# EFFECT OF WATER PARAMETERS ON THE BEHAVIOUR OF INDO-PACIFIC HUMPBACK AND IRRAWADDY DOLPHINS IN COWIE BAY, SABAH, MALAYSIA

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**ABSTRACT.** *Many dolphin species around the world are found generally in coastal areas and may be affected by water parameters. Of particular attention are two species of dolphin inhabiting the Cowie Bay on the eastern coast of Sabah; the Indo-Pacific Humpback (Sousa chinensis) and Irrawaddy (Orcaella brevirostris) dolphins. The objective of this study is to determine effects of water parameters (sea surface temperature (SST), salinity and turbidity) on the behaviour (feeding, socializing and travelling) of the two dolphin species. A boat-based survey was conducted monthly from April 2008 to March 2009 (one year) during spring and neap tides. There were 47 surveys conducted for both species. Irrawaddy dolphins were found in 43 surveys (91.5%). The feeding and socializing behaviour of Irrawaddy dolphins were positively correlated with SST and negatively correlated with turbidity. None of the water parameters affected dolphins' travelling behaviour. The behaviour of the Irrawaddy dolphin was not correlated with salinity. Indo-Pacific humpback dolphins were found only in 41 surveys (87.2%) where its behaviour did not correlate with any water parameters. The socio-economic activities such as logging, agriculture and fisheries highly contribute to suspended sediment and also contribute to high water turbidity in the bay. These are possible causes for the changing of water parameters and may affect the food chain of vast marine life including dolphins. As a recommendation, those activities should be controlled and an the application of sustainable development practices in order to sustain the dolphin population in the bay.*

K**EYWORDS**. Behaviour, Cowie Bay, Indo-Pacific humpback dolphin, Irrawaddy dolphin, water parameters

## INTRODUCTION

The Order Artiodactyla includes all species of whales, dolphins and porpoises. The habitat mostly found in all oceans and most of the seas (Forcada, 2002). According to Jaaman (2004), there are seven species of dolphins in Sabah. However, only two species of dolphins were found in Cowie bay; Indo-Pacific humpback (*Sousa chinensis*) and Irrawaddy dolphins (*Orcaella brevirostris*).

To date, the relationship between dolphins and water parameters has not well documented. According to Hung (2008), understanding the status of an animal species must begin with identification of the spatio-temporal boundaries of its distribution. Differential use of habitat patches of an animal species can provide implication for the importance of various habitats used in their daily life (McNab, 1963). Description of habitat includes factors such as water temperature, salinity, thermocline depth, density, type of substrate and bathymetry, all factors affecting marine mammals' distributions (Forcada, 2002).

Currently less study has been conducted to test the relationship between behaviour (feeding, socializing and travelling) of humpback and Irrawaddy dolphins and water parameters (e.g. Atkins *et al*., 2004; Smith *et al*., 2008). Therefore this study was carried out with objective to determine effect of water parameters (sea surface temperature, salinity and

turbidity) on the behaviour (feeding, socializing and travelling) of humpback and Irrawaddy dolphins in Cowie Bay.

## MATERIAL AND METHOD

### Study area

Cowie Bay is located in Tawau District, on the southeast coast of Sabah, (4°10' N -4°28' N 117°30' E -117°53' E). This bay is oblong shape with approximately 50 km long and up to 13 km wide, with its mouth facing southeast. Mangroves and estuaries form most of Cowie Bay shoreline area. This study covered only the inner area of Cowie Bay (approximately 18 km in length and up to 13 km in width), which includes Simandalan, Marumar, Seranum, Kuala Kalabakan, Brantian, Batumarpun, Mangkalitan and Umas-Umas estuaries. The standard route was established based on the 39 sampling zones starting from Wallace Bay, entering Kalabakan and heading out to the Umas-Umas estuary (Figure 1).

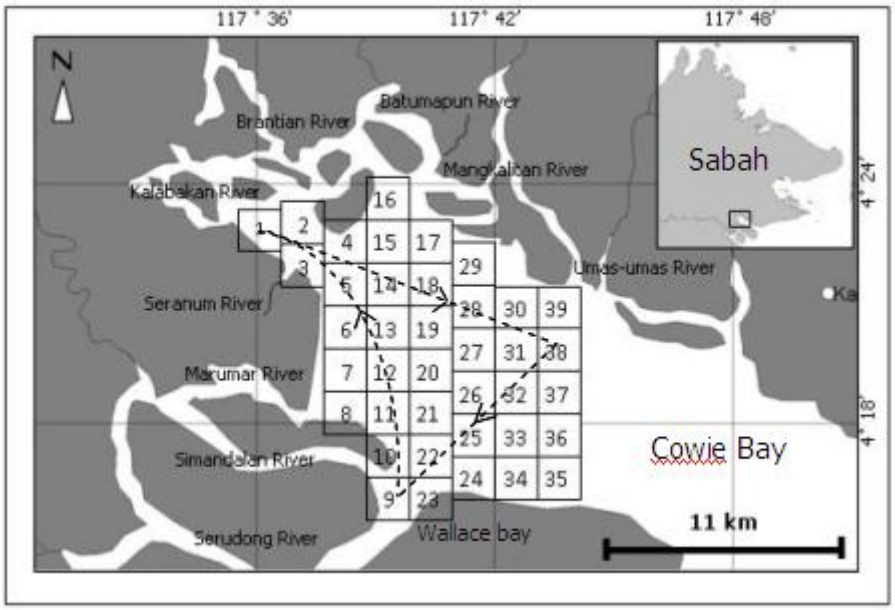


**Figure 1. Location of 39 sampling zones and direction of standard route (dash line) set up in Cowie Bay.**

The bay supports fishing activities and is a channel for transportation especially container tugboats to transport timber from upstream areas. Fishing activities (motorized shrimp trawlers extensive artisanal gillnet, trap hook and line fisheries) are common in this bay (Jaaman, 2010).

### Data Collection

The monthly study was conducted from April 2008 to March 2009 (one year) which covered the semi-diurnal tidal cycle (during neap and spring tides). Survey was conducted for 4 days where two days were spent to sight each species of dolphin.

The selection of sampling dates was based on the highest and lowest difference between high and low tides calculated from tide table, as reported in Tawau (NHC, 2008; 2009). Overall, 94 days were spent to collect sightings' data where 47 days were spent for each species. Out of 47 days, 23 days were spent during spring tide and 24 days during neap tide.

Boat-based surveys were conducted to collect data on sightings. A 7 m fibre glass boat with one 60-hp outboard engine was used in the survey. The speed of the boat was 12 to 15 km/h. Throughout the survey effort (0600 and 1800 hours), weather conditions were good with Beaufort scale of not more than 3, bright sunlight and excellent visibility. Three observers (one in the middle and one on each side of the survey boat) searched for dolphins with the aid of binoculars (Figure 2). The first observer was at the bow of the boat holding a digital camera (NIKON D300 SLR with 70-200mm zoom lens). The other two observers were located at the left and right sides of the research boat each with hand-held binocular Fujinon- Mariner Binocular (7x50 WPC-XL). The helmsman sometimes acted as an additional observer as well as holding a hand-held global positioning system (GPS) (GARMIN 60CSX) to follow the route which was initially set in the GPS.

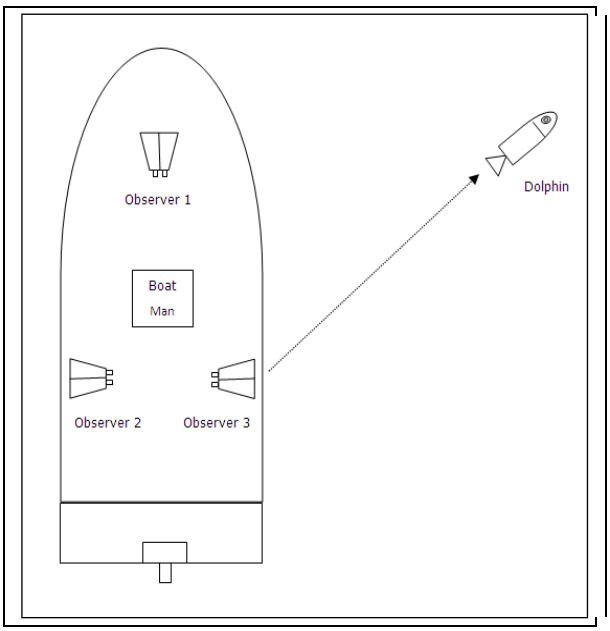


**Figure 2. The location of observers in boat survey.**

Surveys started by following the standard routes and the route was abandoned when the dolphins were spotted (Figure 1). All observers were alerted to the location of the sighting. When a sighting was made, the individuals or groups of dolphin were followed cautiously and continuously until they disappeared from sight. When dolphins were found; 1) behaviour (defined as the action or reaction of dolphins under specified circumstance) and 2) water parameters' data were collected for every 15 minutes interval. Water parameters were measured to identify the relationship of dolphins' behaviour. Turbidity was measured using a HANNA Turbidity Meter (HI 93703). Salinity and SST were measured using a HANNA multi-parameter water quality checker (HI 9828).

When dolphins were not seen or followed for more than 15 minutes, they were noted as 'disappeared' and noted as zero sighting. Then the standard route was used again to find the dolphins. Surveys were ended once the dolphins could not be found anywhere or during bad weather (i.e., heavy rain, strong wind and waves exceeding Beaufort 3).

**Data Analyses**

To test the correlation between dolphins' behaviour and water parameters, data of water parameters (during dolphins' sighting) taken for every 15-minute intervals were combined and averaged per day. Spearman Rho correlation was used to determine the correlation between the behaviour and water parameters.

## RESULTS AND DISCUSSION

In 47 days of effort, humpback dolphins were recorded on 41 days (87.2%). Irrawaddy dolphins were sighted on 43 of 47 days (91.5%). The behaviour of humpback dolphins did not correlate with SST, salinity or water turbidity ($p > 0.05$). Feeding and socializing of Irrawaddy dolphins were positively correlated with SST ($p<0.05$) and negatively with water turbidity ($p<0.05$). However, travelling behaviour of Irrawaddy dolphins did not correlate with depth, SST, salinity or turbidity (Table 1). According to Fowler and Cohen (1990), the value of r from 0.00 to 0.19 is a very weak correlation and 0.20 to 0.39 is a weak correlation. Therefore, the correlation between feeding and SST, feeding and turbidity, socializing and SST and socializing and turbidity were considered weak in this study.

**Table 1. Correlations between behavioural states of humpback dolphins (N=41) and Irrawaddy (N=43) and water parameters.**

| | | | | Feeding | Socializing | Travelling |
|---|---|---|---|---|---|---|
| Spearman's rho | Indo-Pacific humpback dolphin | SST | **r** | 0.25 | 0.31 | 0.03 |
| | | | **p** | 0.12 | 0.05 | 0.84 |
| | | Salinity | **r** | -0.11 | -0.08 | 0.22 |
| | | | **p** | 0.51 | 0.64 | 0.18 |
| | | Turbidity | **r** | 0.01 | -0.14 | -0.03 |
| | | | **p** | 0.97 | 0.4 | 0.86 |
| | Irrawaddy dolphin | SST | **r** | 0.38* | 0.33* | 0.11 |
| | | | **p** | **0.01** | **0.03** | 0.47 |
| | | Salinity | **r** | -0.10 | -0.00 | 0.14 |
| | | | **p** | 0.52 | 0.98 | 0.39 |
| | | Turbidity | **r** | -0.37* | -.035* | -0.22 |
| | | | **p** | **0.01** | **0.02** | 0.17 |

*Correlation is significant at the 0.05 level (2 tailed), r=correlation coefficient, p=probability

The behaviour of humpback dolphins did not correlate with any water parameter in this study. Humpback dolphins were easy to sight compared to Irrawaddy dolphins. Feeding and socializing of Irrawaddy dolphins correlated with SST and turbidity, but none of the water parameters correlated with travelling. In Cowie Bay area, Irrawaddy dolphins tend to follow the fishing boat and trawler compared to humpback dolphins and their feeding behaviour was influenced by time of the day. The dolphins were mostly found during 10 am to 12 pm when the temperature was higher. During field works, fishing boat and trawler activity were observed highest during this time. As the Irrawaddy dolphins tend to follow the fishing boat and trawler, this may influence their occurrence in that area.

The temperature affects their feeding but correlation is very weak and does not seem to influence them. According to Wells *et al*. (1990) the seasonal thermal variability would indirectly affect warms blooded animals only, through influencing the distribution and abundance of their prey. The environmental variables associated with feeding activities may be proxies for the abundance or availability of important prey species (Selzer and Payne, 1988).

Due to the fact that data collection was conducted more during neap tides compared to spring tide, it may influence the water parameters during dolphins sighting. According to Wilson *et al*. (2004), the outflow and inflow of the surrounding rivers discharge during the

spring tide is larger and contribute greater turbidity than neap tide. Irrawaddy dolphins preferred an area with slow moving water (Beasley, 2007 and Smith *et al*., 1997) which occurred during neap tide. Gibson *et al*. (1996) and Hampel *et al.* (2003) cited the presence of dolphins' food (e.g. fish) is known to be influenced by tidal characterises such as tidal phase and tidal range.

The strong current velocities contribute to higher sediment concentration in the water column during spring tides and opposite condition takes place during neap tide (Zhoa, 2003; Chen *et al*., 2006). The increase of sedimentation can cause decrease of zooplankton together with the phytoplankton because of food chain. The phytoplankton needs the light to do the photosynthetic activity and it is reduced as a consequence of light limitation due to high turbidities (Irigoiena and Castel, 1997). Presence of fish means higher availability of food resources for the dolphins. In other words, the zooplankton constitutes a major component of the food chain.

The dolphins in Cowie Bay use the study area for feeding and are engaged in other behaviours. Feeding and socializing of Irrawaddy dolphins were weakly correlated with SST and temperature. This shows that feeding and socializing are also associated with each other as feeding activity increases, more time is needed to cooperate with each other in order to find their food. Travelling behaviour was not correlated with any water parameters in this study area. Thus, travelling behaviour was mostly due to their feeding activities need rather than water parameters induced factors.

## CONCLUSIONS

The feeding and socializing behaviour of Irrawaddy dolphins were positively correlated with SST and negatively correlated with turbidity. None of the environmental factors measured for humpback dolphins was related to the spatial distribution, but this is considered due to the fact that most of the variables measured were within the preferred range of humpback dolphins. As a recommendation, the development of the catchment area of Cowie Bay should be in the sustainable manner in order to sustain the marine life that contribute to food chain to dolphin populations in the bay. Human activities such as fishing activities and sea transportation (such as ferries and tugboats) need to be controlled so that the impact to the dolphin habitats can be minimised.

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