# A visual-acoustic combined observation method to monitor seagrass bed utilization by dugongs (*Dugong dugon*) in a tidal flat

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***ABSTRACT***
Dugongs (*Dugong dugon*) are herbivorous marine mammals distributed in the tropical and subtropical shallow waters in the Indian and the Pacific Oceans. Okinawa Island in Japan is the northern limit of the range of dugongs. Although the isolation of this extremely small population has not been confirmed, a package of measures to prevent their extinction is needed. Unfortunately, the lack of basic research especially the use of seagrass patches by dugongs in the Okinawa waters prevents us from taking any effective countermeasures for the conservation. In this paper, we propose an acoustic- visual combined observation method using AUSOMS-Ds (automatic underwater sound monitoring systems for dugong) and digital cameras on aerial and land based platforms. Attendance of dugongs and birds-eye view of seagrass patches with grazing trails can be obtained. This method has several advantages. First, a map of seagrass species composition, seagrasses coverage and bathymetries in the focal tidal flat can be obtained. Second, the attendance of vocalizing dugongs and the shape and length of dugongs' grazing trails can be observed daily. This new observation method will be tested in Thailand water for validation.

**KEYWORDS: *Dugong dugon*, tidal flat, AUSOMS-D, digital camera, seagrass bed**

## INTRODUCTION

Dugongs (*Dugong dugon*) are herbivorous marine mammals distributed in the tropical and subtropical shallow waters in the Indian and the Pacific Oceans. In the IUCN Red List, dugongs are classified as vulnerable (VU A1 cd). Furthermore the Okinawa Island in Japan is the northern limit of the range of dugongs. In the Okinawa waters, they were designated as Critically Endangerd by the Mammalogical Society of Japan in 1997. Mature individuals are presumed to be less than 50. Although the isolation of this extremely small population has not been confirmed, a package of measures is needed to prevent their extinction. To protect the dugong population, Ichikawa *et al.* (2004-a) described that it was necessary to know their behavioral ecology such as migration patterns and usage of seagrass beds in the proposed area.

Unfortunately, the lack of basic research especially use of the seagrass bed by the dugongs in the Okinawa waters prevents us from taking any effective countermeasures for the conservation. De Iongh *et al.* (1997) reported that the pattern of visiting the sward to forage was consistent during most consecutive observation periods. Anderson and Birtles (1978) reported dugongs arrived in inshore areas shortly after water depth allowed access and fed there until the outgoing tide reduced depth below 1m. Mukai *et al.* (2000) reported that one dugong came into the *Halophila* meadow and foraged about 2 hours once there around high tide and went out to offshore with ebb tide. As reported above, it seems that dugongs have a certain pattern of feeding behavior.

The objective of this study is to establish observation methodology for the monitoring both of seagrass habitat and dugongs' feeding behavior. Our study needs to be conducted in tidal flat's seagrass beds. Although the seagrass beds in the tidal flat exist near the place of human activities and dugongs can feed there only at around high tide, it have been difficult to observe the feeding behavior of dugong, even though a lot of their grazing trails could be observed. The feeding trails as well as the presence of dugongs should be monitored with the information of tide, seagrass species composition and seagrass coverage which are anticipated to be observed for comprehending the condition of the site. To obtain this information, the observation system should be operated continuously without any influence on dugongs' behavior. Acoustic monitoring is considered to be strong tool for the monitoring of dugongs

(Ichikawa *et al*., 2004-a). In the present study we also used visual image monitoring of the seagrass habitats, simultaneously a visual-acoustic combined observation methodology is considered to be an appropriate way for the observation of the feeding behavior of dugongs.

## MATERIALS AND METHODS

1. *Study site*

Our research will be conducted at the seasgrass bed in the tidal flat around Libong Island, Trang province, Thailand (N07°14'00.8'' E099°26'49.1'') where many sightings of dugongs were reported beforehand and many dugongs' grazing trails were confirmed in preliminary survey on December 16 and 17 (Fig. 1).

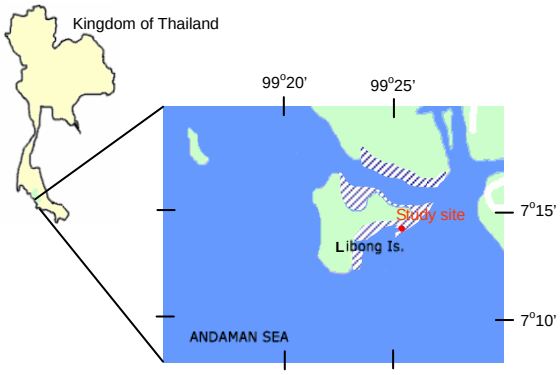


*Fig. 1. Study site. Shaded area shows the seagrass beds in tidal flats.*

2. *Behavior observation*

2-1 *Acoustical observation*

Ichikawa *et al.* (2004-a) clarified that the acoustical analyses on the dugong calls will be a powerful method to locate the vocalizing dugongs without any impact on their behavior at all. The AUSOMS-D (Fig. 2) records the underwater sound with a set of stereo hydrophones at 44.1 kHz sampling rate for over 110 hours (Ichikawa *et al.* 2004-b). By integrating the sound source directions of a call from two AUSOMS-Ds, the position of the vocalizing dugong can be located. Therefore we will deploy two AUSOMS-Ds in our survey area. By using AUSOMS-Ds, we can observe the presence of animals 24 hours in a day. This is a great advantage of acoustical observation method.

2-2 *Visual observation*

Because the acoustic observation by using AUSOMS-Ds cannot identify the attendance of dugongs unless they vocalized, we will conduct visual observation by using a digital camera (Canon Power Shot S60).

*Fig. 2. AUSOMS-D.*

Furthermore, we will find out when dugongs made grazing trails by the visual observation. This observation has another possibility. Most adult dugongs were found to carry scars, visible as they surface to breathe, that permits repeated identification of individuals (Anderson P.K., 1995). If we can obtain several dugongs' photos, these may enable us to identify individuals.

The camera has a function of interval photography. The camera system was tested in the meadow by using the installed base made by iron pipes (Fig. 3). Because the installed base needs to be the simple framework and have strength and the stability, the height of it was about 5m. It successfully took the image 12m (the shorter parallel side) x 140m (the longer parallel side) x 100m (altitude) trapezoid area. The digital image had 2592pixcells x 1944pixcells. It is calibrate by marks in the study site which are found the coordinate. We could confirm the system can record the dugongs' trails by the digital image. This observation is limited to daytime because we will not carry out flash photography in order not to impact dugongs' behavior.

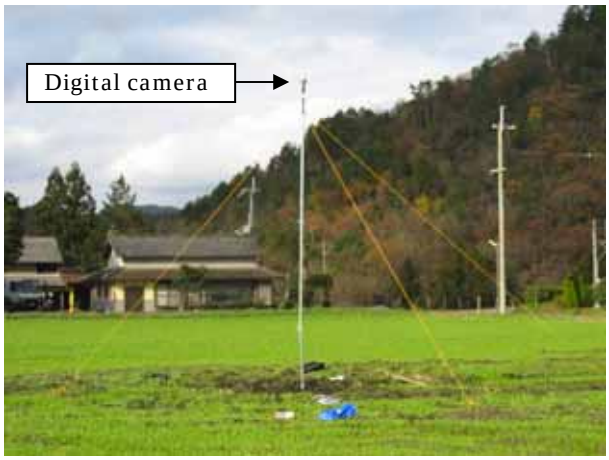


*Fig. 3. The digital camera set on the installed base.*

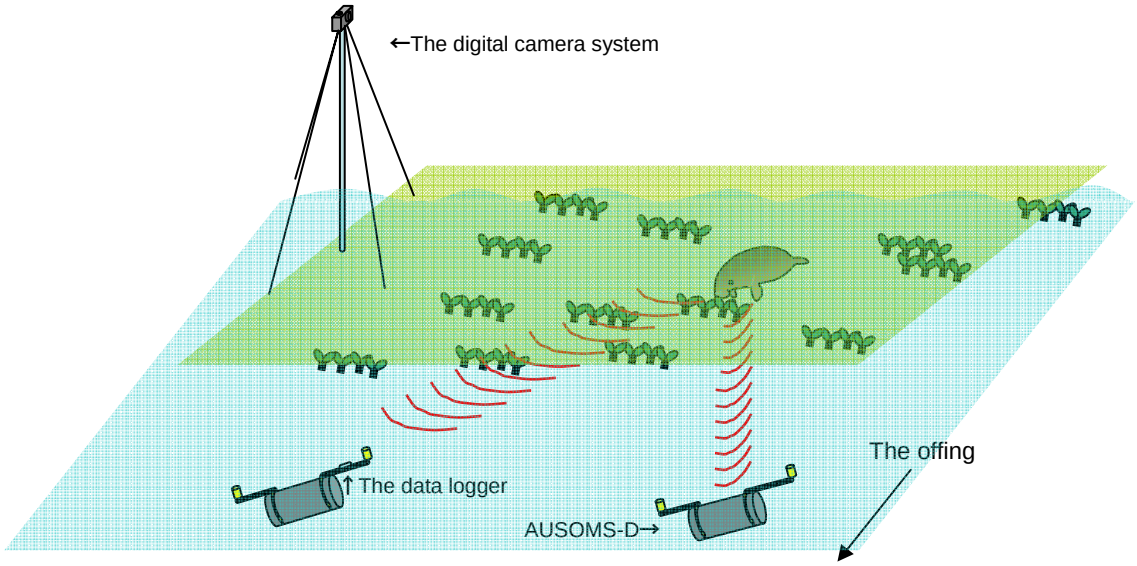


*Fig. 4. The schematic of the visual-acoustic combined observation method*

3. *Water depth measurement*

Bathymetries in a tidal flat can be obtained by using depth meter and the digital camera information. The level contour can be observed during ebb by looking at the water lines of the digital image. Thus, the visual observation has the bimodal use, the dugongs' feeding behavior and the level contour. A data logger (UME-DT; Little Leonardo, Tokyo) can record the water depth of observation area precisely (5cm in resolution). It records time, water depth and water temperature.

## CONCLUSION

The visual-acoustic combined observation method proposed in this paper will be a strong tool for monitoring feeding behavior of dugongs. The acoustic monitoring system provided the attendance of vocalizing dugong as well as the location of the animal when multi AUSOMS-D will be installed in the focal area. The visual observation system provides not only feeding trails but also the map of seagrass distribution and the bathymetries of the tidal flat (fig. 4.)

Such multimodal information of the behavior of dugongs with the environmental condition will provide a good basis on the future research of this species. The observation system proposed here will be tested in the habitat of dugongs, off Libong Island, Trang, Thailand to validate the effectivity.

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