Tourist compliance and the resulting effects on whale shark (*Rhincodon typus*) behavior in Donsol, Philippines

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Abstract

This study examines tourist compliance to the Code of Conduct for whale shark (*Rhincodon typus*) interactions and assesses impacts of tourists on whale sharks in Donsol, Philippines. Whale sharks feed in Donsol's nutrient rich waters between November and June, drawing up to 7,100 visitors annually. Tourist, tour operator, and whale shark behavior were examined during human-whale shark interactions (n=777) on 117 boat trips (March, April and May) in 2004, and on 76 boat trips in 2005 (n=620). Average compliance to Code of Conduct regulations in 2004 and 2005 was 44% for the minimum distance kept; 82% for no touching, no path obstruction, and a maximum of 6 swimmers per whale shark; 89% for a maximum of 1 boat per shark, 99% for no flash photography and no SCUBA, scooters, and jet-skis. Significant predictors of whale shark's directional changes were path obstruction and proximity of swimmer to whale shark, while for whale shark's dive response it was first-time sighting and whale shark feeding. The significant predictor of a violent shudder behavior was touching. Generalized linear modeling evaluated change in direction, dive response and violent shuddering variables, and found that touching, flash photography, and swimmer diving towards the whale shark significantly affected the magnitude of disturbance. Tourism impacts on whale sharks can be minimized through adaptive management that monitors tourism and alters interaction regulations to reflect tourist and tour operator actions that have detrimental effects on whale sharks.

Keywords: whale shark, disturbance, behavior, regulations, ecotourism, Donsol

1. Introduction

To conserve whale sharks (*Rhincodon typus)* while improving the socioeconomic status of the community, community-based whale shark ecotourism was initiated in Donsol in 1998. Donsol is a small fishing village in southern Luzon, an island in the Philippines. From interviews with locals, whale sharks are sighted in Donsol waters all of the months of the year, peaking between March and May. Registered tourism arrivals have increased from 900 visitors in 1998, to 3,175 in 2004 and 7,100 in the 2005 (Donsol Tourism Center, 2005; Ravanilla, pers. comm.). There are up to 20 whale shark tours each day, with 8 people per tour boat and a record high of 69 tours per day on March 24, 2005. The upward trend in visitation reflects a potential for synergistic impacts for both the whale sharks and the community of Donsol. However, the evidence of short or long-term negative impacts on whale sharks from tourism is unclear and difficult to obtain (Colman, 1997; Davis et al., 1997).

As interacting with animals in the wild increase, managers must satisfy conflicting values of providing recreation while protecting the animals (Sorice et al., 2003). Many studies on the anthropogenic effects on wildlife have been conducted, including swim with manatee tourism in Florida, USA (Sorice et al., 2003), and swim-with-dolphin operations in New Zealand (Constantine, 2001) and Australia (Scarpaci et al., 2003). Research in the dolphin tourism industry has shown that dolphins change their behavior by increasing avoidance responses to swimmers when exposed to swim-with-dolphin tourism (Constantine and Baker, unpublished; Scarpaci et al., 2000).

There are two types of impacts humans have on animals: direct and indirect. Direct impacts result from the hunting or harassment of animals, while indirect impacts can result from habitat modification (Hammit and Cole, 1998). Harassment is defined as an activity with the potential to have a significant negative effect on an animal's fitness, and significantly affect normal behavioral patterns, like feeding and breeding (Colman, 1997; Sorice et al., 2003). Harassment may also affect the whale shark return rate to a particular aggregation area (Norman, 2005).

While changes to whale shark behavior may be elusive, it is possible to observe avoidance behavior, such as rapidly diving away from the surface, banking, and attempts by the whale shark to leave the area. In Ningaloo, when a whale shark experiences distress from the swimmers, it attempts to prematurely end the interaction (Norman, unpublished). Banking behavior is another way whale sharks can avoid swimmers because the tough skin on the whale shark's dorsal surface is used for protection. Whale sharks' skin is covered by dermal denticles, reaching up to 14 cm (Taylor, 1994).

The goal of the Code of Conduct is to regulate human behaviors that have the potential to negatively impact whale sharks; these regulations could proxy as indicators of tourism pressure (Colman, 1997; Scarpaci et al., 2003). This study examines the impacts of tourism pressure on whale sharks and the effectiveness of management in minimizing these impacts by examining compliance to the Code of Conduct and analyzing whale shark behavior.

2. Methods

Observations were conducted between March and June 2004, and March and May 2005 on three survey periods that lasted between 4 – 12 days each (March, April and May). Observers collected behavior in two categories: behavior of swimmers and tour operators, and behavior of whale sharks. To deal with limitations in data collection from previous studies, volunteers were chosen according to their experience in the water, and all given the same training.

In 1999, Brad Norman (pers. comm.) conducted a pioneering behavioral study in Ningaloo Reef, Western Australia from observations on commercial whale shark tours. He developed a preliminary repertoire of whale shark behaviors which included eye rolls, diving, banking, and change in swimming speed, degree of mouth opening, and coughing/gill flushing. One difficulty in studying the impact of tourism pressure on whale sharks is not having the opportunity to observe whale sharks under natural conditions. The absence of controls was also an issue for this study, so instead of determining cause and effect relationships between human and whale shark behavior, associations, or groupings of certain types of behaviors were examined, and models of behavioral variables were created.

2.1 Measuring compliance

To examine tourist compliance to the Code of Conduct in Donsol, this study replicated Carol Scarpaci's work on the compliance of dolphin swim tourism in Victoria, Australia (Scarpaci et al., 2003). Donsol's Code of Conduct was adopted from Western Australia's Department of Conservation and Land Management (CALM) and devised by the Donsol Municipal Tourism Council, the regulations are shown in figure 1. Observers noted whether each of these regulations was conformed to or not. Observers gathered data on the duration of each interaction, counted the number of boats within 50 meters of the whale shark, and noted boat approach towards the whale shark. Multiple swimmers in the same interaction were considered together, and if people from different boats were swimming with the same whale shark, it was considered one interaction.

2.2 Observing whale sharks

Observers recorded the presence or absence of injuries, whether the whale shark was feeding and various whale shark behaviors. Whale shark behaviors classified as neutral include feeding and swimming in circles. Whale shark behaviors classified as avoidance behaviors include diving away from swimmers, changing in direction, and banking. Four types of a whale shark's dive response were categorized: instant dive, gradual dive, steep dive, and parabola dive (diving up and down at regular intervals). An instant dive occurs less than 30 seconds after the start of the interaction, a gradual dive refers to a shallow slow dive, whereas a steep dive is defined by an angle of 45 to 90 degrees. Four types of a whale shark changing in direction were categorized: gradual change, abrupt change (turning approximately 90 degrees in less than two seconds), banking (moving to show its back to the swimmer), swimming in circles, and violent shudder. This latter behavior was added in 2005; it may range from the whale shark shaking its head and caudal fin from side to side, to a whole-body writhing, as if the whale shark was attempting to shake off the swimmers.

2.3 Composite scores

Avoidance behaviors lie along a gradient that ranges from no response to exhibiting multiple instances of dive response and changes in direction. Instant and steep dives are classified as avoidance behaviors while gradual and parabola dives, lie towards the neutral behaviors along the neutral/avoidance gradient. To quantify those behaviors, composite scores for dive response and change in direction variables were created, with each variable contributing 1 point to the composite score.

The composite score for the change in direction ranged from 0 to 7. A score of 0 represents no change in direction, a score of 1 represents swimming in circles, a score of 2 represents gradual changes in direction, while a score of 7 represents a whale shark that exhibited a combination of gradual, abrupt changes in direction, and/or banking. Whale sharks with change in direction composite scores of 2 or higher were categorized as 'disturbed' for use in subsequent analyses.

The composite score for a whale shark dive ranged from 0 to 4. A score of 0 represents no dive, 1 for a parabola dive, 2 for a gradual dive, and a score of 3 or 4 represents a steep and/or instant dive. Thus, higher composite scores correspond to a greater degree of avoidance behavior. Whale sharks with dive composite scores of 2 or higher were categorized as 'disturbed'.

2.4 Statistical analyses

The 2004 and 2005 season data could not be aggregated in the analyses because additional variables were collected in 2005. To assess any effects of humans on whale shark behavior, a logistic regression model was used for the 2004 data. To see which behaviors were grouped together, whale shark data from 2005 were analyzed using Principal Component analysis. To predict the magnitude of a whale shark's disturbance, a Generalized Linear Model was created for whale sharks categorized as 'disturbed'.

3. Results

3.1 Data summary

A total of 777 human-whale shark interactions was observed between March and June in 2004, over the course of 117 boat trips, and a total of 620 human-whale shark interactions was observed between March and May in 2005, over the course of 76 boat trips. There was an average of 6.58 interactions per trip in 2004 (SD=5.26), and 8.15 interactions per trip in 2005 (SD=4.18). The length of each trip was approximately 3 hours and the average length of interactions was 3 minutes. Whale sharks were sighted mostly between the hours of 9:30am – 12noon. Whale sharks were observed feeding 13% of the time in 2004 and 36% of the time in 2005. Whale sharks were assessed for injuries in 2005, and 37% of all whale sharks interacted with had injuries.

3.2 Whale shark behavior

The most frequently observed change in direction behavior was a gradual change in direction (23%) with 0 to 3 changes in direction occurring in one interaction. The swimming in circles behavior had a frequency of 16%, while banking and abrupt changes both had frequencies of 11% and a range of 0 to 4 observations per interaction. The gradual dive behavior was observed with a 37% frequency, instant dives 15%, steep dives 12% and parabola dives 8%. The violent shudder behavior was observed 10% of the time, with a range of 0 to 3.

3.3 Human Behavior and Compliance to Regulations

Table 1 shows the compliance of tourists and tour operators to the Code of Conduct during the tourist season in 2004 and 2005. There was an average of 5 swimmers (SD = 1.9) with the whale shark at one time, however a maximum of 16 swimmers was observed. Swimmers dived towards the whale shark 43% of all the interactions, and most dives were towards the head (48%). Swimmers obstructed the path of the whale shark 34% of all the interactions, with a maximum of 4 incidents in one interaction.

In 2004, 97 touch incidents were observed and in 2005 this increased to 125. Overall, there was a touch incident approximately 20% of the time, with a maximum of 4 touches per interaction. In 2004, the average proximity between swimmer and whale shark was 2.03m (SD=1.22m) and in 2005, the average proximity was 1.64m (SD=1.19m).

Boat crowding increased from two incidents a day in March, to five in May. The number of boats in each crowding incident in March and April was significantly less than in May (two-sample t-test, $p=0.001$). During March and April only 2 boats were present during any crowding incident, this increased to up to 7 boats in May.

3.4 Logistic regression model for whale shark behavior

Using logistic regression models, the effects of tour operator and tourist variables were studied on three whale shark avoidance behaviors: change in direction, dive response, and violent shudder. The tour operator variables included number of boats, boat approach, path obstruction by the boat, number of swimmers, and boat crowding. The tourist variables were touching, flash photography, path obstruction, and proximity to the whale shark.

Table 2 shows the results of the logistic regression analysis. There were two significant predictors of a whale shark's change in direction: path obstruction of the whale shark ($p = 0.004$, odds ratio = 3.26) and proximity of swimmer to whale shark ($p = -0.001$, odds ratio = 0.65). The model shows that for each instance of path obstruction, a whale shark is 3.26 times more likely to change in direction. The negative coefficient of the proximity predictor shows that with each additional meter away swimmers were from the whale shark, the whale shark was less likely (0.65 times) to change in direction.

There were two significant predictors of dive response (table 2): first-time sighting ($p = 0.045$, odds ratio = 0.66) and the presence of feeding ($p = -0.009$, odds ratio = 1.84). The model shows that whale sharks sighted for the first-time were less likely to exhibit dive responses than whale sharks that had been swum with repeatedly. The presence of feeding behavior increased the likelihood a whale shark exhibited a dive response by 1.84 times.

There was one significant predictor of a violent shudder in the logistic analysis - a swimmer touching a whale shark ($p = 0.000$, odds ratio = 2.43). This indicates that with each additional touch, a whale shark is 2.43 as likely to exhibit a violent shudder.

3.5 Principal components analysis (PCA)

PCA was used to examine which whale shark behavior variables were grouped together. The correlation matrix shows avoidance behaviors such as violent shudder and banking were grouped together (Pearson correlation 0.213, $p=0.000$), and neutral behaviors like feeding and swimming in circles were grouped together (0.258, $p=0.000$). Steep diving was negatively correlated with swimming in circles (-0.214, $p=0.000$). This shows that an avoidance behavior, like steep diving, is not usually found with a neutral behavior, swimming in circles. An injured whale shark was negatively correlated with banking behavior (-0.214, $p=0.000$). This suggests that whale sharks which are already injured do not exhibit as much avoidance behavior, like banking, as those that are not injured.

Table 3 shows the results of the PCA. Major contributors to explain overall variability in the model were variables with weights greater than 0.3. It is evident that whale sharks exhibiting gradual dive behavior are also likely to be injured, and whale sharks that do instant dives also do steep dives. Injured whale sharks are less ‘skittish’ than non-injured sharks, and those that are injured could be so because they do not exhibit as much instant and steep dives to avoid contact with boats. If a whale shark is feeding, it is more likely to shudder, make abrupt changes, andbank in response to humans. Finally, a gradual change in direction is negatively correlated with swimming in circles. This means that even though the change is gradual, it can be still categorized as an avoidance behavior because it is not grouped with swimming in circles, a more neutral behavior.

3.6 Multivariate generalized linear model (GLM)

A GLM was used to assess the magnitude of disturbance along a continuum for whale sharks categorized as disturbed. Whale sharks were classified as 'disturbed' if they had a score of 2 or higher in either the dive or the change in direction composite scores.Table 4 presents the output of the GLM model, which all have similar results. For disturbed whale sharks, a touch incident, usage of flash photography, and a swimmer diving towards the whale shark all have a significant effect on the magnitude of the disturbance to the whale shark.

4. Discussion

4.1 Compliance to the code of conduct

In a complex physical and sociopolitical setting, prescribed measures to minimize negative effects of human-animal interaction are difficult to put into practice. Managers need to find equilibrium between high quality tourist experiences and impacts from the tourism industry (Davis et al., 1997). When managing harassment of manatees in Florida, Sorice et al. (2003) define the problem as one of social value and not a technical problem. The tourist and tour operator non-compliance highlights varying interpretations and lack of enforcement of the regulations by the Tourism Office staff, the Butanding Interaction Officers (BIOs), and the Boat Operator's Association (BOA). Some tourists and tour operators do not believe their actions have detrimental effects on the whale sharks.

Two ways to manage impacts from the tourism industry are to regulate the number of entrants into the industry, and to regulate the behavior of the operators (Scarpaci et al., 2003). Scarpaci et al.'s (2003) study shows that commercial operators licensed to offer swim-with-dolphin tours do not always follow the regulations, and while these regulations exist to reduce negative impacts on the animals, not following the regulations is a failure of the tourism managers. In Donsol, the BIOs are the primary enforcers of the regulations, but there is no accountability that ensures BIOs follow and enforce the regulations. The Donsol Tourism Office conducts periodic monitoring but they are most effective in ensuring that only registered boats from the BOA are conducting tours. Enforcing other regulations is difficult due to the lack of funds, the large area tour boats cover in one day, and the fact that interactions occur underwater (Davis et al., 1997). The Code of Conduct with whale sharks is the main line of defense to minimize negative impacts from tourism. Knowing which tour operator and tourist behaviors have negative effects on whale shark behavior can rationalize the need for strict compliance to the Code of Conduct. Even with approximately 80% compliance to the regulations, negative short-term impacts on the whale shark's behavior associated with non-compliance to regulations such as path obstruction, less than 3 meters in proximity, and touching have been observed.

4.2 Disturbance to whale sharks

Since Donsol waters are feeding grounds for whale sharks, disturbing them while they feed has the potential to reduce the sharks' chances of survival on the long-term, by diverting their energies from feeding to avoidance behavior (Colman, 1997; Sorice et al., 2003). PCA showed that if a whale shark is observed feeding, it is more likely to shudder, make abrupt changes, or bank. These results suggest that the whale shark exhibits these avoidance behaviors because they are being disturbed by human behavior and/or presence while they feed. The GLM found that touch, swimmer dive, and flash photography had affects on a whale shark's change in direction, dive response and violent shudder. These results show certain behaviors controlled for in the Code of Conduct need to be enforced completely.

The 2004 analysis showed that path obstruction, proximity and first-time sighting of the whale shark affect whale shark behavior. Operators can control for path obstruction and proximity of whale shark by positioning swimmers properly at the onset of the interaction and by thorough swimmer briefing. From the 2005 analysis, touch, flash photography and swimmer dive affect whale shark behavior. These variables can be controlled by operators, and minimized through proper education of tourists and enforcement of regulations. Swimmer diving towards a whale shark is not a breach of regulations but it does affect whale shark behavior, and it is often accompanied by a touch or a path obstruction. Issues with free diving have been discussed in Ningaloo Reef, but no conclusions have been reached as to what amount of free diving during interactions is acceptable. Managers in Ningaloo are currently assessing whether free diving can be incorporated into the license conditions or the Code of Conduct (Roland Mau, pers. comm.).

Future studies should address issues related to disturbance such as boat collisions and boat crowding. Improper ecotourism activities and boat collisions are cited as indirect threats to whale sharks in Donsol (Colman, 1997; Alava, unpublished). In Bahia de los Angeles, Mexico, many whale sharks have injuries due to boat propellers and, like in Donsol, Philippines, are harassed by swimmers. Both sites are similar in that there is little infrastructure to manage the whale shark industry in a sustainable manner (Cárdenas-Torres et al., this volume; Norman, unpublished). High numbers of boat strikes could deter whale sharks from returning to the same area (Australian Government Department of the Environment and Heritage, 2005). Future behavioral studies on whale sharks should examine disturbance from tourism in other locations.

Like in Ningaloo Reef, boat operators often pass whale sharks from one boat to the next when sightings are low, which is a source for negative impacts if not conducted properly (Davis et al., 1997). Interaction guidelines specify that there must be a maximum of one boat per whale shark, but when whale sharks are scarce on a given day, several boats ‘share’ the same whale shark, crowding around it and dropping their swimmers in the water right after the previous boat has dropped their swimmers, without waiting for the first boat’s interaction to end (Quiros, 2005). In Ningaloo Reef, however, passing the whale shark from one boat to the next is conducted in an equitable manner with clear lines of communication between boats resulting in some lag time between separate boats’ interactions.

5. Conclusion

Management that includes monitoring impacts is essential for the industry's sustainability (Colman, 1997; Drumm and Moore 2003). In Ningaloo Reef, Australia, the industry has been prospering since the early 1990s, due to proper monitoring (Colman, 1997) and with adequate financing for the management of the resource. Monitoring can pinpoint influential managerial issues and decrease conflicts between stakeholders, while increasing the quality of the tourist experience. Using adaptive management for managing tourism and altering interaction regulations to be site-specific, tourism impacts on whale sharks can be minimized (Quiros, 2005). As seen in the results of this study, the Code of Conduct is effective in distinguishing the types of human behaviors that significantly affect whale shark behavior, but 100% compliance to regulations is necessary to minimize impacts. In addition, there are human behaviors not included in the Code of Conduct, such as swimmers' free diving towards the whale shark, which should be controlled by being incorporated into regulations. Integrating the results of this monitoring study into management plans of Donsol would improve compliance of operators and tourists to regulations and mitigate adverse impacts to whale sharks.

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Tables

Table 1. Compliance to the Code of Conduct by swimmers and tour operators to regulations in 2004 and 2005

Regulations	Who is accountable	Percent compliance	
		2004 Season	2005 Season
Do not touch or ride the whale shark	Tourists, operators	84%	80%
Do not restrict the movement of the shark or impede its natural path	Tourists, operators	96%	69%
Keep a distance of 3 meters from the head and 4 meters from the tail	Tourists, operators	68%	19%
Do not undertake flash photography	Tourists, operators	99%	97%
Do not use SCUBA, scooters, jet-skis	Tourists, operators	99.9% *	100%
A maximum of 6 swimmers per shark	Operators	80%	84%
Only one boat per shark	Operators	84%	94%

* May 2004 : One incident of Jet-ski use

Table 2. Results of the logistic regression analysis for the whale shark data collected in 2004

	Change in Direction		Dive Response		Violent Shudder
	Path Obstruction	Proximity	First-time sighting	Feeding	Touch
p-value	0.004	– 0.001	0.045	– 0.009	0.000
Odds Ratio	3.26	0.65	0.66	1.84	2.43
	(1.45, 7.33, CI)	(0.65, 0.90, CI)	(0.43, 0.99, CI)	(1.16, 2.91, CI)	(1.62,3.65, CI)
Coefficient	1.18	–0.27	–0.42	0.61	0.89

Table 3. Results of Principal Components analysis for whale shark behavior (2005)

Principal Component	Explains (%) variation	Eigenvalue	Weightings (-)	Weightings (+)
First	16%	1.87	-0.445 gradual dive -0.440 injured whale shark -0.241 feeding -0.044 parabola dive -0.040 gradual change in direction -0.015 swimming in circles	0.472 steep dive 0.410 instant dive 0.206 abrupt change in direction 0.098 violent shudder 0.026 banking
Second	14%	1.70		0.461 feeding 0.455 violent shudder 0.408 abrupt change in direction 0.361 parabola dives 0.344 banking
Third	10%	1.22	-0.749 gradual change in direction	0.509 swimming in circles

Table 4. Results of the Generalized Linear Model for whale shark and human behavior (2005)

Additional Independent Variables	Interactions/ Main Effects	GLM Significant Variables (p value)	Univariate Results Independent => Dependent (p-value)
Model 1: none	Interactions	Touch (0.000) Swimmer dive (0.000) WS Length (0.030) Interaction of Flash Photo * Injured WS (0.035)	• Swimmer dive => change in direction composite (p = 0.002) • Violent shudder => dive composite (0.001) • Interaction of flash photo & injured whale shark => dive composite score (0.006) • Interaction of virgin sighting & injured whale shark & boat approach => dive composite (0.027)
Model 2: Dive head, dorsal, tail	Main effects	Touch (0.001) Swimmer dive (0.003) Flash Photo (0.004) Dive Head (0.049) Dive Tail (0.022)	• Injured => violent shudder (0.05) • Touch => violent shudder (0.000) • Path obstruction => dive composite (0.032) • Number of swimmers => change direction composite (0.032) • Number of swimmers => violent shudder (0.041) • Swimmer dive =>change direction composite (0.022) • Flash photography=> dive composite (0.000) • Dive at the head => violent shudder (0.043) • Dive at the dorsal => change direction composite (0.036).
Model 3: Dive head, dorsal, tail	Interactions	Touch (0.002) Number of swimmers (0.035) Swimmer dive (0.005) WS length (0.050) Dive Tail (0.05) Interaction of Injured *Flash Photo (0.026)	• Touch => violent shudder (0.000) • Path obstruction => dive composite (0.030) • No. swimmers => change dir. composite (0.029) • No. swimmers => violent shudder (0.055) • Swimmer dive => change dir. composite (0.003) • Dive at the dorsal => change dir. composite (0.045) • Dive at the tail => violent shudder (0.007) • Interaction between injured, boat approach & virgin sighting => dive composite (0.031) • Interaction of injured & flash photography => dive composite (0.004)
Model 4: Dive head, dorsal, tail; Touch face, dorsal, back, tail	Main effects	Touch (0.033) Swimmer dive (0.004) Flash photography (0.001) Dive Tail (0.023) Touch Dorsal (0.026) Touch Back (0.005) Touch Tail (0.025)	• Feeding => change dir. composite (0.05) • Touch => dive composite (0.005) • Path obstruction => dive composite (0.020) • Number of swimmers => violent shudder (0.027) • Swimmer dive => change dir. composite (0.005) • Flash photography => dive composite (0.000) • Dive at the tail => violent shudder (0.003) • Touch dorsal => dive composite (0.004) • Touch back => dive composite (0.008) • Touch tail => dive composite (0.004)