Research Article

Marine mammal research in South America: 30 years of publication efforts and collaborative networks

Diana Szteren[1]   **& Diego Lercari[2]**

[1]Laboratorio de Zoología Vertebrados, Departamento de Ecología y Evolución
Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay
[2]Unidad de Ciencias del Mar, Departamento de Ecología y Evolución
Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay
Corresponding author: Diana Szteren (diana@fcien.edu.uy)

ABSTRACT. A notable diversity of marine mammals inhabits the Atlantic and Pacific waters of South America. For decades, South American countries have been producing scientific research focused on these species. However, still, there is no systematic assessment of the magnitude and main subjects on which this research has been focused. This study analyzes the trends and patterns in scientific research on marine mammals in South America, evaluating a pool of bibliometric indicators and mapping collaborative relationships among countries, authors, and research areas. Academic documents were retrieved from two bibliographic databases: SCOPUS and SciELO, from 1990 to 2020. Results showed a gradual increase in publications along the three study decades. Brazil played a central role in the number of publications in both databases, followed by Argentina and Chile. The South American publications on marine mammals were centralized in a small number of journals, and few authors were responsible for a large proportion of contributions. The authors showed a moderate level of collaboration, mainly reflecting stronger links among neighbor countries, including co-authorships with North American and European countries. The most frequent keywords reflected three clusters centered in taxonomic groups (Cetacea, Odontoceti, and Pinnipedia) and two centered in research subjects (pollution and phylogenetics). The scope of the contributions differed among collections. Nevertheless, both databases were complementary and contributed to show marine mammals' research in South America.

Keywords: marine mammals; South America; bibliometric analysis; collaboration network; citations; research topics

INTRODUCTION

Marine mammals are remarkable animals due to multiple causes. They have a long history of direct hunting. They are charismatic objects of touristic activities, play an important role in ecosystems, and face several conservation threats. The group of marine mammals comprises 87 species of cetaceans (belonging to 11 families within the order Cetartiodactyla), 34 species of pinnipeds (belonging to three families within the order Carnivora), four species of Sirenia, the polar bear *Ursus maritimus*, and one to three Mustelid species (Albouy et al. 2017, Nelms et al. 2021). Many species have an important role as consumers, as top predators, keystone species, or due to their role in the transference

and recycling nutrients (Bowen 1997). They are major consumers of production at most trophic levels, from primary production (e.g. sirenians) to predatory fish and even other marine mammals (e.g. polar bears, killer whales, and leopard seals). Because of their relatively large body size and abundance, they are thought to have a major influence on the structure and function of some marine communities (Bowen 1997). Marine mammals represent valuable flagship species for marine environment conservation (Rose et al. 2011). Different stressors have led to around 25% of species classified as threatened and 21% being data deficient, according to the Red List of Threatened Species (IUCN) (Nelms et al. 2021). Scientific research on marine mammals has a long history. According to Würsig et al. (2018), mo-

_____

Corresponding editor: Luis Pastene

dern research occurred in five co-occurring phases. Before the 20th century, contributions were mainly morphological descriptions and systematics from stranded animals; from 1850 to 1970 behavioral, life history, anatomical, and distribution studies were developed from hunting and whaling activities. A third phase, during the 1970s, concentrated on physiological and behavior studies with animals in captivity. Since the 1970s, ecological, habitat use, abundance, life history, behavior, and physiological studies have been conducted. Lastly, since the 1990s, it has been a phase of integration of knowledge, a combination of methods and techniques, in the era of the widest availability of information (Würsig et al. 2018).

The Atlantic and Pacific waters of South America are rich in aquatic mammals, totalizing 67 species: 50 cetaceans, 12 pinnipeds, three mustelids, and two Sirenid species (SOLAMAC 2021). Nevertheless, a clear gradient in publications on marine mammals from the northern hemisphere to the southern hemisphere has been reported: species from the southern hemisphere have been less studied (Jaric et al. 2015). Furthermore, marine mammal research is disproportionately lacking compared to terrestrial mammals worldwide (Schipper et al. 2008).

The production and dissemination of research is very important for policy-making and management planning. Understanding and quantifying when and how much science is produced is necessary to delineate future management strategies, which facilitates the identification of research and management priorities (Palacios et al. 2014, Charles 2017). Quantitative research indicators (bibliometrics) are needed to diagnose the state of the art related to scientific production, determine the most active countries, identify knowledge gaps, and species and geographic areas where most information is being produced (Bornman & Mutz 2015). The quantitative analysis of publications of the academic community is widely accepted to evaluate trends and patterns in most areas of scientific research (Ellegaard & Wallin 2015). However, research effort on marine mammals has under-produced information needed for policy-making and mana-gement to develop sound conservation and restoration measures (Jaric et al. 2015).

Concerning marine mammals, previous biblio-metric reviews have been focused on small regions and certain groups (e.g. Elwen et al. 2011, Tiongson et al. 2021), or limited to one species (e.g. Prieto et al. 2012), or were based just on one journal (e.g. Palacios et al. 2014). Furthermore, global trends in marine mammal research revealed that it had been disproportionately directed toward less endangered species (Jaric et al. 2015). Publications have been centered on cetacean species with larger distribution ranges or more abundant pinniped species (Jaric et al. 2015). Despite most South American countries devote a small investment in scientific research, there is an increasing trend of research groups facilitated by multiple collaborations, technology, and advances in commu-nication. However, there is still limited quantitative information on basic biology, abundance, and trends for many marine mammal species inhabiting South America, restricting the possibility to assess and address conservation threats and conservation measures to protect populations and marine ecosystems (Hücke-Gaete et al. 2004).

Knowing how science evolves would not only help in the delineation of conservation strategies. From a basic perspective, it is also important to summarize and organize the diversity of an accumulation of scientific knowledge of increasing magnitude. In this context, this study aimed to analyze the trends in scientific research on marine mammals in South America, evaluating a pool of bibliometric indicators to assess the number of publications, the impact of these articles, and the role of different countries and authors on the scientific production in this field. In addition, this work seeks to identify clusters of the predominant research subjects in marine mammals by the South American specialized scientific community and explore regional and international collaborations.

MATERIALS AND METHODS

Collection formation

This work is conducted at the continental level, focusing primarily on the bibliometric analysis of publications referring to marine mammals developed fully or partially in South American countries from 1990 to 2020. The publications analyzed correspond to SCOPUS (Elsevier), one of the largest databases of references of arbitrated international literature, including journals, books, proceedings, and other sources. SCOPUS was chosen as an international bibliographic database since access is guaranteed by the State of Uruguay, which subsidizes the subscription annually for all country citizens. Additionally, the Scientific Electronic Library Online (SciELO) bibliographic database and digital library of open access journals complemented the former database. This network was created to meet the scientific communication needs of developing countries (https://scielo.org/en/about-scielo/). SciELO includes sources of a regional or national nature, with more restricted circulation. It was originally established in Brazil in 1997; today, 15 countries integrate this journal collections network.

For this analysis, we seek to obtain a collection of documents that included as many publications as possible, carried out totally or in part focused on marine mammals of South America. First, a general search chain for references was applied in the SCOPUS web interface, pursuing to capture the different works on marine mammals produced in each studied country. Then, we implemented a document collection for each continental South American country. The search of scientific publications was conducted using both scientific and common names of the different groups, within the same search query, as follows:

TITLE-ABS-KEY (*Cetacean* OR *Pinniped* OR *whale* OR *dolphin* OR *seal* OR *manatee* OR *Trichechus* OR *marine otter* OR *Lontra felina*) AND AFFILIATION COUNTRY (name of each country[1]).

[1]All South American countries, i.e. Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guiana, Guayana, Paraguay, Perú, Surinam, Uruguay, and Venezuela.

A general collection for the South American continent was then formed by adding the collections first obtained for each country. Repeated references were omitted.

In that way, manuscripts that included "any of the keywords" in all the considered fields (i.e. title, abstract, keywords) were added to the collection. In a second instance, the references included were manually reviewed one by one to ensure accordance with marine mammal research, the presence of at least one author with a South American affiliation, and the study area. In this process, scientific studies of any knowledge area referring totally or in part to marine mammals were included, according to the following criteria: a) the study was conducted in South America, or b) the contribution on marine mammal knowledge is global (i.e. it is theoretical or was conducted elsewhere in captivity in one South American species) and includes at least one South American author. Studies from the Southern Ocean were excluded. The only Mustelid species included was the marine otter (*Lontra felina*) because it is the only one in South America which is considered a "marine mammal" (Jaric et al. 2015, Avila et al. 2018) and feeds exclusively in the sea (Tinker et al. 2018). Duplicate references were eliminated during this step, and authors' names that appear in two or more different forms were unified. No secondary SCOPUS documents were considered (i.e. those extracted from a SCOPUS document reference list but not available directly in the database).

Secondly, for the SciELO database, we used the following search string:

ALL (Cetacea* OR whale* OR dolphin* OR Pinniped* OR seal OR Trichechus OR manatee OR marine otter OR Lontra felina). *Is used to include singular and plurals.

The resulting collections are provided as a CSV file digital supplementary material A2 and A3.

Due to the incompatibility between the SCOPUS and SciELO databases, a parallel analysis of both databases was performed. After the final corpus was attained, the bibliographic information for each article was collected, including the title, authors, abstract, keywords, year of publication, source (journal details), affiliation countries, and cited references.

Bibliometric descriptors

Several bibliometric indexes described both corpses of acquired articles: total number of articles, articles produced by each country, the average annual growth rate, total number of authors, and other combined indexes (documents per author, authors per document, co-authors per document, collaboration index).

The countries and authors with the highest occurrence (the first 10 cases) in the articles were determined, and those articles and authors most cited during the study period were identified. Impact indexes of authors with higher productivity (the highest 10) were analyzed only for the SCOPUS collection, as SciELO does not include cited references. Two impact indexes were estimated, H and G index. The H index (Hirsch 2005) was estimated by ordering (in descending order) the publications by the number of citations received and establishing the point at which the order number matches the number of citations received by a publication. On the other hand, the G index (Egghe 2006) was estimated as the number of citations received by the articles part of the H core, the volume of the most cited articles considered for calculating the H index.

The relationship between the number of documents produced by the countries and several variables that could explain the differences was explored. For this purpose, the number of marine mammal species, the length of the coastline, and the total human population were collected for each country. The total gross domestic product (GDP) and the percentage of GDP invested in research and development in each South American country were also collected as economic parameters (see details of these estimations in Supplementary files; Table A1). The relationship between the mean number of articles (2017-2019) and the variables mentioned above was explored using Spearman's correlation coefficient. We chose this time

period to compare the same years of the most recent economic parameters.

Collaboration network

We performed a co-authorship network analysis among countries to delineate the research organization's properties and the bibliometric units' influence, allowing the intellectual structure of the discipline occurring on marine mammal research to be defined (Peters & Van Raan 1991). A co-author bibliometric map was constructed following these concepts using the SCOPUS database to identify and visualize the main collaborations among countries, and the collaboration flows between them and foreign.

Research topics: co-word analysis

The conceptual field established around the marine mammals of South America was first analyzed by the main sources (journals) where the documents in the collection were published. In addition, a map of keyword co-occurrences in the articles was constructed to visualize the conceptual structure of the analyzed research field (Courtial et al. 1991, Delecroix & Eppstein 2004). For that, the keywords included in the entire database were identified and ordered based on their frequency of appearance. A conceptual map was made based on the analysis of the co-occurrence of words (in the titles, keywords, and abstracts of the articles) to identify clusters of the predominant research areas occurring about marine mammals of South America.

Data analysis

Bibliometric analysis is a widely used research method for detecting state of the art for a particular field. The method can utilize quantitative analysis and statistics to describe patterns of publications within a given period or body of literature. To develop the quantitative bibliometric analysis of the collections of bibliographic references, the R program (R Core Team 2016) was used. In particular, the specialized bibliometrix package was employed (Aria & Cuccurullo 2017). Mapping the co-word and co-author networks were performed with the visualization of similarities (VOS) viewer program (Van Eck & Waltman 2010). VOS aims to locate items in a low-dimensional space so that the distance between any two items reflects the similarity or relatedness of the items as accurately as possible.

Due to limitations in the SciELO database, the bibliometric analyzes based on keywords and references (citations) were not processed in this case.

RESULTS

Bibliometric descriptors

During the analyzed period, 1893 scientific publications referring to marine mammals in South America were registered in the SCOPUS database. In general, the number of documents published has increased since 1990. The country with the highest number of publications in Brazil, followed by Argentina and then Chile (Fig. 1a). Until the year 2000, all countries produced less than 10 papers per year, but from that year on, Brazil accelerated its rate of article production, which was followed to a lesser extent by Argentina and Chile. Globally, after 2006 publishing rate intensified sharply, reaching 180 articles per year in 2020 (Fig. 1b). The annual percentage growth rate of publications in SCOPUS was 10% (Table 1). No documents from Paraguay, Surinam, or Guayana were produced in the time frame considered.

On the other side, the SciELO database summarized 287 publications during the study period, following a similar increasing trend but with a lower magnitude, reaching a maximum of 24 contributions in 2010, and then slightly declined, varying between 13 and 19 articles (Fig. 1b). The annual percentage growth rate was 12.5%. The preponderate role of Brazil in both databases was highlighted among all other countries, while Argentina and Chile also were countries with a high number of publications (Figs. 2a-b). The recent mean document productivity (2017-2019) of the different countries was significantly associated (Spearman correlation) with three of the context variables: number of marine mammal species ($r = 0.88$; $P = 0.011$), GDP ($r = 0.85$; $P = 0.020$) and coast length ($r = 0.79$; $P = 0.049$).

The description of bibliometric indicators showed that, on average, each document in the SCOPUS database received 16.3 citations in 30 years and 1.72 citations per year. From 1990 to 2020, 4519 authors published on marine mammals, and 68 of them were single authors (Table 1). This collection is composed mainly of articles, followed to a lesser extent by books chapters, notes, and reviews. Concerning authors' collaborations, this collection showed a mean of 2.4 co-authors per document and 0.4 documents by author. In contrast, SciELO only indexed articles. The number of authors publishing on marine mammals was 833 in 71 sources. Twenty-five were single authors, representing a mean of 2.9 authors per document (Table 1). The collaboration index (level of collaboration by co-authorship) was higher in SciELO (3.1) than in SCOPUS (2.5).
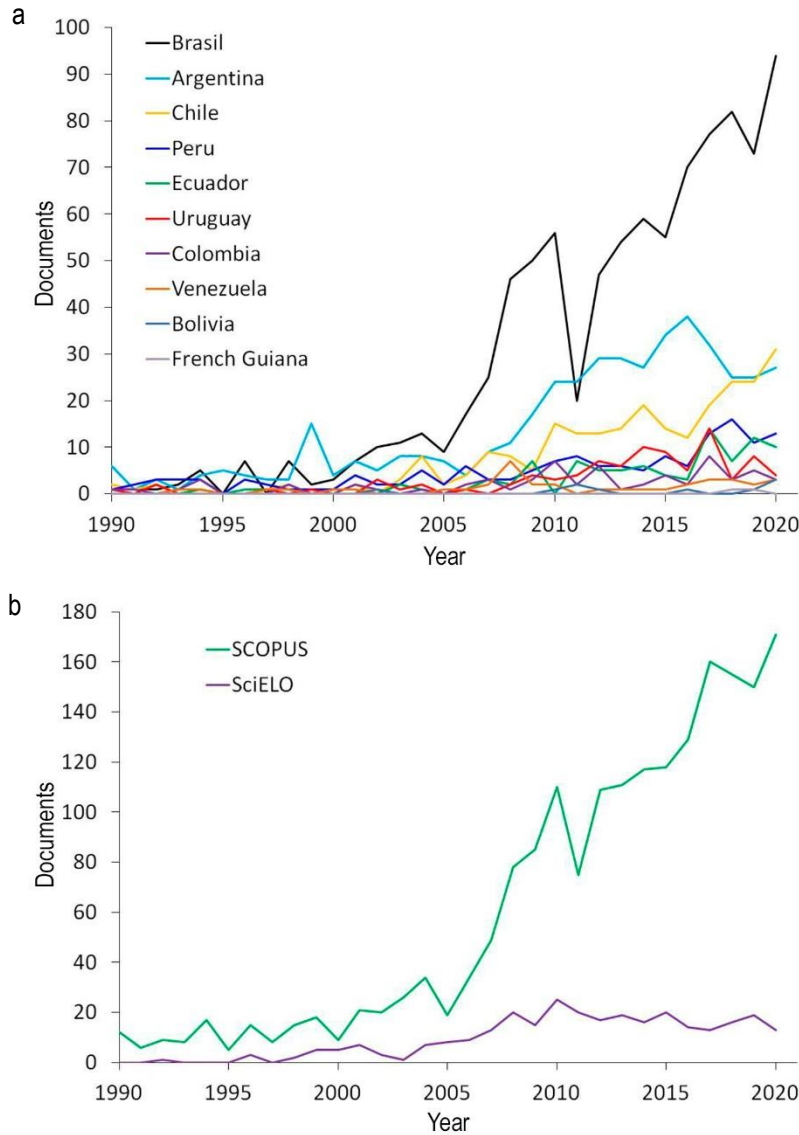
Figure 1. a) The annual number of scientific publications associated with marine mammals of South America by country registered in SCOPUS from 1990 to 2020, b) the annual number of publications per database from 1990 to 2020.

Regarding the most frequently cited articles in SCOPUS, related to marine mammals in South America (Table 2), most of these highly cited references (n = 8) were published before 2010. The first 10 citations received among 140 and 335 total citations and between 8 and 37 citations per year. In addition, the two more cited contributions that also have the highest citations per year have less than a decade (Table 2). South American researchers mainly appear as co-authors, not as the main authors of these documents. The differences in the theme of the main works give an initial idea of the main scientific disciplines that focus on marine mammals in South America. Evolution and health-related topics are highlighted as the most important. This analysis was not performed in SciELO

because the database excludes the references of each article.

Peru and Colombia are the most important concerning average citations per country in the SciELO database. Argentina and Brazil occupy the third and fourth sites, followed by Uruguay (which did not appear among the first five countries considering the total number of publications) (Fig. 2c).

The co-authorship network among countries showed three distinctive clusters or subnetworks that include South American nations (Fig. 3). One major cluster comprises Brazil and Argentina with strong collaborative links with Uruguay, Spain, and the United Kingdom. Another cluster formed by United States,

Table 1. Bibliometric description of publications registered in SCOPUS and SciELO databases associated with marine mammals in South American countries from 1990 to 2020. NA: not available. *Editorial, *erratum*, letter, note, and short survey.

Collection	SCOPUS	SciELO
Documents	1893	291
Sources (journals, books)	443	74
Average years from publication	8.49	9.68
Average citations per document	16.26	NA
Average citations per year per doc	1.72	NA
Document type		
Article	1,669	291
Book chapter	65	0
Note	53	0
Review	53	0
Conference paper	30	0
Others*	22	0
Document contents		
Author's keywords (DE)	3560	NA
Authors		
Number of authors	4519	865
Authors of single-authored documents	68	21
Authors of multi-authored documents	4451	844
Authors collaboration		
Single-authored documents	88	24
Documents per author	0.42	0.34
Authors per document	2.39	2.97
Co-authors per documents	5.44	4.38
Collaboration index	2.47	3.16

including Chile, Colombia, Ecuador, Venezuela, and collaboration links with Brazil, Argentina, and other non-Southamerican countries. Peru forms the third cluster, collaborating with Bolivia and some European countries (Belgium, Italy, and France). In general, external countries with more collaboration were United States, United Kingdom, and Spain.

The first 10 most productive authors in SCOPUS with the highest contribution of documents and citations account for 29.8% of the total published in marine mammals. Authors from Brazil and Argentina are represented. On average, these 10 authors produced 20.7 documents during the study period, while the first three authors produced 79 documents each. H index ranged between 10 and 25 (Table 3). The authors with the most documents in SciELO are from Brazil and Chile. They produced between 6 and 16 articles on marine mammals in the study period (Table 4). Only three coincide with the SCOPUS database; however, the order is different.

During the period studied (1990-2020), diverse sources (443) issued documents related to marine mammals (Table 1, Fig. 4) on the SCOPUS database. However, the 10 most frequent sources account for 31% of the documents. The journal Marine Mammal Science was the most used source reaching almost 9% of the total documents of the collection. Journals focused on marine biology predominate among the first 10, followed by journals focused on mammals and pollution, among other themes. The number of sources that appear in SciELO is much smaller (74). The top 10 most frequent sources include 57% of the total documents, and the most important journal was Revista de Biología Marina y Oceanografía (14% of the total documents). Two journals appear in both databases (Latin American Journal of Aquatic Research and Revista de Biología Marina y Oceanografía).

The keyword co-occurrence network for South American studies on marine mammals in SCOPUS is shown (Fig. 5). It includes the 275 most frequent keywords forming five clusters of research topics. A major cluster is formed around cetaceans and whale keywords and includes some species (mainly *Megaptera novaeangliae* and *Eubalaena australis*) and concepts such as distribution, habitat use, seasonality, abundance, among others. Pinnipeds form another cluster, and concepts mainly related to trophic ecology terms (e.g. diet, stable isotopes, predation) and *Otaria byronia* and *Arctocephalus australis* appear as the main species. Dolphin keyword cluster contains concepts such as conservation, physiology, and human activity and some Odontoceti species (e.g. *Sotalia guianensis*). Another cluster is formed around phylogenetics, genetics, mitochondrial DNA, population structure, pathology, and veterinary medicine, and a fifth cluster contains pollution-related concepts, animal tissue, controlled study, and *Pontoporia blainvillei* as the most associated species. Important and abundant links between the clusters are evident.

DISCUSSION

Our review shows that marine mammal research in South America has accumulated significant knowledge and is also actively growing, reaching more than 2100 peer-reviewed documents (over 1800 from SCOPUS and 287 from SciELO). It also shows that different countries contribute differentially and that knowledge is centralized in a few authors and sources. The main taxonomic groups strongly direct the research topics, with fewer documents that integrate the knowledge between different taxa.

Bibliometric descriptors
According to SCOPUS, the South American scientific output on marine mammal publications followed a sharp increase and did not seem to have reached an asymptotic point. This increase agrees with the ocean

Table 2. SCOPUS articles referring to marine mammals in South America with the highest number of citations received (TC: total citations) during the studied period. The number of cites per year (TC yr^{-1}) is also shown, and a disciplinary theme is mentioned.

| Author	Year	Journal/Theme	TC	TC yr^{-1}
Hassanin et al.	2012	Comptes Rendus Biologies/Cetacean evolution	307	30.7
Bos et al.	2014	Nature/Seals as sources of human tuberculosis	261	32.6
Lee et al.	1991	Journal of Zoology/Growth and maternal investment	220	7.0
Van Parijs et al.	2009	Marine Ecology Progress Series/Passive acoustic sensors	195	15.0
Cousins et al.	2003	International Journal of Systematic and Evolutionary Microbiology/Tuberculosis in seals	195	10.3
Van Bressem et al.	2009	Diseases of aquatic organisms/Infectious diseases in cetaceans	192	14.8
Branch, TA.	2007	Mammalian Review/Abundance of blue whales	170	11.3
Cassens et al.	2000	Proceedings of the National Academy of Sciences of the United States/Evolution of river dolphins	161	7.3
Zerbini et al.	2006	Marine Ecology Progress Series/Migration of humpback whales	140	8.7
Quinete et al.	2009	Chemosphere/Accumulation of perfluorinated compounds in dolphins	129	9.9
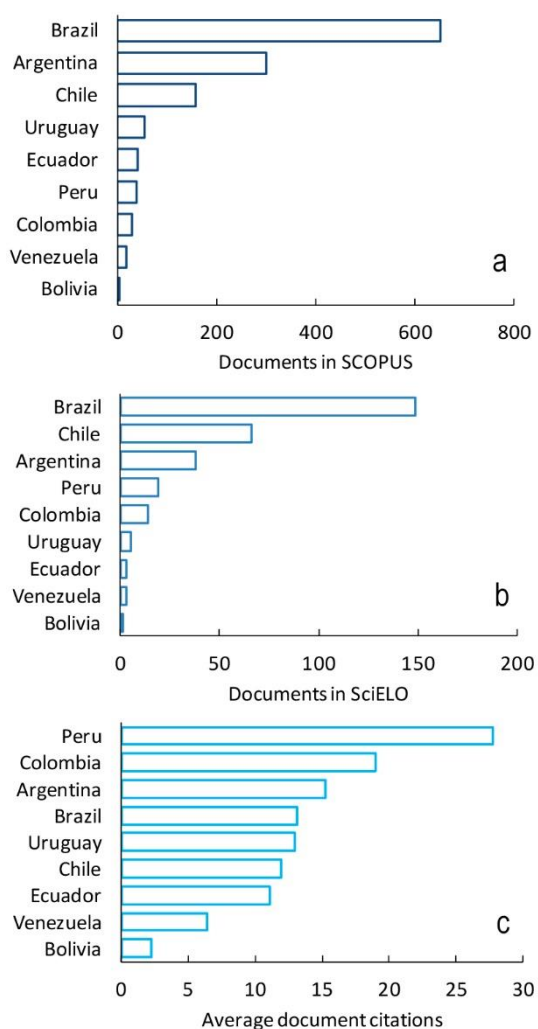
Figure 2. The number of documents per South American country related to marine mammals from 1990 to 2020, a) Listed on SCOPUS database, b) listed on SciELO database, c) average article citations per country in SCOPUS database.

science publications' global trend. Over the past 18 years, it has grown from nearly 40,000 publications in 2000 to more than 115,000 in 2017, with an annual growth rate between 4 and 9% (IOC-UNESCO 2020). The increasing trend is also concordant with marine mammal publications in other regions such as South Africa (Elwen et al. 2011) or the Philippines (Tiongson et al. 2021). In contrast, the slow increase shown by the SciELO database is probably related to a lower number of scientific journals being compiled and the regional or national source or nature of them. In this case, the stability visualized in the last decade may be due to the option for publishing in international and higher impact journals, which is linked to the mentioned growth in funding directed to scientific research in some countries.

The increasing trend observed in SCOPUS is mainly ascribable to Brazil, the largest country, responsible for 48% of these publications. Overall, Brazil doubled the number of publications of Argentina, which doubled Chile, which doubled Peru. However, not all the countries showed the same growth patterns; some (Argentina, Ecuador, Uruguay, and Colombia) have slightly decreased the number of publications recently after a peak in 2017. This trend might be a consequence of a significant reduction in expenditure between 2013 and 2017 in some South American countries (IOC-UNESCO 2020). Similarly, in SciELO, Brazil's production doubled the number of publications from Chile, followed by Argentina. Chilean relevance in this database may be related to the fact that it indexes many journals edited by Brazilian and Chilean institutions.

Similarly, Brazil, Argentina, and Chile covered 74.6% of Latin American scientific presence in bi-annual congresses of experts in aquatic mammals from 1984 until 2016 (3019 abstracts) (Simões-Lopes 2018). This period had the growing participation of new researchers, accompanied by a broadening of areas of
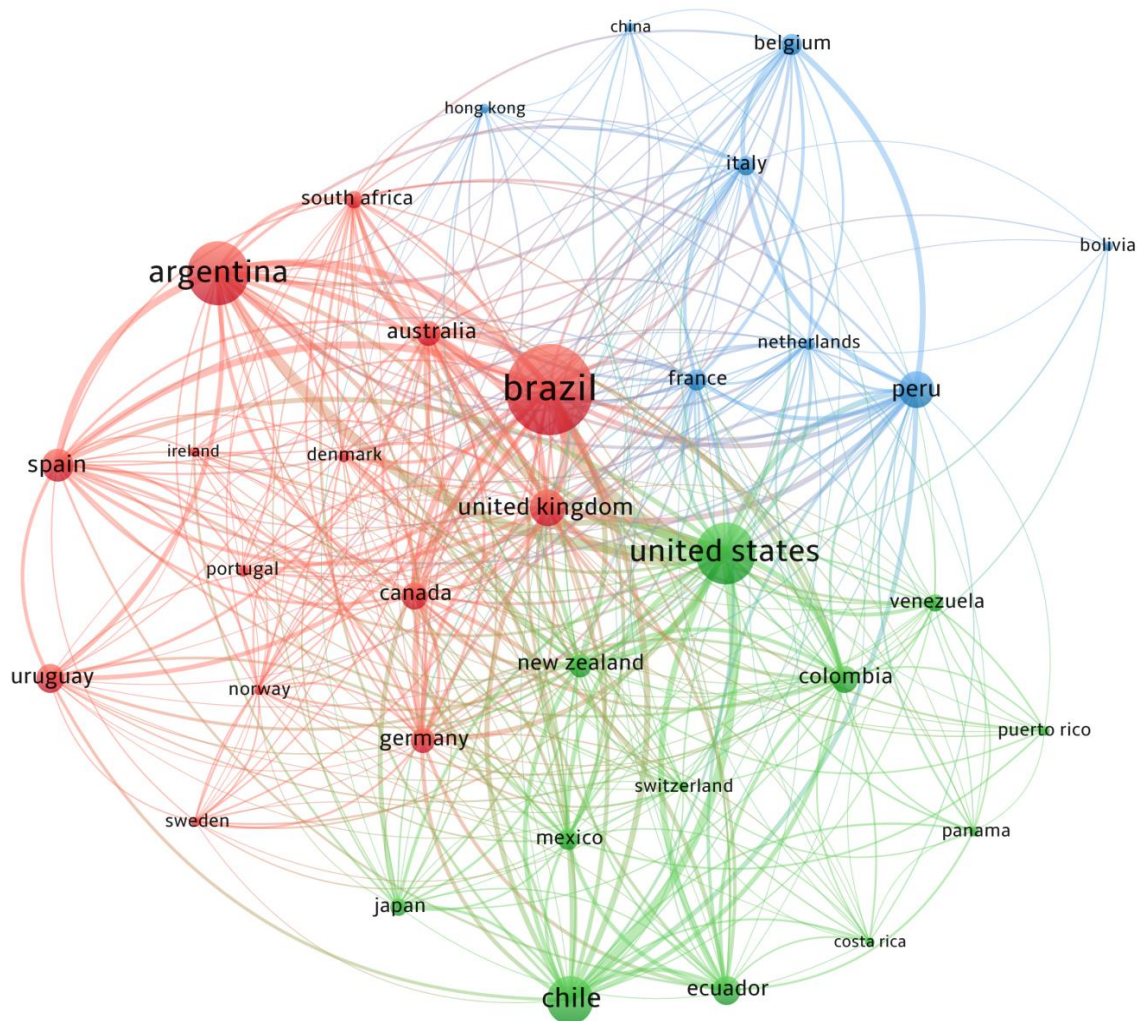
Figure 3. Co-authorship network among countries producing documents related to marine mammals in South America in SCOPUS from 1990 to 2020. For a higher resolution, zoomable version of this figure, please see Supplementary file A4.

specialization and consolidation of several research groups in Latin America (Simões-Lopes 2018). The predominance of the southern-cone countries (Argentina, Chile, south of Brazil, and Uruguay) was explained historically since the 1970s and 80s, since these countries had many experts and resources (Palacios et al. 2014).

The number of articles produced on South American countries was significantly associated with GDP and the number of marine mammal species registered. Both variables were highest in Brazil, followed by Argentina. It has been extensively demonstrated that scientific production is related to the financial budget dedicated to science (De Moya-Anegón & Herrero-Solana 1999, Butler 2004, Pan et al. 2012, Bornmann & Mutz 2015). For example, a strong correlation between economic growth indicators and increased marine science publications has been proved

(IOC-UNESCO 2020). More funding could be directly reflected in more researchers being incorporated into academics, additional funding for data acquisition, and in consequence, more publications of the results (De Moya-Anegón & Herrero-Solana 1999, Pan et al. 2012).

Furthermore, countries in the southern hemisphere have limited access to ocean science technologies, poor infrastructure, supplies, and equipment, fewer grants, and inadequate budgets, contributing to low scientific productivity (Ciocca & Delgado 2017, IOC-UNESCO 2020). This has limited access to the open ocean and has hampered research on offshore pelagic species, logistically difficult and expensive, compared with coastal species. However, modern techniques to collect and analyze data, such as satellite telemetry and passive acoustic monitoring, slowly facilitate conducting ceta-

Table 3. Impact indices of the 10 main authors publishing articles referring to marine mammals of South America from 1990 until 2020 are listed in the SCOPUS database, sorted by the number of publications (NP). H index, G index, TC: total citations, PYstart: year of the first article in this database. [1]Computed only with articles on marine mammals. [2]In the collection.

Author	NP	H[1] index	G index	TC	Year of first publication[2]
Crespo, E.A.	110	25	38	2139	1997
Siciliano, S.	64	17	30	1093	1994
Secchi, E.R.	64	24	36	1482	1998
Simões-Lopes, P.C.	60	18	33	1256	2000
Da Silva, V.M.F.	59	19	30	1037	1998
Lailson-Brito, J.	47	24	36	1358	2007
Azevedo, A.F.	44	24	35	1285	2004
Cappozzo, H.L.	41	16	20	512	2004
Groch, K.R.	39	10	21	535	2010
Dans, S.L.	37	17	26	807	1997

Table 4. Ten main authors publishing articles referring to marine mammals of South America from 1990 until 2020 listed in the SciELO database. Articles fractionalized by the number of co-authors are also shown.

Author	Articles	Articles fractionalized
Simões-Lopes, P.C.	16	4.58
Aguayo-Lobo, A.	12	3.05
Acevedo, J.	9	2.76
Siciliano, S.	9	2.30
Sepúlveda, M.	8	2.01
Simao, S.M.	7	1.95
Santos, M.C.O.	7	1.54
Cremer, M.J.	6	1.50
Crespo, E.A.	6	1.23
Da Silva, V.M.F	6	0.97

cean research efficiently, even in pelagic habitats (Prieto et al. 2012).

Our search included 4519 authors in SCOPUS and 844 in SciELO who contributed to marine mammal science from 1990 to 2020. The most productive authors were from Argentina and Brazil, showing the highest H index. In contrast, in SciELO, the two main authors are from Brazil and Chile. Nevertheless, the countries with more publications in SciELO were not the most cited ones. Peru, Colombia, and Argentina were outstanding, while Brazil has a middle position. Similarly, few authors from Peru and Colombia had disproportionally high importance due to their collaborations and the impact of their publications in the Latin American Journal of Aquatic Mammals (LAJAM) (Palacios et al. 2014), probably related to the fact that the most cited articles included international collaborators and co-authors from these three countries.

Citations

The number of citations can be seen as an indirect measure of the scientific impact of the results reported in the article (Aksnes & Brownman 2016, UNESCO 2017). However, the citation rate depends on the research categories, the number of authors per article, the temporal scale considered, the journal impact factor, and funding (Patience et al. 2017). Global ocean science publications increased recently in South American countries due to greater collaborations with countries and higher capacity development activities (IOC-UNESCO 2020). SCOPUS publications on marine mammals received an average of 14.5 citations during the studied period; however, the 10 more cited articles of the collection received an order of magnitude more citations (8 to 21 times more) than the average (e.g. the most cited article recorded 307 citations). These values may result comparatively lower than those observed in other research areas, as the topic is restricted to a group of marine animals in contrast to broader topics such as marine sciences. Another factor closely related to the number of citations is the temporal dimension, as the number of citations increases over time (Aksnes et al. 2019). In our study, the two more cited articles have been published in the last decade, and eight among 10 have more than 10 years.

Collaboration networks: co-authorship analysis

The collaboration index was higher in SciELO than SCOPUS (3.2 *vs.* 2.5), indicating that publications in SCOPUS tended to have fewer co-authors. The production of high-quality publications positively depends on collaboration within researchers from different laboratories and interactions with foreign researchers (Carillo et al. 2013). The extent to which a
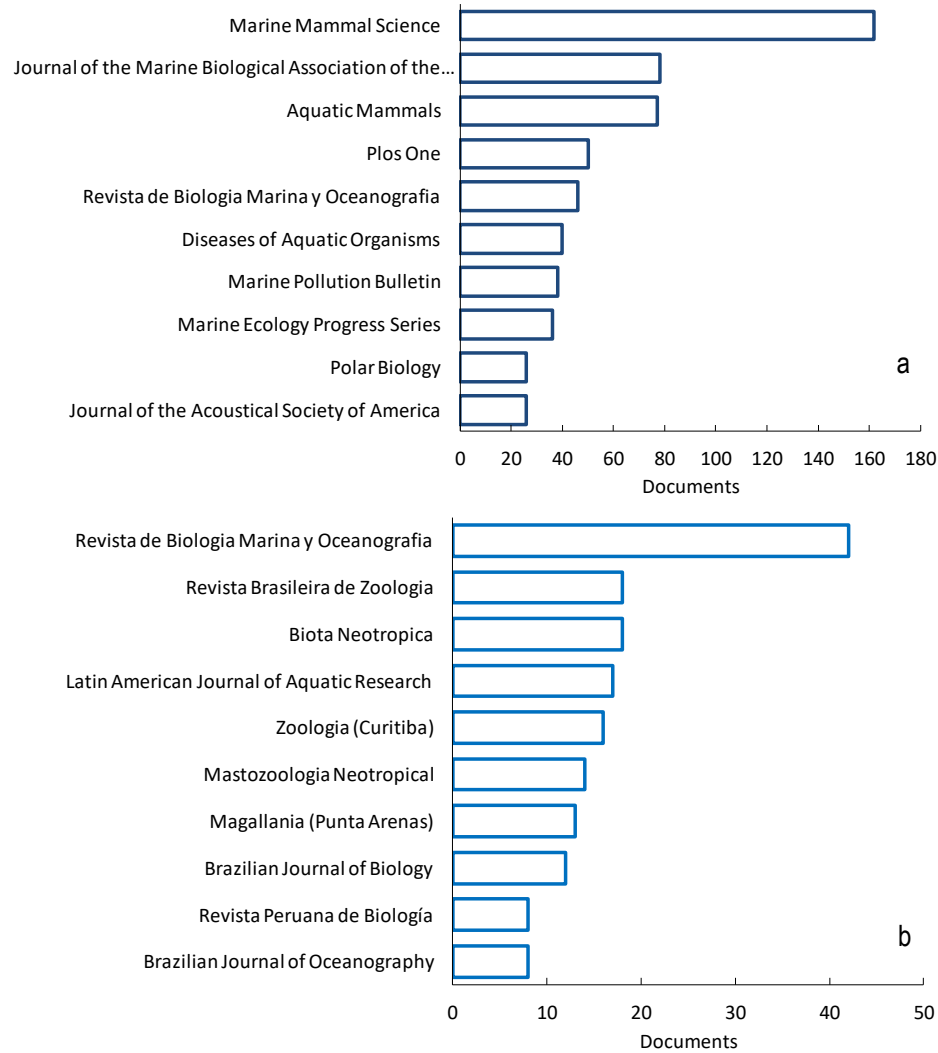
Figure 4. Total articles produced by the 10 most frequent sources (journals) referred to South American marine mammals. a) SCOPUS, b) SciELO.

country is engaged in international collaborations influences its citation rate, as publications that include co-authors from many countries are cited more (UNESCO 2017). In this sense, it is interesting to note that nine of the 10 more cited articles were led by non-South American authors, but included at least one South American co-author. None of the main authors (Tables 3-4) was the leading author in the 10 more cited articles (Table 2), and only a few appeared as co-authors. The former highlights the importance of international collaborations among researchers and authors' contri-bution from the first world countries. The most cited articles are significant advances in topics arising from extensive collaborations among authors from different countries (and areas), including many species (or entire groups such as cetaceans or seals).

The SCOPUS network of co-authors showed three major clusters, reflecting stronger collaborations among neighbor countries: Brazilian, Argentinean, and Uruguayan authors form a cluster in the Atlantic coast, while in the Pacific Ocean, two clusters are evident. Although the clusters logically present strong internal links, they reflect collaborations between research groups and evident interconnections. Scientists tend to cluster in space, and it has been demonstrated that scientific interactions are more likely between scientists from the same or nearby areas. Collaboration implies scientists' preference to interact with peers in their geographic areas (Pan et al., 2012). The collaboration among countries might be related to shared marine mammal species and neighbor countries. For example, the collaboration between southern cone countries (Argentina, Brazil, and Uruguay) may be
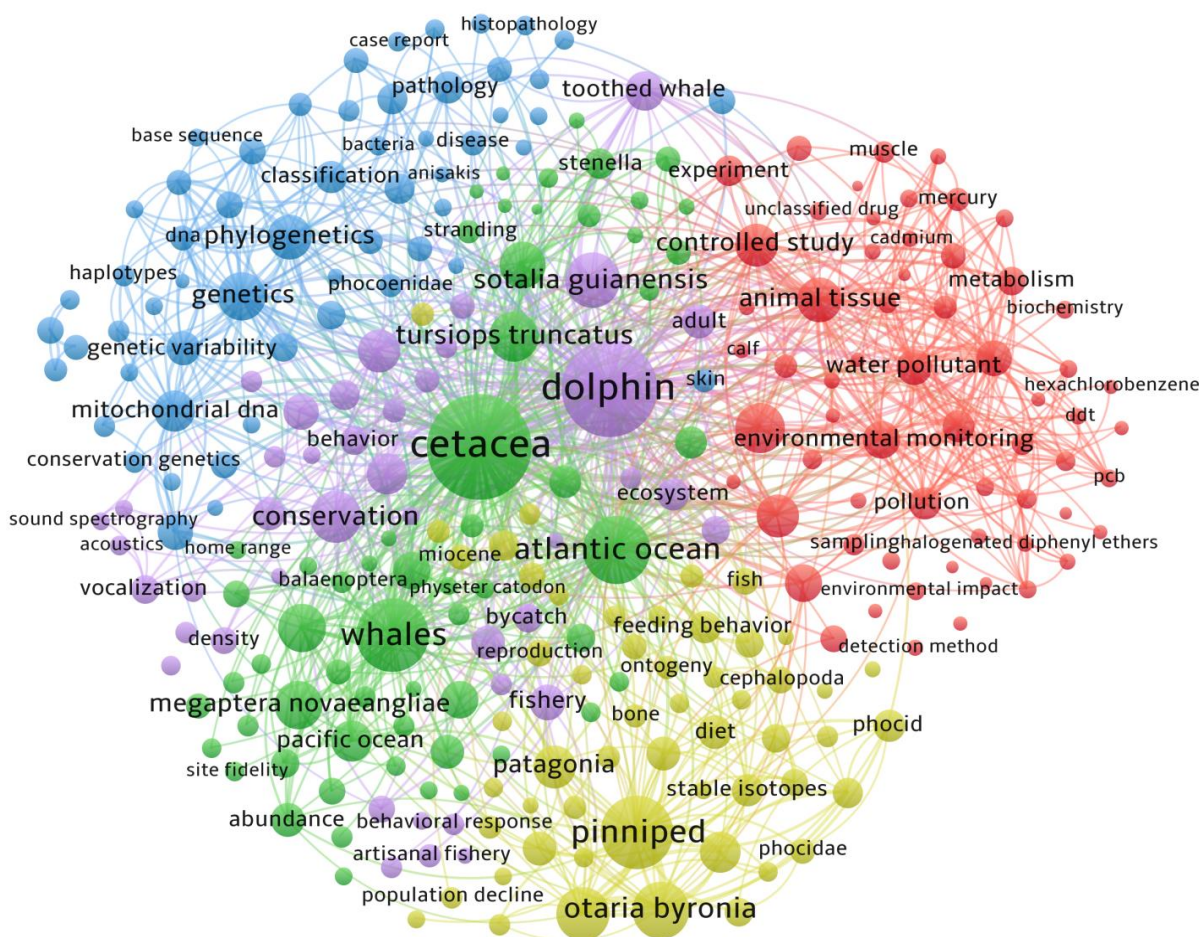
Figure 5. Network visualization of keywords in scientific documents on South American marine mammals in SCOPUS from 1990 to 2020. For a higher resolution, zoomable version of this figure, please see Supplementary file A5.

based on the distribution of many Pinniped and cetacean species they share. On the other side, Peruvian authors collaborate with European countries, reflecting links among the main researchers and areas developed in those countries.

Most documents are published in journals specializing in marine mammals regarding SCOPUS main sources. Marine Mammal Science is the most important, publishing the highest number of marine mammal articles (162 from 1893). This journal from Wiley is published by the Society for Marine Mammalogy from the USA, being the main specialized journal. The other specialized international Journal is Aquatic Mammals, funded by the European Association for Aquatic Mammals (EAAM). In addition, many papers are also published in sources not specialized in marine mammals, such as general biology or marine ecology (e.g. Marine Biology) journals or sources specialized in specific topics, such as pollution, systematics, etc. (e.g. Marine Pollution

Bulletin). In SciELO, there are no journals specialized in marine mammals, and most of the journals have a general scope. Among the 10 most important Journals in the SciELO database, two are from Chile (Revista de Biología Marina y Oceanografía (RBMO) and the Latin American Journal of Aquatic Research (LAJAR)). Other important journals in SciELO are mainly from Brazil and have a zoological or oceanographic scope.

Research topics: co-word analysis

The keywords co-occurrence network in SCOPUS shows the existence of different clusters of research topics or species in the last three decades in South America. Among the five keywords clusters, three were centered on taxonomic groups: Pinnipeds, cetaceans, and dolphins, which appear related to biological research concepts. The other two clusters were centered in phylogenetics-genetics- pathology and pollution-experiments related concepts. The main keywords were clearly reflected in SCOPUS's 10 more cited articles.

Seven of them were conducted in cetaceans, two in pinnipeds, and the main topics appear as keywords: health, evolution, pollution, abundance, and other ecological issues.

Otaria flavescens and *Arctocephalus australis* are relevant keywords concurrent with the reported positive correlation between population sizes and the publication output for pinnipeds (Jaric et al. 2015). Pinnipeds keyword was mainly related to diet, isotopic analysis, and fishery concepts. The cetaceans cluster was linked with basic biology themes (distribution, abundance, feeding). Dolphins cluster included mainly coastal species such as *Tursiops truncatus*, and conservation issues (human activity, bycatch).

Accessibility to coastal species and large ranges influences the amount of research in odontocete cetaceans (Palacios et al. 2014). Veterinary medicine has allowed research on various scientific fields, such as physiology and behavior (Jaric et al. 2015). It seems to be the case with some dolphin species in which some concepts related to health were linked: virology, parasitology, and veterinary medicine, among others. Further, some odontocetes species included as keywords have clear conservation concerns (*Sotalia guianensis*: near threatened (NT), *S. fluviatilis* and *Inia geoffrensis*: endangered (EN), *P. blainvillei*: vulnerable (VU)) (https://www.iucnredlist.org/) reflecting three important aspects. First, these species are distributed in Brazil, and therefore, their importance is associated with Brazilian authors. Second, South American researchers have effectively focused their research on some endangered and vulnerable species; and third, marine mammal species conservation status is of particular concern (Schipper et al. 2008), as at least 25% are classified as threatened (critically endangered, EN or VU) on the IUCN Red List (Nelms et al. 2021). Some conservation problems are associated with a specific species, which have been studied in depth (e.g. *Pontoporia blainvillei* with marine pollution, and pinnipeds with fisheries).

In sum, the scientific focus reflects the greater access of researchers to the animals because less abundant populations are more difficult to find (consequently more expensive), especially if their range becomes restricted to distant areas. In this sense, the high amount of research undertaken with franciscana dolphins (*Pontoporia blainvillei*) would be an exception because, despite their restricted distribution, its low abundance, and difficulty to observe them in the wild, they are frequently found stranded or facilitated by fishers (e.g. Franco-Trecu et al. 2019, Campos et al. 2020). The number of publications on marine mammals was related to the easier access to animals from strandings (Tiogson et al.

2021) or higher accessibility due to the coastal distribution of some species (Elwen et al. 2011). On the contrary, due to their history of commercial exploitation, mysticetes have 10 times more publications globally than non-exploited species (Jaric et al. 2015). Nevertheless, our analysis did not show this trend with Mysticetes, despite some studies, especially on the southern right whale (*Eubalaena australis*) and the humpback whale (*Megaptera novaeangliae*). The relatively small number of publications on baleen whales may be a consequence of excluding publications from the Southern Ocean in our analysis. In addition, cetaceans found in pelagic habitats have received less attention due to the higher costs implied in studying whales (Prieto et al. 2012).

Veterinary medicine, phylogenetics, and evolution have greatly developed since the 1990s with the use of devices suitable to use in nature, diving studies, toxicological determination protocols, and the increasing development of molecular techniques and population genetics (Würsig et al. 2018). Developing these areas is highly dependent on local expertise, institutional support, and long-term programs (Tiongson et al. 2021). In parallel, the prominence of biological-ecological and veterinary disciplines is noticeable, while other disciplines, such as policy, sociology, economy, legislation, are virtually absent. It has been discussed that scientific meetings aimed at protecting threatened marine mammals are represented mainly by biologists, oceanographers and veterinarians. However, there is a lack a lack of economists, politicians and diplomats (Simões-Lopes 2018), which has complicated the shift from the "population vision" to the "ecosystem vision" in conservation.

CONCLUSIONS

The publications focused on marine mammals by South American countries are related with funds devoted to the science and richness of species in each country. Although the most productive countries coincide in both databases, they show some differences in terms of the main authors, the collaboration network and the scope of the contributions. In essence, both databases were complementary and contributed to giving an updated picture of marine mammals' research in South America. In both databases, Brazil played a central role in the number of publications, and on the other side, Peru had a main role among the most cited articles. The South American publications on marine mammals were centralized in a small number of journals, and few authors were responsible for a large proportion of contributions.

Furthermore, the authors showed a moderate level of collaboration, with some very connected clusters and others independent of weakly connected. The most frequent keywords reflected three clusters centered in taxonomic groups and the other two centered in research disciplines. It was noticeable that some of the most endangered species were not among the most studied, and there are still 32 marine mammal species of South America categorized as data deficient by the IUCN (SOLAMAC 2021). Special focus should be placed on species classified as data deficient and endangered species to help define their conservation and address endangering factors (Jaric et al. 2015, Tiongson et al. 2021). Also, some topics on marine mammals that are being increasingly studied globally (Nelms et al. 2021) did not appear in our analysis, such as seismic and offshore exploration, genomics, drones, photo identification, and stable isotope analysis or passive acoustic monitoring. The former should raise an alarm bell to indicate a gap in the South American academic community concerning the current global marine mammals' research trends.

ACKNOWLEDGEMENTS

REFERENCES

Aguirre, L.F., Tarifa, T., Wallace, R.B., Bernal, N., Siles, L., Aliaga-Rossel, E. & Salazar-Bravo, J. 2019. Lista actualizada y comentada de los mamíferos de Bolivia. Ecología en Bolivia, 54: 109-149.

Aksnes, D.W. & Browman, H.I. 2016. An overview of global research effort in fisheries science. ICES Journal of Marine Science, 73: 1004-1011. doi: 10.1093/icesjms/fsv248

Aksnes, D.E., Langfeldt, L. & Wouters, P. 2019. Citations, citation indicators, and research quality: an overview of basic concepts and theories. SAGE Open, 9: 1-17. doi: 10.1177/2158244019829575

Albouy, C., Delattre, V.L., Merigot, B., Maynard, C.N. & Leprieur, F. 2017. Multifaceted biodiversity hotspots of marine mammals for conservation priorities. Diversity and Distributions, 23: 615-626. doi: 10.1111/ddi.12556

Aria, M. & Cuccurullo, C. 2017. Bibliometrix: an R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11: 959-975. doi: 10.1016/j.joi.2017.08.007

Avila, I.C., Kaschner, K. & Dormann, C.F. 2018. Current global risks to marine mammals: taking stock of the threats. Biological Conservation, 221: 44-58. doi: 10.1016/j.biocon.2018.02.021

Bornmann, L. & Mutz, R. 2015. Growth rates of modern science: a bibliometric analysis based on the number of publications and cited references. Journal of the Association for Information Science and Technology, 66: 2215-2222. doi: 10.1002/asi.23329

Bowen, W.D. 1997. Role of marine mammals in aquatic ecosystems. Marine Ecology Progress Series, 158: 267-274. doi: 10.3354/meps158267

Butler, L. 2004. What happens when funding is linked to publication counts? In: Moed, H.F., Glänzel, W. & Schmoch, U. (Eds.). Handbook of quantitative science and technology research. Kluwer Academic Publishers, Amsterdam, pp. 389-405.

Campos, L.B., Lopes, X.M., Da Silva, E. & Santos, M.C.O. 2020. Feeding habits of the franciscana dolphin (*Pontoporia blainvillei*) in south-eastern Brazil. Journal of the Marine Biological Association of the United Kingdom, 100: 301-313. doi: 10.1017/S0025315420000120

Carillo, M.R., Papagni, E. & Sapio, A. 2013. Do collaborations enhance the high-quality output of scientific institutions? Evidence from the Italian research assessment exercise. Journal of Socio-Economics, 47: 25-36. doi: 10.1016/j.socec.2013.08.005

Charles, K. 2017. Marine science and blue growth: assessing the marine academic production of 123 cities and territories worldwide. Marine Policy, 84: 119-129. doi: 10.1016/j.marpol.2017.07.016

Ciocca, D.R. & Delgado, G. 2017. The reality of scientific research in Latin America; an insider's perspective. Cell Stress and Chaperones, 22: 847-852. doi: 10.1007/s12192-017-0815-8

Courtial, J.P., Callon, M. & Laville, F. 1991. Co-words analysis as a tool for describing the networks of interaction between basic and technological researches: the case of polymer chemistry, Scientometrics, 22: 155-205. doi: 10.1007/BF02019280

D´Elía, G., Canto, H.J., Ossa, G., Verde-Arregoitia, L.D., Bostelmann, E., Iriarte, A., et al. 2020. Lista actualizada de los mamíferos vivientes de Chile. Boletín del Museo Nacional de Historia Natural, Chile, 69: 67-98.

De Moya-Anegón, F. & Herrero-Solana, V. 1999. Science in America Latina: a comparison of bibliometric and scientific-technical indicators. Scientometrics, 46: 299-320. doi: 10.1007/BF02464780

Delecroix, B. & Eppstein, R. 2004. Co-word analysis for the non-scientific information example of Reuter's business briefings. Data Science Journal, 3: 1-90. doi: 1.248/dsj.3.80

Egghe, L. 2006. Theory and practice of the g-index. Scientometrics, 69: 131-152. doi: 10.1007/s11192-006-0144-7

Ellegaard, O. & Wallin, J.A. 2015. The bibliometric analysis of scholarly production: how great is the impact? Scientometrics, 105: 1809-1831. doi: 10.1007/s11192-015-1645-z

Elwen, S.H., Findlay, K.P., Kiszka, J. & Weir, C.R. 2011. Cetacean research in the southern African subregion: a review of previous studies and current knowledge. African Journal of Marine Science, 33: 469-493. doi: 10.2989/1814232X.2011.637614

Franco-Trecu, V., Szephegyi, M.N., Doño, F., Forselledo, R., Reyes, F., Passadore, C., et al. 2019. Marine mammal bycatch by the industrial bottom trawl fishery at the Río de la Plata Estuary and the adjacent Atlantic Ocean. Latin American Journal of Aquatic Research, 47: 89-101. doi: 10.3856/vol47-issue1-fulltext-10

González, E., Martínez-Lanfranco, J.A., Soutullo, A., Juri, E., Rodales, A.L. & Botto, G. 2013. Mamíferos. In: Soutullo, A., Clavijo, C. & Martínez-Lanfranco, J.A. (Eds.). Especies prioritarias para la conservación en Uruguay. SNAP, MVOTMA, MEC, Montevideo, pp. 177-197.

Hirsch, J.E. 2005. An index to quantify an individual's scientific research output. Proceedings of the National Academy of Sciences, 102: 16569-16572.

Hücke-Gaete, R., Crespo, E. & Schlatter, R. 2004. Aquatic mammals in Latin America. Proceedings of a workshop on identifying high-priority conservation needs and actions. UNEP/CMS Secretariat, Bonn.

Intergovernmental Oceanographic Commission, United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO). 2020. In: Isensee, K. (Ed.). Global Ocean Science Report 2020 - Charting capacity for ocean sustainability. UNESCO Publishing, Paris.

Jaric, I., Knežević'-Jaric, J. & Gessner, J. 2015. Global effort allocation in marine mammal research indicates geographical, taxonomic, and extinction risk-related biases. Mammal Review, 45: 54-62. doi: 10.1111/mam.12032

Nelms, S.E., Alfaro-Shigueto, J., Arnould, J.P.Y., Avila, I.C., Bengtson-Nash, S., Campbell, E., et al. 2021 Marine mammal conservation: over the horizon. Endangered Species Research, 44: 291-325. doi: 10.3354/esr01115

Pacheco, V., Graham-Angeles, L., Diaz, S., Hurtado, C.M., Ruelas, D., Cervantes, K. & Serrano-Villavicencio, J. 2020. Diversidad y distribución de los mamíferos del Perú I: Didelphimorphia, Paucituberculata, Sirenia, Cingulata, Pilosa, Primates, Lagomorpha, Eulipotyphla, Carnivora, Perissodactyla y Artiodactyla. Revista Peruana de Biología, 27: 289-328. doi: 10.15381/rpb. v27i3.18356

Paglia, A.P., Da Fonseca, G.A.B., Rylands, A.B., Herrmann, G., Aguiar, L.M.S., Chiarello, A.G., et al. 2012. Lista anotada dos mamíferos do Brasil/ Annotated checklist of Brazilian mammals. Occasional Papers in Conservation Biology, 6. Conservation International, Arlington.

Palacios, D.M., Martins, C.C.A. & Olavarría, C. 2014. Aquatic mammal science in Latin America: a bibliometric analysis for the first eight years of the Latin American Journal of Aquatic Mammals (2002-2010). Latin American Journal of Aquatic Mammals, 9: 42-64. doi: 10.5597/lajam00174

Pan, R.K., Kaski, K. & Fortunato, S. 2012. World citation and collaboration networks: uncovering the role of geography in science. Scientific Reports, 2: 902. doi: 10.1038/srep00902

Patience, G.S., Patience, C.A., Blais, B. & Bertrand, F. 2017. Citation analysis of scientific categories. Heliyon, 3: e00300. doi: 10.1016/j.heliyon.2017.e00300

Peters, H. & Van Raan, A. 1991. Structuring scientific activities by co-author analysis: an exercise on a university faculty level. Scientometrics, 20: 235-255. doi: 10.1007/BF02018157

Prieto, R., Janiger, F., Silva, M.A., Waring, G.T. & Goncalves, J.M. 2012. The forgotten whale: a bibliometric analysis and literature review of the North Atlantic sei whale *Balaenoptera borealis*. Mammal Review, 42: 235-272. doi: 10.1111/j.1365-2907.2011.00195.x

Pusineri, C., Martinez, L., Bordin, A., Montgolfier, B., Deffes, O., Rufray, V., et al. 2021. Cetacean community off French Guiana. Latin American Journal of Aquatic Mammals, 16. doi: 10.5597/lajam00266

R Core Team, 2016. R: a language and environment for statistical computing. Foundation for Statistical Computing, Vienna. [https://www.R-project.org/]. Reviewed: June 12, 2021.

Rose, N.A., Janiger, D., Parsons, E.C.M. & Stachowitsch, M. 2011. Shifting baselines in scientific publications: a case study using cetacean research. Marine Policy, 35: 477-482. doi: 10.1016/j.marpol.2010.11.002

Sánchez, J. & Lew, D. 2012. Lista actualizada y comentada de los mamíferos de Venezuela. Memoria de la Fundación La Salle de Ciencias Naturales, 173-174: 173-238.

Schipper, J., Chanson, J.S., Chiozza, F., Cox, N.A., Hoffmann, M., Katariya, V., et al. 2008. The status of the world's land and marine mammals: diversity, threat, and knowledge. Science, 322: 225-230. doi: 10.1126/science.1165115

Secretaría de Ambiente y Desarrollo Sustentable de la Nación - Sociedad Argentina para el Estudio de los Mamíferos (SADS-SAREM). 2019. Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista roja de los mamíferos de Argentina. [http://cma.sarem.org.ar]. Reviewed: June 12, 2021.

Simões-Lopes, P. 2018. Mastozoology history and perspectives in Latin America: marine and freshwater mammals in spotlight. In: Rossi-Santos, M.R. & Finkl, C.W. (Eds.). Advances in marine vertebrate research in Latin America: technological innovation and conservation. Springer International Publishing, Cham, pp. 3-13.

Sociedad Latino Americana de Mamíferos Acuáticos (SOLAMAC). 2021. [http://solamac.org/solamac/english/conteudo_ler/11/aquatic+mammals+of+latin+a merica/research/]. Reviewed: March 12, 2021.

Tinker, M.T., Bodkin, J.L., Ben-David, M. & Estes, J.A. 2018. Otters: *Enhydra lutris* and *Lontra felina*. In: Wursig, B., Thewissen, J.G.M. & Kovacs, K.M. (Eds.). Encyclopedia of marine mammals. Academic Press, Cambridge, pp. 664-671.

Tiongson, A.J.C., Utzurrum, J.A. & De la Paz, M.E.L. 2021. Patterns of research effort and extinction risk of marine mammals in the Philippines. Frontiers in Marine Science, 8: 607020. doi: 10.3389/fmars.2021.607020

Tirira, D.G. 2017. Mamíferos del Ecuador: lista actualizada de especies. Versión 2017.2. Fundación Mamíferos y Conservación, Quito. [http://mamíferos delecuador.com]. Reviewed: March 12, 2021. doi: 10.13140/RG.2.2.16053.58080

Trujillo, F., Gärtner, A. Caicedo, D. & Diazgranados, M.C. (Eds.). 2013. Diagnóstico del estado de conocimiento y conservación de los mamíferos acuáticos en Colombia. Ministerio de Ambiente y Desarrollo Sostenible- Fundación Omacha, Conservación Internacional-WWF, Bogotá.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2017. Global ocean science report - The current status of ocean science around the world. UNESCO Publishing, Paris.

Van Eck, N.J. & Waltman, L. 2010. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84: 523-538. doi: 10.1007/s11192-009-0146-3

Würsig, B., Perrin, W.P. & Thewissen, J.G.M. 2018. History of marine mammal research. In: Würsig, B., Perrin, W. & Thewissen, J.G.M. (Eds.). Encyclopedia of marine mammals. Academic Press, Cambridge, pp. 472-476.

SUPPLEMENTARY FILES
Supplementary file A1

Table A1. The number of marine mammals, length of the coast, total population, and two economic parameters (GDP and percentage of GDP invested in research and development, R+D) in each South American country. Population and GDP for 2020 (or the latest year available) were extracted from datosmacro.expansion.com and https://www.worldometers. info/world-population/french-guiana-population/%GDP R+D from: http://data.uis. unesco.org/Index.aspx?DataSetCode= SCN_DS&lang=en

Country	Coast length (km)	#MM	Total	Citation	GDP (million of USD)	Population	%GDP R+D
Colombia	3000	32C, 4P, 2S	38	Trujillo et al. (2013)	271,554	50,374,000	0.23 (2018)
Ecuador	2237	30C, 4 P, 1S	35	Tirira (2017)	98,808	17,368,000	0.44 (2014)
Perú	2414	32C, 3P, 1S	36	Pacheco et al. (2020)	205,458	32,510,453	0.13 (2018)
Bolivia	0	1 C, OP	1	Aguirre et al. (2019)	36,839	11,673,029	0.16 (2009)
Chile	6435	43 C, 10 P	53	D´Elía et al. (2020)	252,821	19,107,000	0.36 (2017)
Argentina	4989	41 C, 9 P	50	SADS-SAREM (2019)	389,064	44,939,000	0.49 (2018)
Uruguay	660	31C, 8P	39	González et al. (2013)	56,577	3,461,734	0.42 (2018)
Brazil	7491	45C, 7 P, 2S	54	Paglia et al. (2012)	1,444,720	210,147,000	1.16 (2018)
French Guiana	459	25C, 1S	26	Pusineri et al. (2021)	4,870	298,682	N/A
Venezuela	2800	26C, 1S	27	Sánchez & Lew (2012)	98,400 (2018)	28,515,829	0.34 (2014)

Supplementary file A2 = Database-Scopus.csv (to be opened with Bibliometrix R package)
Supplementary file A3 = Database-Scielo.bib (to be opened with Bibliometrix R package)
Supplementary file A4 = Figure 3.json (to be opened with Vos-viewer online https://app.vosviewer.com)
Supplementary file A5 = Figure 5.json (to be opened with Vos-viewer online https://app.vosviewer.com)