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Seasonal Distribution of Indo-Pacific Humpback Dolphins at an Estuarine Habitat: Influences of Upstream Rainfall

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Abstract River estuaries are dynamic regions that are influenced by the interactions between freshwater and seawater as well as seasonal variations in river runoffs. Studies focusing on the distribution of Indo-Pacific humpback dolphins (*Sousa chinensis*) have indicated their general tendency toward estuarine habitats. The seasonal activities of humpback dolphins are likely to synchronize with environmental fluctuations. This study investigated the effects of seasonal changes in river runoffs on the distribution gradient of humpback dolphins by deploying acoustic data loggers along the Xin Huwei River estuary, Western Taiwan, between July 2009 and September 2012. Seasonal shifts were observed in the areas with high detected duration of humpback dolphins, which mainly stayed near the river mouth during the dry seasons but moved seaward during rainy seasons and following heavy rainfall. In addition, the gradient of ambient ultrasonic pulses, dominated by snapping shrimp sounds, exhibited regional differences following heavy rainfall. The outward movements of the humpback dolphins and the snapping shrimp sounds in the estuary indicated a temporary trophic-system shift in response to local environmental changes resulting from high volumes of river runoffs. In the future, the seasonal variation in the distribution of humpback dolphins must be considered during the conservation management of this critically endangered population.

Keywords *Sousa chinensis* · Seasonal distribution · River discharge · Echolocation · Ambient noise · Eastern Taiwan Strait

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Introduction

An estuary is an ecotone environment where freshwater discharge and seawater circulate and mix. Seasonal variations in upstream rainfall determine the river runoff levels and thus influence the hydrological characteristics (e.g., salinity and position of estuarine fronts) of river estuaries (Boyer et al. 1999; Lane et al. 2002; Dong et al. 2004). Despite the other factors involved in the seasonal variations of the estuarine ecosystem, the freshwater input is the major nutrient-loading source for an estuary (Mallin et al. 1991). Seasonal rainfall can influence primary productions and trophic transfers (Mallin and Paerl 1994), thereby altering the species diversity and distribution of aquatic organisms between rainy and dry seasons (Huang et al. 2004).

Cetaceans are the top predators in the marine ecosystem and exhibit varying distributions and core habitats according to season (Laran and Drouot-Dulau 2007; Verfuß et al. 2007; Akamatsu et al. 2010; Rayment et al. 2010). In river and estuarine habitats, the seasonal variations in the water quality and levels can dictate the spatiotemporal changes in the prey resources and thus shape the distribution gradient of cetaceans (Wilson et al. 1997; Martin and da Silva 2004; Fury and Harrison 2011a; Kimura et al. 2012). Moreover, in addition to seasonal fluctuations, estuarine dolphins have also been observed to leave their estuarine habitats temporarily during flood events (Fury and Harrison 2011b).

The Indo-Pacific humpback dolphin (*Sousa chinensis*) is a coastal species that uses estuaries as their primary habitat

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(Jefferson and Karczmarski 2001; Parra 2006), with evident seasonal variations in their distribution within an estuary. The humpback dolphins in the Pearl River estuary exhibit a more even distribution during the dry season; by contrast, an increased number of dolphins move outward to the ocean side of the estuary during the rainy season (Jefferson 2000; Chen et al. 2010). In addition, the humpback dolphins in Xiamen waters also exhibit an outward movement from the Jiulong River mouth during the rainy season (Chen et al. 2008). Recent studies have suggested that humpback dolphins might shift their primary activity range to estuarine margins in response to the increase of river runoff during rainy seasons.

To determine the relationship between the seasonal distributions of humpback dolphins and rainfall, the presence of humpback dolphins must be monitored under various weather conditions. Although visual observations can be difficult during periods with strong winds, heavy rain, or even typhoons, passive acoustic monitoring (PAM) has been effectively used to overcome these challenges (Stafford et al. 2001; Verfuß et al. 2007; Akamatsu et al. 2010). Moreover, a system of multiple hydrophones can be used to localize or identify the bearing angle of calling animals to improve the spatial resolution of PAM. Besides the vocalizations from cetaceans, ambient noises are also recorded though PAM. The major sources of ambient noise in the ocean are wind, rainfall, shipping traffic (Wenz 1962), and biological sounds (Johnson et al. 1947; Cato 1992); therefore, monitoring the variations in ambient noises can elucidate the alterations in the underwater environment.

The present study applied the PAM system in a river estuary to investigate the seasonal variation patterns in the distribution gradients of Indo-Pacific humpback dolphins and snapping shrimps. Biosonars and ultrasonic pulsed sounds were recorded using long-duration recorders to determine the occurrence of humpback dolphins and snapping shrimps. The distribution gradients of the humpback dolphins and snapping shrimps were compared across various levels of upstream rainfall to determine the effects of river discharges on the activities of humpback dolphins.

Methods

Study Site

The waters of Western Taiwan are inhabited by critically endangered humpback dolphins. They inhabit the inshore and estuarine waters with shallow depths (<15 m), which are influenced by numerous creeks and rivers in Western Taiwan. Two regions with high sighting rates of humpback dolphins located at the northern and southern parts of Western Taiwan (Chou et al. 2011). In the present study, the Xin Huwei River estuary at the southern hotspot of the humpback dolphins was selected as the study site. Two reclaimed lands for industrial parks, located by the northern and southern river banks, restrict the width of this estuary to only 2 km (Fig. 1).

According to the records from the Central Weather Bureau of Taiwan, the mean monthly rainfall upstream of Xin Huwei River between July 2009 and September 2012 was 158.58 mm (5.18 mm/day). The upstream rainfall exhibited evident seasonal changing pattern: the mean monthly rainfall from October to March (the north-eastern monsoon period) was 36.86 mm (1.23 mm/day). However, the mean monthly rainfall from April to September (the south-western monsoon period) increased to 262.90 mm (8.57 mm/day). In addition, the rainfall during typhoon season (from July to August) increased to >469.5 mm/month (15.15 mm/day). The drainage area of Xin Huwei River is approximately 110 km^2. Only one rubber dam (height, 1.5 m) is located in the middle stream of Xin Huwei River, which intercepts only a minimal portion of river runoff. In the present study, the amount of upstream rainfall was used as an index of river discharges in this study because the discharges in Xin Huwei River were not recorded.

Data Collection and Instrument Deployment

The biosonar clicks of the humpback dolphins in the Xin Huwei River estuary were recorded using acoustic data loggers (A-tags; ML200-AS2, Marine Micro Technology Inc., Saitama, Japan), from 31 July 2009 to 12 September 2012. Two long-term monitoring stations were established for monitoring the presence of humpback dolphins in the various sections of the estuary (Fig. 1). At the station closer to the river mouth (N 23° 45.5′, E 120° 9.9′), an A-tag was fixed to a pyramid-shaped steel frame on the seafloor, where the local water depth ranged from 3.5 to 8 m. At another station, two A-tags were attached to an offshore fixed pile at a height of 4 m from the sea floor (N 23° 45.6′, E 120° 9.1′) where the local water depth ranged from 8 to 12 m.

The A-tag used in this study is a long-duration event recorder that can continuously record for approximately 30 days before its batteries died. Each A-tag comprised two hydrophones (MHP-140-70, detailed specifications are available at http://cse.fra.affrc.go.jp/akamatsu/A-tag/A-tagSpec.html), which are most sensitive at the peak frequency range (100–180 kHz) of the humpback dolphin clicks (Goold and Jefferson 2004). The detection range of an A-tag can reach up to 1.25 km for stationary monitoring when the detection threshold is set at 140.4 dB p-p re 1 μPa, assuming a spherical sound propagation (Kimura et al. 2010). When ultrasonic pulses were detected, the time, pressure levels, and differences in the arrival time of the sound between the two hydrophones were stored in the flash memory of the A-tag. The sound arrival time difference was measured using a high-speed counter within the A-tag, based on a resolution of 1.08 μs (Akamatsu et al. 2005), which enables the calculation of the sound-source bearing angle with a relatively short 60 cm baseline between the two hydrophones.

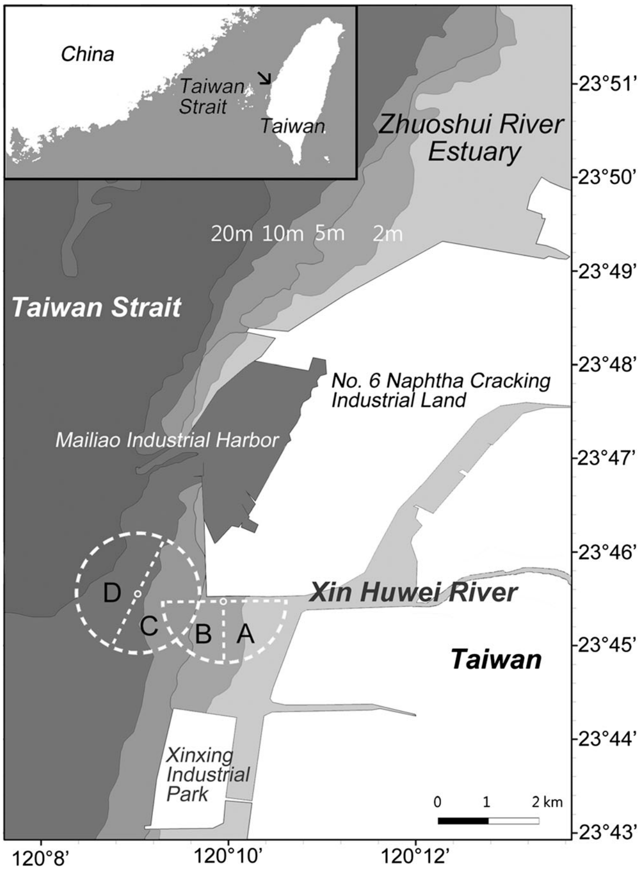

Fig. 1 The location of Xin Huwei River estuary is indicated by the *arrow in the upper left panel*. The monitoring range of the river mouth station was separated into the inner estuary (A) and the outer estuary (B). The monitoring range of the pile station was separated into the inshore section (C) and the offshore section (D). The area surrounded by a *dashed line* represents the 1.25-km detection range of the A-tag. The Mailiao industrial harbor and the no. 6 naphtha cracking industrial land are located by the northern river bank of Xin Huwei River estuary. The Xinxing industrial park is located by the southern river bank

Based on the discrimination of the sound-source bearing angle, the monitoring area was divided into four sections. At the river mouth station, an A-tag was deployed along the shore (two hydrophones were fixed along the east–west direction) to ensure that the imaginary line of zero time difference between the two hydrophones ran perpendicular to the shore, and this imaginary line was used to separate the monitoring area into the inner river estuary (A) and the outer river estuary (B). At the offshore pile station, the fixed pile insulated the high-frequency clicks from the opposite side to ensure that each A-tag recorded the clicks from one side only. Two A-tags were fixed at 4 m from the sea floor on the east and west sides of the pile to separate the monitoring area into the inshore (C) and the offshore (D) sections (Fig. 1). The A-tags were retrieved once every month to ensure data recovery and to change the batteries during favorable weather condition. During the study period, six A-tags were used for field monitoring.

Acoustic Data Processing

The recorded ultrasonic pulsed sounds were processed using Igor Pro 5.01 (Wave Metrics, Lake Oswego, OR, USA). Only pulses ≥133.3 dB (re 1 μ Pa) were used during the ambient noise analysis and then saved for further processing. As described by Lin et al. (2013), a click train was automatically detected by removing the reflections from the sea surface and bottom as well as the sounds from all sources other than the humpback dolphins through the following procedures:

1. The successive clicks detected within 4 ms were eliminated to exclude potential surface or bottom reflections in shallow waters.
2. Each click train was defined as a succession of interclick intervals (ICIs) varying from 50 to 200 %. This aided in filtering out the false detections from the sounds other than those from the humpback dolphins: for example, the pulses with irregular ICIs from waves and other biological sound sources.
3. The click trains with <6 or >500 clicks were discarded from the analysis to exclude isolated pulses and intense shipping noises.
4. The click trains, wherein the coefficient of variation of the pressure levels was <0.3 and the standard deviation (SD) of the time difference between the two hydrophones was <221 μs were considered as dolphin click trains. The sound pressure levels of odontocete click trains changed like a mountain shape (i.e., gradually increasing and decreasing). A pulse-by-pulse change in the pressure levels is unlikely, and therefore, filtering the pressure level variations can decrease the incidence of false alarms. In addition, the selection of click trains with a low SD in time difference ensured that only click trains produced from a consistent bearing angle (i.e., from a dolphin) were used for further analysis.

The threshold selection of each step was validated based on the study by Lin (2013). The correct and false detection rates based on the current threshold setting were 60 and 4 %, respectively. Although some false alarms from boat sonars or wave noises might have been detected after automatic processing, they were easily removed by visually examining the extremely small variations in the ICIs or the irregular changes in the time differences. Only click trains that were visually confirmed by the first author were used for further analysis.

Distribution Pattern Analysis

In this study, the detection of click train was used to indicate the presence of humpback dolphins in this study. Because a single dolphin can produce multiple click trains in a short period, the number of click trains might not accurately reflect the number of dolphins (Fig. 2). In addition to the abundance of animals, the stay duration also assisted in mapping the distribution gradient of the humpback dolphins. The number of hours with click detection for 3 days was recorded as a quantification measurement of the stay duration of the humpback dolphins in each section. Any periods in which measurements were not recorded for three complete days were discarded.

To analyze the seasonal variations in the distribution gradients of the humpback dolphins, the monitoring periods were categorized as winter (January to March), spring (April to June), summer (July to September), and fall (October to December). The factorial analysis of variance (ANOVA) function of the generalized linear model in SPSS 16.0 (IBM Corp., Armonk, NY, USA) was applied to determine the differences in the number of hours with clicks detection across various sections and seasons (Soldevilla et al. 2010). Considering the overdispersed distribution, the data distribution was set as a negative binomial distribution with a log link function in the generalized linear model.

To analyze the effects of upstream rainfall on the distribution gradients of the humpback dolphins, the mean daily upstream rainfall was calculated from 7 days prior to each sampling period. The mean daily upstream rainfall was obtained from the Yunlin weather monitoring station of the Taiwan Central Weather Bureau (N 23° 42.4′, E 120° 30.5′). The rainfall records during the monitoring period were referenced, and the mean daily upstream rainfall of each sampling period was categorized into no rainfall, mild rainfall, medium rainfall, and heavy rainfall, with the three cutoff points of 1, 5, and 15 mm for generating evenly spaced sample size among these categories. Considering the extreme rarity of heavy rainfall in the monitoring area during winter and fall, the effects of rainfall could be analyzed only during spring and summer. The factorial ANOVA function of the generalized linear model with the same data distribution and link function was applied to determine the differences in the detected duration values of the dolphins across various sections and rainfall categories.

Ambient Noise Analysis

The number of ultrasonic pulses (N_p) was recorded for each of the three sampling days in each section. The ambient noise level (A) per hour were calculated as

$$A = \mathrm{round}\left(\frac{N_p}{72}\right). \tag{1}$$

The factorial ANOVA function of the generalized linear model was applied to determine the differences in the number of pulses per hour across various sections and seasons and among the various sections and rainfall categories, as in the previous analysis. The data distribution was set as a negative binomial distribution with a log link function in the generalized linear model.

Results

The two monitoring stations were established at distinct dates. The pile station (sections C and D) was monitored from 31 July 2009, and the river mouth station (sections A and B) was established on 10 April 2011. The number of effective recording days was 311 for sections A and B, 672 for section C, and 642 for section D. The detected duration values of the biosonar clicks of the humpback dolphins were highest in section B (1.60 h/day), followed by sections A (1.12 h/day) and C (1.11 h/day), and the lowest in section D (1.08 h/day).

The monthly detection rate of the humpback dolphins exhibited evident seasonal changing pattern. Particularly in sections C and D, the detected duration values of the humpback dolphins were typically lower during fall and winter than those during spring and summer (Fig. 3). The highest monthly peak of the detected duration in sections A and B were detected during spring when the monthly rainfall gradually increased. Although the detected duration apparently increased with the increasing monthly rainfall during spring, this correlation was not observed during summer. The detected duration values recorded during the summer of 2012 were lower than those recorded during the other summers when the accumulated rainfall increased to 1,396.5 mm in 3 months.

The factorial ANOVA indicated significant differences in the detected duration values of the biosonar clicks among the four seasons (Table 1 (detected hours of humpback dolphins)). The significant interactions between the seasons and the sections suggested that the gradient trends of the detected duration across the four sections varied across seasons. Figure 4a shows that the humpback dolphins were mostly detected in sections A and B during winter, but this distribution gradient was reversed during summer. In addition, the detected duration values varied significantly among the various levels of the upstream rainfall (Table 2 (detected hours of humpback dolphins)). The significant interactions between the rainfall and the sections suggested that the gradient trends of the detected duration during the rainy season correlated with the upstream rainfall. Most of the humpback dolphin detections were concentrated in sections A and B after mild rainfall; however, the detections near the river estuary markedly decreased after heavy rainfall (Fig. 5a).

Regarding the ultrasonic pulse levels, significant differences were detected between the sections and the seasons and among their interactions (Table 1 (number of ultrasonic pulses)). The noise levels during spring and summer were higher than those during fall and winter. In addition, the noise

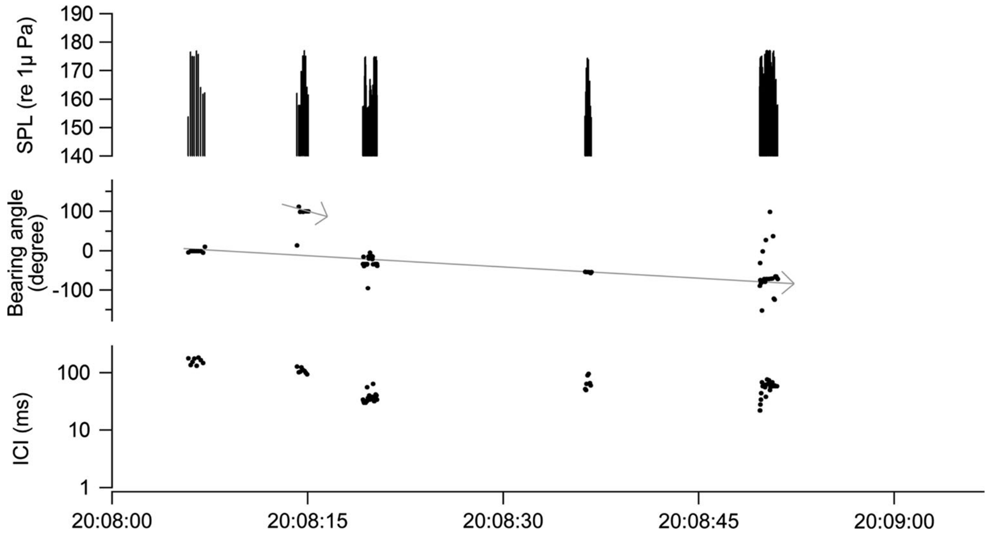

Fig. 2 Example recording data describing the sound pressure level (*SPL*), bearing angle, and interclick inter (*ICI*) of biosonar clicks. *Each dot* represents a detected click. Each dolphin can be discriminated based on the number of independent sound sources. This example shows two dolphins (*arrow*). One dolphin moved from 0° to −100°, another one dolphin was located at 100°

levels peaked in sections C and D during summer (Fig. 4b). Moreover, significant differences were observed among the rainfall categories (Table 2 (number of ultrasonic pulses)). In all the sections, the noise levels following medium rainfall were higher than those following no rainfall and mild rainfall. However, the noise gradients following heavy rainfall exhibited a prominent peak in sections C and D (Fig. 5b).

Discussion

The present study is the first to investigate the distribution gradient of humpback dolphins off the coast of Western Taiwan during various seasons. The acoustic monitoring of the humpback dolphins during the 3-year period suggested a significant seasonal shift in their primary distribution in the monitored estuary. The primary distribution of the humpback dolphins was determined based on the detected duration of biosonar clicks by using multiple acoustic recorders. Click detection is related to the sound intensity, the distance between the calling animal and the hydrophone, and the directionality of the click (Au 1993). A click can be detected even at long distances if the biosonar beam is directed toward the hydrophone; by contrast, the detection can fail at short distances when the hydrophone is directed away from the biosonar axis (Zimmer et al. 2008; Kimura et al. 2010), thereby increasing the uncertainty of the distribution gradient mapping. In the present study, most of the biosonar clicks were detected in sections B and C, which is consistent with the primary inhabited depths of humpback dolphins observed in other onboard surveys conducted in the same area (Chou et al. 2011).

Another uncertainty of the PAM system is that the detection probability can be lower in noisy environments, which mask animal vocalizations. The present results indicated that the detected durations of the humpback dolphins did not

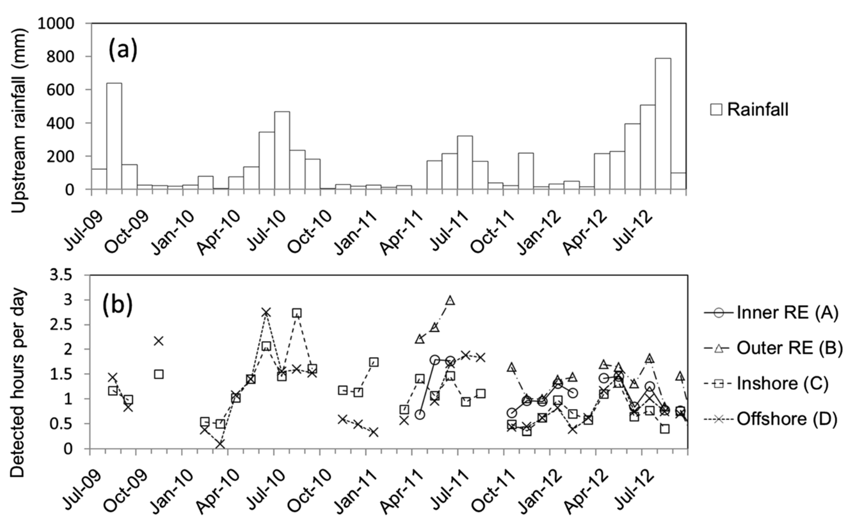

Fig. 3 The monthly upstream rainfall (**a**) and the detected duration of the humpback dolphins (**b**) in the four sections. The months without data represent no recording or the recording lengths are less than 7 days

Table 1 Results of the factorial ANOVA for section and seasonal effects on the detected hours of the humpback dolphins and the number of ultrasonic pulses

	df	Wald	*p* value
Detected hours of humpback dolphins			
Section	*3*	*12.02*	*<0.01*
Season	*3*	*26.66*	*<0.001*
Section× season	*9*	*28.35*	*<0.01*
Number of ultrasonic pulses			
Section	*3*	*43.78*	*<0.001*
Season	*3*	*431.41*	*<0.001*
Section× season	*9*	*151.10*	*<0.001*

Significant effects (p<0.05) are set in italics

Table 2 Results of the factorial ANOVA for section and rainfall effects on the detected hours of the humpback dolphins and the number of ultrasonic pulses during spring and summer

	df	Wald	*p* value
Detected hours of humpback dolphins			
Section	*3*	*8.15*	*0.04*
Rainfall	*3*	*8.53*	*0.04*
Section×rainfall	9	15.97	0.07
Number of ultrasonic pulses			
Section	*3*	*34.30*	*<0.001*
Rainfall	*3*	*37.15*	*<0.001*
Section×rainfall	9	11.82	0.22

Significant effects (p<0.05) are set in italics

decrease during periods with high ambient noise levels. The highest number of ultrasonic pulses recorded in this study was still lower than 6 pulses/s, which indicated that the noise levels were lower than those in the areas with a high abundance of snapping shrimps (Cato and Bell 1992). This suggests that the masking effect was not severe. In addition, the false detections were manually removed after automatic processing. However, the detected duration values were higher than those estimated during the noisy periods of spring and summer. Despite these uncertainties, the long-term acoustic monitoring of humpback dolphins improved our understanding of their habitat use in an estuary, particularly regard seasonal changes.

The seasonal variations in the activities of humpback dolphins comprise fluctuations in the number of dolphins entering the estuary and shifts in the primary activity range. Although PAM cannot identify whether the same dolphin inhabited the monitored estuary, the significant seasonal variations in the detected duration suggest that these dolphins either enter the monitored estuary more frequently or stay there for longer periods during spring. The seasonal fluctuation in the detection of dolphins might be driven by the seasonality of local prey distribution (Wilson et al. 1997; Hastie et al. 2004; Akamatsu et al. 2010). Previous bottom trawl surveys in the same estuary (personal communication with Meng-Hsien Chen) have indicated that the abundance of prey resources for humpback dolphins, including the Sciaenidae, Engraulidae, Clupeidae, Trichiuridae, and Mugilidae families (Jefferson 2000; Barros et al. 2004), increased during spring and summer. In addition, both spring and summer have been reported as the breeding period for the potential prey fish of humpback dolphins in Western Taiwan (Chou et al. 2011). Therefore, the longer stay duration of the humpback dolphins in the estuary during rainy season (spring and summer) might be ecologically related to the seasonality of the local availability of prey.

In addition, clear seasonal changes were observed in the spatial distributions of the humpback dolphins in the estuary, wherein the dolphins inhabited an area close to the river mouth during dry seasons and shifted to the outer parts of the estuary during rainy seasons. The seasonal changing pattern in the present study is consistent with those reported in the Pearl River estuary and Xiamen waters (Jefferson 2000; Chen

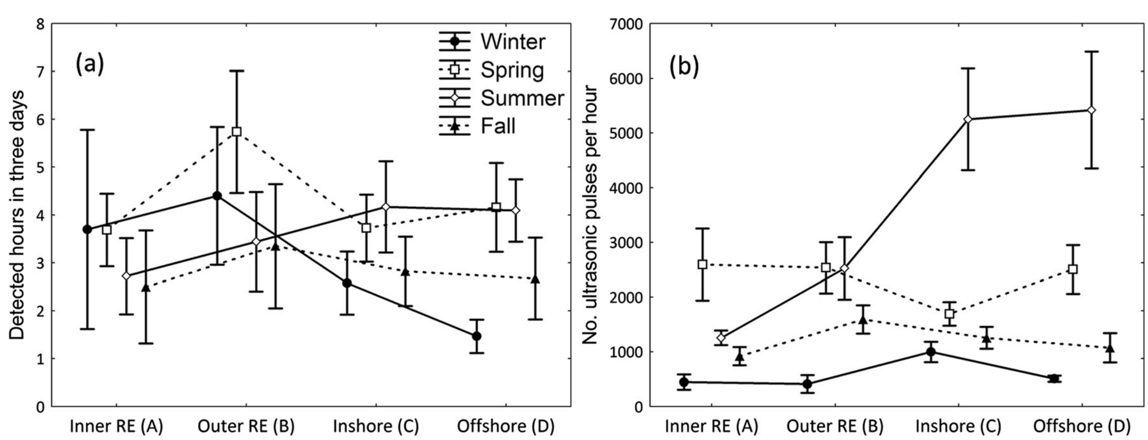

Fig. 4 The detected duration of the humpback dolphins (**a**) and the number of ultrasonic pulses (**b**) in the four sections across the four seasons. The *center point* and *error bar* represent the mean and 95 % confidence interval

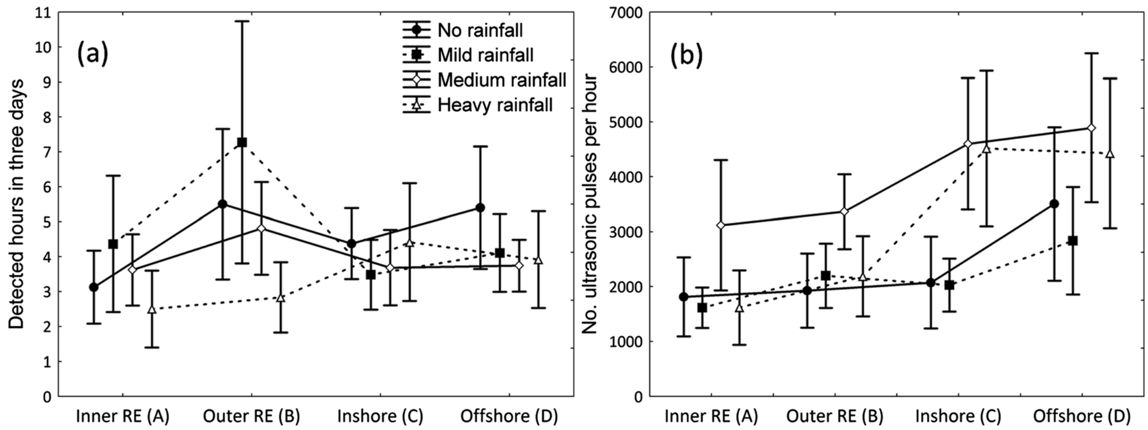

Fig. 5 The detected duration of the humpback dolphins (**a**) and the number of ultrasonic pulses (**b**) during the spring and summer in the four sections across the four rainfall categories. The *center point* and *error bar* represent the mean and 95 % confidence interval

et al. 2008, 2010); however, none of the investigations provided empirical evidence to demonstrate the connection between the seasonality of spatial distributions and the extent of upstream rainfall.

This paper provides empirical evidence to demonstrate the effects of various levels of upstream rainfall on the distribution gradient of humpback dolphins in an estuary, which exhibited an outward movement following heavy rainfall. The effects of heavy rainfall on the spatial distributions of the humpback dolphins were particularly evident during typhoon season: for example, the humpback dolphins were rarely detected in the monitored estuary following Typhoon Morakot, which was responsible for a severe upstream rainfall (377 mm from 8 to 9 August 2009). After such rainstorms, the high river discharge levels can alter the water quality, including its turbidity and salinity. Such temporary changes of the water quality can affect the physiological health conditions of the dolphins or reshape the distribution and movement of the prey resources (Fury and Harrison 2011b; Fury and Reif 2012), which warrants further investigation.

Furthermore, the temporal changes in aquatic environments can be determined by variations in ambient noise levels because ambient noise is a combination of all biological, environmental, and anthropogenic sounds. Regarding the frequency ranges recorded in this study, most of the ultrasonic pulses originated from the snapping shrimps, odontocetes, bubbles from waves and boat propellers, and boat sonars. Based on our experiences, the sound from the boats and odontocete echolocations comprised only a small portion of the recorded ultrasonic pulses. When most of the ultrasonic pulses originated from the wave noise, the noise levels were higher during severe weather conditions (e.g., the strong north-eastern monsoon occurring over the Taiwan Strait during winter and fall) because of the increased production of bubbles and sprays from large waves. Nevertheless, the number of ultrasonic pulses during winter and fall was extremely low in the monitored estuary, suggesting that wave noises are not the primary sound source. In tropical and subtropical areas, the impulsive pulsed sounds produced by snapping shrimps dominate the ultrasonic range (Johnson et al. 1947; Cato and Bell 1992; Au and Banks 1998), and thus, the ultrasonic pulse levels can serve as a straight-forward index for the activities of invertebrates.

The seasonal influence and effect of heavy rainfall on the ultrasonic pulse levels indicated that the activities of the snapping shrimps were higher during the rainy seasons, which exhibited an outward movement during summer and following heavy rainfall. As previously reported, shrimp abundance decreases with an increase in the river runoffs in lagoons (Möller et al. 2009) because the growth of marine shrimps is impeded in a low-salinity environment (Browder et al. 2002). Shrimps can actively or passively alter their distribution in response to local environmental changes (Hughes 1969). Moreover, the movement of the invertebrate fauna can alter the distributions of their predators, such as the distribution of bottom-feeding croakers (Sciaenidae), and in turn influence the distributions of humpback dolphins. The outward movement of the humpback dolphins and the ultrasonic pulses, likely originating from the snapping shrimps, accompanying the seasonality of prey availability in an estuary indicates a temporary trophic-system shift in response to the local environmental changes in the estuary following heavy rainfall. Future studies must investigate the effects of various environmental factors in a monitored area to further elucidate the mechanisms that influence the movement of estuarine animals.

The acoustic monitoring results of the present study indicated dynamic variations in the distributions of the humpback dolphins in an estuary across seasons and during short-term weather conditions, such as upstream rainfall. During the dry seasons, the activity ranges of the humpback dolphins were more restricted and concentrated around the river mouth. Thus, their primary habitats can be scattered around the river estuaries along the coast of Western Taiwan. Future establishment of marine protected area for this critically endangered population should consider protecting such small core habitats. In addition, the current results suggest that the volume of the river runoffs might play a crucial role in the varied habitat usage of humpback dolphins. Therefore, statistical models considering the river discharges and other environmental factors that predict the distribution gradients of humpback dolphins can be used to mitigate the harassment from anthropogenic activities. Moreover, the amount of river runoffs intercepted by dam constructions should be carefully evaluated in the future to reduce the possible impact on this vulnerable population.

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