ASSOCIATION PATTERNS OF COMMON BOTTLENOSE DOLPHINS (*Tursiops truncatus*) IN THE GALVESTON SHIP CHANNEL, TEXAS

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Association Patterns of Common Bottlenose Dolphins (*Tursiops truncatus*) in the Galveston Ship Channel, Texas. (May 2013)

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Dolphins in many parts of the world follow fishing boats to eat fish and invertebrates stirred into the water column by them, and so do the dolphins that frequent Galveston Bay and the Galveston Ship Channel. These individuals are frequently seen following shrimp trawling boats. The purpose of the study was to analyze occurrence patterns, site fidelity, and association patterns of bottlenose dolphins (*T. truncatus*) in the Galveston Ship Channel between September 2013 and March 2014. Patterns of dolphins not following shrimp trawlers were compared to those that follow the trawlers. Photo-identification was used to identify individual dolphins. The survey area was about 180,900 square meters of the western side of the ship channel, in front of the Texas A&M University at Galveston boat basin (29°18'45.84"N, and 94°49'1.42"W). Results show that while most individuals were seen only once, some dolphins returned regularly to the ship channel. More dolphins occurred in the fall and early winter months of the study, and the most common behavior was following after shrimper vessels. There were strong preferred associations between some individuals. The photographs taken in this study contribute to the Marine Mammal Behavioral Ecology Group database for long-term analysis.

DEDICATION

To my parents, Kalin and Kandy Johnson, for always supporting my dream of studying marine mammals

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CHAPTER I

INTRODUCTION

Common bottlenose dolphins (*Tursiops truncatus*) are the most frequently studied cetacean species in the world, as their coastal lifestyle and inquisitive nature make them easily accessible to human researchers. This large dolphin gets to be about 6-8 feet long and can weigh 800 lbs. Dolphins are one of the most intelligent species in the world, and most on the gulf coast live in complex and highly fluid fission-fusion societies. Despite the large number of studies on this species, there is still much to learn about their behavior.

Galveston Island is a barrier island off the coast of Texas. The city of Galveston is home to about 47,700 people as of 2012. Galveston Bay, the main entrance to the Houston ship channel, is one of the most industrialized and polluted bays in the United States (Brager, et. al., 1994). The Galveston Ship Channel (GSC) is a 6.4 km long stretch of water that runs between Pelican Island and Galveston Island. The Port of Galveston stretches along the sides of this channel. Despite the pollution and ship traffic, the waters around Galveston Island are home to a sub-population of bottlenose dolphins that frequently enter the Galveston Bay and the GSC. Being in such close proximity to human development, dolphins in this area often interact with people in many ways. These interactions can be damaging, such as when struck by boats, neutral, or beneficial (such as stranding rescues). Movement patterns of bottlenose dolphins vary depending on the location, but studies show that food resources seem to be the one of the most important factors driving dolphin movement (Shane, et.al.). Dolphins frequently follow commercial fishing vessels, such

as shrimp trawlers, in an attempt to find an easy meal (Würsig, et. al., 1990,Fertl, 1994,Henningsen, et. al., 1992).

Since the 1970's, when photo-identification of cetaceans began, there have been several photography-based studies in the Galveston area. Photo identification of *T. truncatus* in Galveston has been conducted both from shore (Jones, 1988) and by boat, (Würsig 1994 & 2004), (Fertl, 1994, Henningsen, 1992, Bräger, 1994). The majority of photo identification in the Galveston area has been boat-based. The benefits of shore-based photo identification include the ease of gathering information, relatively small amount of equipment needed (camera, telephoto lens, and a computer are the main items needed), and the fact that the animals are not harmed or disturbed by someone taking pictures from the shore (Würsig, et. al., 1990). However, shore-based studies can limit the observer to dolphin groups that travel close enough to shore to be photographed.

At about 430m wide, the Galveston Ship Channel provides a unique opportunity to observe the behavior of dolphins from shore because the narrowness of the channel keeps the dolphins close to the observer on land, and the commercial shrimping vessels that the dolphins follow travel into and out of the ship channel on a regular basis. The dolphins stay close to shore for extended periods of time and travel east and west as they follow the boats into and out of the channel, thus enabling the observer to collect several photographs of the right and left sides of the dorsal fins if desired.

This study also describes patterns of association between individuals. Association indices were first developed as a method for the description of plant co-occurrence patterns (Bejder et. al., 1998). In the last 30 years, this method was quickly adapted to animals and then to marine mammals. When analyzing patterns of association, a pair of individuals is called a dyad and the association indices for all of the dyads in a population are calculated to find patterns of association. Most commonly used among marine mammal scientists is the half-weight index (HWI). This index has a range between 0 and 1, with 0 when two individuals are never seen together and 1 when individuals are always seen together (Bejder, et. al., 1998). There have been several studies done using boat- based photo identification in the Galveston Bay and channels, San Luis Pass, and in other parts of the Texas Gulf of Mexico coast. Most of these studies have shown fairly fluid societies, with very few strong associations (i.e. HWI above 0.5) (Bräger, 1994, Henningsen, 1992, Fertl, 1994). However, bottlenose dolphins in other parts of the world have shown a wide variety of societal structures, including fission-fusion societies, family groups, multi-family groups, and pairs of males that travel alone.

The use of photo identification to establish association patterns can greatly contribute to the understanding of cetacean social systems, including occurrence patterns, migration patterns, and site fidelity (Würsig, et. al., 1990) (Fertl, 1994) (Bräger et. al., 1994), (Jones, 1988) (Irwin et. al, 2004) (Henningsen, et. al., 1991 and 1992)(Bejder et. al., 1998). By studying the individuals that come into the ship channel and with which dolphins they are traveling, it is possible to determine if individual dolphins enter the ship channel and meet randomly, or if the same dolphins are meeting to follow the vessels and forage.

Objectives:

1) Determine seasonal occurrence patterns and site fidelity of individual bottlenose dolphins in the Galveston Ship Channel.
2) Calculate association patterns between these individuals, and compare patterns of association of all behaviors with just groups following trawling vessels.
3) Contribute to the long-term photo identification catalog curated by the Marine Mammal Behavioral Ecology Group.

Predictions and Hypotheses:

Previous studies have shown mostly fluid fission-fusion behavior of Galveston dolphins, so it was predicted that the dolphins in this study would show weak associations when traveling through the GSC. Also predicted was that there would be more encounters of the identified individuals in the fall than in the spring, supported by studies done by Würsig and Bräger in 1990-1991 (Wursig et. al, 1991).

The first null hypothesis of this study is that there is no discernable pattern to how the identified individuals return to the ship channel. The null hypothesis for the second part of the study is that there are no preferred long-term associations between resighted individuals (p-value= 0.05)

CHAPTER II

METHODS

Study Area:

Photographs were taken of bottlenose dolphins in the Galveston Ship Channel between Galveston Island and Pelican Island, Texas. Photographs were taken from the entrance to the TAMUG boat basin every time, covering an area of the channel of about 180,900 square meters. The location of the observer for all study sessions, as well as the study area, is shown in figure 1. GPS coordinates of this location are 29°18'45.84"N, and 94°49'1.42"W.

Figure 1: Map of study area

Data Collection:

Photographs were collected, weather permitting, three days per week from September 2013 to late February 2014. Each study session lasted for one hour. A Nikon D-7000 camera was used with a 400mm lens. The camera was mounted on a monopod to reduce operator shake. The data recorded by the observer included behavior, if they were following a vessel, number of groups, number of dolphins in each group, and length of sighting. Behavior classes included socializing, traveling, foraging, and boat-following.

Analysis:

Once the photographs were collected, they were sorted by quality. Only photographs with a high enough clarity to see unique dorsal fin notches were used and poor quality photographs were omitted from the study (Würsig, et. al., 1990). Quality of the picture is determined by the ability to see individual notches and scars on the dorsal fin, and any that were over or under exposed, or too grainy were discarded. Each picture was cropped to show only the dorsal fin of each animal, and sorted into files by the day they were taken. The photographs were sorted by group and then by individual and each individual received a specific number. The photographs were then matched against others within the same day, using the notches and dorsal fin shape to determine the identity of individual dolphins. Once this was complete, the individuals found in each day were matched against the individuals found in all the other days. This was accomplished using a program called DARWIN (Stanley, 1995). DARWIN is used to digitally trace and isolate the unique edge of each dorsal fin. The program then uses an algorithm to compare the distances between notches on each fin. It then matches selected fins and groups of fins against the entire database. While times vary by the size of the database, DARWIN reduces the amount of time used to match dorsal fins. Once a match was found, these matching pictures were grouped together and given a final number. Individuals seen more than once were given a name, to be used later to find association patterns. The photographs were saved to someday compare against past and future studies involving photo identification to assess long-term patterns.

To find association patterns between individuals, a compiled version of the MatLab-based program called SOCPROG (social programming) was used to find association patterns using a

Half Weight Index (HWI) (Whitehead, et. al. 2009). The HWI for each dyad is calculated using the following formula:

$$\boldsymbol{HWI = \frac{2N}{(n_1 + n_2)}}$$

Where the 2N is the total number of joint sightings scored once for each time the individuals were seen together, n_1 is the number of times the first individual was seen, and n_2 is the number of times the second individual was seen (Bräger, et. al. 1994).

SOCPROG randomly compares HWIs repeatedly thousands of times using randomly generated scenarios. Each scenario is confined to the specifications given such as group sizes and number of times each individual is photographed. The final p value given by the program determines if the animals are associating randomly, or if there are any preferred associations between two individuals.

The half weight indices of each dyad of individuals were calculated by SOCPROG, as well as mean and maximum association indices. Animals with a HWI of less than 0.5 were considered to have a weak association index and are called acquaintances. HWI of greater than 0.5 shows a strong association index, or a strong preference for those individuals to be seen together, and are therefore called preferred associates. A HWI that is negative means that the individuals are avoiding each other (Bräger, et. al. 1994) (Bejder et. al., 1998).

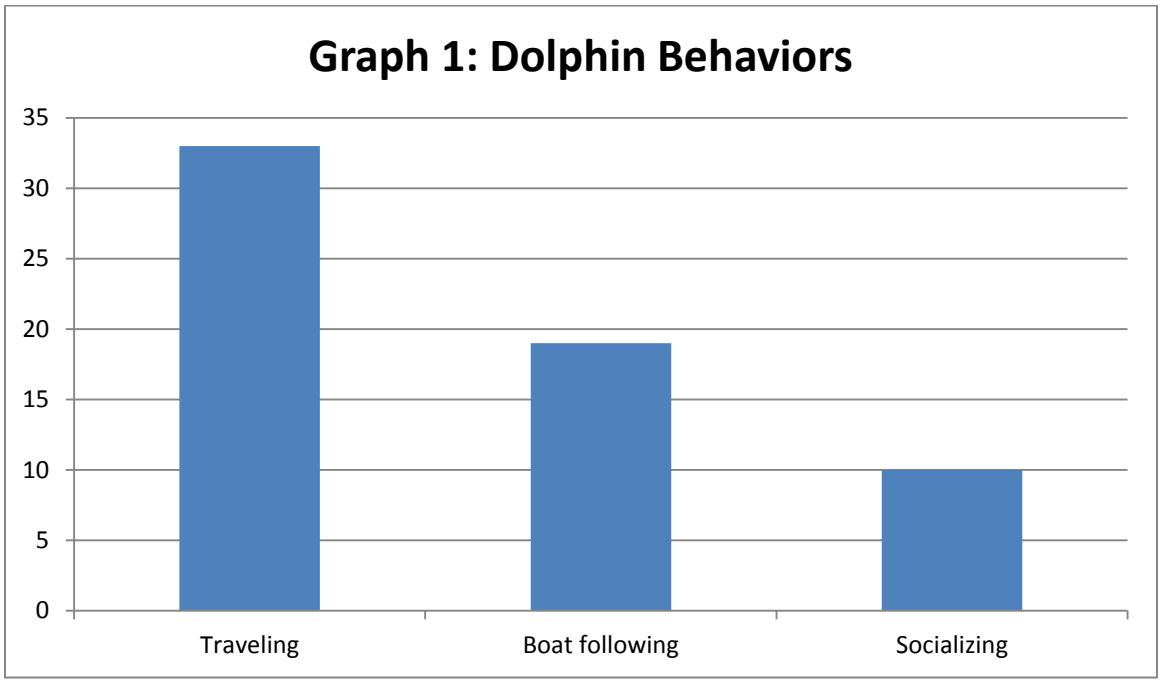
CHAPTER III

RESULTS

Behavior:

Traveling and following vessels were most common, but behaviors such as socializing, feeding, and mating also occurred. Encounters lasted anywhere from a few seconds to 45 minutes. A total of 62 groups were encountered, with 33 traveling, 19 following boats, and 10 socializing.

Graph 1: Dolphin Behaviors



Occurrence Patterns:

Of the 43 1 hour-long observation periods, dolphins were sighted in 30 of them. In total, 81 individual dolphins were identified using photo identification. 21 dolphins were seen more than once. The average group size was 3.65, with the largest group having 10 animals and the

smallest being just 1. The most commonly seen individual was individual number 04, given the name Kacey. She was seen a total of 11 times in the months of October through December, and her gender was determined by the small calf always following her. 5 other individuals were sighted more than 4 times. The dates these 6 individuals were seen are shown in table 1.

Table 1: 6 Most commonly sighted individuals and the dates they were sighted

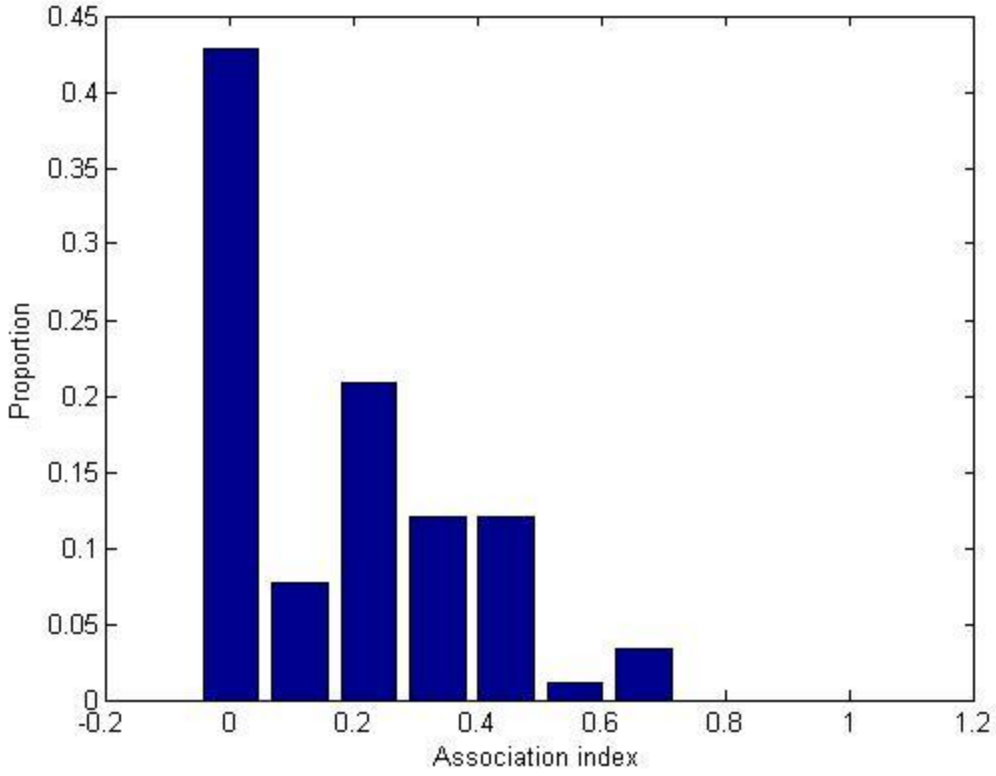
Name	9/12	9/23	10/1	10/2	10/3	10/11	10/14	10/15	10/21	10/22	10/26
Aggie											
Kacey											
Notch											
Riley											
Sammy Ray											
Scout											

Name	10/29	11/2	11/4	11/8	11/14	11/18	11/19	12/5	12/16	12/17	12/19	1/22
Aggie												
Kacey												
Notch												
Riley												
Sammy Ray												
Scout												

Figure 2: Dorsal fins of dolphins seen more than 4 times

Association Patterns:

As shown in figure 3, most dolphins sighted more than once had an association index of zero, meaning they were not seen in the same groups as the other dolphins that were seen more than twice. However, there were some preferred long-term associations. Upon two-sided testing for preferred or avoided associations (11,000 permutations, Sig, value= 0.05), the p-value was 0.001. The strongest association had a HWI of 0.67. The average HWI was 0.178, with a standard deviation of 0.1.



Graph 2: Bar graph of Association Indices

Figure 3 is a cladogram showing associations between individual dolphins. The closer the pairing (vertical line) is to the right, the stronger the association index between the two individuals.

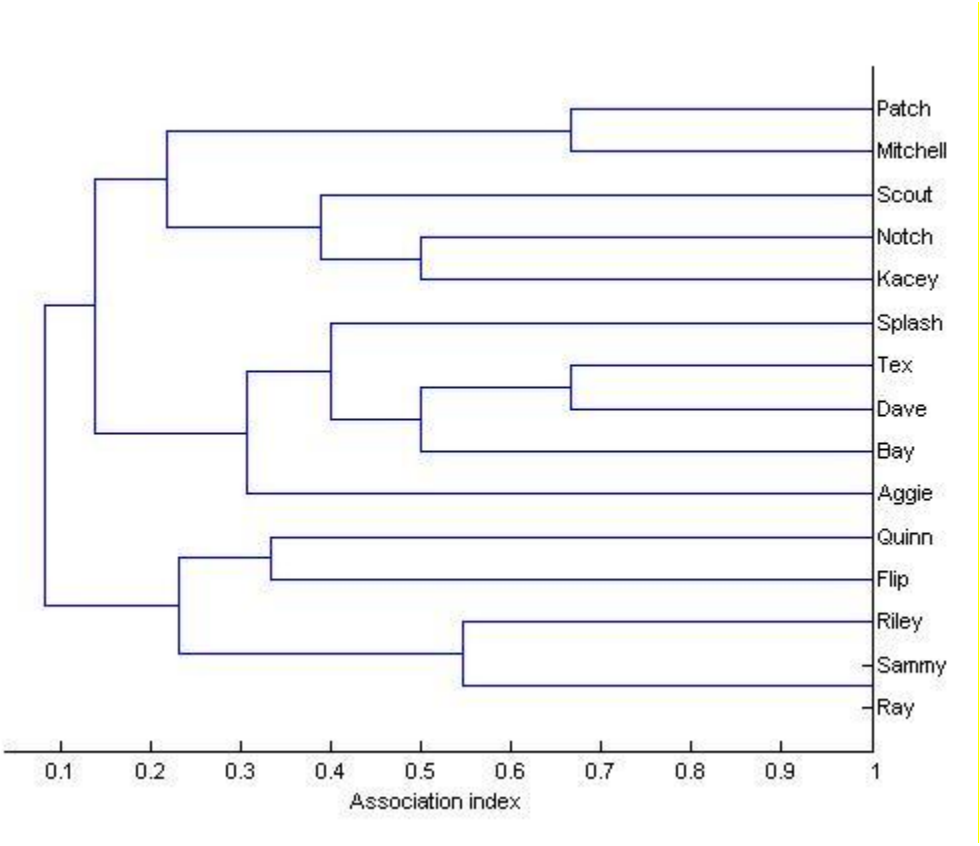


Figure 3: Cladogram showing associations between individuals

Figure 4 is a sociogram showing the 14 individuals that were resighted more than once. The lines connecting them represent their index of association. The thicker the line on this graph, the stronger the association index.

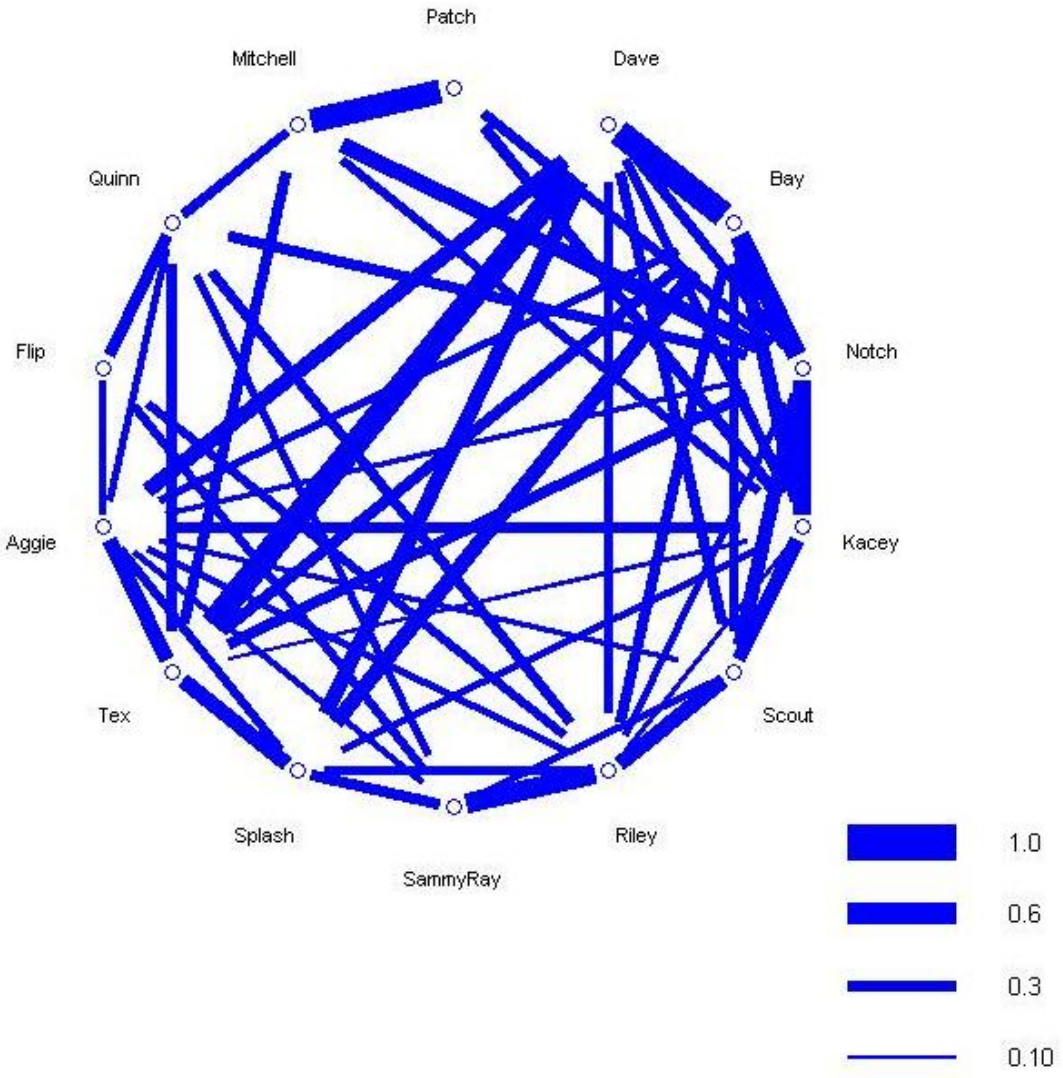


Figure 4: Sociogram showing the strength of association indices between individuals

CHAPTER IV

DISCUSSION

Behavior:

The behavior that occurred most often during this time period was traveling through the channel. The dolphins probably use the channel as a way to travel around Pelican Island and into the other side of Galveston Bay. The other most common behavior is the following of commercial shrimp fishing vessels. Dolphins were seen behind the trawl net, by gates of net, traveling right behind shrimp boat, and traveling alongside the vessel taking bycatch from the vessel's slipway. The people on these vessels did not seem at all troubled by the presence of the dolphins, but this behavior has potential risks for the dolphins including net entanglement, propeller strikes, and ingestion of hazardous materials.

Association Patterns:

Past studies of dolphins in this area have shown few or no strong associations within dyads of individuals (Bräger et. al., 1994). This study, while showing mostly very weak indexes of association, also shows three dyads with significantly strong association indexes. These dyads are Sammy Ray and Riley (HWI=0.55), Dave and Bay (HWI=0.67), and Dave and Tex (HWI=0.67). Since Dave and Bay were only identified 3 times, these could be coincidences. However, this could show true preferences by the individuals to associate within the same group. More data will be needed to support these HWIs, as the dataset and time period of this study are relatively small when compared to other studies.

Future studies should focus on collecting larger amounts of data to compare with this study. All photographs taken in this ongoing study will contribute to the growing database of the Marine Mammal Behavioral Ecology Group at Texas A&M University at Galveston. A recommendation for a future study is to look more closely at the boat following behavior. A possible future study should look at the differences in association strengths when the dolphins are following boats and when they are doing other behaviors. These shrimp fishing vessels possibly attract multiple groups with the amount of food available.

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