Aquatic Mammals 2024, *50*(3), 199-214, DOI https://doi.org/10.1578/AM.50.3.2024.199

Assessing Residency and Site Fidelity in Bottlenose Dolphins: A Literature Review and Bibliometric Analysis

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Abstract

Residency and site fidelity are important parameters in population ecology for many species as they indicate the temporal and spatial use for individuals. Although both terms are clearly different, they are used interchangeably due to lack of clarity in their definitions and the ways to assess them, especially in bottlenose dolphins (*Tursiops* spp.). Individuals with well-defined patterns of residency and site fidelity may be more vulnerable to anthropogenic disturbances; thus, the study of these parameters may help to better assess such impacts. However, interspecific differences and logistical restrictions for the study of dolphins have prevented consensus. We set out to investigate the factors that have influenced measurements of residency and site fidelity in bottlenose and a set of other dolphin species through a retrospective (~30 y: 1990 to 2019) literature review. We found 117 scientific papers with a two-fold increasing trend approximately every 15 years, with 50% published in only four journals. Most of the studies were developed in the United States, followed by Australia and Europe, likely due to strict policies for marine mammal conservation. Author collaboration network analysis showed highly atomized national groups in which North American organizations formed the biggest cluster, followed by Australia, Africa, and Europe. However, large worldwide gaps still exist, possibly because of the heterogeneity in marine mammal sampling efforts and limited information availability in the North Pacific, Central and South America, Africa, Asia, and the Indian Ocean. We found 30 different classification methods in which 12 were based on defined categories. We provide conceptual aid to distinguish between the use of both terms, as well as guidance to tackle the challenge of defining patterns of temporal use due to the variability of thresholds for classifying individuals. A paradigm shift is needed to create comprehensive, standardized, and generalized assessments of residency and site fidelity, which can be compared based on their performance across different populations of bottlenose dolphins around the world.

Key Words: population parameters, definitions, metrics, discrepancy, temporal and spatial scale

Introduction

Dolphins are considered a sentinel species for ecosystem and public health as a result of their high trophic position within aquatic food webs (i.e., apex predators) and their physiology in which elevated levels of pollutants bioaccumulate in their lipid-rich blubber (e.g., Wells et al., 2004; Bossart, 2011; Reif et al., 2015; Kershaw & Hall, 2019). Also, the economic and cultural value of dolphins supports efforts for the conservation of their populations across the world (e.g., Lusseau et al., 2003; Fury & Harrison, 2008; Chabanne et al., 2012).

Identifying individuals that are part of populations as well as classifying their residency and site fidelity are crucial parameters for assessing population dynamics and, thus, developing effective management strategies, especially for conserving at-risk species (Zanardo et al., 2016; Arcangeli et al., 2017). Given that many species of marine mammals are at risk, these approaches are often common in population studies. However, over the past 30 y, definitions of residency and site fidelity have varied at the individual, population, and species-specific levels; such is the case of bottlenose dolphins (*Tursiops* spp.). The methods to assess both metrics can also differ across temporal and spatial scales, depending on variations in study area and project goals (Rossi-Santos et al., 2007; Balmer et al., 2019). Thus, the variability in these definitions has been an obstacle to the standardization and comparison of residency and site fidelity among populations, which are essential for developing robust management practices.

In general, *residency* is defined in terms of the time an animal spends in a particular area (Wells & Scott, 1990). It is important to distinguish the use of residency and residence, which are often used interchangeably. For instance, residency refers to the state of being a resident, or a period of time during which one resides in a particular place; residence, on the other hand, refers to a place where one lives. Thus, residency is a status or condition, whereas residence is a physical location. Ballance (1990) was the first to parameterize residency for bottlenose dolphins, indicating that an individual with a high degree of occurrence, permanence, and periodicity should be considered a resident. However, there is a suite of literature that illustrates that this general definition and associated criteria pose significant challenges to classifying an individual as a resident or not. While the Ballance definition is widely accepted, different categories within the gradient of individual occurrence have been used to refer to residency in bottlenose dolphins during any given study period such as residents (e.g., Möller et al., 2002; Zolman, 2002; Rosel et al., 2009), partial residents (e.g., Martin & da Silva, 2004), multi-year residents (e.g., Ananias et al., 2008; Di Giacomo & Ott, 2016), and seasonal residents (e.g., Zolman, 2002; Ananias et al., 2008).

In addition, the parameters used to establish residency in bottlenose dolphins are highly influenced by their behavior, the environmental conditions, and the logistical constraints that may limit the access of researchers to a given study population (Dinis et al., 2016). For instance, such studies typically require frequent fine-scale spatial and temporal assessments, which are difficult when studying these highly mobile species (Bassos-Hull et al., 2013; Balmer et al., 2014). These limitations can lead to biased information on the distribution and classification of resident individuals within a population depending on their ecology, the field methodology, the definition of residency, and the geographic and/or temporal scope of a given study (Gaspar, 2003; Morteo et al., 2012). Therefore, in many cases, different metrics to evaluate residency have been proposed according to the research goals of a given study (Rossi-Santos et al., 2007).

Also, the variability in migratory patterns derived from the wide distribution of many bottlenose dolphin populations makes it difficult to clearly define residency and distinguish between resident and nonresident individuals within a given stock and/or study area (Silva et al., 2008; Litz et al., 2012; Balmer et al., 2013; Mullin et al., 2017).

Site fidelity, which is another term commonly used in dolphin research, corresponds to the tendency of an individual to return to a previously occupied place (Mayr, 1963; Switzer, 1993) and is typically evaluated through the frequency of sightings (i.e., occurrence), an attribute that leads to evaluating the use of the habitat for each individual showing periodic recurrence. The use of occurrence as a measure of residency (as in Simões-Lopes & Fabian, 1999) shows the ambiguity between these terms and the lack of standardized parameters used for their calculation.

In particular, the techniques to identify residency are the focus of numerous peer-reviewed studies over the past 30 y to estimate abundance, classify site fidelity, and determine movement patterns across populations (Möller et al., 2002; Parra et al., 2006; Balmer et al., 2008; Rosel et al., 2011; Chabanne et al., 2012; Morteo et al., 2012; Dinis et al., 2016; Tschopp et al., 2018; Bolaños-Jiménez et al., 2021). As stated earlier, these data are essential for developing effective conservation and management strategies as the impacts of anthropogenic activities are rapidly increasing on a global scale (Zanardo et al., 2016; Arcangeli et al., 2017). The goal of this review is to identify the metrics used for residency and site fidelity assessment in bottlenose dolphins, based on their units, scales, dimensions, and properties, to describe and provide insights into their different applications.

Methods

Data Collection

The metrics of residency and site fidelity were collated through an extensive review of published literature. A general search was conducted in Google Scholar, Scopus Web, the

ScienceDirect website, the JSTOR platform, the Web of Science platform (Clarivate), and BioOne Digital Library, considering mainly peer-reviewed published articles in English. The cumulative results from these scientific search engines provided a temporal scope of the peer-reviewed literature, collaborations among authors/geographic regions, and a rationale for this literature review in assessing residency and site fidelity. We also reviewed the literature cited in these publications for additional references since some of these papers classified residency or site fidelity as secondary research goals. Publications that mentioned residency or site fidelity in previous studies, but which did not evaluate either metric, were discarded.

These literature review analyses focused mainly on the genus *Tursiops* because of its wide geographic distribution, in addition to being the most studied species in terms of residency and site fidelity worldwide (Aurioles-Gamboa, 2009; Urbán & Rojas, 2009; Wells & Scott, 2009; Morteo et al., 2012). However, additional species of dolphins were included in this review to gain a better understanding of the extent to which these methods have been applied. We only used bibliographies explicitly dedicated to assessing residency and/or site fidelity; therefore, the following key words and Boolean operators were used to refine the general search: "residency" OR "residence" OR "site fidelity" AND "dolphin" OR "bottlenose dolphin" OR "*Tursiops*." Each entry was reviewed, and those with a clear description of some metric were selected to assess residency and/or site fidelity. Thus, the final database included mainly peer-reviewed scientific papers and specific gray literature available online that met our criteria and were published between 1990 (according to the publication date of Ballance's seminal work, who formally proposed specific indicators to measure residency) and 2019.

Data Analysis

Key information was extracted from the reviewed articles and associated data such as authors, journal, year of publication, the method used to estimate residency and site fidelity, species studied, country, and geographic coordinates of the study site(s). Reported geographic coordinates or the geographic center of each study area were plotted using *QGIS*, Version 3.12®, under the SCR WGS 84 spheroid. Geospatial representation of sampling sites from the publications served to determine possible spatial gaps where residency and site fidelity have not yet been assessed.

Authors were analyzed through a collaboration network, based on their co-authorships with other researchers and their number of publications. The network was generated in *VOSviewer*, Version 1.6.18, a free software program used for bibliometric analyses (van Eck & Waltman, 2010). Node (i.e., author) sizes were presented proportionally to their degree of centrality (i.e., number of collaborations), allowing the representation of the number of links that each node has (Wasserman & Faust, 1994). The degree of centrality was used to identify the "key authors" (i.e., those publishing the most on the subjects).

A classification for the indices and parameters under study was performed, based on their units, scales, dimensions, and properties, to identify groups of indicators that share the same characteristics. Since some metrics were used interchangeably in the publications to assess residency or site fidelity, all were listed without distinction. Initially, metrics were classified based on frequencies, proportions, models, and other types of scales. Time scales of each metric were also used and divided into short (e.g., days, months), seasonal (e.g., standard, other type of season), intra-annual (throughout the year), and inter-annual (multiple years). Afterwards, those metrics that provided some classification of degrees of residency were identified to determine ambiguity in the metrics. Finally, all analyzed papers were classified according to the time scale used in the study to find out the conditions in which residency and site fidelity were assessed (e.g., sampling periods, climatic seasons, or years). This descriptive analysis was conducted in *R*, Version 2.0.0 (R Core Team, 2021).

Results

Trends in Publications and Journals

After the removal of duplicates and literature not meeting our selection criteria, we found 117 scientific papers published between 1990 and 2019 (77 of these exclusively for bottlenose dolphins). Despite variability in residency and site fidelity studies, there was a trend in increasing references to residency and site fidelity over time. Prior to 1999, there were a few publications on the subject; however, there has been a clear increase since 2011 as the inclusion of residency and site fidelity estimates in peer-reviewed publications was more evident leading to a two-fold increase approximately every 15 y. In this sense, 57% of the papers were published within the last decade (Figure 1), indicating greater relevance of this topic in recent years. Approximately 50% of the papers were published in only four journals: *Marine Mammal Science* = 20%, *Aquatic Mammals* = 11%, *Journal of Marine Biological Association of the United Kingdom* = 9%, and *African Journal of Marine Science* = 9% (Figure 2).

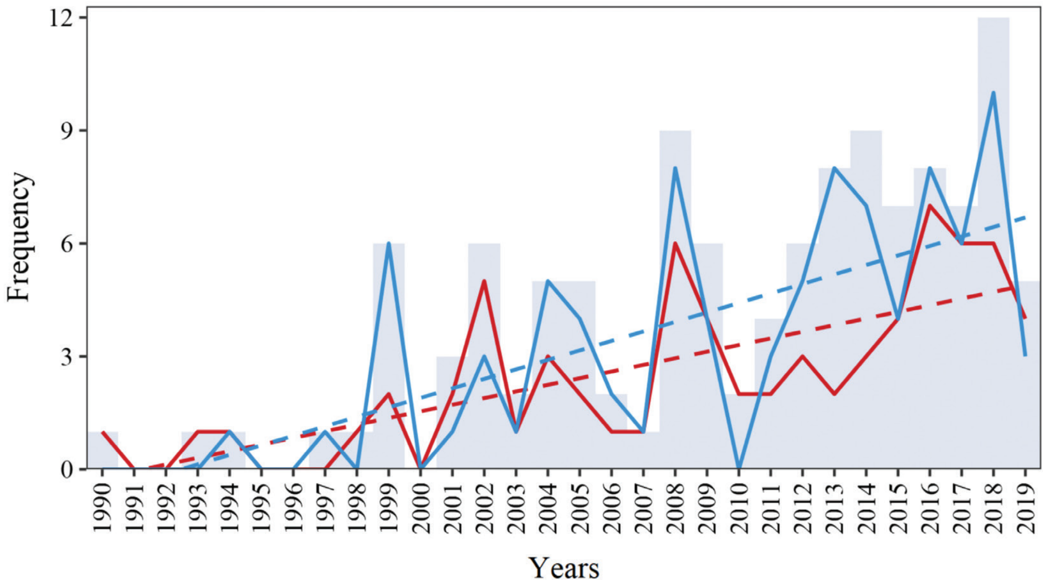

Figure 1. Annual distribution frequency for scientific publications explicitly dedicated to the study of residency (red) and site fidelity (blue) for 17 species of dolphins published in peer-reviewed journals between 1990 and 2019 (*n* = 117). The dotted lines show the linear regression of each indicator. Bars show the total number of publications.

Collaboration Networks and Identification of Key Authors

The co-authorship network represented the collaboration of multiple interconnected individuals (Figure 3). This network consisted of 375 nodes (authors) and 2,668 links (collaborations). Node interactions reflected highly atomized groups (i.e., isolated from each other). Within the network, the authors with the highest degree of centrality (i.e., higher number of collaborations) were represented mostly by researchers from the U.S. (i.e., green cluster) and Europe (i.e., red cluster). In addition, most American papers were connected by two authors (Balmer, B. C., degree of centrality = 33, and Wells, R. S., degree of centrality = 31). Authors from other countries like Australia (i.e., blue cluster), Brazil (i.e., light blue cluster), and Italy (i.e., part of the red cluster and also the left light blue cluster), although having a great number of contributions, are represented in smaller clusters due to a limited number of collaborations.

Taxonomic Trends

Our Boolean search limited the results to residency and site fidelity studies of only 17 species of delphinids from 10 genera. As expected, 66.13% of the peer-reviewed publications belonged to the genus *Tursiops*, but 12.10% also dealt with the genus *Sousa*. Over half of the papers focused on *Tursiops truncatus* (56.45%), followed by *Tursiops aduncus* and *Sotalia guianensis* (7.26 and 6.45%, respectively) (Figure 4).

Geospatialization of Study Areas

The restrictions in our Boolean search showed that only a few nations have contributed significantly to the development of research on residency and site fidelity in dolphins—for instance, 14.43% of the study areas were located in the U.S., whereas 35.14% came from Brazil and Italy, and also two continents, Australia and Africa (Figure 5). The spatial distribution of the species under study was reflected in many cases by the sites of the publications on residency and site fidelity, generally covering wide geographic areas (Figure 5). However, even the most studied species around the world (*T. truncatus*) showed geographic gaps (i.e., absence of studies on the topics), especially on the North Pacific coasts (U.S., Canada, Russia, and Japan), as well as Central and South America (northern Brazil, Surinam, Guyana, Venezuela, as well as Peru, Ecuador, and Colombia). Large areas with no data were also observed in Africa, Asia, and the Indian Ocean. Conversely, the most studied areas were the coasts of Florida in the U.S. and Europe.

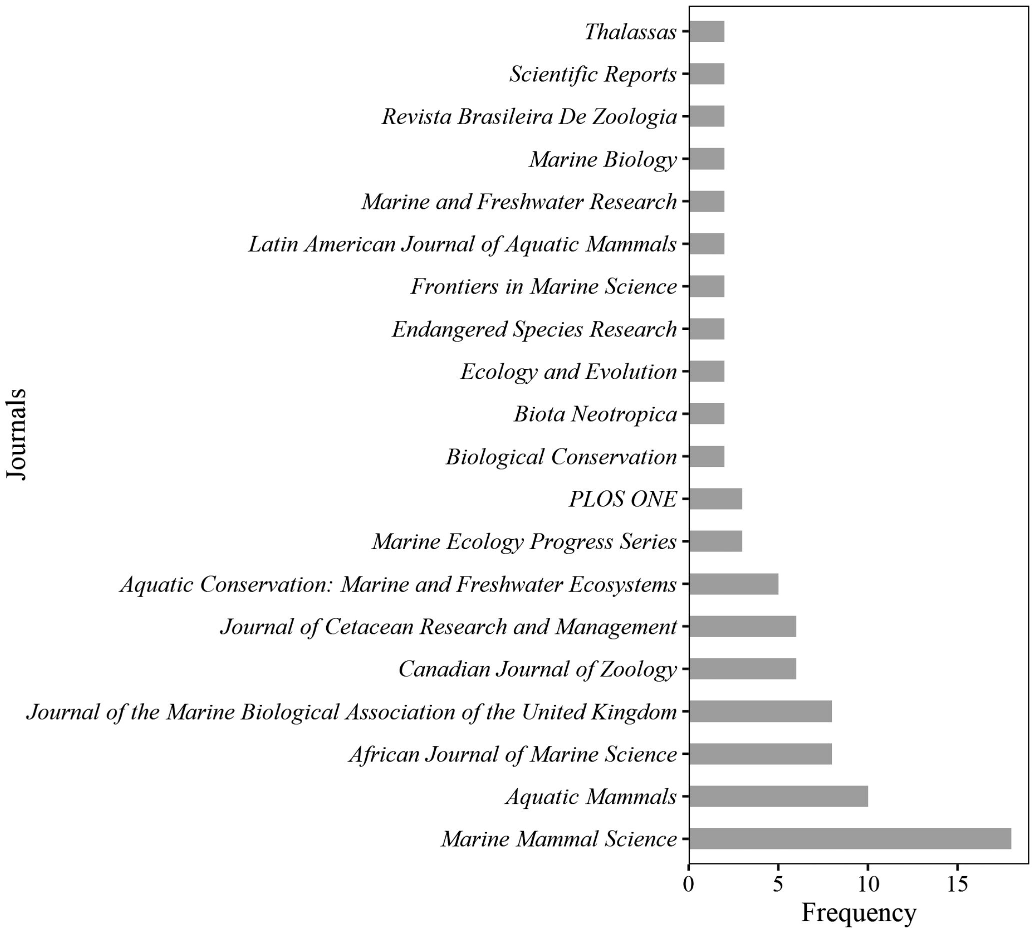

Figure 2. Frequency distribution of scientific journals that published studies explicitly dedicated to residency and site fidelity in 17 dolphin species between 1990 and 2019 (n = 117)

Characterization of Residency and Site Fidelity Metrics

From the 30 measurements of residency and site fidelity identified in the literature specifically for bottlenose dolphins (Supplemental Material 1; the supplemental materials for this article are available on the *Aquatic Mammals* website), 43% were expressed in frequencies, 40% in proportions, 7% consisted of mathematical models, and 10% used a different metric (such as standard deviations, among others; Figure 6A; Supplemental Material 2). Approximately half of these indicators used some form of time scale; specifically, a quarter of these indicators expressly required seasonal or year-level assessments to establish residency and/or site fidelity (Figure 6B; Supplemental Material 2). The other half of the indicators, in general, did not require this type of temporal scale, and thus their assessments were based on the whole study period.

A total of 12 categorical residency indices were identified, which corresponded to criteria provided by various authors using different classifications of individuals (Table 1). All of these contained a categorical scale with two or three levels of classification. Those with two categories classified individuals as residents and nonresidents, whereas those that included three categories also identified occasional and transitory individuals. Also, some indices used categories such as multi-year residents, year-round residents, permanent residents, and partial residents; accordingly, the multi-year category requires individual sightings across different years. Conversely, only two site fidelity indicators used categories for sighting frequencies.

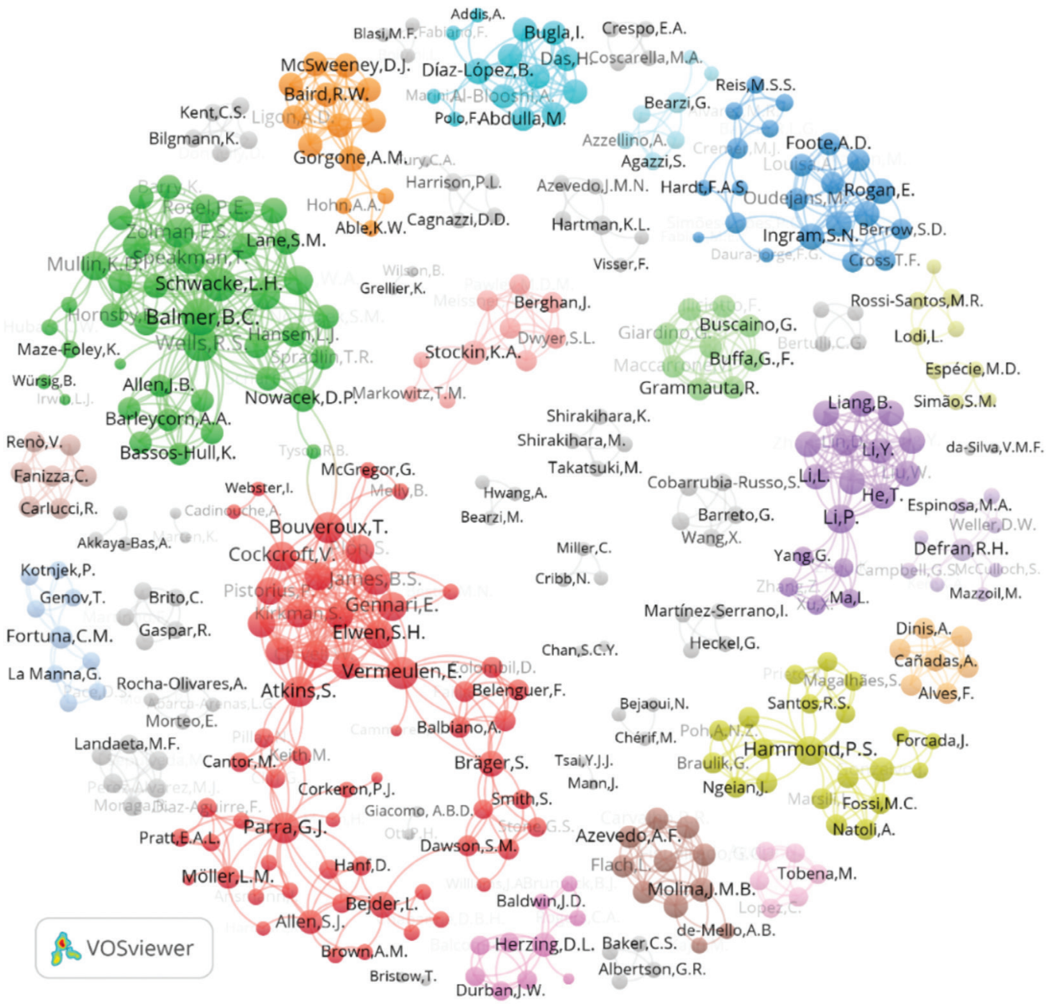

Figure 3. Network of co-authors with scientific publications explicitly dedicated to studying residency and site fidelity in 17 dolphin species between 1990 and 2019 (n = 117). The size of the nodes and the names of the authors are proportional to the number of articles published.

Given the wide variety of criteria among authors, we used a consistent definition of residency indices in which individuals were directly classified as either residents or nonresidents using different indicators of occurrence within a temporal scale (monthly, temporary, seasonal, and/or annual). Conversely, indicators using sighting frequencies to classify individuals, regardless of the temporal division or sampling period, were considered as indices of site fidelity.

The bulk of studies explicitly dedicated to assessing residency and/or site fidelity from our Boolean search (n = 117) collected data during different sampling periods. The largest proportion of studies were carried out during 3 y of sampling effort (28%). Sampling was carried out for 1 y in only 6% of studies, and 23% of the sampling was carried out in at least 5 y. Also, 35% of the studies used the four standard seasons of the year (spring, summer, autumn, and winter); on the other hand, studies that considered only three temporal categories (3.5%) considered at least the summer season in addition to autumn, spring, or winter. Studies with two categories (13%) considered at least the summer in addition to spring or winter. Only 7% of the studies were sampled in a single season, predominantly during summer, and 15% of the studied literature used different time scales such as climatic

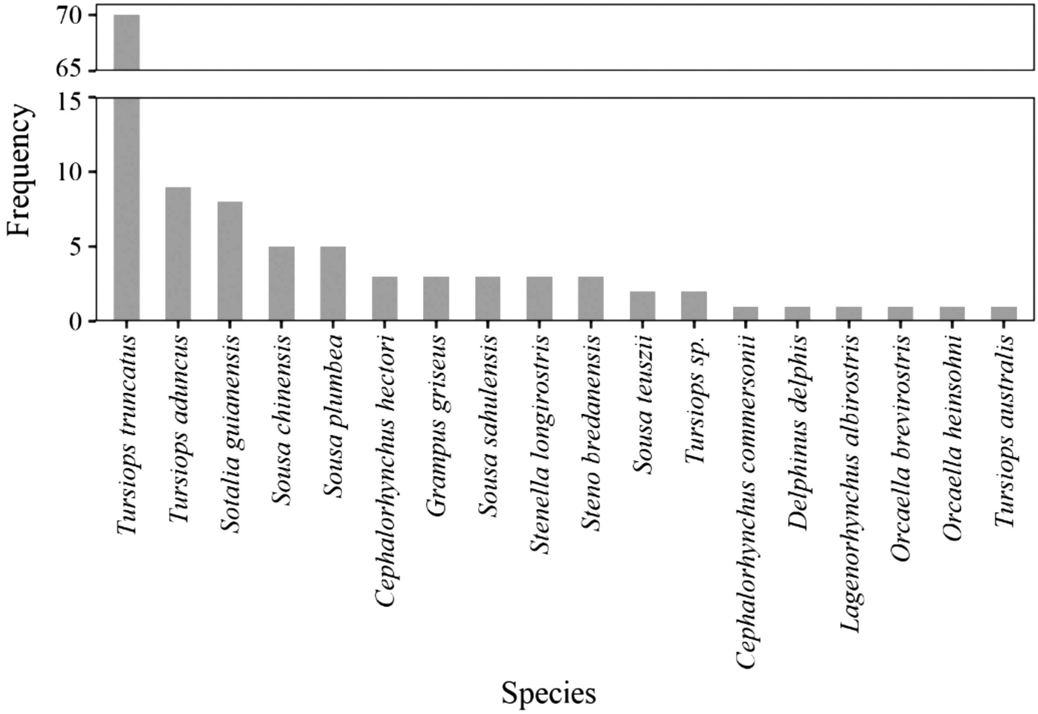

Figure 4. Distribution frequency of studies explicitly dedicated to the assessment of residency and/or site fidelity in dolphin species (n =17) published in peer-reviewed scientific journals between 1990 and 2019 (n = 117)

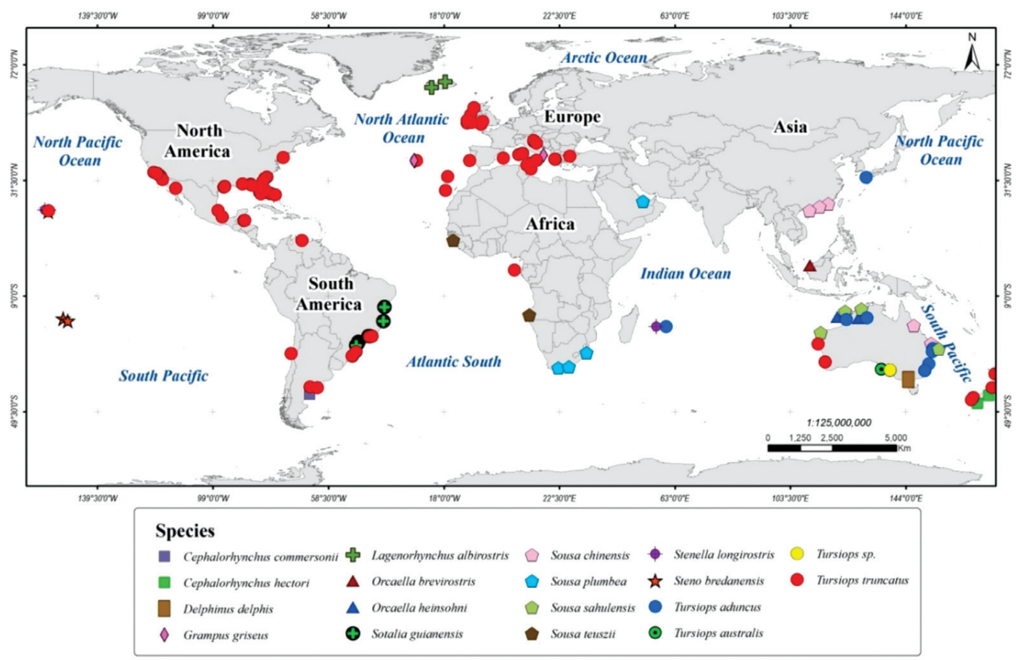

Figure 5. Study areas of scientific papers explicitly dedicated to assessing residency and/or site fidelity in 17 dolphin species that were published in peer-reviewed journals between 1990 and 2019 (n = 117)

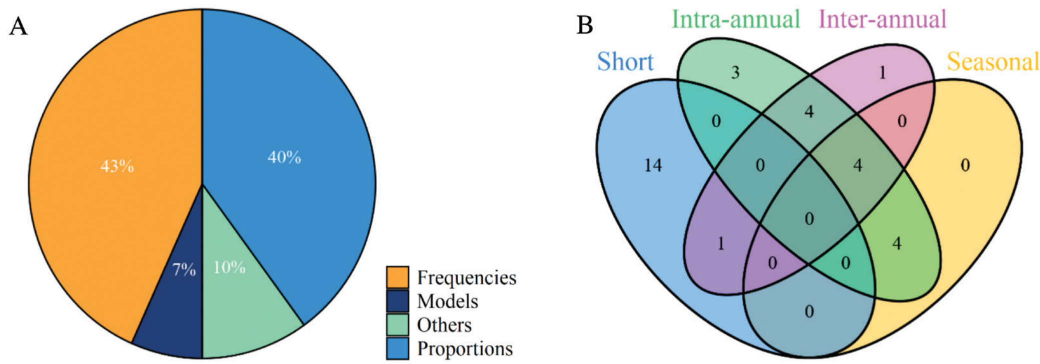

Figure 6. Classification of the definitions of residency and site fidelity in bottlenose dolphins by (A) type of metric for both definitions and (B) temporal scale in residency categories

conditions, fieldwork season, and sampling periods, among others. Finally, it is noteworthy that 28% of the studies did not mention any specific season in which the sampling effort occurred or that it was even carried out in a nonsystematic way, and, thus, these were represented in days, months, or years.

Discussion

Bibliometric and Taxonomic Descriptors

The different definitions of residency and site fidelity used for bottlenose dolphins have been an obstacle to the standardization and comparison of these important population and/or species-specific parameters, particularly in recent years, with these data being applied to conservation and management strategies (e.g., Bolaños-Jiménez et al., 2021). Therefore, in many cases, the definition of residency has been adapted according to the needs of each study (Rossi-Santos et al., 2007). Since the work of Ballance (1990) and until 2019, the number of articles published to study residency and/or site fidelity, particularly in dolphins, has been increasing.

From our Boolean search, the sources of information for these topics identified two main journals with the highest number of publications due to their scope (i.e., *Marine Mammal Science*, founded in 1985, and *Aquatic Mammals*, founded in 1972; Dudzinski, 2014; Todd et al., 2015). Thus, most of the literature was focused on *T. truncatus* globally. This was expected given the criteria used for the selection of bibliographic material and also due to the ubiquitous distribution of the species and easy access by researchers (Aurioles-Gamboa, 2009; Urbán & Rojas, 2009; Wells & Scott, 2009; Palacios et al., 2011; Szteren & Lercari, 2022; Escobar-Lazcano et al., 2023; Huesca-Domínguez et al., 2023). The low representation of other species may also be explained by highly migratory and/or open populations in which the calculation of residency and site fidelity is extremely challenging, which can limit the number of researchers and studies performed. However, there were a few examples of residency and site fidelity for other species, including the Commerson's dolphin (*Cephalorhynchus commersonii*) sighted along the Argentine Sea coast (Righi et al., 2013); the Hector's dolphin (*Cephalorhynchus hectori*), which inhabits the coastal waters of New Zealand (Brough et al., 2019); the Australian snubfin dolphin (*Orcaella heinsohni*) found along the coasts of northern Australia (Bouchet et al., 2021); the Guiana dolphin (*Sotalia guianensis*) distributed from Nicaragua to southern Brazil with possible records in Honduras (Azevedo et al., 2007); the Australian humpback dolphin (*Sousa sahulensis*) inhabiting the coasts from northern Australia (Parra & Cagnazzi, 2016); the Atlantic humpback dolphin (*Sousa teuszii*) present in tropical and subtropical coastal waters of the eastern Atlantic of West Africa (Van Waerebeek et al., 2004); and the Burrunan dolphin (*Tursiops australis*) sighted in southern Australia (Charlton-Robb et al., 2011).

Geospatialization of Study Areas

Most of the publications on residency and site fidelity were conducted in study areas within the U.S., followed by Australia and Europe. While *T. truncatus* is an abundant species in North America, an important aspect of this geographic pattern is that the large proportion of cetacean studies in the U.S. is driven by mandatory stock assessments as required by the Marine Mammal Protection Act (Kaschner et al., 2012). In addition, there are long-term research

Table 1. Indicators of residency and site fidelity that use categories to classify individuals (n = 14) cited in studies (n = 117), published in peer-reviewed scientific journals between 1990 and 2019, which explicitly assessed residency and/or site fidelity for 17 dolphin species

Author(s)	Categories
Keith et al., 2002	Residents, transients
Zolman, 2002	Residents, seasonal residents, transients
Möller et al., 2002	Residents, transients, occasional visitors
Chabanne et al., 2012	Residents, occasional visitors, transients
Quintana-Rizzo & Wells, 2001; Culloch, 2004	Common, frequent, occasional, rare
Martin & da Silva, 2004	Residents, permanent residents, partial residents, nonresidents
Ananias et al., 2008	Year-round residents, seasonal residents, transients
Rosel et al., 2011	Residents, nonresidents
Díaz-López, 2012*	"Farmers" (i.e., annual and seasonal occurrence rates > 0.5), frequent visitors, occasional visitors, sporadic visitors
Daly et al., 2014; Zanardo et al., 2016	Clusters determined by individual occurrences and/or sighting rates
Balmer et al., 2008*	Bin size determined by the statistical distribution of individual occurrences
Di Giacomo & Ott, 2016	Multi-year residents, year-round residents, seasonal residents, transients
Conway, 2017	Residents, nonresidents
Dinis et al., 2016	Residents, transients, migrants

*Classification used to evaluate site fidelity

programs, such as the one in Sarasota, Florida, that allow periodic evaluations of population parameters, including residency and site fidelity (Wells, 2014).

It is noteworthy that the study areas with a higher number of publications on residency and site fidelity recorded in this article are consistent with habitats classified as critical or at high risk for marine mammal species (Avila et al., 2018) due to incidental capture, direct exploitation, pollution, and shipping traffic. This may be explained when considering that as apex predators, small cetaceans, particularly bottlenose dolphins, are often used as sentinels of the quality of their habitats; therefore, studying their movement patterns identifies spatial overlap between anthropogenic activities, land use changes, and potential population-level impacts (Adams et al., 2014; Greller et al., 2021).

On the other hand, the publications considered in this review show worldwide spatial gaps where residency and site fidelity studies have not been carried out or are unavailable online or in the peer-reviewed literature. The review by Avila et al. (2018) argues that the lack of information on risk in certain locations does not mean an absence of threats; rather, it is a result of the heterogeneity in global marine mammal sampling efforts and the limited availability of information regarding the documentation of possible threats to marine mammal species in various areas of the world (Schipper et al., 2008; Kaschner et al., 2012; Avila et al., 2018; Escobar-Lazcano et al., 2023; Huesca-Domínguez et al., 2023). This heterogeneity may result in different levels of documentation regarding the residency and site fidelity (among other issues) of different species of cetaceans, including the bottlenose dolphin.

Collaboration Network: Authorship Analysis

The co-authorship analysis showed that, given our stringent searching criteria, the scientific community explicitly studying residency and site fidelity in the selected dolphin species is for the most part segregated into small national groups with stronger internal collaborative interactions and very low or no interaction outside their respective groups. Two large groups connected by a few researchers were identified: one of them was led by researchers from North American organizations within the U.S., and the other corresponded to Australian and African organizations. Smaller clusters were also found for Italy and Brazil.

Although studies on residency and site fidelity make up a small proportion of the research that is done on dolphins worldwide, it clearly reflects that this scientific community is regionally disaggregated (Palacios et al., 2011; Srinivasan, 2018; Szteren & Lercari, 2022; Escobar-Lazcano et al., 2023; Huesca-Domínguez et al., 2023). This bias is well known since, for instance, at least 66% of the members of the Society for Marine Mammalogy (the largest professional society of marine mammologists worldwide) in 2017 were from North America, followed by Europe (Srinivasan, 2018).

This disaggregation in the scientific community, coupled with the different conditions of each study site, has resulted in local adaptations of the different methods to assess residency and site fidelity, especially in bottlenose dolphins (Rossi-Santos et al., 2007). Although these varying approaches and goals have prevented a comprehensive position, having a general approach would provide the basis for comparable frameworks. A standardized definition of residency needs to be achieved, along with the corresponding methodological recommendations to tackle many or most of the potential scenarios for the different species and populations worldwide. Thus, collaboration is greatly needed among the different research groups around the world to know their needs, priorities, and the difficulties of the different study areas.

Characterization of the Metrics of Residency and Site Fidelity

Traditionally, methodologies to assess residency have been presented as definitions (e.g., Rosel et al., 2011; Conway, 2017), criteria (e.g., Möller et al., 2002; Chabanne et al., 2012), indices (e.g., Koelsh, 1997; Quintana-Rizzo & Wells, 2001), and models (e.g., Pradel et al., 1997; Whitehead, 2001). Similarly, site fidelity assessments have been proposed as indices (e.g., Balmer et al., 2008; Simpfendorfer et al., 2011; Hunt et al., 2017). However, given the complexity of the subject, it is essential to distinguish what a definition, a criterion, an index, and even an indicator refer to so that each concept is correctly classified.

An indicator is a measure that involves only a directly observable data flow, whereas an index corresponds to the quantitative aggregation of two or more variables (Moriarty et al., 2018). In this sense, several of the methods to assess site fidelity meet the characteristics of an indicator since they usually evaluate only a flow of occurrence or number of resightings of individuals (also represented as rates or categories) on different time scales (monthly, seasonal, or annual). In contrast, residency often uses the combination of two temporal occurrence flows such that it has characteristics of an index. In this sense, high site fidelity in different temporal scales leads to classifying individuals in some category of residency.

In general, residency is defined in terms of the time an animal spends in a particular area (Wells & Scott, 1990). Although this definition is widely accepted, different categories within the gradient of individual occurrence have been used as a residency reference, particularly in bottlenose dolphins, during any given study period. For instance, the categories of "partial" and "seasonal" residents both involve a sort of mid-term component; on the other hand, the categories of "permanent" and "multi-year" residents involve a long-term component (usually in multiple years). However, annual residents usually involve a combination of short (usually monthly) and mid (usually seasonal) temporal scales. Interestingly, all the studied variations have at least one of these three temporal scales: (1) monthly, (2) seasonal, or (3) annual. The seasonal and annual scales may be based on the climatic/oceanographic patterns of each study site; however, monthly scales are likely associated with logistical challenges that require researchers to combine months to provide greater resolution or to obtain data to estimate other demographic parameters of importance for each study (e.g., abundance, birth rate, mortality, migration, population structure, etc.).

Likewise, site fidelity has been commonly assessed under the same temporal scales (i.e., monthly, seasonal, or annual) across different study areas (e.g., Quintana-Rizzo & Wells, 2001; Parra et al., 2006; Balmer et al., 2008). The difference observed between both cases (i.e., residency and site fidelity) is mainly that site fidelity is generally based on a count or proportion using only the most convenient scale, whereas residency is based on the combination of different metrics (e.g., frequencies and periods) using at least two different dimensions (spatial and temporal). Site fidelity uses numerical (e.g., Parra et al., 2006; Chabanne et al., 2012; Tschopp et al., 2018) and categorical (e.g., Möller et al., 2002; Balmer et al., 2008; Díaz-López, 2012) metrics to represent the frequency of occurrence in the study area during a given period. However, although both terms are clearly different, in some cases, they have been used interchangeably due to a lack of clarity in the definitions and ways of evaluating them.

In the case of models such as the Lagged Identification Rate (LIR), rather than showing a classification of residency, it shows the estimated residency time for individuals (Whitehead, 2001). Other types of metrics are rarely reported and require additional data such as geographic distances between the range of movement of individuals in a particular area (Levine, 2002).

There are important aspects regarding the two essential dimensions (spatial and temporal) that make up both definitions for residency and site fidelity. In the case of the spatial dimension, it is noteworthy that for site fidelity, the spatial extent of the study area does not usually represent a requirement for its assessment since it only needs to record the presence or absence of an individual during a given period. On the other hand, residency does consider in some way (implicit or explicit) the probability that an individual is found (or not) in a given site of certain dimensions based on the time between consecutive recaptures. In this sense, the extent of the studied area should correspond to the common habitat of the individual or the population. In summary, both definitions have a logical distinction that can be derived using an extreme example: the site fidelity of an individual cannot be evaluated if it cannot leave the planet, whereas the same individual can be considered a resident since it never leaves the planet.

In the case of the temporal dimension, there are important bio-ecological aspects to consider regarding the choice of scale. On the one hand, for individuals to be classified as "seasonal," the temporal scales should reflect shifts that are known (or suspected) to affect their populations or species due to the occurrence of physical (e.g., water temperature) or ecological (e.g., productivity) phenomena (Urian et al., 1996; Zolman, 2002), although this is not always the case. Thus, information on abundance, mating, calving, weaning, and/or prey distribution and availability are typically useful for providing insight on temporal variations for species and their habitats (Reilly & Fiedler, 1994; Sprogis et al., 2018).

Admittedly, classifying climatic seasons can be an obstacle to the assessment of sighting rates in different geographical areas. For instance, Zolman (2002) divides the year into four seasons (autumn, winter, spring, and summer); however, given that the duration of each season differs latitudinally or according to the study area, and the fact that seasons may influence migratory behavior of dolphins, each study area typically uses different time scales to assess the temporal/seasonal pattern of occurrence in estimates of residency and/or site fidelity (Zhang et al., 2002; Chang et al., 2005; Cruz-Escalona et al., 2007; Fury & Harrison, 2011; Morteo et al., 2014, 2017; Tsujimoto et al., 2018; Tubbs et al., 2020; Bolaños-Jiménez et al., 2021).

Time scales used in studies vary in number and duration, thus contributing fundamentally to the classification of individuals as temporary or annual residents. Although using different time scales may lead to methodological inconsistencies between studies, it should be considered as a flexible standard practice. Each researcher should determine the most appropriate and representative temporal division for their respective populations based on an evaluation of the periodicity and relevance of the environmental factors that affect the distribution of the population studied.

Distinguishing between "transient" and "resident" individuals is crucial for population abundance estimates as the inclusion of transient individuals tends to overestimate population size with potential implications for management decisions (Ronje et al., 2020; Bolaños-Jiménez et al., 2021). The categories, such as "occasional visitors" (e.g., Möller et al., 2002; Chabanne et al., 2012), "transitory animals" (e.g., Möller et al., 2002; Ananias et al., 2008), and "nonresidents" (e.g., Martin & da Silva, 2004; Rosel et al., 2011; Conway, 2017), usually involve individuals seen just once, although not all residency metrics include these categories. For indices that include the category of "occasional visitors," authors usually refer to individuals that were sighted multiple times during given seasons but with low frequency. The "transients" may also refer to individuals with very low frequency on different time scales.

Through our review, the biggest challenge in evaluating residency and site fidelity was that the criteria assigned different thresholds to classify individuals. For instance, classifications of "resident" individuals stand out for having intermediate to high monthly, seasonal, and annual sighting rates, with thresholds usually greater than or equal to a sighting ratio of 0.3 (e.g., Möller et al., 2002; Rosel et al., 2011; Chabanne et al., 2012; Conway, 2017). Conversely, "occasional visitors" categories have low to intermediate rates, while "transient" categories have very low sighting rates (e.g., Keith et al., 2002; Möller et al., 2002; Chabanne et al., 2012). Establishing cutoffs for binning proportional values into these categories of sighting frequencies may seem intuitive, but it is largely subjective, considering that the intention is to know if the individuals have high or low sighting frequencies within any given time scale. Moreover, sighting frequencies are known to vary naturally depending on the ecology of the population, or artificially due to the design of the sampling method (Morteo et al., 2012).

Finally, our results are a first step to producing accurate information for management and conservation strategies by identifying the different aspects used in the assessment of residency and site fidelity, particularly in bottlenose dolphins. The results also pinpoint the lack of studies for various populations and areas around the earth which are needed to manage in a better way those highly mobile species. Also, a detailed quantitative analysis of the variations and the performance of all these methods and metrics used is warranted to standardize methodologies around the scientific community targeting these species. There is a clear need for more collaboration between the different research groups around the world. Developing multifaceted teams that extend across geographic boundaries will promote novel data analyses, increase the amount of data available, diminish data gaps across temporal and spatial scales, and potentially decrease research costs.

Note: The supplemental materials for this article are available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147.

Acknowledgments

This work is part of the first author's MSc thesis in Integrative Biology at Universidad Veracruzana. The authors wish to acknowledge the contributions of Jessica Powell, Reagan Munday, and Robin M. Perrtree for providing their collection of reading materials. We are also grateful to Penn Clarke with Dolphin Relief & Research and the Calvin and Marissa Allen Foundation for their economic support in the development of this manuscript. We appreciate Dr. Christina Toms and other collaborators with the Chicago Zoological Society for having an open dialogue on developing standardized metrics for residency and site fidelity.

Literature Cited

Adams, J., Speakman, T., Zolman, E., Mitchum, G., Wirth, E., Bossart, G. D., & Fair, P. A. (2014). The relationship between land use and emerging and legacy contaminants in an apex predator, the bottlenose dolphin (*Tursiops truncatus*), from two adjacent estuarine watersheds. *Environmental Research*, *135*, 346-353. https://doi.org/10.1016/j.envres.2014.08.037

Ananias, S. M. A., Jesus, A. H., & Yamamoto, M. E. (2008). Recorrência e fidelidade espacial do boto-cinza *Sotalia guianensis* na enseada do Curral, Pipa/RN, avaliada através da fotoidentificação [Recurrence and spatial fidelity of the gray dolphin *Sotalia guianensis* in Curral Cove, Pipa/RN, assessed through photo-identification]. In A. H. Jesus, P. I. A. P. Medeiros, & F. J. L. Silva (Eds.), *Boto-cinza* Sotalia guianensis*: Pesquisa e conservação no nordeste do Brasil* [Gray dolphin *Sotalia guianensis*: Research and conservation in northeastern Brazil] (pp. 61-77). Edições UERN.

Arcangeli, A., Campana, I., & Bologna, M. A. (2017). Influence of seasonality on cetacean diversity, abundance, distribution and habitat use in the western Mediterranean Sea: Implications for conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *27*, 995-1010. https://doi.org/10.1002/aqc.2758

Aurioles-Gamboa, D. (2009). Mamíferos marinos: La investigación de los mamíferos marinos en México [Marine mammals: The investigation of marine mammals in Mexico]. In Consejo Nacional de Ciencia y Tecnología, Universidad Autónoma Metropolitana & Instituto de Ciencia y Tecnología del Distrito Federal [National Council of Science and Technology, Autonomous Metropolitan University & Institute of Science and Technology of the Federal District] (Eds.), *Cosmos, Enciclopedia de la ciencia y la tecnología en México* [Cosmos: Encyclopedia of science and technology in Mexico] (pp. 241-249). Universidade Autónoma Metropolitana, Mexico City.

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. https://doi.org/10.1016/j.biocon.2018.02.021

Azevedo, A. F., Oliveira, A. M., Viana, S. C., & Van Sluys, M. (2007). Habitat use by marine tucuxis (*Sotalia guianensis*) (Cetacea: Delphinidae) in Guanabara Bay, south-eastern Brazil. *Journal of the Marine Biological Association of the United Kingdom*, *87*(1), 201-205. https://doi.org/10.1017/S0025315407054422

Ballance, L. T. (1990). Residency patterns, group organization, and surfacing associations of bottlenose dolphins in Kino Bay, Gulf of California, Mexico. In S. Leatherwood & R. R. Reeves (Eds.), *The bottlenose dolphin* (pp. 267-283). Academic Press. https://doi.org/10.1016/B978-0-12-440280-5.50017-2

Balmer, B. C., Wells, R. S., Nowacek, S. M., Nowacek, D. P., Schwacke, L. H., McLellan, W. A., Scharf, F. S., Rowles, T. K., Hansen, L. J., Spradlin, T. R., & Pabst, D. A. (2008). Seasonal abundance and distribution patterns of common bottlenose dolphins (*Tursiops truncatus*) near St. Joseph Bay, Florida, USA. *The Journal of Cetacean Research and Management*, *10*(2), 157-167. https://doi.org/10.47536/jcrm.v10i2.650

Balmer, B. C., Schwacke, L. H., Wells, R. S., Adams, J. D., George, R. C., Lane, S. M., McLellan, W. A., Rosel, P. E., Sparks, K., Speakman, T., Zolman, E. S., & Pabst, D. A. (2013). Comparison of abundance and habitat usage for common bottlenose dolphins between sites exposed to differential anthropogenic stressors within the estuaries of southern Georgia, U.S.A. *Marine Mammal Science*, *29*(2), E114-E135. https://doi.org/10.1111/j.1748-7692.2012.00598.x

Balmer, B. C., Wells, R. S., Schwacke, L. H., Schwacke, J. H., Danielson, B., George, R. C., Lane, S. M., McLellan, W. A., Pabst, D. A., Sparks, K., Speakman, T. R., Townsend, F. I., & Zolman, E. S. (2014). Integrating multiple techniques to identify stock boundaries of common bottlenose dolphins (*Tursiops truncatus*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, *24*(4), 511-521. https://doi.org/10.1002/aqc.2357

Balmer, B. C., Zolman, E., Bolton, J., Fauquier, D., Fougeres, E., George, R. C., Goldstein, T., Gowen, M., Kolkmeyer, T., Le-Bert, C., Mase, B., Norton, T., Peterson, J., Rowles, T., Saliki, J., & Ylitalo, G. (2019). Ranging patterns and exposure to cumulative stressors of a *Tursiops truncatus* (common bottlenose dolphin) in Georgia. *Southeastern Naturalist*, *18*(1). https://doi.org/10.1656/058.018.0112

Bassos-Hull, K., Perrtree, R. M., Shepard, C. C., Schilling, S., Barleycorn, A. A., Allen, J. B., Balmer, B. C., Pine, W. E., & Wells, R. S. (2013). Long-term site fidelity and seasonal abundance estimates of common bottlenose dolphins (*Tursiops truncatus*) along the southwest coast of Florida and responses to natural perturbations. *The Journal of Cetacean Research and Management*, *13*(1), 19-30. https://doi.org/10.47536/jcrm.v13i1.551

Bolaños-Jiménez, J., Morteo, E., Delfín-Alfonso, C. A., Fruet, P. F., Secchi, E. R., & Bello-Pineda, J. (2021). Population dynamics reveal a core community of the common bottlenose dolphin (*Tursiops truncatus*) in open waters of the south-western Gulf of Mexico. *Frontiers in Marine Science*, *8*, 753484. https://doi.org/10.3389/fmars.2021.753484

Bossart, G. D. (2011). Marine mammals as sentinel species for oceans and human health. *Veterinary Pathology*, *48*(3), 676-690. https://doi.org/10.1177/0300985810388525

Bouchet, P. J., Thiele, D., Marley, S. A., Waples, K., Weisenberger, F., Balanggarra Rangers, Bardi Jawi Rangers, Dambimangari Rangers, Nyamba Buru Yawuru Rangers, Nyul Nyul Rangers, & Uunguu Rangers. (2021). Regional assessment of the conservation status of snubfin dolphins (*Orcaella heinsohni*) in the Kimberley Region, Western Australia. *Frontiers in Marine Science*, *7*, 614852. https://doi.org/10.3389/fmars.2020.614852

Brough, T., Rayment, W., Slooten, E., & Dawson, S. (2019). Fine scale distribution for a population of New Zealand's only endemic dolphin (*Cephalorhynchus hectori*) shows long-term stability of coastal hotspots. *Marine Mammal Science*, *35*(1), 140-163. https://doi.org/10.1111/mms.12528

Chabanne, D., Finn, H., Salgado-Kent, C., & Bejder, L. (2012). Identification of a resident community of bottlenose dolphins (*Tursiops aduncus*) in the Swan Canning Riverpark, Western Australia, using behavioural information. *Pacific Conservation Biology*, *18*(4), 247-262. https://doi.org/10.1071/PC120247

Chang, C-P., Wang, Z., McBride, J., & Liu, C-H. (2005). Annual cycle of Southeast Asia—Maritime continent rainfall and the asymmetric monsoon transition. *Journal of Climate*, *18*(2), 287-301. https://doi.org/10.1175/JCLI-3257.1

Charlton-Robb, K., Gershwin, L., Thompson, R., Austin, J., Owen, K., & McKechnie, S. (2011). A new dolphin species, the Burrunan dolphin *Tursiops australis* sp. nov., endemic to southern Australian coastal waters. *PLOS ONE*, *6*(9), e24047. https://doi.org/10.1371/journal.pone.0024047

Conway, J. N. (2017). *Estimating density and residency of bottlenose dolphins (*Tursiops truncatus*) in three estuarine sites in South Carolina* (Electronic theses and dissertations). Coastal Carolina University, Conway, SC. https://digitalcommons.coastal.edu/etd/10

Cruz-Escalona, V. H., Arreguín-Sánchez, F., & Zetina-Rejón, M. (2007). Analysis of the ecosystem structure of Laguna Alvarado, western Gulf of Mexico, by means of a mass balance model. *Estuarine, Coastal and Shelf Science*, *72*(1-2), 155-167. https://doi.org/10.1016/j.ecss.2006.10.013

Culloch, R. M. (2004). *Mark recapture abundance estimates and distribution of bottlenose dolphins (*Tursiops truncatus*) using the southern coastline of the outer Moray Firth, NE Scotland* (Master's thesis). School of Biological Sciences, University of Wales, Cardiff.

Daly, R., Smale, M. J., Cowley, P. D., & Froneman, P. W. (2014). Residency patterns and migration dynamics of adult bull sharks (*Carcharhinus leucas*) on the east coast of southern Africa. *PLOS ONE*, *9*(10), e109357. https://doi.org/10.1371/journal.pone.0109357

Di Giacomo, A. B., & Ott, P. H. (2016). Long-term site fidelity and residency patterns of bottlenose dolphins (*Tursiops truncatus*) in the Tramandaí Estuary, southern Brazil. *American Journal of Aquatic Mammals*, *11*(1-2), 155-161. https://doi.org/10.5597/00224

Díaz-López, B. (2012). Bottlenose dolphins and aquaculture: Interaction and site fidelity on the north-eastern coast of Sardinia (Italy). *Marine Biology*, *159*(10), 2161-2172. https://doi.org/10.1007/s00227-012-2002-x

Dinis, A., Alves, F., Nicolau, C., Ribeiro, C., Kaufmann, M., Cañadas, A., & Freitas, L. (2016). Bottlenose dolphin *Tursiops truncatus* group dynamics, site fidelity, residency and movement patterns in the Madeira Archipelago (north-east Atlantic). *African Journal of Marine Science*, *38*(2), 151-160. https://doi.org/10.2989/1814232X.2016.1167780

Dudzinski, K. (2014). Letters from the editors. *Aquatic Mammals*, *40*(1), 1-4. https://doi.org/10.1578/AM.40.1.2014.1

Escobar-Lazcano, M. J., Morteo, E., Delfín-Alfonso, C. A., Hernández-Candelario, I. C., & Abarca-Arenas, L. G. (2023). Trends and gaps in marine mammal research from Mexico during 1998-2021. *Latin American Journal of Aquatic Mammals*, *18*(1), 39-49. https://doi.org/10.5597/lajam00299

Fury, C. A., & Harrison, P. L. (2008). Abundance, site fidelity and range patterns of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in two Australian subtropical estuaries. *Marine and Freshwater Research*, *59*, 1015-1027. https://doi.org/10.1071/MF08109

Fury, C. A., & Harrison, P. L. (2011). Seasonal variation and tidal influences on estuarine use by bottlenose dolphins (*Tursiops aduncus*). *Estuarine, Coastal and Shelf Science*, *93*(4), 389-395. https://doi.org/10.1016/j.ecss.2011.05.003

Gaspar, R. (2003). *Status of the resident bottlenose dolphin population in the Sado Estuary: Past, present and future*. University of St Andrews.

Greller, R., Mazzoil, M., Titcomb, E., Nelson, B., Paperno, R., & Markwith, S. H. (2021). Environmental drivers of habitat use by common bottlenose dolphins (*Tursiops truncatus*) in the Indian River Lagoon, Florida, USA.

Marine Mammal Science, *37*(2), 512-532. https://doi.org/10.1111/mms.12767

Huesca-Domínguez, I., Morteo, E., Hernández-Candelario, I., Delfín-Alfonso, C. A., Abarca-Arenas, L. G., Marmontel, M., & Palacios, D. M. (2023). Two decades of the *Latin American Journal of Aquatic Mammals* (LAJAM): A bibliometric review for the period 2002–2022. *Latin American Journal of Aquatic Mammals*, *18*(1), 5-20. https://doi.org/10.5597/lajam00294

Hunt, T., Bejder, L., Allen, S., Rankin, R., Hanf, D., & Parra, G. (2017). Demographic characteristics of Australian humpback dolphins reveal important habitat toward the southwestern limit of their range. *Endangered Species Research*, *32*, 71-88. https://doi.org/10.3354/esr00784

Kaschner, K., Quick, N. J., Jewell, R., Williams, R., & Harris, C. M. (2012). Global coverage of cetacean line-transect surveys: Status quo, data gaps and future challenges. *PLOS ONE*, *7*(9), e44075. https://doi.org/10.1371/journal.pone.0044075

Keith, M., Peddemors, V. M., Bester, M. N., & Ferguson, J. W. H. (2002). Population characteristics of Indo-Pacific humpback dolphins at Richards Bay, South Africa: Implications for incidental capture in shark nets. *South African Journal of Wildlife Research*, *32*(2), 153-162.

Kershaw, J. L., & Hall, A. J. (2019). Mercury in cetaceans: Exposure, bioaccumulation and toxicity. *Science of the Total Environment*, *694*, 133683. https://doi.org/10.1016/j.scitotenv.2019.133683

Koelsh, J. K. (1997). *The seasonal occurrence and ecology of Florida manatees (*Trichechus manatus latirostris*) in coastal waters near Sarasota, Florida* (Ph.D. dissertation). University of South Florida, Tampa.

Levine, N. (2002). CrimeStat II*: A spatial statistics program for the analysis of crime incident locations*. Ned Levine and Associates and the National Institute of Justice.

Litz, J. A., Hughes, C. R., Garrison, L. P., Fieber, L. A., & Rosel, P. E. (2012). Genetic structure of common bottlenose dolphins (*Tursiops truncatus*) inhabiting adjacent south Florida estuaries – Biscayne Bay and Florida Bay. *The Journal of Cetacean Research and Management*, *12*(1), 107-117. https://doi.org/10.47536/jcrm.v12i1.597

Lusseau, D., Schneider, K., Boisseau, O. J., Haase, P., Slooten, E., & Dawson, S. M. (2003). The bottlenose dolphin community of Doubtful Sound features a large proportion of long-lasting associations. *Behavioral Ecology and Sociobiology*, *54*(4), 396-405. https://doi.org/10.1007/s00265-003-0651-y

Martin, A. R., & da Silva, V. M. F. (2004). Number, seasonal movements, and residency characteristics of river dolphins in an Amazonian floodplain lake system. *Canadian Journal of Zoology*, *82*(8), 1307-1315. https://doi.org/10.1139/z04-109

Mayr, E. (1963). *Animal species and evolution*. Belknap Press of Harvard University Press. https://doi.org/10.4159/harvard.9780674865327

Möller, L. M., Allen, S. J., & Harcourt, R. G. (2002). Group characteristics, site fidelity and seasonal abundance of bottlenosed dolphins (*Tursiops aduncus*) in Jervis Bay and Port Stephens, south-eastern Australia. *Australian Mammalogy*, *24*, 11-21. https://doi.org/10.1071/AM02011

Moriarty, P. E., Hodgson, E. E., Froehlich, H. E., Hennessey, S. M., Marshall, K. N., Oken, K. L., Siple, M. C., Ko, S., Koehn, L. E., Pierce, B. D., & Stawitz, C. C. (2018). The need for validation of ecological indices. *Ecological Indicators*, *84*, 546-552. https://doi.org/10.1016/j.ecolind.2017.09.028

Morteo, E., Rocha-Olivares, A., & Abarca-Arenas, L. G. (2014). Sexual segregation of coastal bottlenose dolphins (*Tursiops truncatus*) in the southwestern Gulf of Mexico. *Aquatic Mammals*, *40*(4), 375-385. https://doi.org/10.1578/AM.40.4.2014.375

Morteo, E., Rocha-Olivares, A., & Abarca-Arenas, L. G. (2017). Abundance, residency, and potential hazards for coastal bottlenose dolphins (*Tursiops truncatus*) off a productive lagoon in the Gulf of Mexico. *Aquatic Mammals*, *43*(3), 308-319. https://doi.org/10.1578/AM.43.3.2017.308

Morteo, E., Rocha-Olivares, A., & Morteo, R. (2012). Sensitivity analysis of residency and site fidelity estimations to variations in sampling effort and individual catchability. *Revista Mexicana de Biodiversidad*, *83*(2), 487-495. https://doi.org/10.22201/ib.20078706e.2012.2.972

Mullin, K. D., McDonald, T., Wells, R. S., Balmer, B. C., Speakman, T., Sinclair, C., Zolman, E. S., Hornsby, F., McBride, S. M., Wilkinson, K. A., & Schwacke, L. H. (2017). Density, abundance, survival, and ranging patterns of common bottlenose dolphins (*Tursiops truncatus*) in Mississippi Sound following the *Deepwater Horizon* oil spill. *PLOS ONE*, *12*(10), e0186265. https://doi.org/10.1371/journal.pone.0186265

Palacios, D. M., Martins, C. C. A., & Olavarría, C. (2011). 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*(2), 42-64. https://doi.org/10.5597/lajam00174

Parra, G. J., & Cagnazzi, D. (2016). Conservation status of the Australian humpback dolphin (*Sousa sahulensis*) using the IUCN Red List criteria. In T. A. Jefferson & B. E. Curry (Eds.), *Advances in marine biology* (Vol. 73, pp. 157-192). Elsevier. https://doi.org/10.1016/bs.amb.2015.07.006

Parra, G. J., Corkeron, P. J., & Marsh, H. (2006). Population sizes, site fidelity and residency patterns of Australian snubfin and Indo-Pacific humpback dolphins: Implications for conservation. *Biological Conservation*, *129*(2), 167-180. https://doi.org/10.1016/j.biocon.2005.10.031

Pradel, R., Hines, J. E., Lebreton, J. D., & Nichols, J. D. (1997). Capture-recapture survival models taking account of transients. *Biometrics*, *53*(1), 60-72. https://doi.org/10.2307/2533097

Quintana-Rizzo, E., & Wells, R. S. (2001). Resighting and association patterns of bottlenose dolphins (*Tursiops truncatus*) in the Cedar Keys, Florida: Insights into social organization. *Canadian Journal of Zoology*, *79*(3), 447-456. https://doi.org/10.1139/cjz-79-3-447

R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org

Reif, J., Schaefer, A., & Bossart, G. (2015). Atlantic bottlenose dolphins (*Tursiops truncatus*) as a sentinel for exposure to mercury in humans: Closing the loop. *Veterinary Sciences*, *2*(4), 407-422. https://doi.org/10.3390/vetsci2040407

Reilly, S. B., & Fiedler, P. C. (1994). Interannual variability of dolphin habitats in the eastern tropical Pacific. I, Research vessel surveys, 1986–1990. *Fishery Bulletin*, *92*, 434-450.

Righi, C. F., Blanco, G. S., & Frere, E. (2013). Abundance and spatial distribution of Commerson's dolphin (*Cephalorhynchus commersonii*) at a breeding site: Ría Deseado, Patagonia, Argentina. *Aquatic Mammals*, *39*(1), 1-9. https://doi.org/10.1578/AM.39.1.2013.1

Ronje, E., Whitehead, H., Barry, K., Piwetz, S., Struve, J., Lecours, V., Garrison, L., Wells, R. S., & Mullin, K. D. (2020). Abundance and occurrence of common bottlenose dolphins (*Tursiops truncatus*) in three estuaries of the northwestern Gulf of Mexico. *Gulf and Caribbean Research*, *31*, 18-34. https://doi.org/10.18785/gcr.3101.09

Rosel, P. E., Hansen, L., & Hohn, A. A. (2009). Restricted dispersal in a continuously distributed marine species: Common bottlenose dolphins *Tursiops truncatus* in coastal waters of the western North Atlantic. *Molecular Ecology*, *18*, 5030-5045. https://doi.org/10.1111/j.1365-294X.2009.04413.x

Rosel, P. E., Mullin, K. D., Garrison, L., Schwacke, L., Adams, J., Balmer, B., Conn, P., Conroy, M. J., Eguchi, T., Gorgone, A., Hohn, A., Mazzoil, M., Schwarz, C., Sinclair, C., Speakman, T., Urian, K., Vollmer, N., Wade, P., Wells, R., & Zolman, E. (2011). *Photo-identification capture-mark-recapture techniques for estimating abundance of bay, sound and estuary populations of bottlenose dolphins along the U.S. East Coast and Gulf of Mexico: A workshop report* (NOAA Technical Memorandum NMFS-SEFSC-621). U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Rossi-Santos, M. R., Wedekin, L. L., & Monteiro-Filho, E. L. A. (2007). Residency and site fidelity of *Sotalia guianensis* in the Caravelas River Estuary, eastern Brazil. *Journal of the Marine Biological Association of the United Kingdom*, *87*(1), 207-212. https://doi.org/10.1017/S0025315407055683

Schipper, J., Chanson, J. S., Chiozza, F., Cox, N. A., Hoffmann, M., Katariya, V., Lamoreux, J., Rodrigues, A. S. L., Stuart, S. N., Temple, H. J., Baillie, J., Boitani, L., Lacher, T. E., Jr., Mittermeier, R. A., Smith, A. T., Absolon, D., Aguiar, J. M., Amori, G., Bakkour, N., Baldi, R., . . . Young, B. E. (2008). The status of the world's land and marine mammals: Diversity, threat, and knowledge. *Science*, *322*(5899), 225-230. https://doi.org/10.1126/science.1165115

Silva, M. A., Prieto, R., Magalhães, S., Seabra, M. I., Santos, R. S., & Hammond, P. S. (2008). Ranging patterns of bottlenose dolphins living in oceanic waters: Implications for population structure. *Marine Biology*, *156*, 179-192. https://doi.org/10.1007/s00227-008-1075-z

Simões-Lopes, P. C., & Fabian, M. E. (1999). Residency patterns and site fidelity in bottlenose dolphins, *Tursiops truncatus* (Montagu) (Cetacea, Delphinidae) off southern Brazil. *Revista Brasileira de Zoologia*, *16*(4), 1017-1024. https://doi.org/10.1590/S0101-81751999000400012

Simpfendorfer, C. A., Yeiser, B. G., Wiley, T. R., Poulakis, G. R., Stevens, P. W., & Heupel, M. R. (2011). Environmental influences on the spatial ecology of juvenile smalltooth sawfish (*Pristis pectinata*): Results from acoustic monitoring. *PLOS ONE*, *6*(2), e16918. https://doi.org/10.1371/journal.pone.0016918

Sprogis, K. R., Christiansen, F., Wandres, M., & Bejder, L. (2018). El Niño Southern Oscillation influences the abundance and movements of a marine top predator in coastal waters. *Global Change Biology*, *24*(3), 1085-1096. https://doi.org/10.1111/gcb.13892

Srinivasan, M. (2018). Marine mammal science without borders. *Aquatic Mammals*, *44*(6), 736-744. https://doi.org/10.1578/AM.44.6.2018.736

Switzer, P. V. (1993). Site fidelity in predictable and unpredictable habitats. *Evolutionary Ecology*, *7*(6), 533-555. https://doi.org/10.1007/BF01237820

Szteren, D., & Lercari, D. (2022). Marine mammal research in South America: 30 years of publication efforts and collaborative networks. *Latin American Journal of Aquatic Research*, *50*(2), 251-266. https://doi.org/10.3856/vol50-issue2-fulltext-2810

Todd, V. L. G., Todd, I. B., Gardiner, J. C., & Morrin, E. C. N. (2015). *Marine mammal observer and passive acoustic monitoring handbook* (Vol. 24). Pelagic Publishing. www.tandfonline.com/doi/full/10.1080/09524622.2015.1079448; https://doi.org/10.1080/09524622.2015.1079448

Tschopp, A., Ferrari, M. A., Crespo, E. A., & Coscarella, M. A. (2018). Development of a site fidelity index based on population capture-recapture data. *PeerJ*, *6*, e4782. https://doi.org/10.7717/peerj.4782

Tsujimoto, K., Ohta, T., Aida, K., Tamakawa, K., & Im, M. S. (2018). Diurnal pattern of rainfall in Cambodia: Its regional characteristics and local circulation. *Progress in Earth and Planetary Science*, *5*(1), 39. https://doi.org/10.1186/s40645-018-0192-7

Tubbs, S. E., Keen, E., Jones, A. L., & Thap, R. (2020). On the distribution, behaviour and seasonal variation of Irrawaddy dolphins (*Orcaella brevirostris*) in the Kep Archipelago, Cambodia. *Raffles Bulletin of Zoology*, *68*, 137149. https://doi.org/10.26107/RBZ-2020-0015

Urbán R., J., & Rojas, B. L. (1999). Los programas de conservación de mamíferos marinos [Marine mammal conservation programs]. In H. M. C. Rodríguez & F. C. Hernández (Eds.), *Océanos ¿Fuente inagotable de recursos?* [Oceans: Inexhaustible source of resources?] (pp. 541-573). Programa Universitario del Medio Ambiente, UNAM/Semarnap.

Urian, K. W., Duffield, D. A., Read, A. J., Wells, R. S., & Shell, E. D. (1996). Seasonality of reproduction in bottlenose dolphins, *Tursiops truncatus*. *Journal of Mammalogy*, *77*(2), 394-403. https://doi.org/10.2307/1382814

van Eck, N. J., & Waltman, L. (2010). Software survey: *VOSviewer*, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523-538. https://doi.org/10.1007/s11192-009-0146-3

Van Waerebeek, K., Barnett, L., Camara, A., Cham, A., Diallo, M., Djiba, A., Jallow, A. O., Ndiaye, E., Bilal, A. S. O. O., & Bamy, I. L. (2004). Distribution, status, and biology of the Atlantic humpback dolphin, *Sousa teuszii* (Kükenthal, 1892). *Aquatic Mammals*, *30*(1), 56-83. https://doi.org/10.1578/AM.30.1.2004.56

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge University Press. https://doi.org/10.1017/CBO9780511815478

Wells, R. S. (2014). Social structure and life history of bottlenose dolphins near Sarasota Bay, Florida: Insights from four decades and five generations. In J. Yamagiwa & L. Karczmarski (Eds.), *Primates and cetaceans* (pp. 149-172). Springer. https://doi.org/10.1007/978-4-431-54523-1_8

Wells, R. S., & Scott, M. D. (1990). Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. *Reports of the International Whaling Commission*, *12*, 407-415.

Wells, R. S., & Scott, M. D. (2009). Common bottlenose dolphin: *Tursiops truncatus*. In W. F. Perrin, B. Würsig, & J. G. M. Thewissen (Eds.), *Encyclopedia of marine mammals* (2nd ed., pp. 249-255). Academic Press. https://doi.org/10.1016/B978-0-12-373553-9.00062-6

Wells, R. S., Rhinehart, H. L., Hansen, L. J., Sweeney, J. C., Townsend, F. I., Stone, R., Casper, D. R., Scott, M. D., Hohn, A. A., & Rowles, T. K. (2004). Bottlenose dolphins as marine ecosystem sentinels: Developing a health monitoring system. *EcoHealth*, *1*(3), 246-254. https://doi.org/10.1007/s10393-004-0094-6

Whitehead, H. (2001). Analysis of animal movement using opportunistic individual identifications: Application to sperm whales. *Ecology*, *82*(5), 1417-1432. https://doi.org/10.1890/0012-9658(2001)082[1417:AOAMUO]2.0.CO;2

Zanardo, N., Parra, G. J., & Möller, L. M. (2016). Site fidelity, residency, and abundance of bottlenose dolphins (*Tursiops* sp.) in Adelaide's coastal waters, South Australia. *Marine Mammal Science*, *32*(4), 1381-1401. https://doi.org/10.1111/mms.12335

Zhang, Y., Li, T., Wang, B., & Wu, G. (2002). Onset of the summer monsoon over the Indochina Peninsula: Climatology and interannual variations. *Journal of Climate*, *15*(22), 3206-3221. https://doi.org/10.1175/1520-0442(2002)015<3206:OOTSMO>2.0.CO;2

Zolman, E. S. (2002). Residency patterns of bottlenose dolphins (*Tursiops truncatus*) in the Stono River Estuary, Charleston County, South Carolina, U.S.A. *Marine Mammal Science*, *18*(4), 879-892. https://doi.org/10.1111/j.1748-7692.2002.tb01079.x