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The sociology of sea turtle research: evidence on a global expansion of co-authorship networks

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Abstract The conservation of biological diversity represents a major challenge for modern societies. Research offers the fundamental information to advance and integrate our knowledge on ecological systems, their processes and interactions. Yet, the transfer of scientific knowledge and results represents a critical step towards enhancing conservation efficiency. Here, we use sea turtle research, as an example to test the potential and dynamics of international scientific cooperation reflecting the advancement of knowledge. The selection of sea turtles as a case study was mainly based on two factors. First, they represent a highly mobile group of species with cosmopolitan distribution that cross geopolitical borders, policies and agreements. Second, encouraging evidence on global population recovery are increasingly presented. We used research publications on sea turtles (from 1967 since 2016) as the main product of scientific knowledge, to develop a series of co-authorship networks. Countries that were mentioned in authors' affiliations were used as nodes, with two nodes being connected if authors of these countries had collaborated as co-authors in a publication. The properties of the co-authorship networks revealed that sea turtle scientific collaboration networks are] getting larger and spreading constantly over different countries through time. Network metrics revealed a robust and coherent network supported by numerous countries. Our results showed a steady flow of scientific information among countries within sea turtle research communities, a factor that might have contributed to the encouraging evidence on sea turtle population trends observed globally. This analysis highlights the potential benefits generated by international collaborations reflecting the integration of skills, scientific backgrounds and knowledge.

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Introduction

The conservation of wildlife and their habitats represents a major challenge for modern societies (Butchart et al. 2010; Pereira et al. 2010). Ecological research represents the cornerstone for generating policy instruments and mechanisms towards addressing these tasks. Ecological research relies on the availability and accuracy of existing data regarding species and their relationship with the environment (Ludwig et al. 2001). Still, any background information can be useful only once it is translated into knowledge (Mazaris 2017). Under the absence of this knowledge, even well intentioned conservation efforts could fail or negatively affect the conservation targets (Richardson 1999).

The transfer of knowledge and the exchange of expertise are critical towards improving monitoring standards, data quality control and assessment tools (Hochachka et al. 2012; Rands et al. 2010). Traditional ecological knowledge could also offer a diversity of practices and inputs (Drew 2005; Gadgil et al. 1993), while as it often shares similarities to adaptive management it could guide modern conservation tools (Berkes et al. 2000). One efficient path to ensure knowledge transfer is through international scientific cooperation. With respect to conservation needs and efficiency, the provision of improved data and the elimination of the compartmentalization of knowledge could offer the basis for assembling, integrating, developing and sharing advanced conservation practices (Reyers et al. 2010). Overcoming the research–implementation gap could therefore make a viable contribution to achieve conservation targets (Knight et al. 2008).

Opposing the global assessments on the status, trends, and future scenarios of biodiversity (Dirzo et al. 2014; Pereira et al. 2010; Pimm et al. 2014), recent studies on sea turtles have provided some encouraging evidence about recovery of global populations (Chaloupka et al. 2008; Mazaris et al. 2017). Various ecological, environmental and political drivers could influence the observed trends (e.g. Hays 2004; Kittinger et al. 2013; Almpanidou et al. 2017). Yet, identifying the key factors which might have contributed to the promising trajectories of sea turtle populations is of critical importance as it could provide advice regarding research and conservation tools for other taxa.

Sea turtles often travel thousands of km from their nesting to their foraging grounds, spanning geopolitical borders, policies and agreements (Frazier 2002). Monitoring efforts for some nesting sites were initiated more than four decades ago [e.g., in 1971 in Tortuguero, Costa Rica: Bjorndal et al. (1999); in 1973 in French Frigate Shoals, Hawaii: Balazs et al. (2015); in 1963 in South African beaches, South Africa: (Nel et al. 2013); in 1969 in Woongarra Coast, Australia: Limpus (2008); in 1966 in Rancho Nuevo, Mexico: Gallaway et al. (2013)]. In other regions, nesting sites are only recently discovered (e.g. Mingozzi et al. 2007). Given the difference in local knowledge and actions, a solid global network on the exchange of the scientific information and practical expertise seems to be the only promising tool for ensuring an optimistic future (Gaos et al. 2010; Hamann et al. 2010; Mazaris et al. 2014; Wallace et al. 2011).

Conservation actions applied at a local scale (e.g. sea turtle nesting site), such as protection of nests could increase hatchling production (Frazier 2002). Still, mortality of older age classes due to incidental captures in fishing operations and/or harvest, occurring at distant foraging grounds, could have detrimental effects on populations regardless of the efforts applied on the nesting site (Hamann et al. 2010). This example clearly states that for cosmopolitan migratory species, such as sea turtles, international collaboration is more than important for ensuring their persistence and recovery (Almpanidou et al. 2016; Gaos et al. 2010; Mazaris et al. 2014; Wallace et al. 2011). Similarly, translocation of nests and removal into beach hatcheries have been traditionally applied to improve hatching success (Kornaraki et al. 2006). Still, concerns on the efficiency of beach hatcheries (e.g. impact of incubation temperature upon sex ratio) have raised the need to carefully reconsider their design and application (Mortimer 1999). Under the same context traditional knowledge, styles of management and benefits related to the involvement of locals to various conservation actions can offer valuable insights which if communicated could enhance conservation efficiency (Gallo et al. 2006; Hall et al. 2007; Peckham et al. 2007). It therefore becomes apparent that the dissemination and promulgation of research findings is of critical importance to ensure conservation capacity building across distribution ranges of target species.

Social network analysis addresses the collaborative relationships (e.g. information exchange or resource sharing) among a series of interacted actors (Bodin et al. 2006). As that type of analysis targets the patterns of the relationships and the structural characteristics of the interactions among all the involved parts, it could offer a valuable contribution towards addressing conservation challenges and, patterns of knowledge exchange and policy influence (e.g. Mills et al. 2014; Weiss et al. 2012). Here, building upon the principles of social network analyses, we explore data on sea turtle research networks to delineate potential pathways of knowledge at national and international levels. Considering research publications as the main product of scientific knowledge and advances, we study temporal bibliometric patterns and further explore the structure of scientific collaboration. We explicitly investigate whether the scientific collaborations are increasing through time and expand over different countries. Assuming that the transfer of knowledge, technological advances and experience are essential towards effective conservation initiatives (Hamann et al. 2010), we investigate whether the properties of the collaboration network could enhance a steady flow of scientific information among countries, justifying the recent encouraging global population trends.

Materials and methods

Bibliographic data

We extract publications listed in the Scopus database (https://www.scopus.com/) by searching for the phrases “sea turtles” or “marine turtles” within the title, abstract or keywords of articles and reviews published by 2016. The search resulted in 3577 articles published since 1950. The numbers of co-authors per study were noted. For each study, countries mentioned in authors’ affiliations were also extracted.

Analyses

To explore whether the number of research articles published annually increase through time we fitted linear, exponential and power law models; best-fit model was chosen on the basis of the highest correlation coefficient value. Similar analyses were repeated for studying patterns in the mean number of authors publishing articles in a given year, and in the mean number of countries they claim. We used Pearson correlation coefficient to detect whether there was an association between the number of authors and the countries claimed, and thus, to explore if international co-authorship networks are gradually changing as more researches are getting involved in scientific outputs. To examine the expansion of international collaboration in sea turtle research, we developed a series of co-authorship networks and estimated various topology metrics in accordance to graph theory (Bondy and Murty 1976). The countries that are mentioned in authors' affiliations were used as nodes for the design of a network. The edge (i.e. link that represents relationships or interactions between two nodes in a network) between any two nodes was defined when authors of different countries had collaborated as co-authors in a publication. We assigned weight to each edge equal to the number of times that co-authors of the two nodes (i.e. countries) that the given edge connects had published together. We removed information on loops, i.e. an edge that pairs a node to itself, since our target was to examine patterns of collaboration among and not within countries.

We constructed 10 different co-authorship networks, each one describing a different 5-year period bin, from 1967 until 2016 (i.e. 1967–1971, 1972–1976, and so on). We decided to begin with articles published in 1967, as our search revealed only eleven papers prior to this year (1950–1966), while none of these was written by authors claiming different countries, eliminating our ability to construct proper networks.

For each network, we estimated the number of isolated nodes and the size of the largest component (i.e. set of nodes connected to each other but separated from the rest of the network; Fig. 1). Next, we calculated the diameter, the characteristic path length (CPL) and the density of the networks. The diameter represents the longest path (i.e. the sequence of consecutive edges from one node to the other through the network; Fig. 1) between any two nodes, where the path length between these nodes is itself the shortest possible (Minor and Urban 2008). In our case, a short diameter indicates fast flow of scientific information among countries in the network or establishment of international collaborations. The average shortest path length over the network is defined as CPL and represents an estimate of the density of the network (Minor and Urban 2008). A short path length in our case will be considered as indicative of the fact that all countries tend

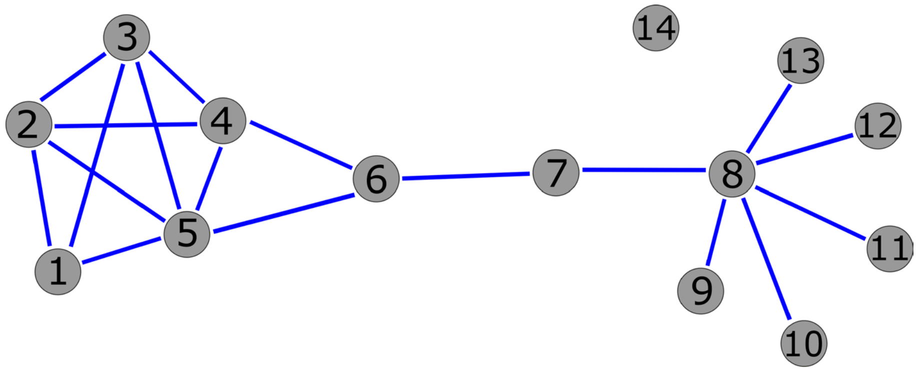

Fig. 1 Illustration of some network terms in a simple network where circles are the nodes and lines are the edges. *1–13* network component, *14* isolated node, *6* articulation node, *1–4* bi-components, *8* example of node with high degree centrality, *6* example of node with high betweenness centrality, *4*, *5* example of nodes with high closeness centrality. Examples of alternative paths between nodes *3* and *5*: 3 → 4 → 5, 3 → 2 → 1 → 5, while the shortest path is 3 → 5. Diameter: 2–10 (along the path 2 → 5 → 6 → 7→8 → 10)

to be easily reachable for the establishment of collaboration. Given that a larger network is expected to have longer paths, we considered diameter and CPL among networks in relation to the number of nodes in each network, in order to have a clearer and more comparative view (Minor and Urban 2008). As the number of countries involved in sea turtle research increases, the establishment of collaborations among all countries and the flow of scientific knowledge from one country to all the others become more difficult; as a result the structure of the co-authorship networks becomes more complex. Density describes the general level of cohesion in a network and was calculated by estimating the ratio of the actual number of edges and the total number of possible edges (Borgatti and Everett 2006). For the co-authorship networks, density can be interpreted as the probability that researchers from two given countries collaborate for the production of a scientific article. The greater the value of this metric the more likely a collaboration (Kim and Perez 2015), in our case among countries.

For each node (i.e. country affiliated by an author), we estimated the following centralities: degree, closeness and betweenness (Fig. 1). A node with large degree describes a country that is directly connected with many others in the network. These countries are characterized as hubs (Minor and Urban 2008). Closeness centrality represents the inverse of the average path lengths from a particular node to each of its neighboring nodes (Urban et al. 2009), characterizing as central countries those with numerous and short connections with other countries. Betweenness centrality represents the proportion of all shortest paths between all nodes on the network that pass through a particular node (Galpern et al. 2011), indicating countries that are important for the establishment of collaboration between other countries. Based on the centrality values of each node, we calculated a network level centralization measure. Centralization measure expresses to what extent the network is organized around its most central nodes (Borgatti and Everett 2006).

To assess the robustness of the co-authorship networks, i.e. to remain connected despite the potential removal of nodes, we estimated the number of articulation nodes and the magnitude of the bi-components (Fig. 1). The robustness of a network lies in the persistence of collaborations among countries even if some countries are removed from the sea turtle research community. Articulation nodes represent the nodes whose removal turns a connected network into a disconnected one (Newman and Ghoshal 2008). Bi-components are defined as coherent sub-networks that do not contain articulation points, i.e. the connection between two nodes occurs at least by two independent paths between them (Newman and Ghoshal 2008). The absence of articulation nodes is indicative of some internal robustness of the network.

To further evaluate the coherence and robustness of the co-authorship networks, we examined their structure compared to some well-studied categories (i.e. random, scale free network). To this end, we plotted the degree distribution of all the nodes (Minor and Urban 2008). Random networks consist of nodes with approximately the same number of connections and thus a bell-shaped distribution. This structure implies that a large fraction of the nodes must be removed to disconnect the network, i.e. researchers from many countries must abandon sea turtle field in order for international collaboration network to collapse. A scale-free network is characterized by the presence of few high-degree nodes (i.e., hubs), while the majority of the nodes have a low degree (Barabási and Bonabeau 2003). Hence, the degree distribution follows a continuously decreasing function and scale-free networks are robust against random removal of nodes but vulnerable to intentional removal of hubs (Minor and Urban 2008). In our case, this structure implies that if countries that establish a lot of collaborations are removed from sea turtle research community, the entire collaboration network will be in danger.

Spearman's rank correlations were applied to investigate potential relationships between the size of largest component, the number of isolated nodes, the density of the networks and the total size of the co-authorship networks generated over the 5-year bins.

Results

Over time, the number of articles related to sea turtle research increased exponentially ($R^2 = 0.93$, $P < 0.01$), as did the mean number of authors being involved in the publications ($R^2 = 0.59$, $P < 0.01$) (Fig. 2). The mean number of countries claimed by authors who published articles related to sea turtles has also increased through time following an exponential pattern ($R^2 = 0.69$, $P < 0.01$). Over the study period, a significant positive relationship was identified between the number of authors and the number of countries that are claimed ($r = 0.88$, $P < 0.01$). The number of nodes per co-authorship network increased from 10 (during 1967–1971) to 118 (during 2012–2016) (Fig. 3).

All co-authorship networks exhibited a structure that contains a large component and some isolated nodes. However, many of these isolated nodes were gradually incorporated in the largest component and different isolated nodes appeared. Over the 5-year time bins, the size of largest component gradually increased (i.e. from 2 to 112), as did the total size of the network (Rs = 0.96, $P < 0.01$). Our analyses revealed no significant relationship between the size of the network and the number of isolated nodes (Rs = − 0.16, $P > 0.05$), with the maximum number of isolated nodes being equal to 15 (during 1972–1976 and 1992–1996).

CPL of the networks ranged from 1 to 2.6 with the maximum value estimated for the network during 2002–2006. Diameter of the networks ranged from 1 to 9, with the highest estimated values found during 2002–2006 and 2012–2016. The density of the co-authorship networks ranged from 0.068 to 0.5, with lower density values reported while the size of the network was increasing (Rs = − 0.9, $P < 0.01$). Interestingly, for networks from the

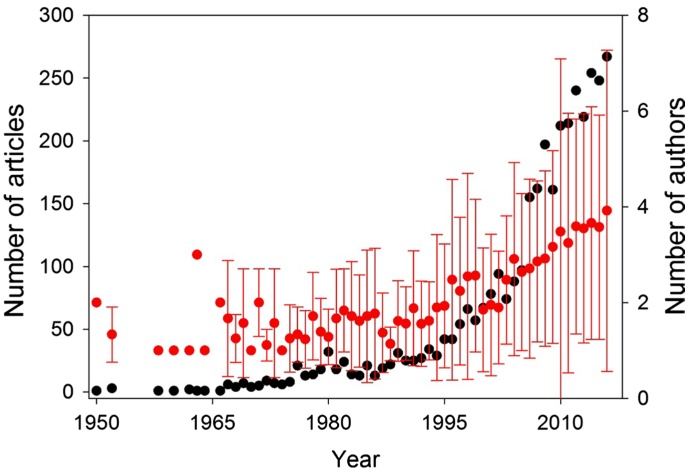

Fig. 2 The number of published articles (black dots; mean ± SD) related to sea turtle research and the number of authors (red dots; mean ± SD) writing these articles from 1966 to 2015. (Color figure online)

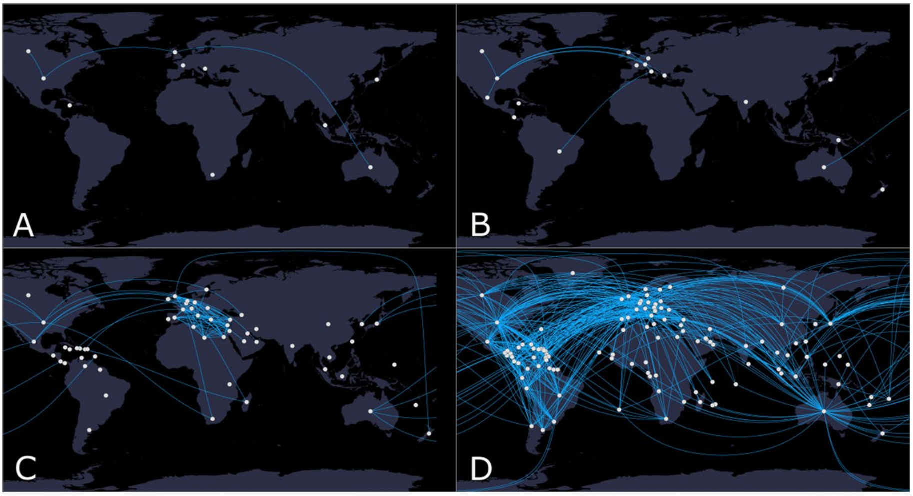

Fig. 3 The temporal evolution of international collaboration networks in the field of sea turtle scientific process, describing four different 5-year time bins **a** 1966–1970, **b** 1981–1985, **c** 1996–2000 and **d** 2011–2015. For each network, nodes represent each country that was mentioned in authors' affiliations in scientific publications. Edges between nodes were defined if authors from different countries had collaborated as co-authors in a publication at least once

last three 5-year periods (i.e. 2002–2006, 2007–2011, 2012–2016), the number of nodes almost doubled from 63 to 118, and the density increased (from 0.068 to 0.1).

All the networks exhibited different levels of organization around their most central nodes based on the centralization measures. Countries such as United States (US) and United Kingdom (UK) have a constant presence regarding publishing and collaborating with other countries since 1967. Since early 2000s, these countries have raised into hubs that play a central role in the networks of co-authorships, along with countries such as Mexico and Australia (Fig. 3). Degree centralization ranged from 0 to 0.7, with a tendency for higher values in recent years. Closeness centralization ranged from 0.08 to 0.64 and betweenness centralization from 0.27 to 0.82, but with a greater variation of the values among years.

The number of articulation points and bi-components increased over time (from 0 to 9 and from 1 to 23, respectively). Of note, some of the countries that were determined as articulation points, were not necessarily characterized by high values of all other centralities (e.g. Tunisia, Croatia; Fig. 4). The most recent networks (i.e. 2002–2006, 2007–2011, 2012–2016) were also characterized by the "scale-free" properties, with the degree distribution following a continuously decreasing function (Fig. 5).

Discussion

It has been acknowledged that promoting the sharing of scientific knowledge and long-term collaborations could contribute to successful management and conservation of marine biodiversity (Parsons et al. 2014). Here, we found that the network of scientific collaborations about sea turtles is getting larger and spreading over different countries, a factor which might have contributed to the encouraging evidence on sea turtle population

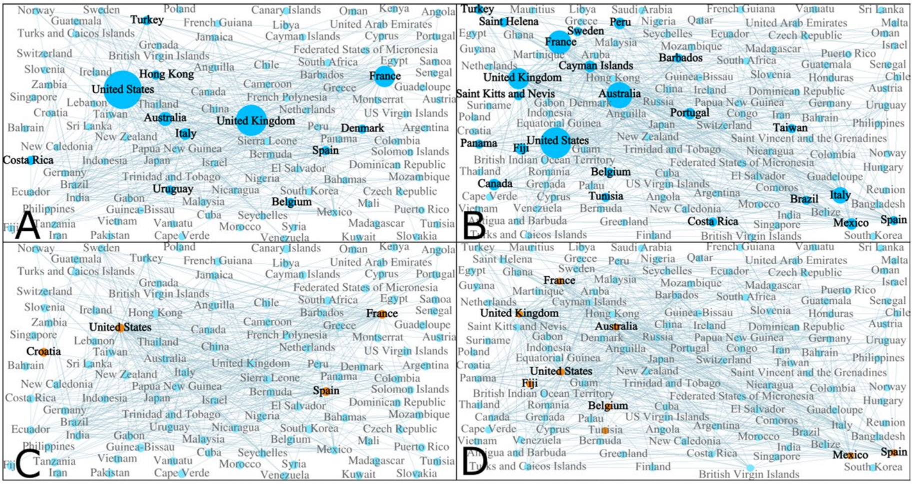

Fig. 4 **a**, **c** 5-year time bin 2011–2015, **b**, **d** 5-year time bin 2006–2010. Upper panels: the size of nodes is increasing according to the value of betweenness centrality. Lower panels: red nodes are the articulation points (i.e. the nodes whose removal turns a connected network into a disconnected one). (Color figure online)

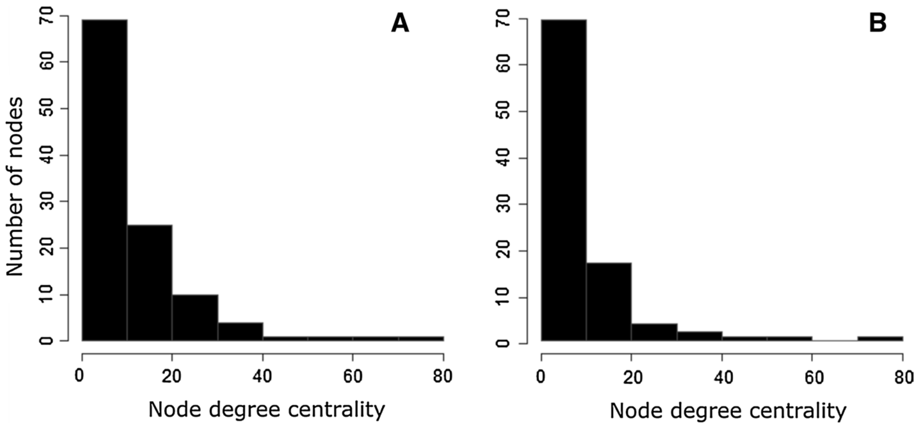

Fig. 5 Node degree histograms for 5-year time bins **a** 2015–2011 and **b** 2006–2010

trends observed across their entire distribution (see Mazaris et al. 2017). Our findings also revealed that even though the co-authorship network is gradually increasing, it maintained a coherent and dense structure, two properties which are indicative of a steady flow of scientific information among countries. Thus, the transfer of knowledge, technological advances and experience which has been generated at various spatial (i.e. national, regional, transnational) scales or administrative levels are essential towards effective sea turtle conservation initiatives (Hamann et al. 2010).

There is a general tendency that networks of scientific collaboration between researchers and institutions are increasing over time. The collaborations related to ecological studies do not deviate from this global rule (e.g. Dangles et al. 2016; Li and Zhao 2015; Liu et al. 2011). Under this context, the overall findings of the present study regarding the increase of sea turtle research collaboration networks in terms of size, density and coherence are not surprising. Still, the central role that some countries play in the network, even if not listed as main contributors to global biodiversity research (Liu et al. 2011), highlights that more complex drivers are likely to be involved in the establishment of sea turtle research network. This suggestion is further supported by the fact that countries which do not host sea turtles (e.g. Germany, Belgium), contribute to the network, along with countries for which ecological research is highly underfunded (see Waldron et al. 2013).

The expansion of global research collaboration is attributed to several factors. For example, the growth of such networks has been greatly supported by the internet (Teasley and Wolinsky 2001). Still, the internet is often considered as a critical tool for communication and exchange of information and documents once collaboration has already been established (Laudel 2001; Wagner and Leydesdorff 2005). Historical and cultural (e.g. common language, shared colonial heritage) relationships could enhance trans-national or trans-continental collaboration (Russell and Ainsworth 2013). An alternative factor could be the establishment of regional, collaborative projects and the raising of research funds towards supporting a common scientific and policy interface (e.g. Katsanevakis et al. 2017). The science community is also highly mobile with young researchers moving around the world to establish links. Some collaboration could also arise due to the need for specific skills (e.g. modeling, spatial analyses). The specialized knowledge gained at given institutions along with the need for scientists to provide a thorough view of a studied subject could also facilitate collaboration.

The importance of international collaborations for conservation efforts is widely acknowledged (Rands et al. 2010). Our findings revealed that global sea turtle research is characterized by an increased involvement of researchers from various countries. However, the most promising message is that this tendency is accompanied by the establishment of more research collaborations, as these are reflected by the co-authorship data. For example, since the beginning of the 80s when satellite tracking technology for sea turtles was introduced (Timko and Kolz 1982), the necessity for international collaboration on the monitoring and management of sea turtle populations became even more pronounced (Blumenthal et al. 2006). As highlighted in a recent review paper (Jeffers and Godley 2016) this need was gradually transformed into a growing network of international collaborations.

Scientific contributions are increasing through time with inputs from various countries (King 2004). Our results supported this notion but further demonstrated that these new entries in sea turtle research were gradually embedded within the main group of the interconnected international partnerships. This pattern, indicative of the coherence and temporal stability of the co-authorship network, could be viewed as a declaration of an open research community rich in collaboration channels. As an example of an efficient way to increase collaboration and interaction between new research communities, the *Global Sea Turtle Network*: *SEATURTLE.ORG* (http://www.seaturtle.org) was originally founded in 1996. This network provides online centralized database management systems to support research and conservation efforts around the globe (Coyne and Godley 2005) linking more than 240 groups from different countries and offers an open-access newsletter (i.e. Marine Turtle Newsletter). As an additional example, *The International Sea Turtle Society* (http://internationalseaturtlesociety.org) having as main goal connecting people who are sharing a common interest in sea turtle biology, has organized 37 annual symposiums all round the world. The dynamics of such collaborations are also highlighted by a recent output, namely *The State of The World's Sea Turtles* (http://seaturtlestatus.org/) with contributors from more than 106 countries sharing information on nesting and telemetry monitoring data (http://seaturtlestatus.org/team/contributors).

Our analyses showed that a few countries claimed by the authors play a critical role on the persistence of the robustness of the co-authorship networks. For all the networks generated, the importance of US as a strong node with various linkages around the globe was revealed based on various network centralities. This finding is not surprising as the US, apart from the relative size and wealth of the scientific community that hosts, has promoted international collaborations through international environmental agreements that focus solely on sea turtle conservation (e.g. the Indian Ocean—South-East Asian Marine Turtle Memorandum of Understanding, the Inter-American Convention for the Protection and Conservation of Sea Turtles). In addition, since 1987, the US have requested from various countries from which they import seafood to equip specialized devices (i.e. Turtle Excluder Devices) which are designed to reduce mortality of older sea turtle classes, to their commercial trawling shrimp boats (NOAA-Southeast Fisheries Science Center 2018). The enforcement of such a legal rule over national borders, foster a deeper consideration of sea turtle conservation needs to various parties and regions, especially as it could have direct economic implications for involved countries (Brewer et al. 2006; Lewison et al. 2003). The UK serves as another example of critical node in the network. Although sea turtles do not nest on British coasts, the geographical location has a proximity to nesting population of *Chelonia mydas*, and *Caretta caretta* in the Mediterranean, in western African coasts and in islands in the central Atlantic (e.g. Ascension Island) (Encalada et al. 1996, 1998), while it is located within the migratory corridors of *Dermochelys coriacea* (Houghton et al. 2006). The identification of UK as a critical node for the global collaboration network is likely to reflect the priority the British government placed on funding research in the British overseas territories (e.g. through the 2010–2015 territorial policy; UK Government 2017).

Besides the broadly recognized leaders in global ecological research such as US and UK (Corbera et al. 2016; Liu et al. 2011), our analyses also identified a few other countries serving a critical role in maintaining the robustness of the network. Such examples are Croatia and Tunisia located in the Mediterranean which were identified as important for the persistence of connectivity, even though they did not establish a steady large number of collaborations through time. A plausible explanation of this pattern could be that such countries play an important role for the enhancement of collaborations at a regional level. Yet, their contribution is also valuable as they operate as stepping stones to offer linkages of regional clusters and teams to the global sea turtle community. Similarly, by the means of the centralization metrics, Costa Rica, was found to play a key role in the inter-connectance of regional sub-networks of co-authorship. Costa Rica represents an important country for sea turtles hosting nesting beaches for four sea turtle species (i.e. *Dermochelys coriacea*, *Chelonia mydas*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*) holding some of the oldest and most extensive conservation projects (Bjorndal et al. 1999; Santidrián Tomillo et al. 2007). As a Spanish speaking country, the history on research and conservation efforts might have contributed to make it a core country to exchange knowledge, methods and training of experts to the rest of the Caribbean and South American regions. Therefore, the importance of scientific collaboration and the exchange of knowledge and experience could be highlighted as a successful path for effective conservation, especially for migratory animals such as sea turtles.

The redirection and flexibility of conservation funds are recognized as critical processes towards improving conservation outcomes (Brooks et al. 2006; Waldron et al. 2013). Interestingly, many underfunded regions (see Waldron et al. 2013) are well represented within the collaboration network identified in the present study. This finding seems to be very encouraging for a main reason; it is likely that although economically rich countries receive most of funding (Brooks et al. 2006), the coherent network of sea turtle researchers might have achieved to re-direct this flow, by supporting conservation projects and research at weaker economies. Several factors have likely contributed to the growth of the international collaborations on sea turtle research. Delineating the exact factors for any such collaboration could be a very demanding task due to the idiosyncratic relationships between individuals, research groups or even nations. Under the same context, any such collaboration might not always equal to knowledge transfer or the evolution of scientific process (e.g. people collaborate to bring in skills, friendships and grant cycles). Still, there are several well defined examples on how the spread of knowledge has been proved beneficial for global conservation efforts. Such examples include the concerns on the technical requirements for beach hatcheries and the elimination of the use of incubation boxes (Richardson 1999). Another example is the development of a common database of unique sea turtle tags globally (http://www.seaturtle.org/tagfinder/). The modernization of the research tools used (e.g. environmental DNA sequencing, satellite tracking, molecular genetics), the expansion of research to the marine realm (e.g. foraging, migration habitats), the consideration of the various spatial scales at which different factors affect population viability (e.g. regional management unites, meta-population level) are indicative of how this active network is evolved towards satisfying global research priorities (Hamann et al. 2010; Rees et al. 2016).

Despite the encouraging population trends there is still a lack of knowledge on population status and trends for many regions around the globe. These gaps are also highlighted in our research with limited nodes in the more recent network identified along Southeast Asia and South Africa. Considering that the sea turtle research community represents a rapidly growing international network of collaboration, it becomes apparent that there is still space for future multinational collaborations. The identification of a metric to assess the quality of scientific articles is still debated (Avkiran 1997; Leimu and Koricheva 2005a, b; Lortie et al. 2007), while a geographical pattern might be obtained in collaboration patterns for specific scientific disciplines (Catini et al. 2015; Scellato et al. 2015). However, with respect to sea turtle research the potential impact of multi-authorship and of multinational collaborations is more likely to reflect the integration of skills, talents, scientific backgrounds and knowledge that improve global conservation capacity.

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