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The Influence of Species and Context on Human-Dolphin Interactions

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The University of Southern Mississippi

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HUMAN-DOLPHIN INTERACTIONS

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A Dissertation
Submitted to the Graduate Studies Office
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
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ABSTRACT

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Anthropogenic activities pose a threat to marine mammals around the world. Cetaceans that use coastal waters are at particular risk for potential disturbances caused by vessel traffic and human swimmers. Although many cetacean species are found near the coast of Utila, Honduras, little is known about their behavior or the effects of anthropogenic activities on their behavior. Whether the presence of boats and human swimmers led to short-term changes in dolphin behavior was investigated for three commonly sighted species of dolphins; rough-toothed (*Steno bredanensis*), spinner (*Stenalla longirostris*), and bottlenose (*Tursiops truncatus*). The dolphins' behavioral activities, with and without other boats present (in addition to the research vessel), were compared using individual behavioral events and behavior states. In addition, all occurrences of dolphin behaviors in response to human swimmers entering the water were recorded. Varying activity levels of humans in the water (e.g., floating vs. chasing) led to different responses by the dolphins. The results suggest that the behavior of the three species of dolphins differed when humans were present. Rough-toothed dolphins were the species that were most likely to encircle and orient towards human swimmers in the water. Spinner and bottlenose dolphins were likely to interact with moving boats (e.g., bowriding with the research vessel).

Some interactions between humans and dolphins seemed non-aversive (e.g., dolphins sometimes approached human swimmers).

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CHAPTER I

INTRODUCTION

It is well known that many species of marine mammals have been impacted by human activities in waters around the globe (e.g., Laist, Knowlton, Mead, Collet, & Podesta, 2001). Analyzing behavior changes are frequently used to investigate potential anthropogenic impacts on marine mammals (e.g., Lusseau, 2006). When the normal behavioral activities of an individual, a group of individuals, or a whole population have been altered or disrupted in some way, these changes may be short term or long term. Short term effects include those that take place only when human activity is present. With continued exposure to human activities, dolphins may change habitats, a long term effect. The presence of vessels and human swimmers may change dolphin behavioral repertoires, such as swimming patterns, and preferred habitats over long periods of time (Nowacek, Wells, & Solow, 2001). Anthropogenic activities have been shown to influence behavior in some dolphin species. However, there are populations of dolphins in which the individuals appear to no longer respond to human activities, including vessel traffic and human swimmers (e.g., Samuels, Bejder, & Heinrich, 2000; Samuels, Bejder, Constantine, & Heinrich, 2003). The reasons for these differential sorts of effects are unclear.

The Effect of Vessels on Dolphins

General Vessel Traffic

Dolphins have been shown to respond behaviorally to boats in various locations, particularly those that have a large volume of vessel traffic. Oceangoing vessels pose the threat of physical injury to marine mammals and boat/dolphin collisions are not uncommon. If dolphin behavior is significantly impacted by vessel traffic, there could be long term health risks, especially if foraging and resting behaviors are interrupted. For example, Courbis (2004) found that if uninterrupted by vessel traffic, spinner dolphins (*Stenella longirostris*) would typically rest in bays on average for three to four hours at a time. When vessels were present the dolphins were rested less and performed more high-energy behaviors, such as aerial displays.

A study conducted in Ensenada de La Paz, Mexico, an area with heavy boat traffic, determined that bottlenose dolphins (*Tursiops truncatus*) in this area modified their behavior due to boat presence (Acevedo, 1991). The dolphins' behavioral reaction depended on how close in proximity the boats approached the animals. When boats merely cruised by the dolphins at a distance greater than five meters, the dolphins did not exhibit any behavioral modifications. However, when a boat cruised to within five meters of the dolphins, the dolphins reacted by diving. Once the boat had passed, they resumed the previous behavioral state. Additionally, Acevedo (1991) found that dolphins changed their behavior if they were followed closely by boaters.

Additional studies of bottlenose dolphin interactions with boaters in Sarasota Bay, Florida, concluded that dolphins decreased their inter-animal distance and swam more closely together when boats were present (Nowacek, Wells, & Solow, 2001). The dolphins increased the time interval between surfacing when boats were present. The animals changed swimming direction away from the boat and increased swimming speed in response to vessels. This type of behavioral change, altering swimming direction to avoid approaching boats, was also seen in spinner dolphins

(Au & Perryman, 1982). This type of response was considered a short-term escape strategy in response to presence of boats.

Breathing patterns and surfacing behaviors in bottlenose dolphins were also shown to be altered by boat presence. In Moray Firth, NE Scotland, bottlenose dolphins decreased their breathing rate (or increased their dive time) in response to boat traffic (Janik & Thompson, 1996). These findings were similar to those of Nowacek et al. (2001). Similarly, bottlenose dolphin breathing synchrony was shown to increase in response to boat traffic in Cromarty Firth, NE Scotland (Hastie, Wilson, Tufft, & Thompson, 2003). It is possible that dolphins in Cromarty Firth perceived boats as a threat and that breathing synchrony and close spatial configurations were a type of anti-predator response to boats. Or vessel noise may have made it difficult for dolphins to communicate, and therefore, a closer inter-animal distance paired with an increase in synchrony was necessary to maintain social cohesion. Although the reasons for breathing synchrony in the presence of boats were somewhat unclear, the dolphins did show a short term behavioral response to the boats.

Similar to Hastie et al. (2003), anti-predator type responses were also found for bottlenose dolphins in reaction to boats near Choros Island, Chile (Yazdi, 2005). Boats that approached the dolphins closer than one hundred meters altered the dolphins' behavior significantly. The dolphins engaged in evasive maneuvers and increased swim speed. They were also more likely to perform leaps and tail-slaps when compared to control situations when boats were not present. This was considered a sign of possible disturbance because these behaviors were similar to techniques used to avoid predators (Yazdi, 2005). These close boat encounters (<100

M) also resulted in a decrease in the normal behavioral patterns, such as feeding, resting, and social behaviors.

Similarly, Mississippi Sound bottlenose dolphins significantly increased traveling behavior and decreased feeding behavior in response to high-speed personal watercraft (Miller, Solangi, & Kuczaj, in press). Bottlenose dolphins in the Mississippi Sound, Mississippi, did not significantly change their behavior to either approach or evade a research vessel (Bohn, Kuczaj, & Solangi, 2005), most likely due to the cautious approach made by the research vessel. However, the presence of boats other than the research vessel affected the dolphins' behavior. The most prevalent behavior when boats were present was traveling, which changed to milling behavior. Bottlenose dolphins in Jervis Bay, Australia, were also more likely to change their behavior from traveling to milling when approached by a powerboat within one hundred meters than when only a research boat was present (Lemon, Lynch, Cato, & Harcourt, 2006). The dolphins in Jervis Bay also changed their direction of travel away from an approaching boat on 75% of the approaches. Goodwin and Cotton (2004) found that bottlenose dolphins in Teignmouth Bay, United Kingdom, changed their direction of travel away from boats and/or dove in the vicinity of motor boats and jet skis, but not in response to other types of boats. The negative responses (move away, change direction, and dive) were more frequent for moving boats rather than for stationary boats, possibly due to the noise generated during motion. Similarly, in a comparison of the responses made to power boats versus kayaks, Lusseau (2006) found that bottlenose dolphins were more likely to dive deeper and vertically to avoid power boats, suggesting that vessel noise, as well as vessel speed, was an important factor. Conversely, bottlenose dolphins in Cardigan Bay, West Wales, did not show any signs of behavioral changes in response to motorized vessels (Gregory & Rowden, 2001). However, they did display negative responses to kayaks and other non-motorized vessels, perhaps because they could not hear them coming from further distances. The response of dolphins to boats off Hilton Head, South Carolina, also varied depending on the boat type (Mattson, Thomas, & St. Aubin, 2005). However, shrimp boats were the most likely to elicit changes in behavior, followed by jet skis and motor boats.

In addition to vessel traffic affecting dolphin behavior, harassment by pleasure boaters was documented near the Island of Ischia, Central Mediterranean Sea (Miragliuolo, Mussi, & Bearzi, 2001). Several pleasure crafts "penned" a group of Risso's dolphins (*Grampus griseus*) into a shallow coastal enclosure where many boats were anchored. The boaters then harassed the dolphins by heading towards them at high speeds. The dolphins reacted by swimming erratically, increasing the rate of breathing, swimming in circles, and colliding with one another.

In addition to the short term behavioral responses, several studies have investigated possible long-term effects of vessel traffic on dolphins. Allen and Read (2000) found a shift in habitat preference in a population of bottlenose dolphins in Clearwater, Florida when there were high levels of boat traffic, such as on the weekends. Similarly, Bejder, Samuels, Whitehead, and Gales (2006) found that bottlenose dolphins in Shark Bay, Australia shifted habitats as a form of avoidance. There was a significant decline in population abundance in areas of high vessel traffic. Gannier and Petiau (2006) also found a greater boat disturbance on spinner dolphin habitat usage for weekend days in the Baie des Pecheurs, Tahiti. Boat presence was thought to dissuade spinner dolphins from going into the bay to rest. The presence of boats has also been found to affect the behavior of populations of bottlenose dolphins in Milford Sound, New Zealand. Bottlenose dolphins were found to avoid areas with heavy boat traffic during the season when the amount of boat traffic was the highest (Lusseau, 2005). When comparing experimental vessel approaches to groups of bottlenose dolphins that had exposure to high vessel traffic and those that had not, the dolphins showed a greater disturbance in the sites that did not have a high level of traffic (Bejder, et al., 2006). Dolphins in areas with low levels of boat traffic may be more sensitive to disturbances because they have not habituated to boat traffic.

Commercial Tourist Vessel Traffic

Marine mammal-watching tourism has increased world-wide in recent years (e.g., Lusseau, 2004). Several studies have investigated the effects of dolphin watching tour boats on wild dolphin behavior. In both Doubtful and Milford Sounds, New Zealand, bottlenose dolphins spent significantly less time resting and socializing when tour boats were present (Lusseau, 2004). Increased diving duration, a possible anti-predatory response, was observed in bottlenose dolphins in response to tour boats in Doubtful Sound, New Zealand (Lusseau, 2003a). The predictability of the times and routes of tour boat operations seemed to be a key factor in explaining avoidance tactics. The boat "behavior" could be used to predict diving patterns in the dolphins. Interestingly, the behavioral responses to the tour boats differed for male and female dolphins. Male dolphins avoided tour boats immediately upon arrival. Females waited until boat interactions became more intrusive and then used vertical avoidance (i.e., increased dive intervals). This sex difference may have been due to the high energetic cost of vertical avoidance on females. Females typically have other energetic demands, such as pregnancy or dependant calves. The increase in diving intervals (i.e., vertical avoidance) could be limited if a female is accompanying a calf that cannot dive as deep or as frequently.

Constantine, Brunton, and Dennis (2004) investigated the impacts of dolphin-watching tourism on bottlenose dolphin behavior in the Bay of Islands, New Zealand. They found a reduction in resting behaviors and an increase in milling behaviors due to the tour boat activities. Stensland and Berggen (2007) reported similar reductions in Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) resting behavior in Zanzibar. When more tourist boats were present the dolphins increased the amount of time spent traveling and decreased the amount of time spent resting, socializing, and foraging. Foraging and resting behaviors in common dolphins (*Delphinus* spp.) were also disrupted by tour boats in New Zealand (Stockin, Lusseau, Bindell, & Orams, in press).

Killer whales (*Orcinus orca*) in Johnstone Strait, British Columbia, Canada switched their activity states when vessels were present (Williams, Lusseau, & Hammond, 2006). When boats were present the whales spent less time rubbing on pebble beaches and feeding and increased the time spent traveling or resting. This resulted in a decrease in overall feeding opportunities, which may have long term energetic costs to this population of whales.

The long term effect of dolphin-watching tourism in New Zealand has lead to groups of dolphins actively avoiding certain areas of the fjords (Lusseau, 2004). Determining the long-term effects of human activities such as tour operations on dolphin populations is important from an environmental management standpoint. Behavioral changes that appear to be long term, such as area avoidance, may indicate a need to delineate critical habitats for some species of dolphins (Lusseau & Higham, 2004).

In addition to behavioral responses, vocalization rates have also been influenced by tour-boat traffic. Bottlenose dolphin sound production has been demonstrated to change depending on the presence or absence of dolphin-swim tour boat operations (Scarpaci, Bigger, Corkeron, & Nugegoda, 2000). Bottlenose dolphins increased whistle production during traveling, feeding, and socializing behaviors when dolphin–swim tour boats were present. This increase could have been due to physical separations caused by the boat itself or due to the excitement/stress caused by the tour boat.

In some cases, dolphins may have a neutral or positive response to tour boats. Rough-toothed dolphins (*Steno bredanensis*) off of La Gomera, Canary Islands were observed engaging in many boat related behaviors (Ritter, 2002). The boat related behaviors that were observed when a whale-watching boat was present included approaching, scouting, bowriding, wake riding, spy hopping, orienting towards the boat, accommodation of speed, and accommodation of direction (see Table 1).

Table 1.

Definitions of Boat Related Behaviors Shown by Cetaceans off La Gomera (see Ritter 2002)

Behavior	Definition
Approach	Reduction of the distance between animals and boat, the latter maintaing a constant direction or being motionless.
Scouting	Breif approch toward the boat up to a few metres and then moving away.
Bowriding/Wakeriding	Swimming in the pressure wave in front of the boat. Swimming in the wake produced by (and behind) the boat.
Spyhop	Lifting the eyes above water while in an upright position.
Orientation Towrds the Boat	Floating or swimming very slowly at the surface, turning the head towards the boat.
Accomodation of Speed	Changes in the speed of animal(s) in accordance to changes in boat speed.
Accommodation of Direction	Changes of direction of animal(s) in accordance to changes in boat direction, while animal(s) were close to the boat.

For the majority of the study period the dolphins had no response to the boat. However, the most frequent boat related activities observed were approaching, bowriding, and scouting, in that order. During the approaches dolphins also acoustically investigated a hydrophone at the stern of the boat. Scouting, a brief approach within a few meters prior to moving away again, was more likely to be performed by juveniles or calves rather than adults. Kuczaj and Yeater (2007) also observed rough-toothed dolphins expressing an interest in a research vessel, other boats, and swimmers by approaching them. Similar to Ritter (2002), Kuczaj and Yeater (2007) found on separate occasions the dolphins examined a hydrophone and slow moving propeller. Interactive behaviors, such as scouting, approaching, orienting towards the boat, and accommodation of speed and direction, were also seen in dense beaked whales (*Mesoplpdon densirostris*) (Ritter & Brederlau, 1999). Approaching the boat was the most frequently observed of these behaviors.

Thus far, studies that have investigated the effect of vessels on dolphin behavior have demonstrated the need to more closely examine the responses by various species. The conflicting findings in the literature indicted that there were a wide variety of responses for all cetaceans exposed to vessel traffic. It remains a possibility that there are differences within the species, population, group, and even individual level. Although, there were similarities between several studies (i.e., Au & Perryman, 1982; Janik & Thompson, 1996; Lemon, et al., 2006; Nowacek, et al., 2001), each species, or group of dolphins may respond to boat traffic differently.

The Effect of Swimmers on Dolphins

The majority of cetacean-watching tourism is boat-based and does not involve swimmers entering the water (Hoyt, 2001). There is continued disagreement with wildlife managers (conservationists), tour operators, and scientists as to whether impacts of swim-with-dolphin activities are harmful, beneficial, or neutral to the targeted dolphins (Samuels & Bejder, 2004). Some advocates believe that the animals have a choice as to whether or not they will interact with human swimmers. Cases of solitary social animals have shown that some dolphins actually redirected their social behaviors towards and regularly approached humans (Wilke, Bossley, & Doak, 2005).

A study conducted in Porpoise Bay, New Zealand found that most (57%) swim-with-dolphin encounters did not disturb Hector's dolphins (*Cephalorhynchus hectori*) (Bejder, Dawson, & Harraway, 1999). The change in behavioral state from dispersed to tight, or vice versa, was investigated to assess potential impacts from human activities. Pods of Hector's dolphins remained in tight formations and did not disperse for the majority of the observations. Ritter (2002) and Mayr and Ritter (2005) also found that rough-toothed dolphins frequently swam in tight spatial configurations when a boat or swimmers were present. Ritter (2002) believed this behavior strengthened social bonds between the group members. Kuczaj and Yeater (2007) similarly found that synchronous behaviours and "tight" groupings were common for rough-toothed dolphins off Utila, Honduras during boat encounters and also assumed that this was important for social cohesion. However, tightening of groups might also be a reaction to a surprise, threat or danger and may allow interactions with boats and swimmers to be less stressful to an individual dolphin (Bejder et al., 1999).

There may be risks to both the dolphins and the humans during in-water encounters. Dolphins frequently targeted for swim-with encounters have behaved aggressively towards humans (Constantine, 1999). Near Panama City Beach, Florida, chronic interactions between humans and dolphins have impacted some of the dolphins that have been conditioned to interact with humans by means of provisioning the animals (Samuels & Bejder, 2004). The conditioned animals stayed within the same area and interacted with humans frequently. The only instances of traveling behavior that were observed for conditioned animals were between vessels. The non-provisioned dolphins had a much greater range of travel and did not interact with humans.

Constantine (2001) found that not all dolphins in a group interacted with human swimmers. The bottlenose dolphins in the Bay of Islands, New Zealand, that did not interact with humans remained as a group and swam away from the dolphins that were interacting with swimmers. Once the two groups were separated by about one hundred meters, the interacting dolphins would terminate the interaction with swimmers and then rejoin the group. Constantine (2001) also discovered that juveniles were significantly more likely to interact with swimmers than were adults. The juveniles swam in circles around the swimmers, emitted whistles, and performed other behaviors that were interpreted as play. Then the juveniles would terminate the interaction and return to the rest of the group on their own accord. It was suggested that experiences with human swimmers by juvenile dolphins would make the dolphins more tolerant of humans as the dolphins matured.

Constantine and Baker (1997) and Constantine (1999, 2001), studied the effects of swimmer placement on bottlenose dolphin behavior in the Bay of Islands, New Zealand. Different strategies for swimmer placement in the water near dolphins affected the animals' responses. In the "line abreast" strategy the swimmers were placed to the side and slightly ahead of the dolphins' path of travel. For the "in path" strategy the humans were placed directly in the dolphins' path of travel. During the "around boat" strategy the dolphins were milling around the boat when swimmers entered the water. Both the "in path" and "around boat" strategies resulted in a significant increase in avoidance responses by the dolphins. The "line abreast" strategy resulted in a decrease in avoidance responses, but there was also a decrease in swimmer interactions with dolphins. In these cases, the dolphins initiated the interactions. So, even though there were fewer interactions, those that did occur were probably more positive for the interacting dolphins.

Constantine and Baker (1997) investigated the behavioral states before and after tour boats approached bottlenose dolphins and common dolphins (*Delphinus delphis*). The results demonstrated that bottlenose dolphin social behavior was more likely to be changed by swim-with-dolphin tour operations than was common dolphin social behavior. Bottlenose dolphins approached the boat to bow-ride more frequently than they exhibited avoidance behaviors, such as diving. Constantine and Baker also found that successful swims (e.g., where the humans interacted with dolphins) were initiated and sustained more frequently for bottlenose dolphins than for common dolphins.

Spinner dolphins are thought to use bays primarily for resting behaviors, and vessel traffic and swimmers have been shown to increase their activity while in bays in Hawaii (Norris et al., 1994). Courbis (2004) found instances of increased aerial activity by spinner dolphins in response to being followed by swimmers. The dolphins also appeared to move away from, or avoid, approaching vessels in the bays. In a similar study by Danil, Maldini, and Martin (2005), spinner dolphins reacted to human swimmers at Makua Beach, Oahu, Hawaii. Swimmers were observed following the dolphins and at times pursuing them aggressively. The presence of swimmers within one hundred meters of the dolphins adversely impacted their resting behaviors, which was evidenced by an increase in activity and avoidance behaviors.

The reactions of rough-toothed dolphins in response to human swimmers that entered the water from whale-watching boats were observed off of La Gomera, Canary Islands (Ritter, 2002). During seven of the twenty-one swim attempts the dolphins showed "little curiosity" and stayed far away from the swimmers or actively swam away. Ritter (2002) does not address whether or not these "little curiosity" behaviors were classified as avoidance or no change. "Intermediate curiosity" interactions involving scouting and approaching behaviors were observed during four swim attempts. "Sustained interactions" were seen during five swim attempts, and involved repeated approaches and scouting by dolphins, with dolphins sometimes coming as close as two meters to the humans. One swimmer/dolphin interaction lasted twelve minutes, although most were much shorter. These interactions appeared to be positive for the dolphins and indicated that the dolphins exhibited curiosity towards human swimmers. A similar interpretation to the frequent underwater approaches and encircling behaviors was found in a study of bottlenose dolphins (*Tursiops aduncus*) by Sakai, Hishii, Takeda, & Hoshima (2006). Sakai et al. referred to this as "inquiring" behavior, which also suggests curiosity about human swimmers on the dolphins' part.

There continue to be discrepancies, even within the scientific community, as to whether impacts of swim-with-dolphin activities are harmful, beneficial, or neutral to the targeted dolphins (Samuels & Bejder, 2004). Based on previous studies, there may be species and population differences in terms of dolphin responses to human swimmers. Therefore, a comparison of various species, populations, and context of the human-dolphin interactions should be investigated further.

Is the Impact Always Adverse?

Not all anthropogenic activities have adverse effects on wildlife. Behavioral alterations due to vessels or swimmer are not always averse, and in some cases anthropogenic activities with dolphins appear to be more appetitive for the dolphins. Positive or appetitive responses included approaching boats for the excitement of bow-riding. Gregory & Rowden (2001) observed bottlenose dolphins swim towards tourist boats in order to bow-ride. In the Mississippi Sound population of bottlenose dolphins, the presence of boats did not appear to affect feeding, except in the case of shrimp boats, which appeared to increase feeding behaviors (Bohn, et al., 2005). The dolphins may have learned that the shrimp boat trawls provide a possible food source. The idea that dolphins used boats as a food source and of feeding behind shrimp boats as an appetitive type of behavior, must be interpreted cautiously. A study in the Indian River Lagoon, Florida has demonstrated harmful behaviors such as begging, disease, propeller cuts, and entanglement by fishing nets/line as a consequence of bottlenose dolphins interacting with fishing vessels (Durden, 2005). These behaviors have led to both animal and human injuries and fatalities. This shows that there can be multiple outcomes of the same behaviors.

All of the boat related behaviors observed by Ritter (2002) for rough-toothed dolphins were recorded and defined to be appetitive. These included: approaching, scouting, bowriding, wake riding, spy hopping, orienting towards the boat, accommodation of speed, and accommodation of direction. Ritter (2002) acknowledged that the failure to observe any cases of avoidance during the study does not mean that avoidance did not occur, but instead simply may not have been detected for that group of animals. Nonetheless, it is possible that some species of dolphins, including rough-toothed dolphins, may not be as susceptible to the negative impacts often associated with human activities. Ritter (2002) and Kuczaj and Yeater (2007) attributed the apparent interest in humans by rough-toothed dolphins to the inherent curiosity of this species.

One hypothesis that has gained popularity is the idea that certain populations of dolphins have become habituated to human activities. Habituation is the gradual weakening of a behavior response to a recurring stimulus (Bejder & Samuels, 2003). In behaviorist terms, habituation is the decrease in the strength of the elicited behavior following repeated presentations of the eliciting stimulus (Powell, Symbaluk, & MacDonald, 2005). Samuels, et al. (2000) and Samuels, et al. (2003) categorized swimming with wild dolphin populations based on the types of dolphins involved: (1) lone sociable, (2) food provisioned, (3) habituated, or (4) not habituated. In these studies dolphins that were labeled as habituated tended to tolerate or seek human swimmers for sustained interactions on a regular basis. These categories did not include dolphins in which the added incentive of food-provisioning was present. Dolphins that took part in cooperative fishing efforts with humans were also considered to be "habituated". Although there are a few locations where dolphins appear to "chose to" interact with humans and are thought to be habituated to humans, most dolphin populations are not habituated and have shown disturbances (such as avoidance) to vessels and swimmers. Therefore, one hypothesis is that the majority of dolphin populations may show sensitization (the gradual increase in response to a stimulus) rather than habituation to human activities (e.g., Frohoff, 2000). There remains much that is unknown about most populations of wild dolphins and there is continued disagreement over the idea of wild animals actually habituating to human presence.

Part of the issue may be that humans sometimes behave inappropriately during interactions with dolphins. There is a possibility that with proper instruction to swimmers, human-dolphin interactions may become more positive for both humans and dolphins. Samuels, et al. (2003) found that human related injuries/deaths with lone solitary dolphins were often related to inappropriate human actions. For example, Dudzinski, Frohoff, and Crane (1995) found that a lone sociable dolphin responded aggressively after human swimmers grabbed or touched the animal's sensitive areas, such as the genitals and blowhole.

Samuels, et al. (2003) believed that future studies were needed to investigate in-water interactions between cetaceans and humans, including the types and frequencies of interactions. They suggested that: (1) the behavior of the same individual dolphins should be compared in the presence and absence of swimmers, (2) members of the same dolphin community that do not interact with human swimmers should be compared with those that do, and (3) a determination of the individuals, age classes, or sex classes are more likely to interact or avoid interactions is needed. In addition, it is not clear what proportion of a given dolphin population is likely to be affected by human activities.

The fact that dolphins respond to vessels and human swimmers has important consequences for conservation and management of certain populations of dolphins in locations where they are known to be exposed to chronic interactions with humans.

Continued monitoring will be essential for determining the long-term effects on various populations of wild dolphins. In conclusion, vessel traffic and human swimmers may pose a potential threat to the welfare of dolphins and may become an important conservation issue. Therefore, future impact assessments on vessels and swimmers are necessary for all species of cetaceans within varying contexts.

Present Study

There has been an increase in tourism over the last thirty years due to the pristine waters and the diversity of wildlife surrounding the island of Utila, Honduras. Currently, tourism is the main source of income for many of the residents on the island. Since the 1970's, the Bay Islands (Roatan, Guanaja, and Utila) have had an increase in the number of tourists from 1,000 visitors per year to roughly 93,000 in 1997 (Currin, 2002). Specifically, the number of hotel rooms available in Utila has increased from 5 in 1979 to 330 in 2001 (Currin, 2002). Although tourism and recreational scuba diving have increased on the island, there has been very little research conducted on the wild dolphins that live in the coastal waters. There are several populations of relatively unstudied cetaceans inhabiting the waters off of the coast of Utila, Honduras. Therefore, the present study assessed the behavior of the dolphin species that are frequently found close to shore and so are subjected to more human activities, such as boating and human swimming in the vicinity of dolphins. Although there are no commercial "dolphin watching" tours operating in Utila, dive boats often place swimmers in the water with dolphins when dolphins are encountered on dive trips.

The primary species of interest was the rough-toothed dolphin (*Steno bredanensis*). Currently, little is known about their behavior or life history in the wild. Rough-toothed dolphins are listed as data deficient by the IUCN Species Survival Commission. Rough-toothed dolphins are rarely studied due to the difficulty of sighting them in the wild. However, near Utila individual rough-toothed dolphins have been resighted and identified many times over the past several years using photo-identification techniques (Kuczaj & Yeater, 2007; Kuczaj, Yeater, & Brown, 2005). Therefore, this particular population of rough-toothed dolphins were good candidates for research on possible human impacts because they were likely to be sighted by humans. The anthropogenic influences on rough-toothed dolphins were especially important due to the fact that this species has been rarely observed.

In addition to rough-toothed dolphins, there were many other cetacean species present that may have been potentially impacted by boaters or swimmers off of Utila. These included sperm whales (*Physeter macrocephalus* – Vulnerable), short-finned pilot whales (*Globicephala macrorhynchus* – Conservation Dependent), killer whales (Conservation Dependent), spinner dolphins (Conservation Dependent), common dolphins, and bottlenose dolphins (Data Deficient). The present study focused on collecting data from rough-toothed dolphins, spinner dolphins, and bottlenose dolphins because they were the most commonly sighted species in the waters off of Utila. The study gathered information on the short-term reactions of these dolphin species to anthropogenic activities (human-dolphin interactions). This included interactions with additional boats, with swimmers, or both additional boats and swimmers.

Hypothesis

1) It was hypothesized that there would be species differences in reactions to human presence. Of these species, it was predicted that rough-toothed dolphins would engage in more investigative type of behaviors (i.e., more approaches) towards swimmers based on previous studies (e.g., Ritter, 2002; Kuczaj & Yeater, 2007). Spinner dolphins were expected to engage in less approaching behaviors directed toward human swimmers than the other two species based on pilot studies (Yeater & Kuczaj, 2005). However, spinner dolphins were predicted to have approached boats more often than the other species based on the same pilot studies.

2) The vessel speed when approaching dolphins was expected to have an effect on the dolphins' behavior. It was hypothesized that greater vessel speed would increase the amount of avoidance behaviors for all species based on previous studies (Goodwin & Cotton, 2004; Miller et al., in press; Miragliuolo et al., 2001). In addition, when swimmers were present the different types of human movements in water (i.e., chasing or floating) may have produced very different behavioral reactions in all groups of dolphins.

3) It was hypothesized that the dolphin group cohesion and spatial configuration would be influenced by anthropogenic activities. Changes in spatial configuration have been interpreted as a form of predator avoidance in previous studies (i.e., Hastie et al., 2003).

4) The age class of the dolphins was also investigated in the current study as a possible factor influencing human-dolphin interactions. Constantine (2001) found that juvenile dolphins were more likely to interact with human than were adult

dolphins. Therefore, it was predicted that juvenile dolphins in the present study would be more likely to engage in human-dolphin interactions.

5) It was predicted that when human swimmers were in the direct path of travel, chasing or grabbing at dolphins, individual dolphins behavior would differ from that of a dolphin interacting with a calm, slow swimming or floating human. This prediction was based on Lundquist's (2007) finding that Southern right whales (*Eubalaena australis*) showed a greater magnitude of response to "noisy" versus "calm" swimmers.

CHAPTER II

METHODOLOGY

Study Site

Utila is an island that lies approximately 28.9 kilometers from the Northern coast of the Honduran mainland (N 16°05'46.5", W86°55'47.8"). The island is 41 square kilometers in size and is the smallest of the Honduran Bay Islands. Visibility underwater is normally 24 to 37 meters, which provides excellent opportunities for both underwater and surface observations. Water temperatures range from 27 to 29°C for most of the year (Behrens, 2002). Coastal water depth is from 0-10 meters (close to shore) to more than 1500 meters due to nearby steep underwater drop-offs.

General Dolphin Survey Procedures

Boat-based surveys were conducted off of the coast of Utila in May 2006, September 2006, May 2007, and June 2007. Personnel on the research vessel were trained to conduct surveys and record ethogram data. Inter-rater reliability was greater than 90%, or the observer was not used for this study.

During a survey, an observer scanned the sea while looking for indications of dolphin surface activity. When dolphins were sighted, the research vessel carefully approached the dolphins in order to obtain photographs of dorsal fins and video recordings of dolphin behavior. At this time an observer began collecting the ethogram data by recording the time of day and starting a stopwatch. After approximately five minutes of baseline data collection, if conditions permitted, snorkelers were allowed to enter the water in order to obtain underwater photographs and video.

Observational Procedure

In order to assess whether the presence of boats led to short-term changes in dolphin behavior, the dolphins' behavioral activities with and without other boats (the research vessel was always present) were compared using individual behavior events and behavior state data. Behavior events were recorded using all occurrence sampling for behaviors of interest. A list of behavioral events can be found listed in Appendix B. Overall group behavior state data were collected every minute using instantaneous scan sampling (Altmann, 1974). The behavior states are defined in Appendix B. When possible, baseline behaviors were recorded before other boats approached the dolphins. Data were collected for before, during, and after human-dolphin interactions. The "before" time period included data that were collected when the research vessel was the only anthropogenic activity present. The "during" time period data included observations made when additional vessels (i.e., dive boats) were present and/or human swimmers were in the water. The "after" time period was defined as the when the research vessel was the only vessel in the vicinity of the dolphins after the other vessels had left the vicinity and/or the human swimmers were removed from the water.

Vessel approaches to the dolphins were categorized as slow, average, or fast in terms of vessel speed. A slow approach was defined as 0-10 mph. An average speed was defined as 10-20 mph (which is a typical bowriding speed because a power boat starts to plane at 12-15 mph). A fast approach was over 20mph. These speeds were estimated based on the wake of the vessel and whether or not the boat was on a plane. The dolphins' behaviors were coded as either approaching the boat, evasive towards boat (avoid boat), or no response/no change in behavior (ignore human presence). In addition, the number of vessels present near a group of dolphins at any one time was recorded, to see if the number of vessels may influence dolphin behavior similar to Williams and Ashe (2007).

Behavioral Ethogram

A behavioral ethogram was recorded for each encounter of a cetacean species. The ethogram was divided into two major sections: (1) the specific interactions between humans and dolphins, and (2) dolphin behavior. The behavior events section contained specific dolphin-human interactive behaviors and was further broken down into three subsections: general information, dolphin behaviors, and human behaviors. See Appendix A for a sample ethogram.

In the general information section, the number of vessels (and their vicinity) was recorded. If swimmers were in the water, the number of human swimmers with the dolphins was recorded. In addition, human proximity to the dolphins (touching distance, near, far) was recorded. Touching distance was defined as at least one dolphin being within one arm's length of the swimmer. Near was defined as the dolphin being within five meters of the human swimmer. Far was defined as a dolphin being within 100 meters of a human swimmer. The overall type of spatial configuration of the dolphin group was also noted as tight, average, or dispersed. In a tight spatial configuration the dolphins swam in close proximity to each other, typically within touching distance of one another. When dispersed, members of the group swam over 100 meters away from each other.

The dolphin behavior section of the ethogram included behaviors that a dolphin performed in response to humans. Space was reserved to include other interactive behaviors that had not been seen before. In the human behavior section, the specific human behavior (i.e. “float” versus “chase dolphin”) was recorded. The dolphin and human behaviors relating to interactions were recorded continuously for each minute of an observation.

In the second section, behavioral states were recorded every minute using the instantaneous scan sampling method (Altmann, 1974). The behavior states listed included: feed, social, travel, mill, with boat, rest, and not found. A behavior state represented what the majority of the dolphins that could be seen were doing at that point in time. Operational definitions of these states were adapted from those provided by Shane, Wells, and Wursig (1986) and Shane (1990). Appendix B lists the operational definitions associated with the ethogram.

Another part of the ethogram involved identifying individuals and the dolphins’ age classes. An attempt was made to identify the rough-toothed dolphins and bottlenose dolphins using the preexisting photo-identification catalogs created from previous field seasons. The age classification for the group composition was also recorded as adults, juveniles, or calves.

Video Analysis

Underwater videography was collected using a Sony® VX 2000 camera within an Ikelite housing that was customized to input acoustical data onto the mini-DV tapes from two external hydrophones. Underwater videos were analyzed for human-dolphin interactions. The underwater video data were recorded on the same ethogram data sheet. Video analysis allowed for the unique underwater perspective of the swimmer-dolphin interaction, which was used for a more fine-scale analysis of individual dolphin behavior events. The boat-based observations were the best method for gaining a more holistic picture of the behavioral states during swimmer interactions, when swimmers were in the water, including when only an underwater camera person was in the water.

Analysis

Chi-square tests were used to investigate changes in behavior state (e.g., from traveling to milling) that occurred when boats and/or swimmers were present. To investigate a change in behavior events as a result of different types of human behavior, chi-square tests were used for each species of dolphins. The relationship between individual behavioral events and species was analyzed using a two-way chi-square test. In addition, for each species of dolphin, two-way chi-square tests were used to investigate the relationship between group age class composition for individual behavioral events.

CHAPTER III

RESULTS

Data were collected over the course of three field seasons. Two of the field seasons were during early summer (May/ June 2006 and May/ June 2007) and one field season was during late summer (September 2006). Thirty-eight days of surveys (239 hours) were completed in the three field seasons. Data were collected on twenty days, with twenty-three separate cetacean encounters as shown in Table 2. A total of 1189 minutes (~20 hours) of human-dolphin interaction data were collected. Three species of dolphins were sighted during the study: spinner, bottlenose, and rough-toothed.

Table 2.

Encounter Data

	Spinner Dolphin	Rough-toothed Dolphin	Bottlenose Dolphin
Number of Encounters	18	1	6
Encounter Time Range (min)	4-235	220	5-95
Mean Encounter Length (min)	64	220	52
Number of Boat Only Encounters	6	0	1
Swimmer and Boat Encounters	12	1	5

Table 3 lists the number of minutes of data that were analyzed before, during, and after human-dolphin interactions for each dolphin species.

Table 3.

Minutes of Data Collected

	Spinner Dolphin	Rough-toothed Dolphin	Bottlenose Dolphin
Before Human Interaction - Total	272	20	22
Before Human Interaction - Mean	27	20	13
During Human Interaction - Total	203	115	88
During Human Interaction - Mean	23	115	26
After Human Interaction - Total	321	85	82
After Human Interaction - Mean	18	85	26
Total Time	846	220	231

Effects of Humans on Behavior State

The results suggest that the three dolphin species differed overall in terms of their behavioral responses to human activity as predicted in Hypothesis 1. Bottlenose dolphins demonstrated a significant change in behavior state after human-dolphin interactions χ^2 (4, N = 121) = 75.39, $p < .01$. Specifically, there was a significant increase in traveling behavior after human-dolphin interactions for the bottlenose dolphins. This was determined by removing behaviors one at a time and calculating the chi-square tests. The only behavior that changed the results was traveling. Therefore, the change in behavior state was due to the increase in traveling after human interactions. The behavior states of spinner dolphins also changed significantly following interactions with human swimmers or boats χ^2 (4, N = 143) =

102.31, $p < .01$. Spinner dolphins engaged in significantly more social behaviors after human-dolphin interactions. When removing social behavior from the analysis the results were non-significant. Therefore, the increase in social interactions accounts for the change in behavior.

For rough-toothed dolphins the statistical significance could not be determined using a chi-square test because data was only collected during one encounter. For 75% of the cases involving human-dolphin interactions, there was no change in behavior state. The only behavior in the "after" condition was traveling.

To strengthen the conclusion that changes in the dolphins' behavior following human interactions (i.e. comparing dolphins' behavior between time periods; before and after human interactions) were in fact due to the human interaction and not strictly a function of random change, similar measures of change were examined with chi-square tests for each species within the following time periods; before, during, and after human interactions (i.e. five minute intervals within the same time periods; before-before, during-during and after-after human interactions). Because significant changes in behavior were observed only between but not within time periods, it is highly likely that these changes in behavior were a direct result of human interactions and not simply a reflection of random or active dolphin behavior patterns.

Effects of Humans on Behavioral Events

Behavioral responses to boats and swimmers differed for each species of dolphin. The relationship between species and behavioral responses was significant χ^2 (16, N = 5050) = 1303.62, $p < .01$. This supported the hypothesis that there would be a significant difference in frequency of behavioral responses after human interactions for the different groups of dolphins observed by species as stated in Hypothesis 1. All of the behaviors that were observed are shown in Figure 1. Although the chi-square results suggested that there were species differences, Figure 1 demonstrates that there may be more similarities than actual differences between species. A possible explanation may be that all dolphins react by approaching, bowriding, and performing aerial behaviors such as jumps and leaps due to the anthropogenic activity in general.

Figure 1.

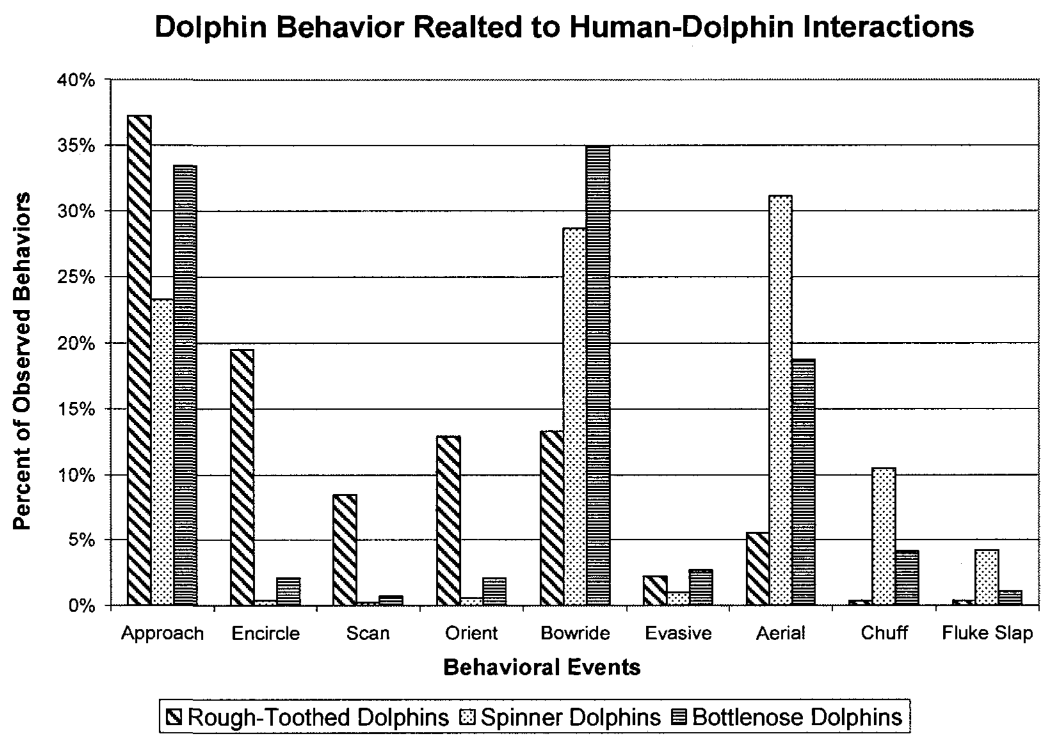

Figure 1. The percentage of behaviors observed for all dolphin species when human-dolphin interactions occurred.

To further investigate the results for the most prevalent behavior for all three species, the data from Figure 1 were separated to only examine approach, bowride, and aerial behaviors. The data for approach behavior suggested that there may have been species differences, such as the greater percentage of approaching behaviors performed by rough-toothed dolphins during human-dolphin interaction (see Figure 2). Of the approaches made during the human-dolphin interactions the percentage for each species was broken into three categories. The first category was "additional boats only", which included observations of other vessels interacting with the dolphins, in addition to the research vessel. The second category, "swimmers only", included only observations of swimmers (researchers and videographers) who entered the water from the research vessel. The last category was "additional boats and swimmers". This included observations when other vessels were interacting with the dolphins in addition to the research vessel and there were swimmers in the water, either associated with the research vessel or the other vessel(s). During human-dolphin interactions was the only phase investigated further because by definition the before and after data cannot be categorized in this manner.

Figure 2.

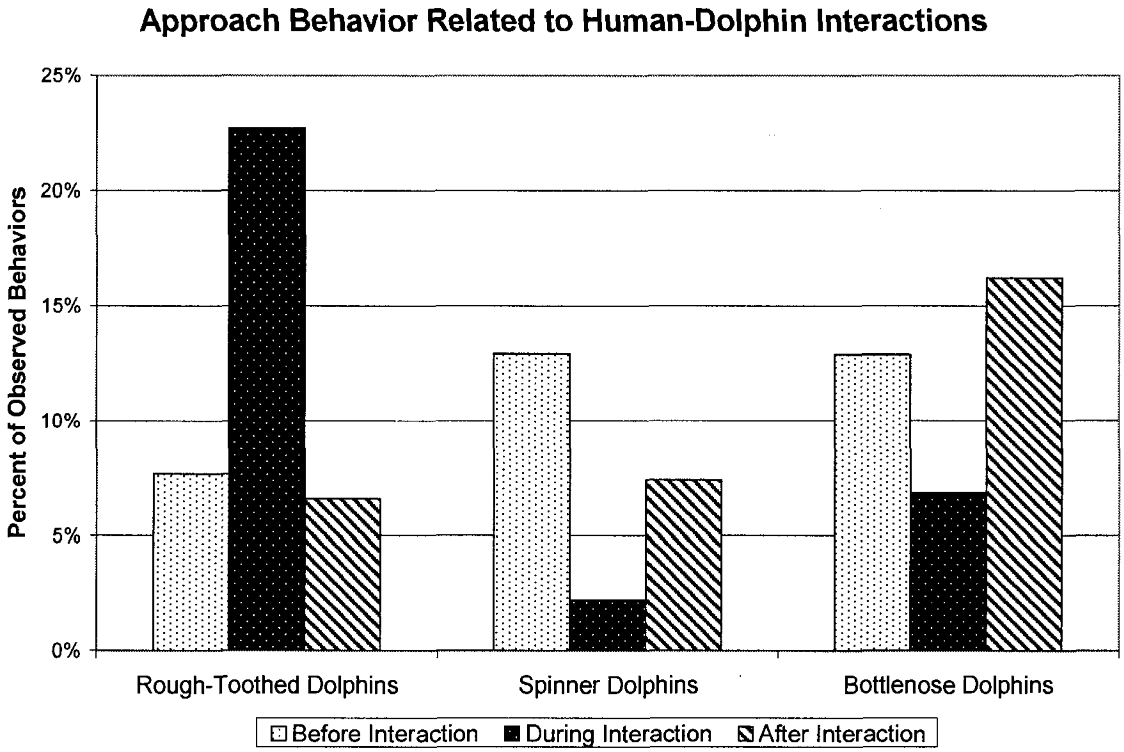

Figure 2. The percentage of approach behaviors observed for all species of dolphins before, during, and after human-dolphin interactions.

When data from during the human-dolphin interaction was broken into these three categories the three species appeared more likely to approach human swimmers rather than boats, during a human-dolphin interaction. These data are shown in Figure 3.

Figure 3.

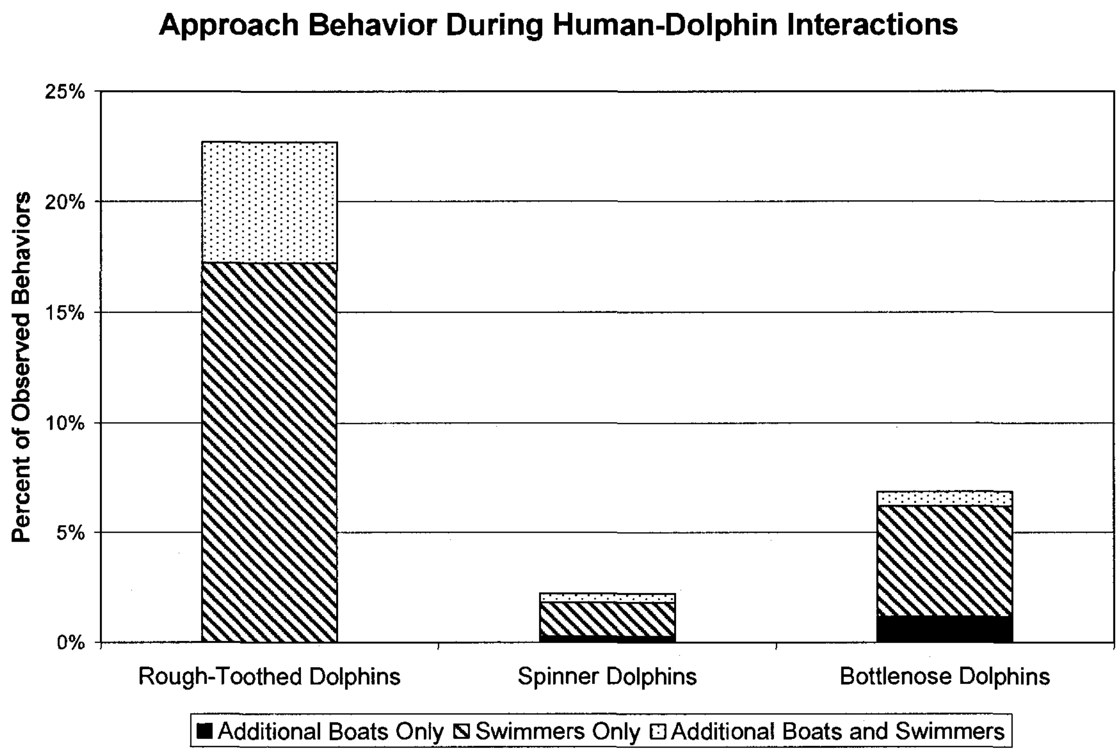

Figure 3. The percentage of approach behaviors broken into categories; additional boats only, human swimmers only, and additional boats and swimmers.

All three species showed a greater percentage of bowriding behavior for the before and after time periods (see Figure 4). This was because the research vessel was most likely underway during those time periods. Spinner dolphins showed twice as much bowriding behavior for the before time period than the after time period. Rough-toothed dolphins preformed a higher percentage of bowriding after the human-dolphin interactions. Bottlenose dolphins showed similar responses both before and after human-dolphin interactions.

Figure 4.

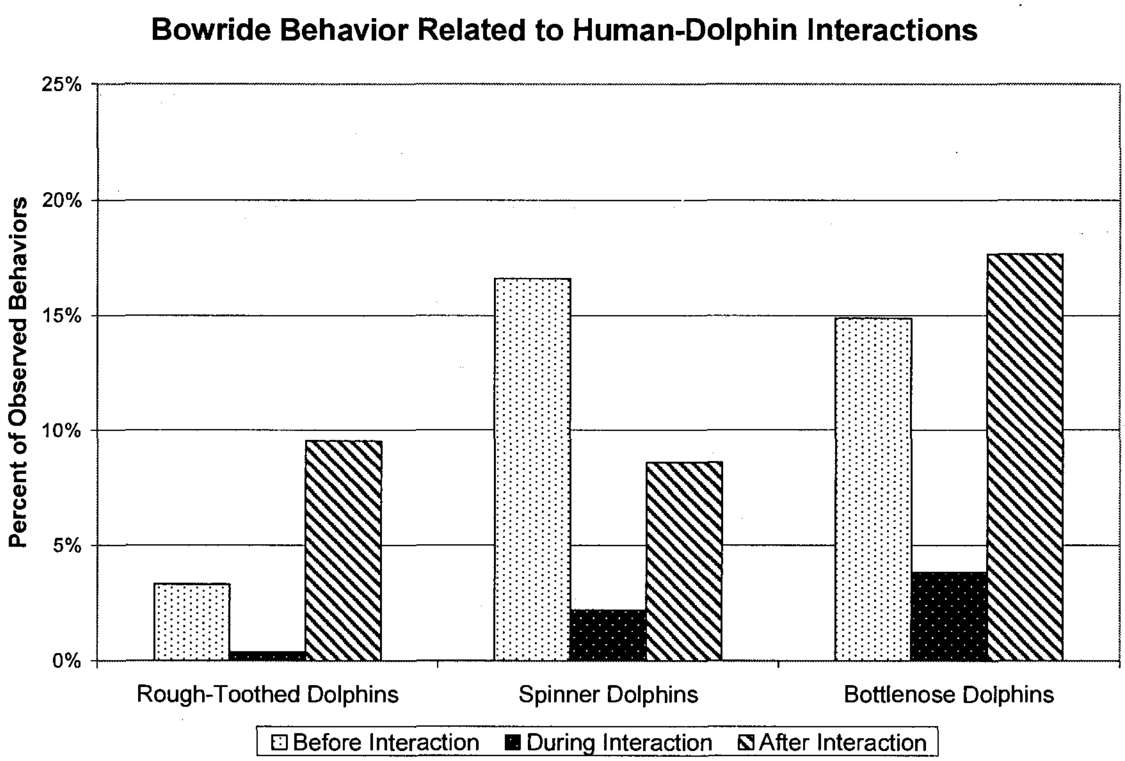

Figure 4. The percentage of bowride behaviors observed for all species of dolphins before, during, and after human-dolphin interactions.

Figure 5 illustrates the aerial behaviors for the three species. Spinner dolphins demonstrated a higher percentage of aerial behaviors in response to humans, in the before time period. Bottlenose dolphins showed a greater percentage of aerial displays after human-dolphin interactions, when the research vessel was the only boat present. Therefore, these results suggest that the research vessel alone may account for the aerial displays of behavior.

Figure 5.

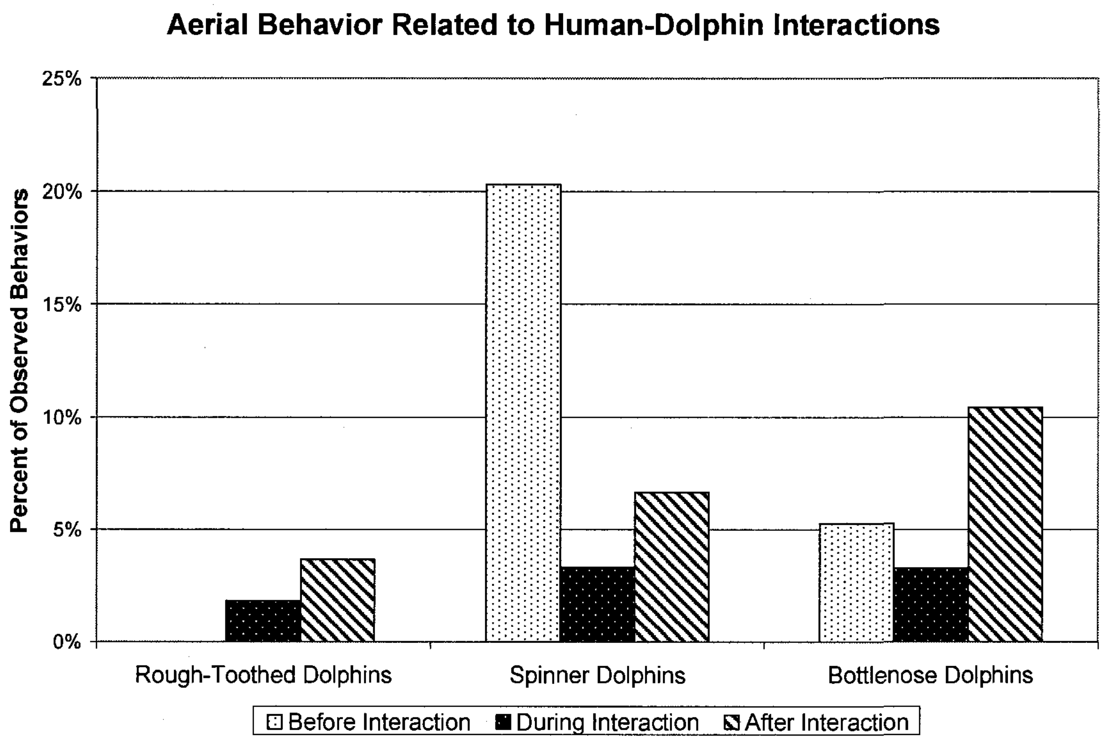

Figure 5. The percentage of aerial behaviors observed for all species of dolphins before, during, and after human-dolphin interactions.

Upon the research vessel's initial approach, all species of dolphins responded by initially approaching the boat, with the exception of one encounter in which no change in behavior state was observed for a group of spinner dolphins. Thus, none of the species of dolphins showed a tendency to avoid the research vessel. Bottlenose dolphins were more likely to travel whenever one or more additional vessels joined the research vessel during a dolphin encounter. Spinner dolphins responded to additional vessels by changing their behavior to "with boat" behaviors, such as bowriding. Although spinner dolphins did not change their overall behavior state ("with boats") when additional boats approached, they were observed to switch the particular vessel with which they were interacting. Rough-toothed dolphins showed no change in behavior when one or more vessels approached them. This species always continued to travel regardless of the number of vessels which approached.

The limited data on vessel speed does not seem to support Hypothesis 2. The data suggested that bottlenose dolphins changed behavior states to traveling in response to human presence, regardless of whether the vessel speed was categorized as fast, average, or slow (see Table 4). The majority of vessels made slow approaches to spinner dolphin groups (see Table 5). Therefore, it was difficult to assess the different effects of vessel speed on dolphin behavior. There were not enough data on rough-toothed dolphin behavior and vessel speed because that species was only encountered once.

Table 4.

Bottlenose Dolphin Vessel Speed Data

	Slow	Average	Fast
Minutes of Vessel Approach	13	24	3
Behavior Frequency			
Aerial	12	30	6
Approach	8	33	4
Bowride	29	55	6
Chuff	5	3	2
Evasive	1	0	0
Behavior State			
Travel	13	24	3

Table 5.

Spinner Dolphin Vessel Speed Data

	Slow	Average	Fast
Minutes of Vessel Approach	66	8	14
Behavior Frequency			
Aerial	170	27	28
Approach	105	19	4
Bowride	124	8	21
Chuff	40	0	5
Fluke Slap	18	0	4
Evasive	1	0	1
Behavior State			
Travel	15	8	2
With Boat	42	0	8
Social	0	0	2
Mill	6	0	1

When human swimmers entered the water, proximity to the dolphins did not appear to greatly modify dolphin behavior. Table 6 illustrates the number of observations for each proximity distance (touching distance, near, far) for each species. The bottlenose and spinner dolphins did not allow humans swimmers within near or touching distance. The rough-toothed dolphins were the only species that allowed human swimmers within touching distance. It should be noted that the rough-toothed dolphins never allowed human swimmers to actually touch them. Spinner dolphins appeared to stay the furthest distance from the human swimmers overall. The effects of the number of swimmers in the water were not clear. Perhaps the behavior of the human swimmers was more influential than the number of swimmers present.

Table 6.

Proximity of Dolphins Relative to Human Swimmers

	Rough-Toothed Dolphins	Spinner Dolphins	Bottlenose Dolphins
Less than Five Swimmers			
Touching Distance	3	0	0
Near	5	7	6
Far	4	66	26
Five or More Swimmers			
Touching Distance	6	0	0
Near	12	6	4
Far	7	44	13

The spatial configuration (i.e., swimming in either a tight, average, or dispersed formation) of all species of dolphins did not show any significant differences before, during, or after human-dolphin interactions. The spatial configuration of the bottlenose and spinner dolphins was dispersed in most cases; before, during, and after human-dolphin interaction (see Table 7). Hypothesis 3, that human presence would influence group cohesion in the dolphins, was not supported by these data. In response to humans, neither spinner nor bottlenose dolphins increased group cohesion. Nor did the spinner and bottlenose dolphins disperse if they were already tightly grouped. Unfortunately, there were insufficient data collected on spatial configuration and human interactions for rough-toothed dolphins to draw meaningful conclusions.

Table 7.

Human-Dolphin Interaction Spatial Configuration

	Before	During	After
Bottlenose Dolphins			
Tight	-	-	-
Average	-	-	2
Dispersed	13	14	85
Spinner Dolphins			
Tight	25	3	1
Average	43	50	95
Dispersed	318	84	122

Effects of Age Class on Behavior

An analysis of age class was conducted to investigate differences in behavioral responses in all three species when scan sample consisted of adults, juveniles, and calves (mixed age class) compared to when scan samples consisted of only adult dolphins. Two-way chi-square tests indicated that the relationship between age class and behavioral response was significant.

Bottlenose dolphins demonstrated a significant difference between behavioral responses when adult only observations were compared to observations of mixed age class χ^2 (8, N = 810) = 56.37, $p < .01$. When removing each behavior one at a time from the analysis to investigate where the differences were, none of the individual behaviors seemed to account for the difference.

Figure 6 shows the three most frequently observed behaviors for bottlenose dolphins. The bottlenose dolphin observations with adults only showed 14% more approach behaviors than the mixed age class observations. Mixed age class observations of bottlenose dolphins demonstrated 16% more bowriding than the adult only observations.

Figure 6.

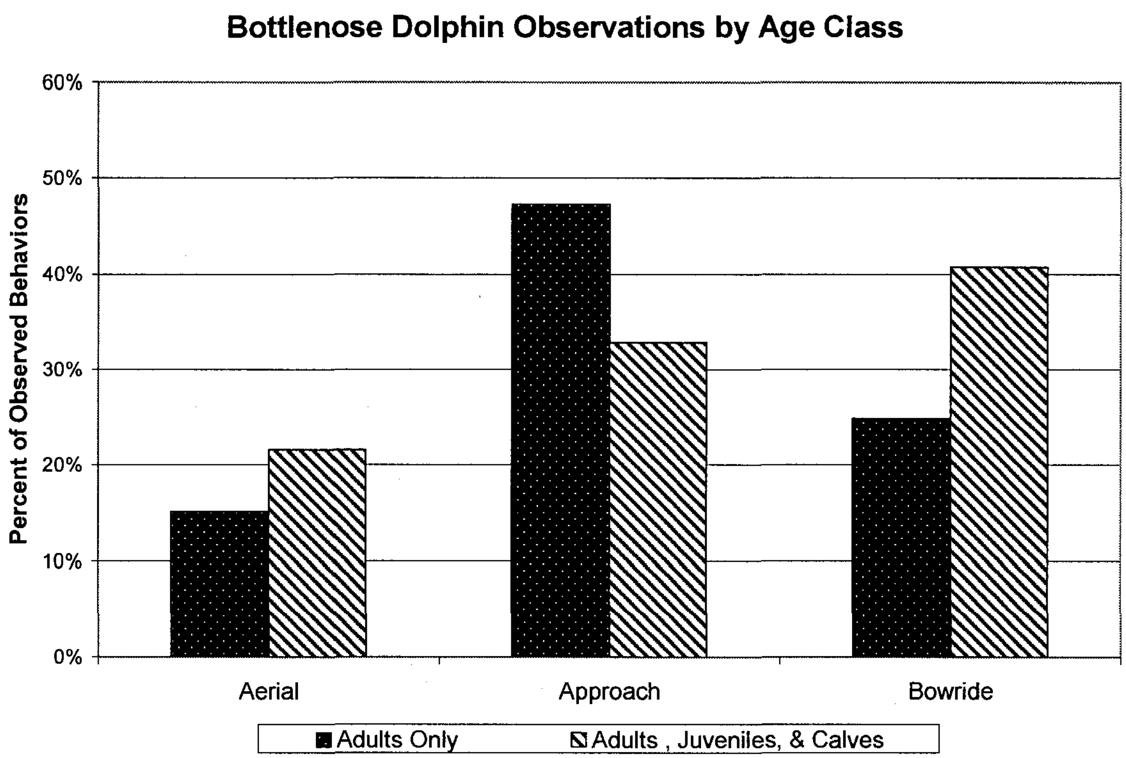

Figure 6. The percentage of behaviors observed for bottlenose dolphins by age class when human swimmers or boats were present.

Spinner dolphin age classification also significantly influenced behavior across behavioral responses. A two-way chi-square test indicated that the relationship between age class and behavioral response was significant. There was a significant difference for spinner dolphin adult only observations and mixed age class observations χ^2 (8, N = 3931) = 96.78, $p < .01$. When removing each behavior from the analysis one at a time, none of the behaviors could account for the difference between mixed age class observations and adult only observations.

Figure 7 shows the most frequently observed behaviors for spinner dolphins. These behaviors were similar in terms of percentages in which the behavior occurred in adult only observations compared with mixed age class observations. The aerial behavior response showed the largest difference with the mixed age class observations 12% greater.

Figure 7.

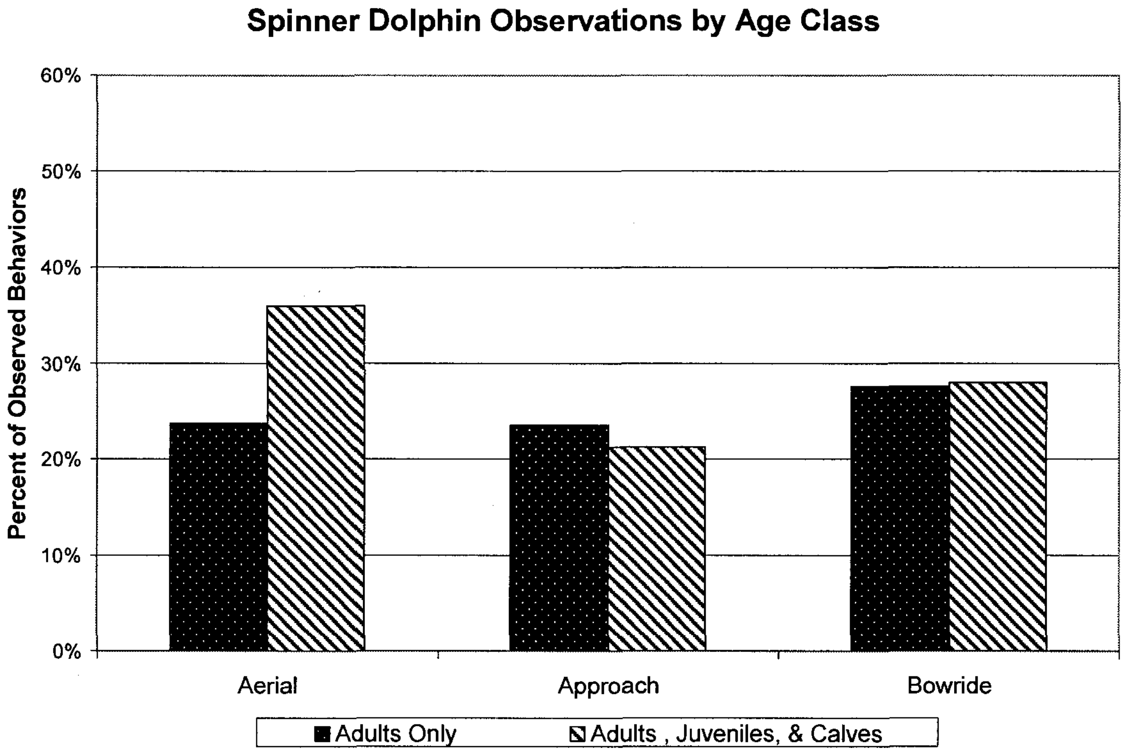

Figure 7. The percentage of behaviors observed for spinner dolphins by age class when human swimmers or boats were present.

There was also an effect of age class on rough-toothed dolphin behavior. A two-way chi-square test indicated that the relationship between age class and behavioral response was significant for rough-toothed dolphins χ^2 (8, N = 271) = 21.51, $p < .01$. When taking out each behavior one at a time from the analysis to see where the differences were, the results indicted that the adult rough-toothed dolphin groups were significantly more likely to orient to human swimmers and engage in bowriding behavior with boats. However, the mixed age class groups were significantly more likely to encircle human swimmers. Furthermore, calves and juveniles were the most likely age class (within these groups) to encircle human swimmers, which supports Hypothesis 4. One juvenile in particular, FIN 4, frequently encircled human swimmers during the observations. (The rough-toothed dolphins have been photo-identified during previous studies; see Kuczaj & Yeater, 2007). These results are shown in Figure 8.

Figure 8.

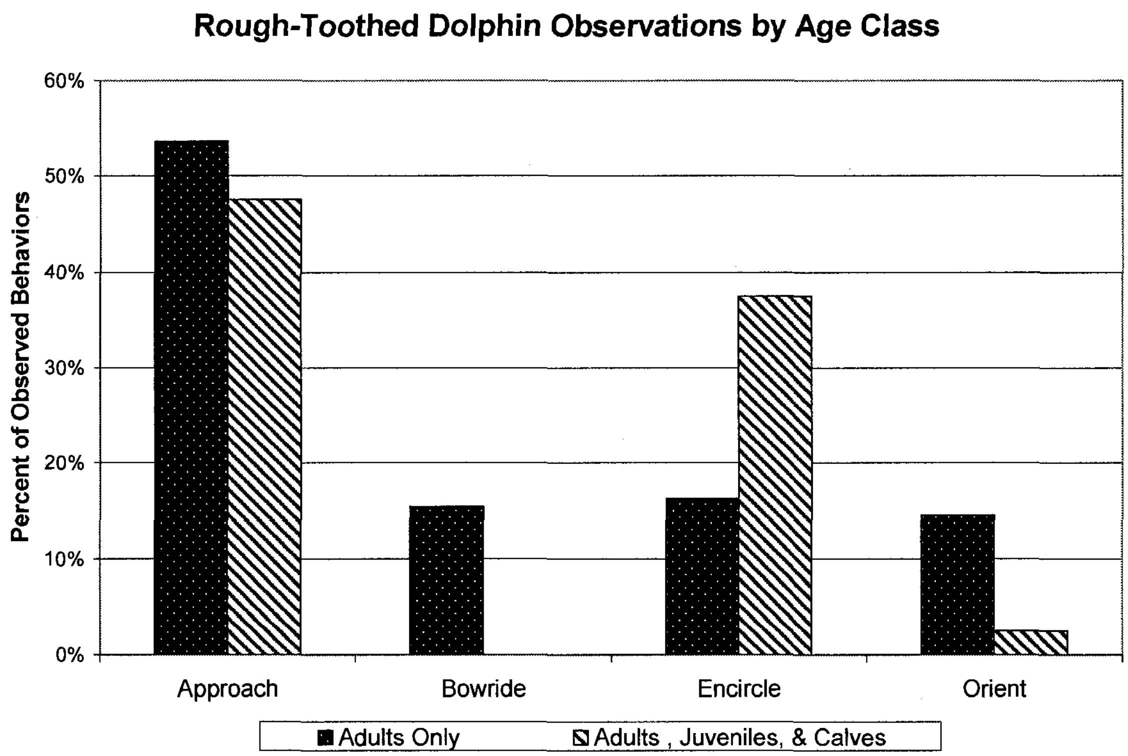

Figure 8. The percentage of behaviors observed for rough-toothed dolphins by age class when human swimmers or boats were present.

Effects of Swimmer Behavior on Dolphin Behavior

Some species of cetaceans may vary their behavioral response according to the way in which human swimmers behave (Lundquist, 2007). An analysis of the activity level of the swimmers was investigated. Human swimmer behavior was categorized, and the corresponding dolphin behavior was recorded. Spinner dolphins showed a trend in which they tended to approach humans when the swimmers floated passively in the water. (Refer to Table 8 for a list of the number of behavior events observed). However, when human swimmers approached spinner dolphins, the dolphins appeared to increase of avoidance behaviors, such as, evasive maneuvers, fluke slaps, chuffs, and aerials. These data suggest that human swimmers may have caused a change in spinner dolphin behavior and offers some limited support to Hypothesis 5, although these changes were not significant.

Table 8.

Spinner Dolphin Behavior in Response to Varying Human Behaviors

	Dolphin Behavior								
Human Behavior	Approach	Encircle	Scan	Orient	Evasive	Aerial	Chuff	Fluke Slap	Dive
Slow Approach	11	1	0	1	20	37	21	7	0
Chase	0	0	0	0	0	2	1	0	0
Float	18	0	0	0	4	26	8	1	2
Enter Water	5	0	0	0	10	11	15	0	4
Splash Kick	10	0	0	0	18	21	16	4	2
Try to Touch *	8	0	0	0	0	3	0	0	0

* Dolphins did not allow human contact.

The nature of the response to human swimmers was not as clearly defined for bottlenose dolphins. This species was both evasive and curious about humans and there appeared to be individual differences in terms of dolphin response. (Refer to Table 9 for the number of behavior events observed.) Insufficient data were collected on rough-toothed dolphin behavioral responses to varying activity levels in human swimmers to draw any meaningful conclusions.

Table 9.

Bottlenose Dolphin Behavior in Response to Varying Human Behaviors

	Dolphin Behavior							
Human Behavior	Approach	Encircle	Scan	Orient	Evasive	Aerial	Chuff	Fluke Slap
Slow Approach	5	3	1	2	5	0	4	0
Chase	3	0	0	1	3	7	4	0
Float	3	0	1	0	3	7	4	0
Enter Water	3	0	1	0	2	5	3	0
Splash Kick	4	0	1	2	3	1	6	0

CHAPTER IV

DISCUSSION

The results suggest that the three species of dolphins investigated (bottlenose, spinner, and rough-toothed) showed evidence of different behavioral responses to human-dolphin interactions. This supports Hypothesis 1, that there would be species differences in some behavioral reactions to human presence. The data suggest species differences; however, there may be more similarities than differences. Valuable information on the short-term reactions of these relatively unstudied populations of dolphins near Utila, Honduras to human activities was gained. The behavior of the dolphin populations was modified by anthropogenic activities.

Overall Effects of Human Interactions

Bottlenose dolphins significantly increased traveling behavior after human interactions. Lusseau (2003b) also found that bottlenose dolphins were significantly more likely to travel after an interaction with a boat. The results of the present study were consistent with the hypothesis that dolphins may change their swim direction (path of travel) and increase swim speed as a result of human presence. This finding was similar to studies conducted on other populations of bottlenose dolphins by Goodwin and Cotton (2004), Hastie et al. (2003), and Yadzi (2005). An increase in traveling behavior may indicate an attempt to avoid boats and swimmers. Consequently, this type of response was considered an evasive maneuver for the overall group behavior.

Stress related to human interactions in this species, as suggested by avoidance responses, could decrease individual fitness and may result in lowered survival probabilities (Lusseau, Lusseau, Bejder, & Williams, in press). Utilizing population models, Lusseau, Slooten, and Currey (2006) found that dolphin-watching tours affected the viability of bottlenose dolphin populations in Doubtful Sound, New Zealand. In these populations of dolphins the stillbirth rate increased and the overall population abundance decreased dramatically. According to Lusseau et al.'s (2006) model it was predicted for that particular population of dolphins that they may become extinct within the next fifty years if the current trend continues. This model has not yet been proven, but it may be a useful tool for education and tourism guidelines. Lusseau et al. (2006) proposed a marine sanctuary to minimize the dolphin-boat interactions.

Spinner dolphins engaged in significantly more social behavior states after human-dolphin interactions. This increase in social/affiliative behaviors may possibly function to strengthen social bonds after the anthropogenic disturbance on the social group by boats and human swimmers. The increase in social behaviors after human impact may indicate that social relationships are especially important to this species, and they may perform more social behaviors in order to reinforce the social bonds between members of the group, especially after a disruption. This finding is the opposite of the expected results based on previous studies on several cetacean species which indicated a reduction in social behaviors following human-dolphin interactions (Lundquist, 2007; Lusseau, 2003b, Lusseau, 2004; Miller et al., in press; Stensland & Berggen, 2007).

There were significant differences in behavior states and events in response to human-dolphin interactions for each species of dolphin. Spinner dolphins did not seem to be aversely impacted by humans. In fact, they showed an interest in interactions with humans by approaching and bowriding. The spinner dolphins may be considered "habituated" because they were the most commonly observed species. They were most often found near the shore (close to vessel traffic). This species appeared to be tolerant of human presence and were actually attracted to the vessels. Both spinner and bottlenose dolphins frequently interacted with moving boats (e.g., bowriding). Constantine and Baker (1997) also found that bottlenose dolphins were more likely to approach boats and bowride than they were to behave evasively. In terms of specific behavioral events, spinner dolphins engaged in aerial behaviors, chuffs, and fluke slaps in response to other boats. However, it was possible that the spinner dolphins' aerial behaviors could be a natural species specific behavior for spinner dolphins and not necessarily a clear sign of disturbance as indicated by previous studies (i.e. Courbis, 2004). Furthermore, an interesting finding was that the spinner dolphin calves seemed to perform aerial behavior more often than adults.

Of the three cetacean species, rough-toothed dolphins were observed interacting with human swimmers more often than the other species. This was consistent with the prediction that rough-toothed dolphins were the most "inquisitive" of the three species. Similar to findings by Constantine (2001), the current study suggests that juvenile rough-toothed dolphins were more likely to interact with swimmers than were adults, as demonstrated by the significant encircling behavioral data results. However, the adult rough-toothed dolphin groups were more likely to approach both vessels and swimmers, which was also a sign of "curiosity". Therefore, this "inquisitive" trait may be a species trait, and may not be determined by age class.

Each of the three species investigated responded differently anthropogenic activities. The species differences could have been due to differences in group size or social structure. For example, the average group size was much larger for spinner dolphins (~100 dolphins) compared to the rough-toothed and bottlenose dolphins (~20 to 50 respectively). Group size seemed to vary consistently with species and, therefore, could have been a factor that influenced the way in which a group behaviorally responded to humans. The rough-toothed dolphin population in Utila, Honduras was observed to have at least one adult male that remained with the resident group of females and juveniles (Kuczaj & Yeater, 2007). This type of social structure is very different from that indicated by studies of bottlenose dolphins in which male dolphins usually separate from the group of females and juveniles after mating (Connor, Read, & Wrangham, 2000). This possible variation in social structure may account for the rough-toothed dolphins' bolder and more inquisitive type behaviors (such as encircling swimmers). It is possible that the calves and mothers might have felt less threatened by humans because the adult male, who most likely sired the calves, was present. Therefore, social structure may additionally account for the difference in rough-toothed dolphin behavior compared to other species, and not only the hypothesis that this species is naturally more curious.

Further investigations are necessary to discern the influence of human interactions on spatial configurations and group cohesion. Similar to the findings on

Hector's dolphins by Bejder et al. (1999), the present study suggests that these three species of dolphins were not immediately influenced by human presence to change their group cohesion. The fact that the groups were most likely to remain dispersed throughout an encounter is not consistent with an anti-predator response toward the humans. Although the rough-toothed dolphins were the primary species of interest, due to the rarity in sighting these animals, further studies are especially important. This species appeared to have an unusually tight spatial configuration while swimming (Kuczaj & Yeater, 2007; Ritter, 2002). Although previous research suggested that tight spatial configurations may be unique for rough-toothed dolphins, it remains unclear whether this is truly part of their normal behavioral repertoire, or if this is a behavioral reaction to humans. Therefore, Hypothesis 3 was neither supported nor refuted.

In future studies, experimental variation of speed and number of vessels would help to determine the roles of such factors on dolphin behavior. Previous studies have indicated that greater vessel speeds increased the amount of avoidance behaviors observed in cetacean species (e.g.,Goodwin & Cotton, 2004; Miller et al., in press; Miragliuolo et al., 2001). These studies demonstrated a greater response to higher speed vessels. Williams and Ashe (2007) found that killer whales responded differently to experimental approaches of less than three boats versus more than three boats, with the greater number of vessels leading to more avoidance behaviors. Based on limited findings, it appeared that the bottlenose and spinner dolphins did not increase evasive behavior when boat speeds were faster, which was contrary to the hypothesis that greater vessel speeds would increase avoidance. However, most of the vessels made slow approaches to the dolphins. Further research is necessary on the effects of vessel speed and number of vessels for all three species of dolphins observed off of Utila, Honduras.

Activity Level of Swimmers

Swimmer activity level affected dolphin behavior. In general, the data supported the hypothesis that different types of human behaviors in the water lead to different behavioral responses by the dolphins. There were aversive behavioral responses exhibited by the spinner dolphins during this study to human swimmers approaching and splash kicking near dolphins. These aversive responses included evasive/avoidance behaviors and fluke slaps. Lundquist's (2007), investigation of activity level of swimmers on southern right whale behavior found that whales did not respond differently to "noisy" versus "calm" swimmers, although, swimmer behavior did affect the magnitude of the response. However, these whales reoriented their swimming direction in response to all swimmers, which suggested an evasive or avoidance maneuver.

In the present study, individual bottlenose dolphins responded differently to each type of human behavior. Some animals approached human swimmers as they swam towards the dolphins, whereas other dolphins behaved evasively in response to approaching humans. It is possible individual differences within each species of dolphin exist in terms of behavioral response to human interaction, just as the overall group differences were observed for each species. In the future it would be possible to investigate this idea that each individual dolphin may respond uniquely to humans if the identity of each animal in a population was known.

The Impact is Not Always Adverse

Some interactions between humans and dolphins seem non-aversive (such as dolphins approaching human swimmers), but management plans should consider species specific and group differences when formulating guidelines for dolphin-human interactions. Similar to the results by Gregory & Rowden (2001), no change in behavior state was observed for rough-toothed dolphins as a consequence of human-dolphin interactions. Rough-toothed dolphins off of La Gomera, Canary Islands, were observed engaging in many positive boat related behaviors by Ritter (2002). Ritter (2002) and Sakai, et al. (2006) also described dolphins' behavior in terms of curiosity towards human swimmers. The results of the rough-toothed dolphins in Utila support the idea that there could possibly be appetitive human-dolphin interactions in the wild. Rough-toothed dolphins in Utila engaged in many investigative type behaviors such as approaching, encircling, orienting, and scanning towards human swimmers. It appeared that the humans (novel stimuli) were reinforcing to the dolphins. The results also demonstrated that spinner and bottlenose dolphins voluntarily approached and engaged in bowriding behaviors. These interactions did not appear to aversely affect behavior. In fact, bowriding behavior may be a form of play (Bel'kovich, 1991). It is possible that the arousal (excitement) associated with bowriding was reinforcing to the dolphins, therefore, this lead to the increase in the future likelihood of bowriding behavior. Therefore, for spinner dolphins especially, moving vessels may actually be appetitive stimuli.

Swim-With Dolphin Guidelines

On the island of Utila, most of the economy is driven by tourists participating in scuba diving and the local fishing industry. Recently, there has been an increase in the number of resorts and dive shops operating on Utila (Currin, 2002). Therefore, the waters surrounding the island are busy with vessel traffic daily. Anecdotally, it appears that dolphins were of particular interest to tourists onboard dive vessels. Frequently, the dive boats have been observed following dolphin groups and allowing tourists the opportunity to swim with the dolphins. Discovering more about the effects of humans on the dolphins was an essential step in the protection of the dolphin species which inhabit the waters of Utila.

If swimming with dolphins becomes even more of a tourist attraction in Utila in the future, there are several issues which must be addressed to ensure that the tourism activity does not have an aversive impact on resident populations of dolphins. The results may be used to establish educational criteria for dive shops and the local government agencies that could assist in protecting these species. Species differences in response to humans was evident, therefore, based on these finding dive boats should be more cautious when interacting with bottlenose dolphins. Bottlenose dolphins appeared to be more susceptible to anthropogenic disturbances than the other two species. Fortunately, there currently are no swim-with dolphin tours in Utila. The opportunity exists to establish educational guidelines prior to the emergence of full-fledged of the commercial dolphin-watching industry. The need to further educate dive shop operators and the local inhabitants of Utila on proper etiquette for observing and interacting with dolphins was demonstrated. These results may be used as an educational tool to help reduce the possibility of dolphin-human interactions resulting in injury to the humans or to the animals. For example, information explaining the risks posed to both the dolphins and swimmers when humans attempt to grab, chase, or splash kick loudly around wild dolphins, would reduce the risk of injury. Specifically, it was demonstrated that a swimmer floating passively had less evasive behavioral responses by the dolphins than a swimmer that was splashing or actively approaching the dolphins. In the future, dive classes should promote a "look but do not touch" approach. The data showed that none of the species allowed the humans to make physical contact. The dolphins' moved away from the humans by keeping them at further distances away from them. Human swimmers should not actively try to approach the dolphins within touching distance.

Hopefully, the amount of harassment of the three dolphins species commonly found near the Utila shoreline will be reduced. Furthermore, these results could help reduce the aversive consequences that are sometimes associated with human interactions with wild dolphins. Currently, there appear to be no official guidelines on interactions with wild cetaceans in Utila. Even a small increase in boater and swimmer knowledge could potentially have a large impact on the types of human-dolphin interactions in these waters.

Appendix A.

Behavioral Ethogram

Name:		Date:					Start Time:										**Human Interactions**				
Species:		Encounter:					End Time:										**Data Sheet**				
	Time	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
General	B/D/A																				
	Vessels																				
	Vessel Speed																				
	At approach																				
	Swimmers																				
	Proximity																				
	Spatial Config.																				
Dolphin	Approach																				
	Encircle																				
	Scan																				
	Orient																				
	Scout																				
	Bow Ride																				
	Evasive																				
	Aerial																				
	Chuff																				
	Fluke Slap																				
	Other																				
Human	Slow Approach																				
	Chase																				
	Float																				
	Enter Water																				
	Splash kick																				
	Other																				
Bx State	Feed																				
	Social																				
	Travel																				
	Mill																				
	W/ Boat																				
	Rest																				
	Not Found																				
	# of Dolphins																				
Focal Anim.	**ID/ Fin Num?**																				
	Age Class?																				

Appendix B

Operational Definitions

General Information

B/D/A: During each minute on the ethogram it will be recorded whether it is before, during, or after a human interaction.

Vessels: How many oceangoing watercraft including dive boats, fishing boats, kayaks, etc… are present.

Vessel speed: Categorized as slow (0-10 mph), average/planing (10-20 mph), or fast (over 20 mph). Code as S, A, or F.

At approach: Dolphins in general approach, are evasive or avoid, or are neutral (no response) to the research vessel. Code as A, E, N.

Swimmers: A person completely immersed in the water and engaged in active swimming, snorkeling, or treading water. (Danil, et al., 2005).

Proximity:

1) Touching distance: Dolphins are within an arm's length from the swimmers (TD).

2) Near: The dolphin is within 5 meters from the human swimmer, "close by" (N).

3) Far: Dolphin is within 100 meters of a human swimmer (F).

Spatial Configuration:

1) Tight (T) = close in proximity, within 5 meters of each other or touching distance.

2) Average (A) = 5 – 50 meters apart.

3) Dispersed (D) = 50 - 100 meters from each other.

Dolphin Behaviors

Approach: The dolphin swims toward the boat or human swimmers of its own free will. Dolphin may change swimming direction and begin to head toward the swimmers.

Encircle: During the encircling behavior, a rough-toothed dolphin swims around an underwater human swimmer within two body lengths, usually repeatedly. The dolphin usually makes eye contact with the humans in the water. (Scheer, Hofmann, & Behr, 2004).

Scan: Individual dolphins swim directly towards or underneath a human swimmer and bend their heads towards a swimmer to rapidly echolocate, or scan, on the human. (Scheer, et al., 2004).

Orient: The dolphin turns its head and body and looks at a person. This must be done for a duration of two seconds or more (longer than a scan).

Scout: Brief approach to boat or human up to a few meters away and then moving away (Ritter, 2002).

Bowride: The dolphin swims or gets pushed in front of the boat by the water pressure created by the bow.

Evasive: Avoidance of boat or swimmers. Movement or direction change away from humans (Ritter, 2002).

Aerial: Jumps or leaps coinciding with humans in the water. Includes any acrobatic display.

Chuff: A forceful exhalation usually performed repeatedly. Sounds like a sneeze.

Fluke Slap: The dolphin makes contacts with its flukes to the surface of the water, or moves its flukes in a manner that is not characteristic of normal swimming.

Other: Other behaviors will be described in the field notes.

Human Behavior

Slow approach: Humans swim towards the dolphins in a slow and controlled manner.

Chase: Humans are actively pursuing the dolphins in an inappropriate manner.

Float: Humans are stationary in the water floating at the surface.

Enter water: Humans jump into the water from a boat.

Splash kick: Humans swim while splashing excessively and kicking loudly.

Other: Any human behavior that is not listed, such as grabbing a dolphin.

Focal Animal

ID/ Fin number: If possible, identify which individuals the ethogram data is documenting.

Age Class: Classify the focal animals in the ethogram as adults, juveniles, or calves.

Juvenile = 2/3 the size of an adult

Calf = 1/3 the size of an adult

Behavioral State

Feed: Any of a variety of behaviors distinguished by such things as repeated dives in varying directions in one location, feeding circles, feeding splashes, fish kicks, feeding rushes, and fish tosses.

Social: The dolphins are interacting with one another. This may include group social balls, chases, mating, rubbing and other tactile behaviors.

Travel: The dolphins are moving in one direction in a tight or close spatial configuration.

Mill: The dolphins move in varying directions in one location but show no surface behaviors and no apparent physical contact between individuals, usually staying close to the surface.

With Boat: Dolphins are close to the boat and may be either bowriding or wakeriding.

Rest: Dolphins are stationary at the surface in a horizontal position or motionless

Not Found: Dolphins were not seen for that one minute period.

Number of Dolphins

How many dolphins were seen at each time increment. The number of focal individuals.

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