Characterization of fish behavior in earthen fish pond with a mechanically scanned imaging sonar

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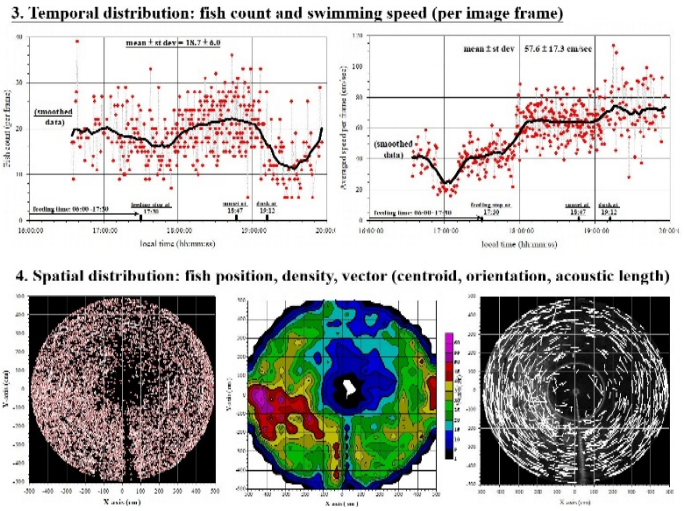
Abstract

Fish behavior holds important information of the living quality. From the spatial ecology view point, adequate technological solutions for fish behavior investigation should highlight four crucial observational challenges, i.e., detectability, spatial coverage, temporal repetition rate and temporal coverage. A mechanically rotated, acoustic-based surveying system (i.e., mechanically scanned imaging sonar) with point-fixed deployment configuration was adopted and implemented.

In the current investigation, acoustic image frames with range setting at 5 m (an analysis window of 79 m^2), temporal repetition rate of 30 sec per frame were collected in a milk fish pond which lasted for four hours and covered daylight (with feeding), twilight and night photoperiods. Based on spatial and temporal analyses on position, abundance, trace length and aspect angle of individually discriminated fish targets, it was concluded that averaged fish count per image frame is 18.7 ± 6.0. Temporal variations of both fish count and averaged swimming speed are evidently distinguishable among photoperiods and a tight correlation of fish behavior with the ambient light cycle. Fish movement behavior in the scanned area (analysis window) followed two strictly distinct patterns, i.e., a structured movement pattern (i.e., circling or milling at the analysis window) and an unstructured movement pattern (i.e., holding or erratic). Biophysical coupling investigation illustrated that fish with holding or erratic movement characteristics are strictly correlated with substrate features such as earthen mounds. Spatial distribution characteristics at specific temporal periods varied from a dispersed state with relatively slower swimming speed in daylight period to a relatively gathering distribution state with faster speed in night period.

The proposed surveying system, due to its fish target detection and delineation capability (i.e., detectability) as well as spatial and temporal sampling potential (spatial coverage, temporal repetition rate and temporal coverage), represented a practical and cost effective methodology for the characterization of benthic fish behavior at various underwater environments.

Image



Recent Publications (minimum 5)

1. Shih-Liang Tsao, Wen-Miin Tian, Chih-Yung Shen, Tai-Yueh Chen (2019) "Benthic fish behavior characterization with a mechanically scanned imaging sonar", *Aquacultural Engineering*, 84: 1-11.
2. W. Tain (2019), "An acoustical technique for the characterization of fish behavior in earthen fish pond" Proceedings of The International Conference on Underwater Acoustics Technology and Education for Sustainable Fisheries in Asia. AFAS2019, pp. 39-40 (abstract).
3. Godo, O.R., Handegard, N.O., Browman, H.I., Macaulay, G.J., Kaartvedt, S., Giske, J., Ona, E., Huse, G., Johnsen, E., (2014). "Marine ecosystem acoustics (MEA): quantifying processes in the sea at the spatio-temporal scales on which they occur". Ices *J. Mar. Sci.* 71 (8), 2357–2369.
4. Cooke, S.J., Martins, E.G., Struthers, D.P. *et al.* (2016) "A moving target—incorporating knowledge of the spatial ecology of fish into the assessment and management of freshwater fish populations". *Environ Monit Assess,* **188,** 239 (2016).
5. Wu-Jung Lee, Dajun Tang, Timothy K. Stanton, and Eric I. (2018) "Macroscopic observations of diel fish movements around a shallow water artificial reef using a mid-frequency horizontal-looking sonar", The Journal of the Acoustical Society of America 144, 1424-1434.



Biography

Dr. Wen-Miin Tian has his expertise in marine geotechnical engineering and underwater acoustic surveying on both stationary objects (e.g., artificial habitat) and mobile objects (e.g., fish and shrimp). For the last ten years, he has dedicated in integrating acoustic instruments, incorporating proper deployment capabilities and developing practical processing procedures for the quantifying and describing the spatial ecology of fish and their habitat.

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Notes/Comments: