



Quality assurance and quality control summary of IMOS Bioacoustics sub-Facility data

Version 1.0

Kunnath Haris, Tim E. Ryan, Rudy J. Kloser, Ryan A. Downie, Gordon Keith, Amy W. Nau



Citation

Haris K, Ryan TE, Kloser RJ, Downie RA, Keith G, Nau AW (2022). Quality assurance and quality control summary of IMOS Bioacoustics sub-Facility data. Version 1.0. CSIRO, Australia. DOI: 10.26198/krfw-pq81 (https://doi.org/10.26198/krfw-pq81).

Copyright

© Commonwealth Scientific and Industrial Research Organisation 2022. To the extent permitted by law, all rights are reserved and no part of this publication covered by copyright may be reproduced or copied in any form or by any means except with the written permission of CSIRO.

Important disclaimer

CSIRO advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

CSIRO is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document please contact csiro.au/contact.

Document history

Version	Date	Revisions	Author
1.0	2022-06-07	Finalised version 1.0	Haris K
			Ryan TE
			Kloser RJ
			Downie RA
			Keith G
			Nau AW

Acknowledgments

Funding for IMOS Bioacoustics sub-Facility was received from IMOS and CSIRO Oceans and Atmosphere. IMOS is enabled by the National Collaborative Research Infrastructure Strategy (NCRIS). It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent. The sub-Facility is grateful to all platform operators for generously contributing data to the program. Particularly, the commercial fishing companies Austral Fisheries, Australian Longline Pty Ltd, Sealord Group Ltd, and Talley's Group Ltd were instrumental to foster existing ocean industry collaboration. Likewise, the National Institute of Water and Atmospheric Research (NIWA), The Australian Antarctic Division (AAD), and National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) were instrumental to foster scientific data sharing and reuse. We express our appreciation to the officers and crew in charge of the respective fishing trips and scientific voyages. We thank present and past members of ICES Working Group on Fisheries Acoustics, Science and Technology (WGFAST) for facilitating calibration standards, data quality measures, and metadata standards.

Background

Since 2010, as a part of existing ocean industry collaboration, Australia's Integrated Marine Observing System (IMOS) Ships of Opportunity Bioacoustics sub-Facility (here onwards IMOS Bioacoustics sub-Facility) has been collecting opportunistic, supervised, and unsupervised active bioacoustic data from different platforms including commercial fishing and research vessels transiting ocean basins (Figure 1) (Kloser *et al.*, 2009; Haris *et al.*, 2021). The resulting acoustic snapshots (Simmonds and MacLennan, 2005) provide a proxy for the combined effects of size, abundance, distribution, diversity, and behavior of mid-trophic mesopelagic communities including macro-zooplankton and micronekton in the twilight zone of global oceans (Figure 2). The broad goal of IMOS Bioacoustics sub-Facility is to provide repeated active bioacoustic observations for the status and trend of ocean life to 1000 m at basin and decadal scales.



Figure 1. Schematic overview of IMOS Bioacoustics sub-Facility operations to collect and publish bioacoustic data with related metadata. Bioacoustic data received from diverse operators are quality controlled and made available through the Australian Ocean Data Network (AODN) Portal. IMOS currently has a portfolio of 13 Facilities that undertake systematic and sustained observations of Australia's marine environment. It is integrated in terms of its geographic domain (from coast to open ocean) and scientific domain, combining a wide range of physical, chemical, and biological observations from a variety of platforms. IMOS observations are turned into data that can be discovered, accessed, downloaded, used, and reused through the data Facility AODN.

The primary data-type derived from IMOS Bioacoustics sub-Facility is the georeferenced, calibrated (Demer *et al.*, 2015), and processed (Ryan *et al.*, 2015) single-beam water column volume

backscattering coefficient s_v (m² m⁻³) values, representing the linear sum of backscatter from acoustically detectable individual organisms within the sampling volume (Figure 2) (Simmonds and MacLennan, 2005).



Figure 2. Example of how bioacoustics data is collected from a vessel by transmitting pulses of sound in water that reflects off the organisms to produce an echogram (38 kHz).

Data processing routines

Data sets were initially processed using Echoview[®] software (Echoview Software Pty Ltd, Hobart, Tasmania, Australia) that includes a sequence of data processing filters designed to remove noise and improve data quality (Ryan *et al.*, 2015). Transect data files applying related time offset to Coordinated Universal Time (UTC) and calibration parameters were visualized (Figure 2) as frequency-specific echograms in Echoview[®] for visual inspection, transducer motion correction, and filtering processes (Figure 3). Subsequent processing and packaging were completed using MATLAB[®] software (MathWorks, Natick, Massachusetts, USA). All processing steps were semi-automated using a custom open-source MATLAB[®] Graphical User Interface (GUI) integrated with Component Object Model (COM) objects controlling Echoview[®] software.



Figure 3. Flowchart of methods implemented to produce quality-controlled bioacoustic data, providing an overview of data processing sequences in the context of key data variables present in a NetCDF file.

Data review, packaging, and submission routines

Processed data sets were stored in Network Common Data Form (NetCDF, www.unidata.ucar.edu) file (NetCDF-4 format) with a resolution of 100 m horizontal distance and 5 m vertical depth (note the data resolution was 1 km horizontal distance and 10 m vertical depth until the year 2020). This NetCDF file conforms standardized naming conventions and metadata content defined by the Climate and Forecast (CF) (Eaton *et al.*, 2011), IMOS (IMOS, 2020), and International Council for the Exploration of the Sea (ICES) (ICES, 2016) published over the years (Figure 4) (Haris *et al.*, 2018).

Processed NetCDF files were independently reviewed by both analyst and principal investigator to further investigate data quality. If suitable, the NetCDF file along with ancillary files: (1) acquired raw data (.raw files), (2) platform track in CSV format (containing date, time, latitude, longitude, and time offset to UTC), (3) platform motion data (if recorded) in CSV format (including date, time, pitch, and roll measurements), and (4) a snapshot of processed echogram as Portable Network Graphics (PNG) format were packaged and submitted to the publicly accessible AODN Portal.

Processed NetCDF files are published via the Australian Ocean Data Network (AODN) Portal at:

https://portal.aodn.org.au/search?uuid=8edf509b-1481-48fd-b9c5-b95b42247f82.

This portal allows transect selection and data download with spatial and temporal subset options implemented for each platform and frequency.

A generic metadata record of the project is available via GeoNetwork at:

https://catalogue-imos.aodn.org.au/geonetwork/srv/api/records/8edf509b-1481-48fd-b9c5-b95b42247f82.

The NetCDF files are also accessible via the AODN THREDDS data server that can be accessed remotely using the OPeNDAP protocol at:

http://thredds.aodn.org.au/thredds/catalog/IMOS/SOOP/SOOP-BA/catalog.html.



Figure 4. Primary components and organization of key variables present in a NetCDF file with illustrations of key metadata categories.

References

- Demer, D., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., et al. 2015. Calibration of acoustic instruments. ICES Cooperative Research Report 326: 1-133.
- Eaton, B., Gregory, J., Drach, B., Taylor, K., Hankin, S., Caron, J., Signell, R., et al. 2011. NetCDF Climate and Forecast (CF) Metadata Conventions. Version 1.6.
- Haris, K., Kloser, R. J., and Ryan, T. E. 2018. IMOS SOOP-BA NetCDF Conventions. Version, 2.2. 42 pp.
- Haris, K., Kloser, R. J., Ryan, T. E., Downie, R. A., Keith, G., and Nau, A. W. 2021. Sounding out life in the deep using acoustic data from ships of opportunity. Scientific Data, 8: 23.
- ICES 2016. A metadata convention for processed acoustic data from active acoustic systems. Series of ICES Survey Protocols SISP 4-TG-AcMeta.: 1-47.
- IMOS 2020. IMOS NETCDF CONVENTIONS. Version 1.4.1. IMOS.
- Kloser, R. J., Ryan, T. E., Young, J. W., and Lewis, M. E. 2009. Acoustic observations of micronekton fish on the scale of an ocean basin: potential and challenges. ICES Journal of Marine Science, 66: 998-1006.
- Ryan, T. E., Downie, R. A., Kloser, R. J., and Keith, G. 2015. Reducing bias due to noise and attenuation in open-ocean echo integration data. ICES Journal of Marine Science, 72: 2482-2493.
- Simmonds, J., and MacLennan, D. N. 2005. Fisheries Acoustics: Theory and Practice, Blackwell Science. 437 pp.

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us

1300 363 400 +61 3 9545 2176 csiro.au/contact csiro.au

For further information

Oceans and Atmosphere Haris Kunnath +61 3 6232 5416 Haris.Kunnath@csiro.au csiro.au/Oceans and Atmosphere