waters in the Patagonian coast is not a recent issue and dates back to the last decades.

The captures herein reported reinforce the need for further studies on *G. galeus* to elucidate its life history patterns in southern Patagonia that would surely contribute to improve the conservation actions of this critically endangered species in the SWA. Moreover, we recommend urgent fishery control measures to ensure the sustainability of this depleted population based on the precautionary principle approach for responsible fisheries.

**References**


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