<table>
<thead>
<tr>
<th>Title</th>
<th>Preliminary estimation of detection rate of dugong acoustical observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author(s)</td>
<td>ICHIKAWA, KOTARO; AKAMATSU, TOMONARI; ARAI, NOBUAKI; SHINKE, TOMIO; HARA, TAKESHI; ADULYANUKOSOL, KANJANA</td>
</tr>
<tr>
<td>Issue Date</td>
<td>2009-03</td>
</tr>
<tr>
<td>URL</td>
<td><a href="http://hdl.handle.net/2433/71022">http://hdl.handle.net/2433/71022</a></td>
</tr>
<tr>
<td>Type</td>
<td>Conference Paper</td>
</tr>
<tr>
<td>Textversion</td>
<td>publisher</td>
</tr>
</tbody>
</table>

Kyoto University
ABSTRACT
Dugongs are the only marine mammal that feeds on benthic seagrass. They are found in warm shallow waters of tropical to sub-tropical areas. Many of the dugong populations are close to extinction. We have established a new methodology to record the presence of dugongs by a passive acoustic monitoring technique using automatic underwater sound monitoring systems for dugongs in the southern part of Talibong Island, Trang, Thailand. This study described the preliminary estimation of detection rate of the dugong acoustical observation system. Visual and acoustical observation was performed simultaneously to compare the detections by each method. The results showed that almost 30% of the dugongs in the monitored area were acoustically detected. It was in the spring tide era when the maximum number of detections was obtained.

KEYWORDS: passive acoustical observation,
**Materials and Methods**

**Study site and the observational design**

To evaluate the detection rate of the passive acoustical observation by AUSOSM-Ds, 4 sets of AUSOMS-Ds were deployed off south of Talibong Island (Fig. 2). The recording took place from November 11 to November 15 and from November 17 to November 21, 2006. An acoustic array using AUSOMS-Ds was arranged as illustrated in Fig. 3. Visual observation was conducted simultaneously from the top of a mountain near by the acoustic array. Each of the 4 visual observers used high-resolution binocular Victory 10 x 32 T*FL (Zeiss, Japan) to observe a plot of 260m x 260m, that divided the acoustical monitoring area into 4 plots (Fig. 3).

The visual observation was started at around 9:00 and ended at 12:00, having 10 minutes break between 50 minutes of ceaseless observation. The observation period was selected because wave and wind were calm compared to rough conditions in the afternoon driven by seasonal wind pattern. Exact time in seconds was recorded when the dugongs were found. Then, the underwater sound at the time when the dugong was sighted was replayed. If the acoustical detection was within a 2-minute time window of the visual detection, the visual detection was regarded as “acoustically detected”, hereinafter called $DR_{ac}$. Additionally, if the distance between the position of the dugong sighting and acoustical localization of the sound source was within 130m, the visual detection was regarded as “acoustically localized”, hereinafter $DR_{loc}$. The detection rate was determined by calculating the following Eq. 1.

\[
DR_{ac} = \frac{Na}{Nv}\\
\]

\[
DR_{loc} = \frac{Naloc}{Nv}\\
\]

(Eq. 1)

where $Na$ is the number of “acoustically detected” detections, $Nv$ the number of visual detections and $Naloc$ the number of “acoustically localized” detections.

**Acoustical localization**

A total of 4 sets of AUSOMS-Ds were used for the acoustical array. A couple of AUSOMS-Ds were deployed as an acoustical
localization unit, then two units were set at two different positions. Sound source directions were calculated from arrival-time difference at each unit and then converted into deflection angle (θ₁ and θ₂) in a plane with the coordinate system, where one of the units, base unit, is set at the origin. The position of the sound source was localized by working through simultaneous equation (Fig. 4, Eq. 2)

\[ L1: y = \tan(\theta_1) \times x \]
\[ L2: y = \tan(\theta_2) \times x + q_2 \]

Eq. 2.

where \( q_2 \) is y coordinate relative to the base unit. Therefore the position of the sound source (x, y) was calculated as Eq. 3.

\[ x = q_2 / (\tan(\theta_1) - \tan(\theta_2)) \]
\[ y = \tan(\theta_1) \times q_2 / (\tan(\theta_1) - \tan(\theta_2)) \]

Eq. 3.

RESULTS

The observation was performed for 1245 hours in total. Sea state and weather conditions were calm and fine throughout the survey. A total of 10 dugongs were “Acoustically detected” and 7 were “Acoustically localized”, out of 36 dugongs sighted by the observation. The DRac and DRloc were calculated to be 28.8 and 19.4 %, respectively. Additionally, 70 % of the acoustical detections were localized correctly (Table 1).

The numbers of both visual and acoustical detections increased in the spring tide era with the maximum detections by the visual (n = 12) and acoustical (n = 65) observations on the ninth day (Fig. 5).

CONCLUSION AND DISCUSSION

The DRac showed that almost 30% of the dugongs in the monitored area were acoustically detected. It was in the neap tide era before the system maintenance and spring tide era after the maintenance. The DRac will increase to be 37.0 % when calculated for only the spring tide era. In any case, the detection rates were relatively low compared to other marine mammals, such as finless porpoise (56 %; Kimura et al., submitted). Difference in the function or the use of the acoustical signals may have been the reason for the low detection rate of the dugongs. Finless porpoise use their acoustical signals very often to explore their surroundings (Akamatsu et al., 2005), whereas the dugongs vocalize occasionally (Ichikawa et al., 2006; Hishimoto et al., 2005). The next logical step for better application of the passive acoustical observation should include interpreting the function of the dugong vocalizations.

Dugong mating behavior was observed in almost the same time of the year around Talibong Island (Kanjana et al., 2007). Ovarian cycle of a female dugong was determined to be about 53 days throughout the year based on intervals of urinary progesterone measurements (Wakai et al., 2002).
Therefore, the dugong mating behavior may be observed all year round. Relationships between the mating behavior and the vocalization rate of the dugongs have not been documented yet. The future studies should consider the effect of the mating behavior on the vocalization of the dugongs.

ACKNOWLEDGEMENTS
This study was partly supported by a Grant-in-Aid for Scientific Research (13375005, 12556032 and 14560149), Information Research Center for Development of Knowledge Society Infrastructure, the Ministry of Education, Culture, Sports, Science and Technology and Bio-oriented Technology Research Advancement Institution (BRAIN) Promotion of Basic Research Activities for Innovative Biosciences of Japan. The author is grateful for the kind acceptance for this study by Dr. Warapan Wicharn of the National Research Council of Thailand.

REFERENCES


