

Assessing Skin Lesion Progression and Resolution in Bottlenose Dolphins (*Tursiops truncatus*)

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INTRODUCTION

Human activities impact the health of cetaceans that reside in coastal waters. Fluctuations in water quality, salinity, and temperature, as well as disturbance and pollution can increase stress [1], suppress immune system function [2,3,4], and promote disease [5] in marine mammals. However, these effects on marine mammal health can be difficult to monitor, because typical methods of assessing and monitoring levels of disease in wild mammals are not applicable to wild cetaceans.

Skin lesions in wild cetacean populations are often indicative of infectious disease or the effect of poor environmental conditions [6,7]. As with other cetaceans, bottlenose dolphins do not have hair or fur obstructing skin visibility [8]. Therefore, monitoring the progression, recurrence, and resolution of skin lesions among bottlenose dolphins can be useful as a tool for general disease surveillance. Photo-identification (photo-id) data can be used to assess levels of skin disease, because it is not as invasive or expensive as other methods [9,10,11,12,13], such as capture-release health assessments. Although photo-id data is limited to photographing mainly the dorsal fin, photo-id data is more representative of the population than examining by-catch or stranding data, which can be limited by small sample sizes or compromised health of stranded individuals [13].

Skin lesions among dolphins can vary by shape, size, color, texture, and number [11,12]. Pathological analyses of cetacean skin lesions have revealed a variety of causes. Lesions are sometimes the result of traumatic scarring [14], fungi [15], or parasitic diatoms [16], but can also be caused by infectious pathogens, such as herpesvirus [17,18], poxvirus [6,19], or leishmaniasis [20,21]. As skin lesions are often symptomatic of or comorbid with infectious diseases, they can shed light on general disease levels within a population. Additionally, individuals can be recognized by the unique nicks and notches on their dorsal fins. This allows for keeping track of an individual's skin lesion progression, recurrence, and resolution [22,23] over time.

It can be difficult to ascertain the pathology of skin lesions, but assessment of lesion progression and resolution across years can indicate patterns in individual and population health. It is important to track levels of disease within cetacean populations to ensure that legislation appropriately protects wild cetaceans. Coastal cetaceans may be more likely to have disease than pelagic cetaceans, due to the heavily concentrated anthropogenic impacts closer to shore [24]. Lesion persistence across years could indicate a health deficiency in an individual, potentially the result of increased stress or a suppressed immune system due to human activity [10,25]. The objective of the present study is to characterize patterns in skin lesion progression among individuals, asking the following questions: (1) Does lesion presence in one year predict lesion presence in future years for an individual?, (2) Do lesions tend to persist across years for an individual?, and (3) Does lesion type persist across years?

METHODS

Study Area: The bottlenose dolphins in this study were sighted in North Carolina's Roanoke Sound, ranging from the northern tip of Roanoke Island south to Oregon Inlet (Figure 1). The average depth of

the water ranges from 1-4 feet, and a manmade channel 4-16 feet in depth runs through the center of the study area, frequently utilized by dolphins for traveling and feeding [26]. Salinity in the sound varies with downstream freshwater flow and ocean tides. This renders the area brackish and dissuades many large shark species from entering the area, providing a safer spot for bottlenose dolphins to reside, from late spring to early fall [27,28].



Figure 1. The study area located within Roanoke Sound.

Field Data Collection: The OBXCDR regularly conducts photo-ID surveys along a set transect route from April through October, when the bottlenose dolphins typically use the Roanoke Sound as their seasonal habitat. The present study analyzed survey data conducted from 2012 through 2016 aboard a 17' outboard vessel. Once sighted along the transect, dolphin groups were approached slowly at an angle. Standardized photo-identification techniques were used to collect photos and sighting data [29]. These measures were taken in an effort to minimize harassment and preserve the dolphins' natural behavior, in accordance with NMFS General Authorization Permits LOC-13416 and LOC-17988 awarded to J. Taylor.

Data recorded included: time and GPS coordinates for the start and end of each sighting, group size estimates, observed behaviors, the presence of skin disorder and xenobalanus barnacles, and environmental conditions (water and air temperatures, wind speed, salinity, visibility, sightability, and cloud cover).

Data Processing: Photographs and sighting data were processed and analyzed using FinBase [30]. Each photo was cropped to best show the dorsal fin of each individual, then cropped photos were sorted by each unique dorsal fin. Photos were then graded for quality based on focus, color contrast, angle of the dorsal fin to the camera, amount of dorsal fin visible, and distance from the camera. The

distinctiveness of each dorsal fin was also rated [31]. Poor quality images and indistinct fins were excluded from further analysis. Next, previously sighted dorsal fins were matched to individuals in the OBXCDR catalog and new fins were registered in the database. Both sorting and matching steps were verified by a second researcher.

Original sighting photographs of each individual were then screened for lesions, classified as: Black, Dark-Fringed, Pale, Spotted, Vesicular, White-Fringed, or Other. These lesion classifications are based on the skin lesion identifications set forth by Hart et al. [13].

Data Analysis: The sample of dolphins analyzed in the present study includes individuals that were sighted in multiple years between 2012 and 2016 and had lesions present in at least one year. Microsoft Excel was used to sort through the individuals and analyze presence, absence, and type of lesions present in each year.

The individuals that were found to present lesions in multiple years were assessed to determine whether lesions were present in consecutive or nonconsecutive years. An individual was found to have “consecutive” years of lesions if it had at least two sequential sighting years in which lesions were present.

RESULTS

Of the 47 individuals in this study, 53.2% (n=25) of these individuals were found to present lesions in only one year, whereas 46.8% (n=22) of these individuals were found to present lesions in more than one year.

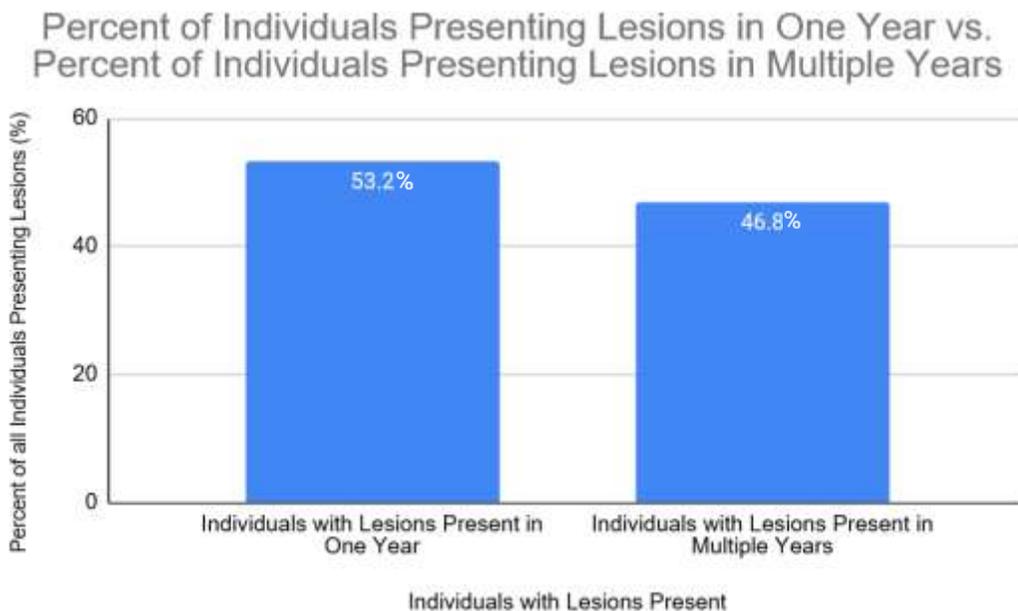


Figure 2. Percentage of individuals presenting lesions in one year compared to percentage of individuals presenting lesions in multiple years. 53.2% of individuals presented lesions in only one year of the years in which they were sighted. 46.8% of individuals presented lesions in multiple sighting years.

Upon examining the 22 individuals that presented lesions in more than one year, 68% (n=15) presented lesions in consecutive years.

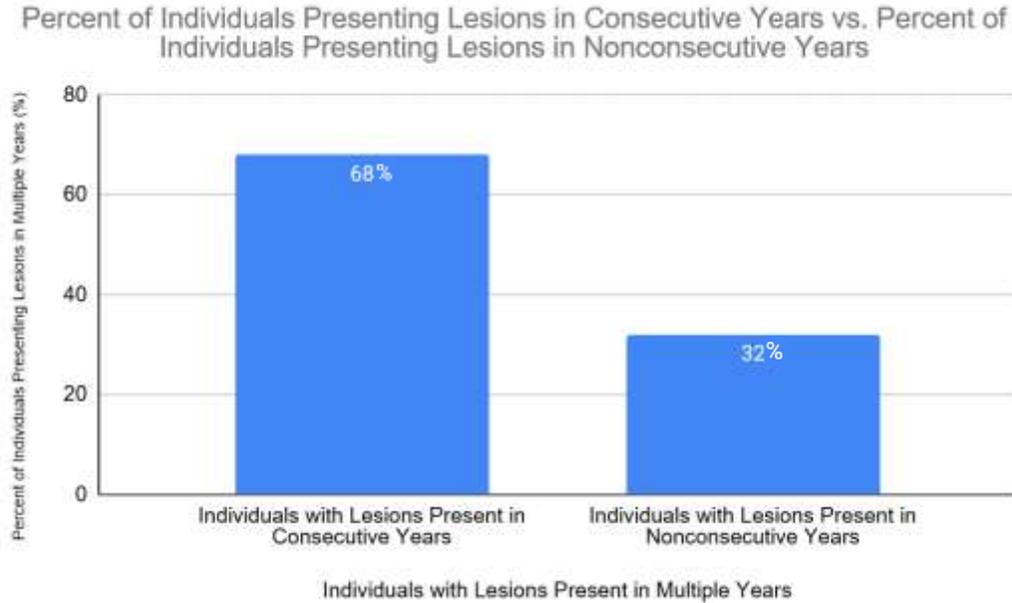


Figure 3. Percentage of individuals presenting lesions in consecutive years compared to percentage of individuals presenting lesions in nonconsecutive years. 68% of individuals presented lesions in consecutive years. 32% of individuals presented lesions in nonconsecutive years.

Of these same 22 individuals, 45.5% (n=10) had consecutive sighting years with recurrent lesion type. Several individuals present lesions that appear to have persisted or resolved over several years' time.



Figure 4. The dolphin named “Fatlip” (ID 315) presents lesions in color-corresponding spots on 30 September 2011 and 13 August 2014.



Figure 5. The dolphin named “Dallas” (ID 1155) presents lesions in different shapes and positions on 8 June 2014 and 28 May 2016.

DISCUSSION

The long-term component of the present study is important because of its unique ability to examine lesion progression across years. The study found that lesion presence in one year does not appear to predict lesion presence in future years, although further analyses are needed to confirm this trend. For the individuals with lesions present in more than one year, it would be interesting in future studies to note if they frequent colder or lower salinity areas more than dolphins with fewer occurrences of skin lesions. This could indicate that their prolonged exposure to those adverse environments either does not allow them to heal completely from year to year or has impacted their immune systems in such a way that they do not heal as quickly, as suggested in other studies [6,7].

Lesions tend to persist across years for an individual. 68% of individuals with lesions in multiple years were found to have lesions in consecutive years. This could mean that lesions can linger and worsen for years or that individuals with lesions are more susceptible to other diseases that also manifest on the epidermis. Future studies could focus on the amount of body coverage of lesions from year to year. This would help control for individuals that present an extraordinarily large amount of lesions, in comparison to individuals with only one or two small lesions.

Individuals with lesions in multiple years are not more likely to have the same type of lesion in those consecutive years. This could be a result of the changing appearance of lesions, which can grow in size or change in shape and color, appearing to be a different lesion type, when it could in fact be just an earlier or later stage of healing/progression. Although some skin lesions are better documented, such as lacaziosis lesions [23] and tattoo skin lesions [11,12,22], further research should be conducted on the changing appearance of other lesions over time. Individuals with more easily visible lesions—particularly lesions present on the dorsal fin—such as Fatlip and Dallas, who were examined in this study, should continue to be monitored and their skin lesions analyzed for signs of lesion progression

and resolution. Additionally, a larger sample size is needed for elucidating finer patterns in lesion progression.

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