Interactions between Indo-Pacific Humpback Dolphins (*Sousa Chinensis*) and the speedboats in Tai O waters of Hong Kong

Patty Tse, 2010

Abstract

The purpose of the present study is to observe the frequency of speedboats and their interactions with the Indo-Pacific humpback dolphins (*Sousa chinensis*) at Tai O waters of Hong Kong, which is believed to be an important habitat for the dolphins. The general situation of the speedboat operation in the study area was reviewed and it was found that the number of speedboat involved in dolphin watching had slightly increased in recent years. The behaviour of the skippers was measured against the Code of Conduct for Dolphin Watching Activities issued by the Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region. While most operators had slowed down at a certain distance when approaching dolphins, practices which created disturbances to the dolphins were observed from time to time, as shown by the evasive behaviour of the dolphins. Those practices include approaching the dolphins at high speed, clustering around the dolphins in high numbers, cutting across the course of dolphins, abrupt changes in boat direction, etc. Although the negative impacts of dolphin watching activities are cumulative rather than catastrophic, repeated disturbances could have deleterious long term effects on the dolphin population. In view of this, recommendations to the government were made in stepping up measures to reduce disturbances to the dolphins and increase the education value of dolphin watching at Tai O, to ensure the sustainability of the dolphin population, as well as the dolphin watching activities in Tai O waters.

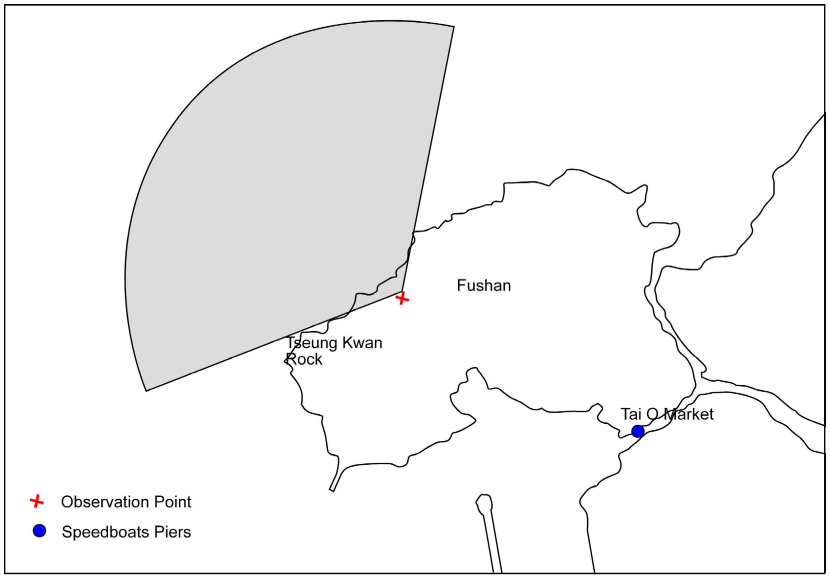
I. Introduction

Dolphin watching is becoming more and more popular worldwide and has brought considerable income to the local economy. At the same time, the impact of dolphin watching on dolphins has become a concern. The purpose of the present study is to observe the frequency of speedboats and their interactions with the Indo-Pacific humpback dolphins (*Sousa chinensis*) at Tai O waters of Hong Kong, which is believed to be an important habitat for the dolphins. The impacts are assessed with reference to the Code of Conduct for Dolphin Watching Activities issued by the Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region. Situations under which dolphins appeared to be disturbed were identified, with a view to give recommendations to the government and tour operators on what could be done to minimize impacts on dolphins for the sustainability of the dolphin population and dolphin watching in the area.

II. Materials and Methods

A total of 12 valid land-based observations (total 35.37 hours) were conducted between 17 May 2009 to 1 May 2010 on high grounds of roughly 65 metres above sea level at Fushan of Tai O, Lantau. As the main purpose of this study is to observe the interactions between speedboats and dolphins, observations were carried out in the afternoon for three hours (except summer months with duration shortened to two hours) between 13:00 hours and 17:00 hours on Sundays or public holidays when demands for speedboat rides were expected to be higher. Binoculars of 10 times magnification (front lens diameter of 25mm and 42mm) were used to aid observation and a digital camera with 100-400mm focal length lens was used for recording and observation purposes. Roughly 1 kilometre of clear field of view could be obtained from the observation point with binoculars and bare eyes (Please refer to figure 1 for the study area). The investigator was present every time land-based observation was carried out to ensure consistency of the data collected. Volunteers who were given a briefing beforehand, were present occasionally to assist in data taking and observation.

Figure 1: The study area



As the boats under different companies are painted in different colours and each of them bears a number, the boats can be identified from a distances with the help of binoculars and camera to avoid confusion or double counting. Hence, the duration of

each boat staying in the study area and the time spent on dolphin watching can be counted. Number of passengers on board was also recorded to make a more accurate assessment on the demand for the activity.

Dolphins' reaction to each of the boat was recorded. A new record was made whenever there is a change in the situation, e.g. the leaving of a boat from the scene, the appearance of a boat in the scene, or when new dolphin(s) was/were observed in the area. Different groups of dolphins were identified as far as possible by their group size, colour pattern, position, etc.

The influences of boats on dolphins are determined by dolphins' reactions to the boats: "evade", "no reaction" or "approach". Evasive behaviour was identified as dolphin(s) disappearing in the proximity or reappearing much further away from the approaching boat(s) or changing direction of travel. Where dolphin(s) reappeared within 1-2 minutes in the proximity of the boat(s), the observation was recorded but it would be considered as "no reaction", which suggested no apparent change in behaviour. As dolphins sometimes appeared quite close to some of the boats while the boats tended to move closer to the dolphins at the same time, it was very difficult to determine if it was the dolphins which approached the boats or it was out of the movement of the boat itself. Unless there was a clear indication that the dolphin was approaching the boat from a distance, the reaction of dolphins was considered as "no reaction" in such case.

III. Results

3.1 Speedboats in the area

3.1.1 Speedboats – number and colour

It was found that there was a slight increase in the total number of speedboats involved in dolphin watching in the Tai O waters as compared to previous years of 2004-2006 when surveys were conducted during summer time. In 2006, only 9 boats were involved in dolphin watching. Yet, during the observation period, a total of 11 boats were found to be involved in dolphin watching (table 1).

Table 1: Speedboat numbers and colours operating in different years

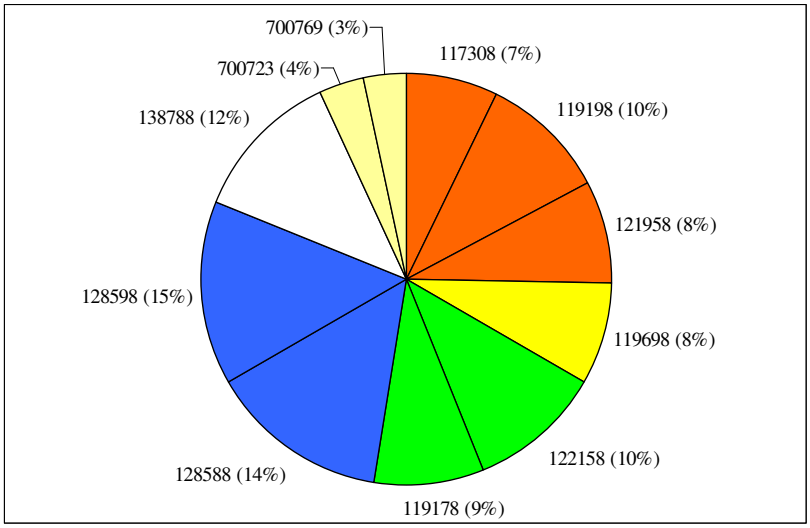
Boat colour/Year	2004*	2005*	2006*	2009/10
NA	114308	114308		
Orange	117308	117308	117308	117308
Green	119178	119178	119178	119178
Orange	119198	119198	119198	119198
Yellow	119698	119698	119698	119698
NA	120528	120528	120528	
Orange	121958	121958	121958	121958
Green	122158	122158	122158	122158
Blue		128588	128588	128588
Blue		128598	128598	128598
White				138788
Yellow/White				700723
Yellow/White				700769
Total no. of boats	**8**	**10**	**9**	**11**

** Based on previous studies done by the Hong Kong Dolphin Conservation Society in summer time of the year indicated*

NA = Information not available

Among all boats, the most frequently sighted boats are the two blue boats under the company literally translated as Dolphin Travel (海豚旅遊). The percentage as per the frequency of boats observed is shown in figure 2 with the number and colour of the boats indicated.

Figure 2: Percentage as per the frequency of boats observed



3.1.2 Frequency of speedboats and duration of dolphin watching

The frequency of speedboats in the area is highly demand driven, that is, it depends on how many visitors come to Tai O on the day and how many of them join the boat ride. No clear seasonal pattern was observed. An average of 9.82 boats (median=10; mode=11) were in operation on the same observation day (please refer to table 2). All the 11 boats would be in operation on days when demand for the boat ride was high. The highest boat frequency per hour reached 21 trips, with a norm of roughly 12-15 trips per hour. On windy days, most speedboats stayed in the sheltered area near to the pier and did not venture out to the study area, therefore, the number of boats per hour could be as low as two boats within the study area. Yet, the boat frequency remained more or less 12-15 boats per hour on those days as observed from the pier.

As the boat ride lasts for roughly 20-30 minutes, the turnover rate for the boats can be quite high. The boat ride includes sightseeing to the stilted houses and dolphin watching. The average time spent in the study area was 8 minutes (range: 1-22 mins; median= 8 mins; mode=7 mins).

Table 2 General Statistics on Tai O Speedboat Operation on Public Holidays

	Boats in operation each day	Boat Frequency per hour	Passengers per hour	Duration in the study area (mins)	Successful rate of seeing dolphin (%)	Dolphin watching duration (mins)
Mean	9.8	12.5	114	8.0	38	4.9
Median	10.0	13.0	118	8.0	46.67	5.0
Mode	11.0	12, 15	104	7.0	0.00	1.0
Standard deviation	1.3	4.4	49	4.1	32.26	3.3
Maximum	11.0	21.0	207	22.0	95	15.0
Minimum	7.0	2.0	13	1.0	0	1.0

The successful rate of seeing dolphins varied greatly with days (standard deviation = 32.26). The successful rate was calculated by the number of boats observed to encounter dolphins divided by total number of boats observed in the area during each observation day with the results converted to percentages. While the mean rate was 38%, it was worth noting that there were days with 0% of the boats having dolphin encounter and there were days with as high as 95% of the boats having dolphin encounters. Time spent on dolphin watching varied as well. While the mean duration was roughly 5 minutes, some boats just left the area once dolphins were sighted. And yet, some boats tended to stay longer (longest as 15 minutes) when dolphins were sighted.

3.2 Dolphins in the area

The presence of dolphins could be very unpredictable in the study area. There were 4 out of 12 observation days with no dolphin being observed in the study area within the three hours of observation. Yet, there were 5 occasions with dolphin(s) being present in the area for over an hour in the study area.

The group size observed ranged from 1 to 8 individuals. The dolphins were observed carrying out different activities in the study area. Most of the time, dolphins were observed milling (43.9%) and breaching (40.3%). While it was very difficult to ascertain whether dolphins were feeding underwater, there were occasions when dolphins were observed following fishing boat. Fishermen were throwing small fishes into the sea and dolphins were observed just next to the fishing boat with fish-eating sea birds flying above. This activity was identified as feeding. Travelling was identified when the dolphin passed by the study area from one direction towards another direction and disappeared. Socializing was identified when a group of dolphins were found rubbing against each other, tail slapping or creating splashes.

Table 3: Dolphin's activities in the study area

	General situation		**Without boats**		**With boats**	
Activity	**Occurrence**	**%**	**Occurrence**	**%**	**Occurrence**	**%**
Feeding	8	5.9%	3	9.4%	5	4.9%
Milling	58	43.0%	11	34.4%	47	45.6%
Breaching	56	41.5%	14	43.8%	42	40.8%
Travelling	4	3.0%	1	3.1%	3	2.9%
Socializing	7	5.2%	2	6.3%	5	4.9%
Spyhopping	2	1.5%	1	3.1%	1	1.0%
Total	**135**	**100%**	**32**	**100%**	**103**	**100%**

As shown in table 3, dolphins seem to breach and feed more and mill less when the boats were not around. And yet, due to the small sample size, more observation would be needed to make an accurate comparison on the activities of dolphins with and without the presence of speedboats.

3.3 Interactions between Speedboats and Dolphins

3.3.1 Speed of boats when approaching dolphins

A total of 134 boats were observed having interaction with dolphins. While it was impossible to measure the speed of the boats from the observation point, the splashes / traces made by the boat could give quite an accurate estimation on its speed. Boats travelling in different speed modes are shown in figure 3.

Figure 3: Boats travelling in different speed modes

Table 4 below shows the reaction of dolphins in response to speedboat number and speed. It can be seen from table 4 that 76.12% of the speedboats (102 out of 134) slowed down when they came closer to the dolphins. Some even stopped. However, in spite of this, there were 43.14% of the occasions that the dolphins still evade with the slow approach of the speedboats.

Table 4: Dolphins' reaction to speedboat number and speed

	Approaching Speed					
	Fast		Normal		Slow / Stop	
	Evade	No reaction	Evade	No reaction	Evade	No reaction
1st boat	1	1	2	2	13	28
2nd boat	3	3	2	1	12	18
3rd boat	4	1	2	0	11	12
4th boat	1	0	2	1	3	0
5th boat	0	0	2	1	3	0
6th boat	0	0	1	0	1	0
7th boat	0	0	2	0	1	0
Subtotal	9 (64.29%)	5 (35.71%)	13 (72.22%)	5 (27.78%)	44 (43.14%)	58 (56.86%)
Total	14		18		102	

Some boats approached the dolphins at high speed and only slowed down when they almost got to the point where dolphins just appeared. When boats approached dolphins at high speed, dolphins evaded in 64.29% of the occasions. Of the 35.71% of occasions where dolphins showed no reaction, the boats had slowed down when they got closer to the dolphins. When boats approached dolphins at normal speed, dolphins evaded in 72.22% of the occasions. Similarly, of the 27.78% of occasions where dolphins showed no reaction, the boats had slowed down when they got closer to the dolphins.

Figure 4: Speedboat approaching dolphins (at right corner) at speed (taken from boat around Yi O)

It was in fact common to find speedboats entering into the study area at either normal or high speed. If there was no sign of dolphins (when no other speedboats stopped or clustered at a certain area or no dolphin was sighted), some of them tended to slow down to search for dolphins. However, when there were a few speedboats clustering in a certain area, latecomers usually drove at high speed towards them, believing that they could find dolphins there. The latecomers only slowed down when they got close to other boats. Some even drove pass other boats at high speed, through the area where dolphins just appeared, as shown in figure 5.

Figure 5: Speedboat driving through the area where other boats were watching dolphins

3.3.2 Number of boats surrounding dolphins

The traffic in the study area was basically dominated by the speedboats, with occasional occurrences of ferries (running between Tuen Mun to Tai O), dolphin watching boats, private yachts, small fishing sampans and fishing boats. Table 5 below shows the number of boats in the proximity of dolphins at the same time.

Table 5: No of boats in the proximity of dolphins (including dolphin watching boats and private yachts)

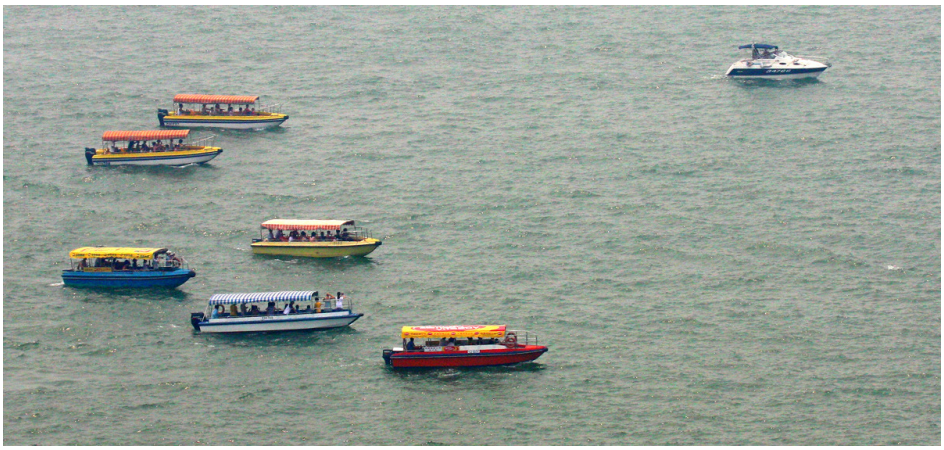
	No. of Occasions	**Percentage (%)**	
0 boats	21	20.39	
1 boat	22	21.36	69.90%
2 boats	25	24.27	
3 boats	25	24.27	
4 boats	1	0.97	9.70%
5 boats	4	3.88	
6 boats	2	1.94	
7 boats	3	2.91	
Total	103	99.99	

As shown in table 5, it is common to find dolphins having 1-3 boats in their proximity. The percentage reached 69.9% in total. Boats kept on coming and going, as some boats left soon once dolphins were sighted, with new comers joining in within a short time.

On days when boat rides were in high demand, dolphins were found to be surrounded by as many as seven boats at the same time, as shown in figure 6a and 6b. Sometimes, apart from the speedboats, larger dolphin watching boats or private yachts were also present.

Figure 6a: The dolphin watching boat was leaving the scene while others kept following the dolphin

Figure 6b: Dolphin with seven boats in their proximity again (splash of dolphin on the right)



To further elaborate on the data presented in table 4, it is shown that dolphin reacted negatively when the number of speedboats increased in their proximity, as shown in table 6. Evasive behaviour increased drastically with the approach of the fourth boat from 57% to 86%. Evasive behaviour reached 100% when the sixth or seventh boat came into the proximity of the dolphins.

Table 6: Dolphins' reaction to increasing number of boats

	Evade (%)	No reaction (%)	Total no. of boats
1st boat	34%	66%	47
2nd boat	44%	56%	39
3rd boat	57%	43%	30
4th boat	86%	14%	7
5th boat	83%	17%	6
6th boat	100%	0%	2
7th boat	100%	0%	3

3.3.3 Position of boats

While most skippers slowed down when they approached dolphins, some of them did maneuver their boat in a way that was observed to create disturbances to dolphins. For instance, some boats left the scene at high speed by passing from the front of other boats next to it, driving through the location where dolphins just appeared, as shown in figure 7. Some reversed their boat and left at normal or even high speed.

Figure 7: Speedboat leaving the scene at speed passing the location where dolphins just appeared

While some speedboats left the scene once dolphins were sighted, some tended to stay for some time. The speedboats come and go at high frequency. As shown in figure 8, a small area could be congested with 3-4 boats (middle of figure 8). To make the matter worse, the movement of the boats could be in different directions (right side of figure 8: blue boat facing the observation point; yellow/white boat, orange boat facing outward; left side: white boat and orange boat facing right, with one green boat facing left about to leave). Some boats came into the scene (e.g. green boat on the left) or left the scene at speed. The movement of the boats, together with the speed, would make the boats unpredictable to the dolphins.

Figure 8: Speedboats moving in different directions, with a small area congested with boats.

Boats were observed to approach dolphins at shallow waters close to the shore. The dolphins were 'cornered' to shore and disappeared, as shown in figure 9.

Figure 9: 'Cornering' dolphins to shore

3.3.4 Change of dolphins' location and group size in response to speedboats

Dolphins were observed to keep changing their location towards a direction that is away from the approaching speedboats, suggesting that the dolphins were evading from the speedboats. The following observation was made on 13 December 2009:

"With the presence of the boats, the seemingly same group of dolphins had been changing location from time to time to evade from the boats, though they stayed in the area for almost three hours." The approximate movements of the dolphins are shown in figure 10. The group size also changed accordingly in response to the speedboats and this is summed up in table 7.

Figure 10: Change in dolphins' position in response to speedboats on 13 December 2009

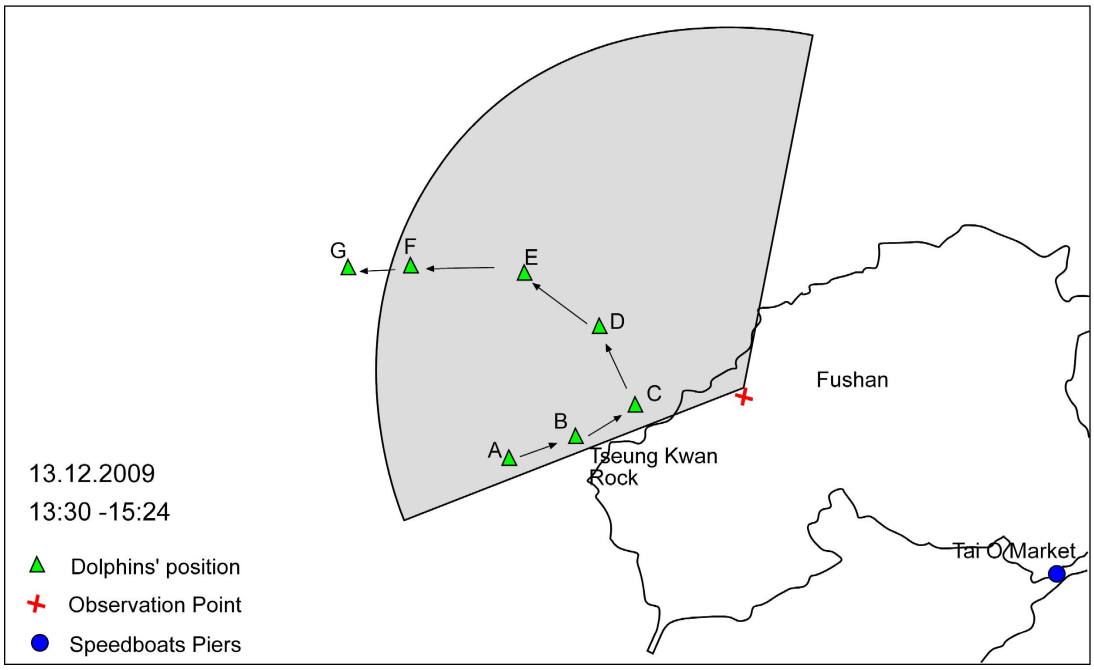


Table 7: Changes in dolphins' position and group size in response to speedboats on 13.12.2009

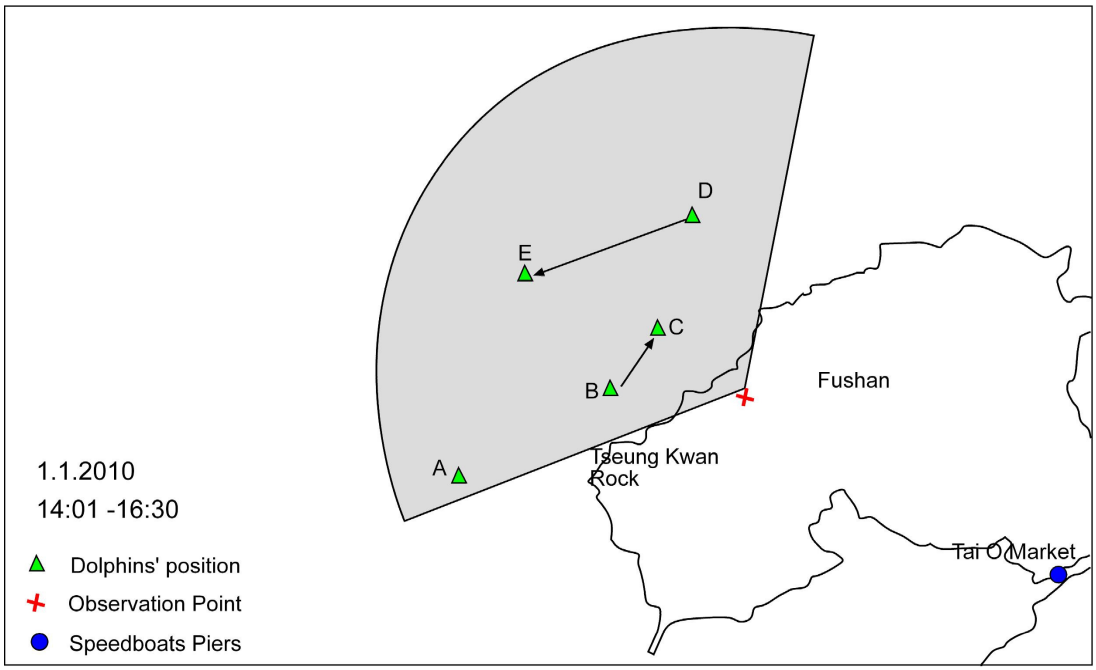
Time	Position	Group size	Boats around	Response
13:30 – 13:33	A	6	0	
13:33 – 13:37	A → B	4 → 2	2	evade
13:59 – 14:01	C	2	1	no reaction
14:06 – 14:08	C	4	3	evade
14:12 – 14:14	C	8	1	no reaction
14:16 – 14:27	C → D	8 → 4	3	evade
14:44 – 14:49	E	4	3	evade
15:01 – 15:04	F	1-2	2-3	evade
15:22 – 15:24	G	1-2	3	evade

Reduction in group size and evasive behaviour were observed when dolphins were 'cornered' to shore at around 13:33 hours. While the group started to aggregate at point C between 13:59 to 14:14 hours, it reduced again in the presence of three speedboats, the third of which came into the scene at high speed. The group size kept decreasing with the approach of more boats.

Similar observations were made on 1 January 2010 with dolphins changing their location towards a direction that was away from the approaching boats, as shown in

figure 11. At around 15:36 hours, a dolphin watching boat was observed at point B where 2 dolphins were present breaching. Two speedboats joined in for dolphin watching. Between 15:28 hours and 15:49 hours, a total of 8 boats (7 speedboats and 1 dolphin watching boat) had come and gone for dolphin watching. Dolphins moved from point B to C and disappeared at 15:49 hours. Later on at around 16:23 hours, 1 dolphin was sighted and it changed its position from point D to E with the approach of 7 speedboats coming from different directions almost at the same time (Figure 8). It disappeared for roughly 5 minutes and reappeared further away from the speedboats at 16:29 hours.

Figure 11: Change of dolphins' position in response to speedboats on 1 January 2010



IV. Discussion

The discussion below is mainly based on the observation of the speedboat skippers' behaviour and the observable response of dolphins to the speedboats. Practices of boat skippers are measured against the Code of Conduct for Dolphin Watching Activities ("the Code of Conduct") issued by the Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region ("AFCD"). Studies on impacts of cetacean watching activities on dolphins or whales were also quoted as a reference to facilitate discussion.

4.1 The Code of Conduct for Dolphin Watching Activities

The Code of Conduct is a voluntary code with the purpose of minimizing disturbances to dolphins in dolphin watching activities. Incompliance with the Code of Conduct may mean causing various extents of disturbance to the dolphins. Table 8 below is the Code of Conduct, with points highlighted to facilitate discussion.

As shown in Section 3.3 above, certain behaviours of the skippers were observed to be incompliant with the Code of Conduct as highlighted in table 8, and such practices did give rise to negative responses from the dolphins. While it was not possible to measure the exact speed of the speedboats with bare eyes, some boats did approach

the dolphins at high speed though some slowed down when they got close to the dolphins or other speedboats that had slowed down or stopped for dolphin watching. It was obvious that some speedboats had not ***"(kept) vessel at slow, steady speed without sudden course changes" or "slow(ed) down to no-wake speed, and stop(ped) if dolphins appear directly ahead within 100 metres"*** and they ***"approach(ed) dolphins head on".*** In response to the approaching fast-moving speedboat(s), dolphins evaded in most cases (64.29%), suggesting the boats caused disturbances to the dolphins.

Table 8: The Code of Conduct for Dolphin Watching Activities is as follows:

Code of Conduct for Dolphin Watching Activities
- The General Rule: Watch from a distance, and do not seek to touch, feed or harm dolphins.
- Allow dolphins to make the choice to approach or leave. If a group of dolphins is difficult to observe and elusive, leave them alone and try to find a more accommodating group.
- Never chase or intercept the course of dolphins, separate mothers and calves or 'corner' dolphins.
- Never approach dolphins head on.
- Always slow down to no-wake speed, and stop if dolphins appear directly ahead within 100 meters.
- Keep vessel at slow, steady speed without sudden course changes. Boat speed should not exceed 10 knots.
- Only one dolphin watching vessel should be present within 500 metres of a group of dolphins
- Never conduct reverse throttling when dolphins are nearby.
- Don't litter or discharge any pollutants into the sea.
- Never touch, swim with, or feed dolphins.
- When observing dolphins near pair trawlers, the dolphin watching vessels should not:
i) go near the marker buoy of the trawl net;
ii) move away suddenly after trawlers hauled up the net.

As shown in section 3.3.2, as many as 7 boats could be found within a small area in the proximity of the dolphins during the times when the demand for boat ride was high, which was totally incompliant with the Code of Conduct of ***"Only one dolphin watching vessel should be present within 500 metres of a group of dolphins"***. The present study had shown that dolphins reacted negatively to the increasing number of boats.

As discussed in section 3.3.3, some skippers did drive their boat in a way that cause disturbance to the dolphins. Some had ***reversed throttling*** when they left the scene. Some had ***chased or intercepted the course of dolphins, or 'cornered' dolphins*** between boats and shore. While some dolphins remained in the area in spite of these, some did evade from the scene. Boat strike was likely to occur especially when there were so many speedboats coming and going, moving in different directions, sometimes at high speed, which are unpredictable to the dolphins, and with little space between the boats (as shown in figure 8).

Although the social structure of the Indo-Pacific humpback dolphins is very fluid and group composition changes frequently, with mean group size as 4 (according to the website of AFCD), a group of 8 individuals was observed socializing in the study area. And yet, the group was split up with the continuous approach of speedboats.

Given the short duration of the boat ride (20-30 minutes in total), the skippers had been eager to show dolphins to the tourist as soon as they could. Even if there were

already quite a few boats around the dolphins, the late comers still tried to get close to the dolphins regardless of the fact that the dolphins were trying to evade from the boats. If the dolphins were evasive, they would follow them for a longer time. This is incompliant with the Code of Conduct on ***"Allow dolphins to make the choice to approach or leave. If a group of dolphins is difficult to observe and elusive, leave them alone and try to find a more accommodating group."***

The present study had confirmed that while most speedboats had slowed down for dolphin watching, malpractices did exist when measured against the Code of Conduct. Evasive behaviours of the dolphins were observed, suggesting that the dolphins were exposed to disturbances.

4.2 Implications for the dolphins in Tai O waters

4.2.1 Importance of Tai O waters to dolphins

The Executive Summary of the "*Monitoring of Marine Mammals in Hong Kong waters – Data Collection (2008-09)*" issued by AFCD has confirmed the importance of Tai O waters to the Indo-Pacific humpback dolphins as nursery, feeding and socializing grounds.

> *"From 2002-08, high densities of young calves can be found around Lung Kwu Chau, near Tai O Peninsula, Kai Kung Shan, Fan Lau and Kau Ling Chung. All these areas can be considered important* ***nursery areas****, which should be protected by more stringent measures. In addition, a total of 35 and 26 dolphin sightings were associated with feeding and socializing activities respectively. Most of these sightings were found along the west coast of Lantau and around Lung Kwu Chau. From 2002-08, several areas recorded higher sighting densities for* ***feeding activities****, including the grids near Tai O and Peaked Hill, around Lung Kwu Chau and at Sham Shui Kok. And the grids with very high sighting densities for* ***socializing activities*** *were located at Sham Shui Kok and around Lung Kwu Chau. All these areas could be considered important feeding and socializing habitats for dolphins."*

Given the importance of Tai O waters to the local Indo-Pacific humpback dolphins, disturbances described above may have various implications on the dolphin population.

4.2.2 Threshold of Disturbance

Animals have threshold disturbance levels. While dolphins may find a low level of disturbance arising from human behaviour tolerable, increasing disturbances may reach a level that cause them to shift their movement and behaviour patterns more drastically (Lundquist and Markowitz, 2009). In the present study, dolphins were found to be sensitive to two measurable aspects of the boats where two types of threshold of disturbance could be identified, namely the speed and number of boats in the proximity of dolphins.

Speed of boats

As shown in the present study, dolphins tended to show less negative responses to the speedboats if the boats slowed down or stopped when they approached dolphins

(evasive rate: 43.14%). Some dolphins indeed surfaced quite closely to the boats and even breached just next to the speedboats, a friendly action as described by Ng and Leung (2003). However, as shown in section 3.3.1, dolphins evaded from the scene in all cases when the boats approached at fast or normal speed no matter how many boats were around, unless the boats slowed down or stopped on time when they got close to the dolphins. In some cases, even if the boats slowed down or stopped when they got close to the dolphins, the dolphins still evaded. This indicates that dolphins considered speedboats moving at fast or normal speed a disturbance.

The study by Ng and Leung (2003) also confirmed that the Indo-Pacific humpback dolphin community is sensitive to high-speed vessels. The first reason is the travelling speed which allows dolphins the least amount of time to adjust their behaviour to a fast-moving vessel. For some extreme cases in their study, aggregated dolphins fled in different directions upon the approach of a high-speed vessel. The second possible reason is the noise produced by the high-speed vessels. From the perspective of conservation, they suggested that high-speed vessels are of the most concern because they often cause behavioural disruptions to the dolphins, which are believed to be detrimental to the social order and behaviour of the animals (Richardson et al, 1995). Behavioural disruption may also cause energy implications to dolphins. For example, rapid fleeing results in more energy expenditure while interrupted feeding implies less energy intake. Such energy implication may have a long-term subtle effect on the sustainability of the dolphin population (Nowacek & Wells, 2001).

Number of boats

In the present study, dolphins were also found to respond negatively to the increasing number of boats in their vicinity, as shown in section 3.3.2. While evasive behaviour occurred even with 1 boat around, such response increased drastically from 57% to 86% for the third boat and fourth boat to be present respectively. Evasive behaviour reached 100% when the sixth or seventh boat came into the proximity of the dolphins. While the level of intolerance in terms of evasive behaviour increased gradually from the presence of 1 boat to 3 boats, the drastic increase in evasive behaviour with the approach of the fourth boat suggested that the threshold of disturbance to the dolphins in terms of the number of boats might have been reached when more than 3 boats were in the proximity of the dolphins.

Many studies had confirmed that the impact of vessels on dolphin is directly related to the number of boats approaching the dolphins (Constantine et al, 2004; Bejder & Samuels, 2006), probably linked to the increase in noise (Bejder & Dawson, 1999) and the possibility for the animals to easily and comfortably escape a possible threat scenario (Wursig, 1996) through increased dive duration or changing swimming speed and direction (Lemon et al, 2006). The increasing number of boats would cause changes in the behaviours of dolphins, which may give rise to long term impact on the population.

The study of Lundquist and Markowitz (2009) revealed that the behaviour of dolphins was significantly affected by the number of boats within 300m. Their study showed that in general, resting and socializing decreased, travelling and milling increased, and

transitions between behavioural states occurred much more frequently. When one boat was present, dolphins rested, socialized, and milled less and travelled more. Two boats resulted in less resting and travelling and more milling. The presence of three boats resulted in switching between behavioural states very frequently. More than three boats resulted in increased milling.

According to Arcangeli and Crosti (2009), travelling, resting and feeding were the behavioural states more affected by the presence of the tour boat. Decrease in the time spent on foraging is likely to result in a reduction in energy acquisition due to decrease in food intake. Therefore, repeated interruptions by tourist boats during foraging are likely to have long-term negative impacts on dolphins' survival (Christiansen et al, 2010). Resting is important for the health of many animal species (Bishop, 1999). A reduction in time spent on resting due to human disturbance has been shown to induce physiological stress, cause an increase in heart rate and energetic costs, and reduce energy reserves for a variety of mammal species (Constantine et al, 2004).

4.2.3 Habituation and Displacement of certain individuals

It is worth noting that in 50.74% of all the interactions observed, dolphins seemed to show no reaction or negative response to the speedboats. Yet, such observation by no means indicates that the disturbances discussed above do not have any negative impact on the dolphin population.

The concept of "habituation" may be used to explain this phenomenon. As quoted by Bejder and Samuels (2003), "habituation" is defined as a gradual weakening of the behavioural response to a recurring stimulus that provides no apparent reward or punishment (Allaby, 1999). In their study, they found that dolphins categorized as "habituated" engaged in human-interaction activity during 77% of observation time, whereas other dolphins, categorized as "unhabituated", never engaged in human-interaction activity. Human-interaction behaviours indicative of habituation included: remain close to vessels, leap up or lunge at vessel, beg from humans or accept food from humans. In some circumstances this can cause problems when the reduction in the animals' natural wariness to human activity results in heightened vulnerability to vessel strikes, entanglement and vandalism (Samuels and Bejder, 1998, in press; Spradlin et al, 1998, 2001; Stone et al, 2000).

Various studies suggested that, when dolphins are disturbed in an important habitat, the more tolerant ones may choose to stay and yet their usual activity may be affected, while the less tolerant ones may choose to leave the area. And yet, according to Bejder et al (2006), while it was formerly assumed that animals moving away from disturbances are more greatly affected than those that remain (Foster & Rahs, 1983; Fowler, 1999), recent studies suggest that departing animals may be the ones with sufficient condition to do so (Stillman & Goss-Custard, 2002; Beale & Monaghan, 2004b). That means, those without sufficient condition to leave would have no choice but to stay in the area. Moreover, if disturbance is concentrated in a critical habitat, animals may have no other option but to stay (Creel et al, 2002; Dyck & Baydack, 2004).

Human disturbances are also found to result in short-term changes in ranging patterns and habitat use. The study of the Society for Marine Mammalogy (2000) showed that, bottlenose dolphins decrease their use of primary foraging habitats during periods of high boat density. Allen and Read (2000) suggested that dolphins shift habitat use either to directly avoid areas of high vessel traffic or in response to vessel traffic. In the long term, disturbances may result in redistribution of animals within a population, such that less tolerant individuals or members of certain age, sex or reproductive classes become sensitized and displaced to less optimal areas where food resources are less abundant or predators are more prevalent (Bejder and Samuels, 2003).

4.2.4 Possible Long Term Impacts on the population

While some dolphins may be habituated to human presence, according to various studies quoted above, their usual activities are affected and they are exposed to higher risk caused by human activities. Studies on various cetacean species had shown that, repeated disruptions due to human activity are likely to affect cetacean behavioural activity budget (that is how much time dolphins spend on foraging, resting, socializing) and could ultimately affect survival or reproductive success of the population (Bejder and Samuels, 2003). Lusseau (2003) found that there may also be an energy-budget threshold where the stress caused by boat interactions cannot be energetically counterbalanced by the benefits of the area. When animals switch from short-term evasive tactics to long-term site avoidance in response to escalating disturbance, costs of tolerance have likely exceeded benefits of remaining in previously preferred habitat (Bejder et al, 2006). The community may then shift to a suboptimal area to escape the energetic costs of boat impact (Gibeau et al, 2002).

4.3 Recommendations for Management

Given the fact that certain practices of the speedboat skippers in the area were observed to cause disturbances to dolphins, for the well being of dolphins as well as sustainability of the dolphin watching activities in the area, the following recommendations are made for the consideration of the Government.

4.3.1 Promote good practices to speedboat skippers

It should be acknowledged that the speedboat operators or skippers should have no intention at all to cause harm to the dolphins as they rely on them to attract people for a boat ride. Having operated the speedboats for quite a long time in the area, the skippers should be acquainted with how they should approach the dolphins so that dolphins would not evade. Yet, sometimes when the skippers were too eager to show the dolphins to the tourist, especially on days with high demand, they may not be aware that their behaviour were causing disturbances to the dolphins and may have long term impacts on the dolphins in the area, which may in turn affect the sustainability of dolphins and the dolphin watching activities in the Tai O waters.

As many of them may not be aware of the existence of the Code of Conduct, which can help them to minimize their disturbance to the dolphins, the government should provide training and briefings to the speedboat operators. The skippers should be informed of the problem caused by their eagerness to approach dolphins and its possible consequences (that is some dolphins may choose to leave the area due to disturbances). The good practices detailed in the Code of Conduct should be

promoted to the skippers. As it was identified in the present study that dolphins are sensitive to the speed and number of boats, speedboats skippers should be requested to approach dolphins at slow steady speed, and there should not be any sudden change of course. Moreover, they should not cluster around dolphins.

4.3.2 Number of speedboats involved in dolphin watching

As it is shown in section 3.3, the increasing number of boats in the proximity of dolphin did create pressure on dolphins and the present study shows that the disturbance threshold appeared to be 3 boats. According to the Code of Conduct, only one dolphin watching vessel should be present within the 500 meters of a group of dolphins. While the Code of Conduct should best be followed, it may be quite unrealistic to have this strictly implemented, given the short duration of a boat ride. However, it would greatly reduce the disturbance to dolphins if the number of boats in the proximity of the dolphins could be strictly restricted to 3 boats (speedboats or other dolphin watching boats or private yacht) at one time. Skippers should be encouraged to find another group of dolphins if there are already three boats surrounding a group of dolphins.

It is noted that the number of speedboat involved in dolphin watching at Tai O had slightly increased in recent years. In order to prevent further increase in the number of speedboats involved in dolphin watching, a licensing system should be put in place. Only the present speedboats operators should be granted a licence to include dolphin watching in their boat ride. While it would be infeasible to reduce the number of licence at this stage as it would affect the livelihood of certain vested parties, license should be limited to the present number of 11. The licences should not be transferable and when some of them become expired, no more new licence should be issued. This would enable the Government to maintain the number of boats involved in dolphin watching to a certain number and avoid competition among speedboats, which may increase disturbance to dolphins. The licence should be revoked if the skipper of the speedboat were found to repeatedly cause disturbances to the dolphins.

4.3.3 Increase Public Awareness

One of the purposes of ecotourism is to educate the public. While it is unrealistic to expect the boat skippers who were fishermen or local villagers to provide educational briefing to the public, information panels can be set up at Tai O, probably around the pier area, with emphasis on good practice in dolphin watching (that is the Code of Conduct). This would increase public awareness on how the dolphins should be approached in order not to cause disturbances to dolphins in dolphin watching activities. When they go for a boat ride, they will have the knowledge to judge by themselves whether the skipper is causing any disturbance to the dolphins. In case they find that the boat skipper is causing disturbances to the dolphins, as a customer, they could ask the skipper to adjust his behaviour or to report the case to the concerned authority. Yet, leaflets should not be distributed at the pier or by the skippers as the speedboats are relatively less sheltered, and some of them may end up in the sea.

4.3.4 Monitor for Malpractice

In order to ensure that the speedboat skippers, as well as other dolphin watching operators, follow the Code of Conduct to minimize disturbance to dolphins in the area, AFCD should patrol the area and conduct land-based monitoring in high grounds. Where malpractices are identified, follow-up actions should be taken to make sure that corrective measures are implemented.

A complaint hotline should also be set up for members of the public to report malpractices of any dolphin watching vessel (speedboats, leisure yacht or ferry) by providing the time, place and boat number or type for following up action by the Government.

4.3.5 Setting up a Marine Park in Tai O Waters

Given the importance of Tai O waters as a dolphin habitat, the Government should set up a marine park in Tai O waters. This would provide the legal framework for making the Code of Conduct mandatory and implementing the suggested measures in this section. For instance, the speed of all the boats in the area can be limited. The marine park would also serve the valuable purpose of educating the public about marine and dolphin conservation. As agreed by Ng and Leung (2003), designating the area of high dolphin abundance as a marine park or reserve is the best available solution for dolphin conservation.

4.4 Limitations of the Study

In the present study, the field of view is limited to the bay area. Observation had to be discontinued once dolphins and boats were out of sight. Moreover, when the boats go very far away from shore, land-based observation can be very difficult even with a 10x binoculars, especially on days with relatively low visibility. However, as pointed out by Bejder and Samuels (2003), land-based observations are valuable for studying coastal groups of cetaceans, having the advantage that remote observers on land are unlikely to have any impact on cetaceans in nearby waters. The elevated land platform is also a good vantage point for getting a 'big picture' perspective, which is useful to track the speed and direction of movements of animals, vessels, to measure group cohesion and spread.

The present study is limited by the weather and availability of manpower, and interactions between boats and dolphins could only be observed with the presence of both. While the sample size of the study may not be large enough to make it statistically sound, some of the observations did confirm that dolphins showed negative responses to those speedboats which were incompliant with the Code of Conduct.

V. Conclusion

In the present study, the frequency of speedboats and their interactions with the dolphins in Tai O waters were observed. The general situation of the speedboat operation in the study area was reviewed and it was found that the number of speedboats involved in dolphin watching had slightly increased. While most operators had slowed down at a certain distance when approaching dolphins,

malpractices which created disturbances to the dolphins were observed from time to time, as shown by the evasive behaviour of the dolphins. These include approaching the dolphins at high speed, clustering around the dolphins in high numbers, cutting across the course of dolphins, abrupt changes in boat direction, etc. Although there are limitations about the present study, they should not undermine the accuracy of the observations that some of the boats were operating in a way that is incompliant with the proper practices as detailed in the Code of Conduct and thereby causing disturbances to dolphins in the area.

While the negative impacts of cetacean watching activities are cumulative rather than catastrophic, repeated disturbances which cause disruption to breeding, social, feeding or resting behaviour can have deleterious long term effects on reproductive success, health, distribution and ranging patterns, or access to preferred habitat (Bejder and Samuels, 2003). If the malpractices and hence disturbances continue, with the less tolerant individuals moving away from the area, the successful rate of seeing dolphin by the speedboats would decrease, thus making the dolphin watching activity unsustainable in Tai O.

It would be mutually beneficial to the humans and dolphins if cetacean watching activities are run properly. For the benefits of dolphins and the dolphin watching tour operators, recommendations are made to the government in the present study in stepping up measures to reduce disturbances to the dolphins and increase the education value of dolphin watching in Tai O, so as to ensure the sustainability of the dolphin population, as well as the dolphin watching activities in Tai O waters.

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