A metadata convention for processed acoustic data from active acoustic systems

ICES WGFAST Topic Group, TG-AcMeta

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Background and Terms of reference

The ICES Working Group on Fisheries Acoustics, Science and Technology (WGFAST) meeting in 2010, San Diego USA recommended the formation of a Topic Group that will bring together a group of expert acousticians to develop standardised metadata protocols for active acoustic systems. Through annual meetings in 2011-2013 and email correspondence the Topic Group on Acoustic Metadata (TG-AcMeta) developed a metadata convention for active acoustic data which is presented in this document.

The terms of reference for TG-AcMeta were “To develop standardised metadata protocols to suit requirements for data acquisition, processing, quality control and data dissemination of calibrated integrated active acoustic backscatter data. This includes data from a range of platforms such as Ships of Opportunity including research, merchant and commercial fishing vessels, moorings, AUV’s and acoustic instruments such as calibrated single- and multi-beam acoustic systems.”

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Purpose of this document

Metadata is data describing data, and should allow potential users to determine the fitness for their purposes of that data from the metadata alone, without having to access the actual data. A metadata convention is a systematic set of metadata attributes that have been developed to describe a particular genre or type of data. This document describes a metadata convention that details the attribute fields necessary to describe water column backscatter data obtained from active acoustic systems.

This convention is not intended to conform to general metadata standards, such as FGDC, ISO:19115/19139, etc., nor to describe a metadata profile consistent with such standards. Essentially it describes a set of attributes to be included with the acoustic data itself to make a fully self-documenting data set. In addition to these, it also defines best practice for storing and managing fisheries acoustic data by providing a standard approach. That said, the metadata elements described here include all those necessary to populate any aggregated (or even global) metadata catalogue describing the available bioacoustic datasets managed in multiple institutional repositories.

It is recommended that processed acoustic data is stored in SI units of linear s_v (m^{-1}). Depending on the purpose, acoustic backscattering data is sometimes stored in a number of other forms including S_v, volume backscatter in logarithmic form (dB re $1m^{-1}$), area backscattering coefficient s_a ($m^2\ m^{-2}$), or scaled to nautical area scattering coefficient, s_A (aka NASC, $m^2\ nmi^{-2}$) cite:[maclennan2002]. The actual form of the backscattering data needs to be specified as part of the data attributes and the dimensions of the echo integration cell also specified.

This convention was developed for processed acoustic data, but has relevance for archiving raw acoustic data. Processed acoustic backscatter data are generated by applying procedures to the instrument acquired acoustic data (i.e., raw data) that address data quality and calibration and, in many cases, resampling to a lower resolution than the acquired data. Unless stated otherwise in the metadata, appropriate calibration offsets and time varied gain (TVG) corrections will have been applied. Metadata attribute fields are provided that will allow description of processing procedures specific to the data set.

In many cases the cost of collecting acoustic data is significant and adhering to this metadata convention will facilitate the discovery, reuse, and exchange of processed acoustic data while ensuring its longevity.

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Global attributes

The metadata attribute fields in this document build on existing conventions and are presented following the netCDF (network Common Data Format) cite: [rew1990,unidata2017] format of global attributes. The global attributes describe the overall contents of the file and allow for data discovery. Global attributes can be thought of as conveying five kinds of information:

- What: What are the data in the dataset?
- Where: The spatial coverage of the data.
- When: The temporal coverage of the data.
- Who: Who produced the data?
- How: How were the data produced and how are they being made available?

All fields should be human-readable and can be of either “character” or “numeric” type. Where applicable, metadata attribute definitions will state that controlled vocabulary should be used. Use of controlled vocabulary aids consistency, accuracy, interoperability, and data discovery. Standard lists for controlled vocabulary developed specifically for this metadata convention are given in Appendix B, *Standard lists for controlled vocabulary*. If the appropriate words are not present in the standard list users should provide their own terminology. The standard lists can be extended according to user feedback to accommodate new terminologies in future versions of this metadata convention.

Wherever possible, the global attributes are based on established authorities. In some instances the metadata attribute may cite other authorities, while other metadata attributes may be unique to this metadata convention. Where they exist,

the relevant authority is cited for each of the attribute fields. A table of the various metadata authorities is given in Appendix A, *Metadata authorities*.

The metadata attributes are grouped according to logical categories. This is done to help both author and reader navigate the metadata record, but it is important to note that this does not describe a formal hierarchical structure. The metadata record of this convention is effectively a continuous list. Thus each global attribute must have a unique name for it to be unambiguously identified. Attribute names that are sourced from existing authorities are by necessity identical to that used by the authority in order to facilitate automatic harvesting of metadata. To ensure uniqueness, non-authoritative attributes are prefixed with the category name of this metadata convention. White spaces or blank characters are not allowed in attribute names as these are not supported by some of the established authorities (e.g. CF, the NetCDF Climate and Forecast Metadata Convention) and the underscore "_" character is used instead. Specific categories of ship and mooring attributes have been developed for this current version of the metadata convention. Further development of metadata attribute fields for other acoustic systems (e.g. autonomous underwater vehicles, gliders, towed bodies, acoustic lenses, and parametric arrays) can be developed as required, following the form of existing conventions used in this document.

There is no constraint on the addition of extra metadata attributes to fully describe a dataset. Such extra attributes would be a super-set of the attributes of this convention and might be specific to a particular institution but their presence would not violate this convention.

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Implementation of metadata convention

This document describes a metadata convention for processed acoustic data. It is assumed that appropriate data and metadata management of unprocessed acoustic data files will be in place, discussion of which is beyond the scope of this document.

Processed acoustic data and metadata may be held in a variety of formats including, but not limited to, relational databases, Extensible Markup Language (XML), JavaScript Object Notation (JSON), Network Common Data Form (netCDF) and Hierarchical Data Format (HDF). Storage of the data and associated metadata is a question of implementation and is not mandated or defined by this document. When choosing a data format some key considerations are ease of data exchange, visibility of data and metadata, and potential for automated harvesting of metadata. It is recommended that guidance and assistance from metadata experts is sought when realizing this metadata convention in a specific implementation format.

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Summary of metadata categories

Metadata Record

Uniform resource identifier (URI) that uniquely identifies the metadata record.

Mission metadata

Metadata that gives a high level description of the overarching initiative (e.g. mission, project, ocean observing system) under which the acoustic data were collected.

Cruise metadata

Attributes that describe the cruise from which the acoustic data were acquired. Metadata should provide information that readily enables the cruise to be identified and be aware of cruise objectives, other instrumentation, and data acquired.

Ship metadata

Attributes that describe the ship from which acoustic data were collected. Metadata should provide information that uniquely identifies the ship and its basic specifications to enable an understanding of the type of ship and its purpose.

Mooring metadata

Attributes that describe the mooring from which acoustic data were collected.

Transect metadata

Attributes that describe transect data. Transect metadata would normally apply to acoustic data from a moving platform.

Instrument metadata

Attributes that describe the acoustic instrument that recorded the raw data from which the processed data were derived.

Ancillary instruments

Attributes that provide the opportunity to list ancillary instruments that may be of relevance to the acoustic data set.

Calibration metadata

Attributes that describe calibration procedures and calibration accuracy and precision.

Data acquisition metadata

Attributes that describe the data acquisition process.

Data processing metadata

Attributes that describe the data processing procedures. Data processing procedures may be complex and difficult to capture in a simple list of attributes. Therefore links to documents that give more comprehensive descriptions of processing procedures should be given if appropriate.

Dataset metadata

Attributes that describe the set of data. Some attributes will vary with each data file and may be automatically generated from the data file. When possible, automatic generation of dataset attribute metadata is preferred to reduce effort and the possibility of human error. Other attributes will need to be manually generated. In many cases attributes may be unchanged between datasets; hence the use of a metadata template which includes stable attributes may be beneficial.

Data metadata

Attributes that describe the data in a dataset, including the type of scattering quantity that is stored and the data horizontal and vertical dimensions.

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Description of metadata category table headers

Attribute name

Unique name for the attribute. When possible, names will conform to existing standards. Non-authoritative attributes are prefixed with the category name to ensure that they are unique. For example the 'name' attribute for cruise and ship categories are prefixed to be cruise_name and ship_name respectively. White space or blank characters are not allowed and the underscore ´_´ character is used instead. For this metadata convention all attribute fields are lowercase.

Definition

Description of attribute.

Data type

S for string, N for numeric

Units

If applicable, the units to be used for numeric attributes, using the SI standard.

Authority

Where they exist, the relevant authority is cited for each of the attribute fields. The field is left blank if no authority exists.

Obligation

Following Dublin Core documentation cite:[dublincore2004], Obligation “indicates whether the element is required to always or sometimes be present. In this application profile, the obligation can be: mandatory (M), mandatory

if applicable (MA), strongly recommended (R) or optional (O). Mandatory ensures that some of the elements are always supported and mandatory if applicable means that this element must be supported if the information is available. An element with a mandatory obligation must have a value. The strongly recommended and the optional elements should be filled with a value if the information is appropriate to the given resource but if not, they may be omitted." An example of an MA field would be attributes in the mooring table that are only populated if the data relates to the mooring in some way.

Maximum occurrences

Specifies the maximum number of instances of the attribute. Single occurrences are shown by "1". Multiple, but specified number of occurrences, are indicated by "N". A fixed number of occurrences are allowed (e.g., "2", "3", etc). For example, if the data comes from a cruise then the attribute field cruise_name is mandatory and applicable and has a maximum occurrence of 1.

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Definition of attributes for active acoustic metadata

7.1. Category: Metadata record

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
convention_name	Name of this convention. "A metadata convention for processed acoustic data from active acoustic systems"	S			M	1
convention_author	"ICES WGFAST Topic Group, TG-AcMeta"	S			M	1
convention_year	2016	N			M	1
convention_organisation	International Council for the Sea (ICES)	S			M	1
convention_publication	The Series of ICES Survey Protocols (SISP) http://www.ices.dk/publications/our-publications/Pages/Survey-Protocols.aspx	S			M	1
convention_version	A label that states the convention version that the metadata conforms to. Must be of the form *major.minor* where *major* and	S			M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	minor are non-negative integers separated by a full stop, aka period (.). E.g. Version 1.10 would be the 10th revision of the version 1 series. Note for metadata versions prior to V1.10 the leading zeros in *minor* should be ignored (e.g. V1.05 is the 5th revision of the version 1 series)					
convention_reference	Reference reference for this convention. Note that while the convention version label is included in the convention reference as per the example full entry below, the authoritative version label is given in the convention version attribute. Example of a full entry for this version is: “ICES. 2016. A metadata convention for processed acoustic data from active acoustic systems, SISP 4 TG-AcMeta Version 1.10, ICES WGFAST Topic Group, TG-AcMeta. 47 pp.”	S			M	1
Uniform_resource_identifier	Uniform resource identifier (URI) that uniquely identifies the name and location of the metadata record.	S			O	1

7.2. Category: Mission attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
mission_name	Name of mission	S			M	1
mission_abstract	Free text description of the mission, its purpose, scientific objectives and area of operation. Other instruments and experiments within the mission which may or may not relate directly to the acoustic data can be included	S			M	1
mission_start_date	Start date of mission in ISO 8601 format including local time zone. For example, a local time of 18:00 on the 24th of October 2008 would be represented as 2008-10-24T08:00:00Z +10 (local)	S			M	1
mission_end_date	Later mission_start_date	S			MA	1
principal_investigator	Name of the principal investigator in charge of the mission	S		IMOS	M	1
principal_investigator_email	Principal investigator e-mail address	S		IMOS	M	N
institution	Name of the institute, facility, or company where the original data were produced	S		CF	M	N
data_centre	Data centre in charge of the data management or party who distributed the resource	S		IMOS	M	N
data_centre_email	Data centre contact e-mail address	S		IMOS	M	N
mission_id	ID code of mission	S			M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
mission_platform	Platform type (see Section B.1, “Category: Mission attributes: mission_platform; Ship attributes: ship_type”, Standard lists)	S			M	N
creator	An entity primarily responsible for making the resource.	S		Dublin core	M	N
contributor	An entity responsible for making contributions to the resource	S		Dublin core	M	N
mission_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

7.3. Category: Cruise attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
cruise_name	Formal name of cruise as recorded by cruise documentation or institutional data centre	S			MA	1
cruise_description	Free text field to describe the cruise. May include list of objectives of the cruise. For example scientific survey, commercial fishing, resupply, or combinations of these.	S			MA	1
cruise_summary_report	Publication or web-based references that links to the cruise report. SeaDataNet - Pan European Infrastructure for Ocean and Marine Data Management have a well developed Cruise Summary Report (CSR) system that is in wide use and follows	S		ICES/ SeaDataNet	MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	ISO standards. Adoption of this format is recommended and may be obligatory for nations that participate in the SeaDataNet endeavour. See http://www.seadatanet.org/Standards-Software/Metadata-formats/CSR and http://www.seadatanet.org/Metadata/CSR-Cruises for more information. Alternatively, institutional cruise reports should be referenced. If available, DOI's (Digital Object Identifiers) should be given.					
cruise_area_description	Descriptions of areas of operation (e.g. Southern Pacific Ocean, Chatham Rise Region; Indian Ocean High Seas)	S			MA	N
cruise_start_date	Start date of cruise in ISO 8601 format. For example, a local time of 18:00 on the 24th of October 2008 would be represented as 2008-10-24T08:00:00Z +10 (local).	S			MA	
cruise_end_date	same as cruise_start_date	S		IMOS	MA	1
cruise_id	Cruise id where one exists.	S		IMOS	O	1
cruise_northlimit	The constant coordinate for the northernmost face or edge	N		Dublin core*	MA	1
cruise_eastlimit	The constant coordinate for the easternmost face or edge	N		Dublin core*	MA	1
cruise_southlimit	The constant coordinate for the southernmost face or edge	N		Dublin core*	MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
cruise_westlimit	The constant coordinate for the westernmost face or edge	N		Dublin core*	MA	1
cruise_uplimit	The constant coordinate for the uppermost face or edge in the vertical, z, dimension.	N		Dublin core*	MA	1
cruise_downlimit	The constant coordinate for the lowermost face or edge in the vertical, z, dimension.	N		Dublin core*	MA	1
cruise_units	The units of unlabelled numeric values of cruise_northlimit, cruise_eastlimit, cruise_southlimit, cruise_westlimit. Units specified as appropriate to the projection. E.g. geographic coordinates specify 'signed decimal degrees', UTM specify 'm'.	S		Dublin core*	MA	1
cruise_zunits	The units applying to unlabelled numeric values of cruise_uplimit, cruise_downlimit. SI units are 'm'.	S		Dublin core*	MA	1
cruise_projection	The name of the projection used with any parameters required, such as ellipsoid parameters, datum, standard parallels and meridians, zone, etc.	S		Dublin core*	MA	1
cruise_start_port	Commonly used name for the port where cruise started	S			O	1
cruise_end_port	Commonly used name for the port where cruise ended	S			O	1
cruise_start_BODC_code	BODC code from where cruise starts. Recommend use of British Oceanographic Data Centre (BODC) port gazetteer:	S		BODC ports gazetteer	O	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	+ http://seadatanet.maris2.nl/v_bodc_vocab/search.asp?name=(C381)%20Ports+Gazetteer&l=C381.					
cruise_end_BODC_code	BODC code for cruise start_BODC_code	S		BODC ports gazetteer	O	1
cruise_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

* Dublin core DCMI Bounding Box Encoding Scheme - see http://dublincore.org/documents/dcmi-box/index.shtml

7.4. Category: Ship attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
ship_name	Name of the ship	S			MA	1
ship_type	Describe type of ship that is hosting the acoustic instrumentation. (See first three rows in Section B.1, “Category: Mission attributes: mission_platform; Ship attributes: ship_type”, Standard lists)	S			MA	1
ship_code	For example, in-house code associated with ship, e.g. SS = Southern Surveyor or ship national identifier	S			O	1
ship_platform_ICES_code	ICES database of known ships. See http://vocab.ices.dk/Request/Login.aspx?ReturnUrl=	S		ICES/SeaDataNet	MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Occurrences
	%2frequest. Requests can be made to add new vessels to the database by contacting accessions@ices.dk[1]					
ship_platform_class	ICES controlled vocabulary for platform class. http://vocab.ices.dk/?ref=311	S		ICES/SeaDataNet	MA	1
ship_callsign	Ship call sign	S			MA	1
ship_alt_callsign	Alternative call sign if the ship has more than one.	S			O	1
ship_IMO	Ship's International Maritime Organisation ship identification number.	S			O	1
ship_operator	Name of organisation or company which operates the ship	S			MA	1
ship_length	Overall length of the ship	N	m		MA	1
ship_breadth	The width of the ship at its widest point	N	m		R	1
ship_tonnage	Gross tonnage of the ship	N	t		R	1
ship_engine_power	The total power available for ship propulsion	N	kW		R	1
ship_noise_design	For example, ICES 209 compliant cite:[mitson1995]. Otherwise description of noise performance of the ship.	S			R	1
ship_acknowledgement	Any users (including re-packagers) of this data are required to clearly acknowledge the source of the material in this format. For	S			R	1

[1] mailto:accessions@ices.dk

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	example, ship of opportunity - acknowledge contribution by ship and company.					
ship_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

7.5. Category. Mooring attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
mooring_description	Describe type of mooring that is hosting the acoustic instrumentation	S			MA	1
mooring_depth	Seafloor depth at mooring site	N	m		MA	1
mooring_northlimit	The constant coordinate for the northernmost face or edge	N		Dublin core*	MA	1
mooring_eastlimit	The constant coordinate for the easternmost face or edge	N		Dublin core*	MA	1
mooring_southlimit	The constant coordinate for the southernmost face or edge	N		Dublin core*	MA	1
mooring_westlimit	The constant coordinate for the westernmost face or edge	N		Dublin core*	MA	1
mooring_uplimit	The constant coordinate for the uppermost face or edge in the vertical, z, dimension.	N		Dublin core*	MA	1
mooring_downlimit	The constant coordinate for the lowermost face or edge in the vertical, z, dimension.	N		Dublin core*	MA	1
mooring_units	The units unlabelled numeric values of mooring_northlimit, mooring_eastlimit,	S		Dublin core*	MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	mooring_southlimit, mooring_westlimit. Units specified as appropriate to the projection. E.g. geographic coordinates specify 'signed decimal degrees', UTM specify 'm'.					
mooring_zunits	The units of unlabelled numeric values of mooring_uplimit, mooring_downlimit. SI units are 'm'.	S		Dublin core*	MA	1
mooring_projection	The name of the projection used with any parameters required, such as ellipsoid parameters, datum, standard parallels and meridians, zone, etc	S		Dublin core*	MA	1
mooring_deployment_date	Start time of the mooring deployment in ISO 8601 format. For example, a local time of 18:00 on the 24th of October 2008 would be represented as 2008-10-24T08:00:00Z +10 (local).	S			MA	1
mooring_retrieval_date	see mooring_deployment_date	S			MA	1
mooring_code	e.g. mooring ID	S			O	1
mooring_site_name	Name of location where mooring is deployed	S			O	1
mooring_operator	Name of organisation which operates the mooring	S			MA	N
mooring_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

* Dublin core DCMI Bounding Box Encoding Scheme - see http://dublincore.org/documents/dcmi-box/index.shtml

7.6. Category: Transect attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
transect_name	Name of the transect	S			O	1
transect_id	Identifier for the transect	S			O	1
transect_description	Description of the transect, its purpose, and main activity	S			MA	1
transect_related_activity	Description of related activities that may occur on the transit	S			O	1
transect_start_time	Start time of the transect in ISO 8601 format. For example, a local time of 18:00 on the 24th of October 2008 would be represented as 2008-10-24T08:00:00Z +10 (local).	S			MA	1
transect_end_time	Same as transect_start_time	S			MA	1
transect_northern_limit	The constant coordinate for the northernmost face or edge	N		Dublin core*	MA	1
transect_eastern_limit	The constant coordinate for the easternmost face or edge	N		Dublin core*	MA	1
transect_southern_limit	The constant coordinate for the southernmost face or edge	N		Dublin core*	MA	1
transect_western_limit	The constant coordinate for the westernmost face or edge	N		Dublin core*	MA	1
transect_upper_limit	The constant coordinate for the uppermost face or edge in the vertical, z, dimension.	N		Dublin core*	MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
transect_downlimit	The constant coordinate for the lowermost face or edge in the vertical, z, dimension.	N		Dublin core*	MA	1
transect_units	The units of unlabelled numeric values of transect_northlimit, transect_eastlimit, transect_southlimit, transect_westlimit. Units specified as appropriate to the projection. E.g. geographic coordinates specify 'signed decimal degrees', UTM specify 'm'.	S		Dublin core*	MA	1
transect_zunits	The units of unlabelled numeric values of transect_uplimit, transect_downlimit. SI units are 'm'.	S		Dublin core*	MA	1
transect_projection	The name of the projection used with any parameters required, such as ellipsoid parameters, datum, standard parallels and meridians, zone, etc	S		Dublin core*	MA	1
transect_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

* Dublin core DCMI Bounding Box Encoding Scheme - see http://dublincore.org/documents/dcmi-box/index.shtml

7.7. Category: Instrument attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
instrument_frequency	Frequency of the transceiver/ transducer combination in kHz.	S	kHz		M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	Some systems such as broadband and multi-beam will have a range of frequencies. If so, specify the minimum, maximum and centre frequency					
instrument_transducer_location	Location of installed transducer. Refer to Section B.2, “Category: Instrument attributes: instrument_transducer_location” for a list of standard transducer locations.	S			M	1
instrument_transducer_manufacturer	Transducer manufacturer	S			M	1
instrument_transducer_model	Transducer model	S			M	1
instrument_transducer_beam_type	For example 'single beam, split-aperture'. See controlled vocabulary table for transducer types in Section B.3, “Category: Instrument attributes: instrument_transducer_beam_type”.	S			M	1
instrument_transducer_serial_number	Transducer serial number	S			R	N
instrument_transducer_depth	Mean depth of transducer face beneath the water surface.	N	m		O	1
instrument_transducer_orientation	Direction perpendicular to the face of the transducer. A simple description for a ship mounted sounder would be 'downward looking', a mooring could be 'upward looking'. If required Appendix C, *Transducer orientation conventions* provides a comprehensive description	S			M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	of transducer orientation conventions.					
instrument_transducer_ps	Manufacturer-specified transducer equivalent beam angle, expressed as $10\log_{10}(\psi)$, where ψ has units of steradians. Note this value is not necessarily used for processing. Check data processing attributes.	N	dB		R	1
instrument_transducer_beamwidth_major	Major beam opening angle, major referred to athwartship angle. See Appendix D, *Beam geometry* for description of beam geometry conventions	N	degrees		R	1
instrument_transducer_beamwidth_minor	Minor beam opening angle, minor referred to alongship angle. See Appendix D, *Beam geometry* for description of beam geometry conventions	N	degrees		R	1
instrument_transceiver_manufacturer	Transceiver manufacturer	S			M	1
instrument_transceiver_model	Transceiver model	S			M	1
instrument_transceiver_serial	Transceiver serial number	S			R	1
instrument_transceiver_firmware	Transceiver firmware version	S			R	1
instrument_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

7.8. Category: Ancillary instrumentation

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
ancillary_instrumentation	List of instruments and other equipment (e.g. net systems, CTD,	S			O	N

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	ADCP) potentially relevant to the acoustic data set.					

7.9. Category: Calibration attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
calibration_date	Date of calibration in ISO 8601 format including local time zone. For example, a local time of 18:00 on the 24th of October 2008 would be represented as 2008-10-24T08:00:00Z +10 (local).	S			M	1
calibration_aquisition_method	Describe the method used to acquire calibration data. (see Section B.4, “Category: Calibration attributes: calibration_aquisition_method”, Standard lists)	S			M	1
calibration_processing_method	Describe method of processing that was used to generate calibration offsets.	S			M	1
calibration_accuracy_estimate	Estimate of calibration accuracy. Include a description and units so that it is clear what this estimate means (e.g. estimate might be expressed in dB or as a percentage).	S			M	1
calibration_report	URL or references to external documents which give a full account of calibration processing and results may be appropriate	S			M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
calibration_comments	Free text field to for relevant information that might not be captured by the defined attributes	S			O	1

7.10. Category: Data acquisition attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
data_aquisition_software_name	Name of software that controls echosounder and its data logging	S			R	1
data_acquisition_software_version	Version of software that controls echosounder and its data logging	S			R	1
data_acquisition_format	Name of the data format in which data is stored. For example Simrad raw format, HAC.	S			M	1
data_acquisition_ping_duty_cycle	Free text field to describe ping duty cycle. For a ship system this may be continuous pinging at a certain rate. For a mooring this may describe the duty cycle. For example 10 minutes pinging at 1 ping per second, followed by 50 minute sleep mode.	S			M	1
data_acquisition_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

7.11. Category: Data processing attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
data_processing_software_name	Name of software that was used to process raw acoustic data	S			M	N

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
data_processing_software_version	Version of software that was used to process raw acoustic data	S			M	N
data_processing_software_ver_ES60	Applies to Simrad ES60 and ES70 echosounders only. Simrad ES60/70 echosounders have an error function embedded in the raw data that overlays addition of to the data of a triangle wave of +/- 0.5dB peak to peak and period of 2720 pings. A utility (ES60adjust) to correct for this error can be found at https://bitbucket.org/gjm/calibration-code/wiki/Home. Controlled vocabulary is “Yes” if error has been corrected and “No” if not. See also pages 63, 64 of Demer, D. A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., and Domokos, R. et al. 2015. Calibration of acoustic instruments. ICES Cooperative Research Report No.326: 133 pp.	S			MA	1
data_processing_channel_id	Unique identifier for each data channel.	S			R	1
data_processing_bandwidth	Bandwidth associated with processed data	N	kHz		R	1
data_processing_frequency	Transmit frequency associated with processed data	N	kHz		M	1
data_processing_nominal_power	Nominal transceiver power	N	W		M	N
data_processing_pulse_length	Transmit pulse length	N	ms		M	N

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
data_processing_system_on_axis_gain	Total system gain value when calibration sphere is on-axis. This term accounts for whole of system calibration including the power source, the transducer directivity multiplied by its efficiency, and any other gains or losses through the echosounder system including the transducer cable. It is commonly denoted as Go in the sonar equation. Echoview software refers to it as the Transducer Peak Gain and EK60 systems refer to it as 'Ek60TransducerGain'. Simrad refers to this as Transducer Gain with symbol 'G' in their EK60 manual. Note: manufacturers of other echosounders may express calibration in different terms and users are encouraged to propose new attributes be added to this metadata convention that will meet their specific needs. In the meantime additional or different calibration parameters can be described in the data_processing_comments field as appropriate. Alternatively a superset of discrete calibration parameters specific to the particular system can be added to the metadata record.	N			M	N
data_processing_on_axis_gain_units	Units for the data_processing_on_axis_gain	S			M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	attribute. Units may be in dB for some systems (e.g. Simrad) but on other instruments may be dimensionless numeric values					
data_processing_sacorrection	Sa correction value (Simrad transceivers)	N	dB		O	1
data_processing_absorption	Absorption of sound by seawater value. Leave blank if absorption profile was used and give appropriate description in the data_processing_absorption_description field	N	dBm^{-1}		R	1
data_processing_absorption_description	Describe (i) equation used to calculate absorption, (ii) source of input data into absorption calculation (e.g. model, XBT, CTD), (iii) arithmetic or geometric mean of depth-absorption profile or nominal value applied to entire data set. e.g. (i) Equation: Francois and Garrison 1982, (ii) WOCE98 model, (iii) nominal value for entire data set.	S			R	1
data_processing_soundspeed	Sound speed used by transceiver. Leave blank if sound speed profile was used and give appropriate description in the data_process_soundspeed_description field	N	ms^{-1}		R	1
data_processing_soundspeed_description	Describe (i) equation used to calculate sound speed, (ii) source of input data into sound speed calculation (e.g. model, XBT,	S			R	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	CTD), (iii) arithmetic or geometric mean of depth-absorption profile or nominal value applied to entire data set. e.g. (i) Equation: Mackenzie 1981, (ii) WOCE98 model, (iii) nominal value for entire data set.					
data_processing_transducer_beam	The transducer equivalent beam angle, expressed as $10\log_{10}(\psi)$, where ψ has units of steradians.	N	dB		M	1
data_processing_text_field	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

7.12. Category: Dataset attributes

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
project	The scientific project that produced the data	S		NACDD	M	1
title	Short description of the dataset	S		NUG	M	1
abstract	A paragraph describing the dataset: type of data contained in the dataset, how the data was created, the creator of the dataset, the mission for which the data was created, the geospatial coverage of the data, the temporal coverage of the data. Manually generated attribute.	S		IMOS	M	1
history	Provides an audit trail for modifications to the original data. It	S		NUG	R	N

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	should contain a separate line for each modification, with each line beginning with a timestamp and including user name, modification name and modification arguments. Manually generated attribute.					
comment	Miscellaneous information about the data or methods used to produce it. Any free-format text is appropriate. Manually generated attribute.	S		CF	O	N
keywords	A comma separated list of key words and phrases. Keywords are an important tool in data discovery and the use of words or phrases from 'standard' vocabularies is encouraged to maximise the discoverability of the data by others. The use of keywords from the Global Change Master Directory (GCMD) vocabulary (Olsen et.al., 2007) is recommended. The GCMD keywords list can be downloaded from: http://gcmd.nasa.gov/learn/keyword_list.html Non-GCMD keywords may be used at your discretion, but consideration should be given to using keywords from other standard catalogues (e.g. BODC)	S		NACDD	M	N

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	if there are no applicable GCMD keywords.					
references	Published or web-based references that describe the data or the methods used to produce the data. If available, DOI's (Digital Object Identifiers) should be given.	S		CF	M	N
doi	Digital Object Identifier (DOI) for project documentation	S		IDF	O	N
citation	The citation to be used in publications using the dataset should follow the format:"ProjectName. [year-of-data-download], [Title], [Data access URL], accessed [date-of-access]". Manually generated attribute.	S		IMOS	M	N
license	Describe the restrictions to data access and distribution. For example visit Australian National Data Service website AusGoal licensing framework (http://www.ands.org.au/publishing/licensing.html) which incorporates Creative Commons licences (http://creativecommons.org/).	S		NACDM	M	1
author_email	Email address of the person responsible for the creation of the dataset	S		IMOS	M	N
author	Name of the person responsible for the creation of the dataset	S		IMOS	M	N

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
distribution_statement	Statement describing data distribution policy, e.g., re-packagers of this data should include a statement that information about data quality and lineage is available from the metadata record and a statement that data, products and services from are provided "as is" without any warranty as to fitness for a particular purpose	S		IMOS	M	1
date_created	The date on which the data was created in ISO 8601 format. Will vary with each data file, possibly automatically generated. For example, a local time of 18:00 on the 24th of October 2008 would be represented as 2008-10-24T08:00:00Z +10 (local).	S		NACDD	M	N
northlimit	The constant coordinate for the northernmost face or edge	N		Dublin core*	MA	1
eastlimit	The constant coordinate for the easternmost face or edge	N		Dublin core*	MA	1
southlimit	The constant coordinate for the southernmost face or edge	N		Dublin core*	MA	1
westlimit	The constant coordinate for the westernmost face or edge	N		Dublin core*	MA	1
uplimit	The constant coordinate for the uppermost face or edge in the vertical, z, dimension. Reference edge for this attribute is the water surface.	N		Dublin core*	MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
downlimit	The constant coordinate for the lowermost face or edge in the vertical, z, dimension. Reference edge for this attribute is the water surface.	N		Dublin core*	MA	1
units	The units of unlabelled numeric values of northlimit, eastlimit, southlimit, westlimit. Units specified as appropriate to the projection. E.g. geographic coordinates specify 'signed decimal degrees', UTM specify 'm'.	N		Dublin core*	MA	1
zunits	The units of unlabelled numeric values of uplimit, downlimit. **SI units are** 'm'.	N		Dublin core*	MA	1
projection	The name of the projection used with any parameters required, such as ellipsoid parameters, datum, standard parallels and meridians, zone, etc	S		Dublin core*	MA	1
dataset_linestring	OGC SFS/WKT compliant LINESTRING geometry representing each transect. A LineString consists of a sequence of two or more vertices, along with all points along the linearly-interpolated curves (line segments) between each pair of consecutive vertices	S			O	N
time_coverage_start	Start date of the data in UTC Date format is ISO 8601. For example, a local time of 18:00 on the 24th of October	S		NACDM	M	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	2008 would be represented as 2008-10-24T08:00:00Z +10 (local). Will vary with each data file, possibly automatically generated.					
time_coverage_end	see time_coverage_start	S		NACDM	M	1
dataset_comments	Free text field for relevant information that might not be captured by the defined attributes	S			O	1

7.13. Category: Data attributes

It is usual and recommended for the cell dimensions (ping-axis interval and range-axis interval) to be stored for each data value to be stored with the data. These cell dimensions should also be defined in the metadata if possible. If cell dimensions do vary within the dataset then they cannot be specified in the metadata record and it will be essential that they are stored with the data. Similarly it is expected that time and position (if appropriate) of each data value will be stored with the data.

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
data_acoustic_variable	In what form is the acoustic data stored? Controlled vocabulary options include : • Sv, Volume backscattering strength (dB re 1 m^{-1}) • s_v, Volume backscattering coefficient (m^{-1}) • sA, Nautical area scattering coefficient (m2 nmi $^{-2}$) • s_a, Area backscattering coefficient (m2 m^{-2})	S			M	

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	see also citenp:[maclennan2002]					
data_ping_axis_interval_type	Ping axis interval type by which data have been binned. Controlled vocabulary include: • Time based intervals Time (minutes); Time (seconds); Time (hours); Time (day) • Distance based intervals Distance (nautical miles); Distance (metres);Distance (kilometres) • Ping based intervals Number of pings User-defined interval types can be used if not on controlled vocabulary list.	S			M	1
data_ping_axis_interval_origin	Location of ping axis interval value in the ping axis interval. Controlled vocabulary include: Start Middle End	S			M	1
data_ping_axis_interval_value	Numeric value for data ping axis interval according to its specified type	N			MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	Examples: (1) data_ping_axis_interval_type: Time (seconds) data_ping_axis_interval_value: 600 (2) data_ping_axis_interval_type: Distance (metres) data_ping_axis_interval_value: 1000 (3) data_ping_axis_interval_type: Number of pings data_ping_axis_interval_value: 300 Notes: If ping axis interval values vary within each dataset they cannot be specified as a single number in this metadata record. Leave this record blank if this is the case. Note that it would be usual for the ping axis interval information to be stored at the same level as the data itself.					

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
data_range_axis_interval_type	Basis in terms of type by which data has been binned. Controlled vocabulary include: Range (metres) Time (seconds) User-defined interval type can be used if not on controlled vocabulary list.	S			M	1
data_range_axis_interval_origin	Location of origin range value in the range axis interval. Controlled vocabulary include: Start Middle End	S	m		M	1
data_range_axis_interval_value	Numeric value of data range axis interval according to its specified type, e.g. data_range_axis_interval_type: Distance (metres) data_range_axis_interval_value: 1000 SI units are 'm' Notes: If range axis interval values vary within each dataset they cannot	N			MA	1

Attribute name	Definition	Data type	Units	Authority	Obligation	Maximum occurrences
	be specified as a single number in this metadata record. Leave this record blank if this is the case. Note that it would be usual for the range axis interval information to be stored at the same level as the data itself.					

Appendix A. Metadata authorities

Table A.1. Authorities for various metadata attribute fields used in this convention or used for general reference:

NetCDF	Network Common Data Form	http://www.unidata.ucar.edu/software/netcdf/docs/BestPractices.html http://en.wikipedia.org/wiki/Netcdf
NUG	NetCDF User's Guide	http://www.unidata.ucar.edu/software/netcdf/guide_toc.html
COARDS	Cooperative Ocean/Atmosphere Research Data Service	http://ferret.wrc.noaa.gov/noaa_coop/coop_cdf_profile.html
CF	NetCDF Climate and Forecast (CF) Metadata Convention	http://www.cfconventions.org/ http://cf-pcmdi.llnl.gov/ http://en.wikipedia.org/wiki/Climate_and_Forecast_Metadata_C
NACDD	NetCDF Attribute Convention for Dataset Discovery	http://www.unidata.ucar.edu/software/netcdf-java/formats/DataDiscoveryAttConvention.html

Dublin Core	The Dublin Core Metadata Initiative (DCMI)	http://dublincore.org/
IMOS	Integrated Marine Observing System	http://imos.org.au/fileadmin/user_upload/shared/emii/IMOS_netCDF_usermanual_v1.2.pdf
BASOOP	IMOS Bio-acoustic Ships of opportunity	http://imos.org.au/fileadmin/user_upload/shared/SOOP/plugin-SOOP-BA_NetCDF_manual_v1.1.pdf
Udunits	UniData units software	http://www.unidata.ucar.edu/software/udunits
ISO8601	ISO standard for dates	http://www.iso.org/iso/home/standards/iso8601.htm
MMI	MMI Platform Ontology	http://mmi.svn.sourceforge.net/svnroot/mmi/mmisw/platform.owl
IDF	International DOI Foundation	http://www.doi.org/
SeaDataNet	Pan-European infrastructure for ocean and marine data management	http://www.seadatanet.org/

Appendix B. Standard lists for controlled vocabulary

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B.1. Category: Mission attributes: mission_platform; Ship attributes: ship_type

Ship, research
Ship, fishing
Ship, other
Buoy, moored
Buoy, drifting
Glider
Underwater vehicle, autonomous, motorised
Underwater vehicle, towed
Underwater vehicle, autonomous, glider

- Controlled vocabulary sources from Marine Metadata Interoperability project (MMI, https://marinemetadata.org/), MMI Platform Ontology, http://mmi.svn.sourceforge.net/svnroot/mmi/mmisw/platform.owl

B.2. Category: Instrument attributes: instrument_transducer_location

Hull, keel

Hull, lowered keel
Hull, blister
Hull, gondola
Towed, shallow
Towed, deep
Towed, deep, trawl net attached
Ship, pole

B.3. Category: Instrument attributes: instrument_transducer_beam_type

Type	Comments
Single-beam	Single beam
Single-beam, split-aperture	Single beam transducer with elements divided into groups to provide information on the direction of arrival of echoes. Typically four equal quadrants but other groupings are possible.
Multi-beam	Multiple single beams.
Multi-beam, split-aperture	Multiple single beams with elements divided into groups to provide information on the direction of arrival of echoes. Typically four equal quadrants per beam but other groupings are possible.

B.4. Category: Calibration attributes: calibration_aquisition_method

Method	Comments
Standard sphere, in-situ	As per citenp:[foote1987,simmonds2005]
Standard sphere, tank	
Standard sphere, other	

Method	Comments
Reciprocity	
Hydrophone	
Seafloor reflection	
Nominal	For example, As per manufacturer’s nominal specification
Intership	For example, comparison between echo integration from two ships in the same regions either as a relative difference, or comparing results from an uncalibrated ship to those from a calibrated ship.

Appendix C. Transducer orientation conventions

This Appendix was reproduced with permission from the Echoview 5.1 help file (see also www.echoview.com[1]).

About transducer geometry

Transducer geometry in Echoview refers to the configurable location and orientation of transducers[2]. This page covers:

- Overview of transducer geometry
- About transducer location
- About transducer orientation

For information about how transducer geometry affects displayed data and exports, see What is affected by transducer geometry[3].

Overview of transducer geometry

Each transducer may be located in space and oriented as desired. Illustrated below is a schematic displaying the relative positions in space of a reference point, a GPS antenna and a transducer with non-vertical orientation. How to define location and orientation for each transducer is described below.

Transducers are always associated with a platform[4]. The reference point of the platform is at (0,0,0) by definition and defines the position of the platform in the real world (that is, the platform is considered to be, in the real world, wherever it's reference point is).

[1] http://www.echoview.com
[2] http://support.echoview.com/WebHelp/Reference/Glossary.htm#Transducer
[3] http://support.echoview.com/WebHelp/Using_Echoview/What_is_effected_by_transducer_geometry.htm
[4] http://support.echoview.com/WebHelp/Reference/Glossary.htm#Platform

The position of the reference point is not explicitly entered in Echoview, but all other positions are entered relative to it, wherever it may be.

Please note that the positive Z direction is downwards when the X-Y plane is horizontal (considered to be on a rigid platform that does not pitch and roll).

For many applications, such as a typical ship based echo integration survey with multiple downward looking transducers, the only aspect of transducer geometry required is the definition of transducer depth (draft[5]), if desired. Other applications, such as multiple frequency TS techniques, surveys with non-vertical transducers, and applications that require the position of samples to be precisely located in the world, Echoview's transducer geometry settings allow full specification of the transducer set up.

Echoview transducer geometry settings allow enough information to be stored about the location and orientation of transducers and GPS antennas to determine the geographic coordinates of any sample or single target in the acoustic beam - given the assumption of a stable platform with no pitch and no roll. In Echoview, some data formats may support roll data or roll and pitch data. For further information regarding relevant data formats and the effects of using roll and pitch data see About roll data[6] and About pitch data[7].

Note: Transducer geometry calculations are not used in Echoview for calculating the geographic position of lines (and hence bathymetric data). Bottom picks are assumed to be at the position of the GPS antenna even if the beam is pointing at some angle to the vertical and the transducer is offset from the Reference point.

About transducer location

The relative location of the water level and GPS antenna and the location of each transducer are defined on the Location page[8] of the Transducer Properties dialog box[9].

[5] http://support.echoview.com/WebHelp/Using_Echoview/About_transducer_draft.htm
[6] http://support.echoview.com/WebHelp/Files,_filesets_and_variables/Variables/About_roll_data.htm
[7] http://support.echoview.com/WebHelp/Files,_filesets_and_variables/Variables/About_pitch_data.htm
[8] http://support.echoview.com/WebHelp/Windows_and_Dialog_Boxes/Dialog_Boxes/Transducer_Properties_dialog_box.htm#Location_page

Locations are all defined relative to a system reference point. The system reference point may be any point defined relative to the transducer platform (it is not defined explicitly in Echoview, the locations of transducers, GPS antenna and water level are defined relative to it).

The coordinate system utilises three axes (X, Y and Z) and their orientation depends upon whether the platform is fixed or mobile.

Fixed Platform

The location of the system reference point is specified in geographic coordinates (latitude, longitude and altitude).

- The X axis is defined to run south-north (positive northwards, negative southwards)
- The Y axis is defined to run west-east (positive eastwards, negative westwards)
- The Z axis is defined to run vertically (positive downwards, negative upward)

Mobile Platform

The geographic location (latitude, longitude and altitude) of the GPS antenna is measured by a Global Positioning System (GPS) device. The location of the GPS antenna relative to the system reference point is specified in X, Y, Z coordinates (m). Hence the geographic location of the system reference point and the location of the face of each transducer can be determined in geographic coordinates (latitude, longitude and altitude) from the known position of the GPS antenna.

- The X axis is defined to run alongship (positive towards the bow, negative towards the stern)
- The Y axis is defined to run athwartship (positive towards starboard, negative towards port)
- The Z axis is considered to run vertically (positive downwards, negative upwards)

[9] http://support.echoview.com/WebHelp/Windows_and_Dialog_Boxes/Dialog_Boxes/Transducer_Properties_dialog_box.htm

To determine the geographic location of a sample point or a single target in geographic coordinates it is also necessary to define the orientation of the transducer.

About transducer orientation

Transducers are not only located, but also oriented - that is, they point somewhere. Like location, orientation requires three parameters to be specified, in this case angles rather than coordinates. The orientation for each transducer is defined on the Orientation page[10] of the TransducerProperties dialog box[11].

The X-Y-Z axes as defined above are taken as a reference for orientation. In summary:

For fixed platforms:	For mobile platforms:
• The X axis runs south-north • The Y axis runs west-east • The Z axis runs up-down	• The X axis runs stern-bow • The Y axis runs port-starboard • The Z axis runs up-down

Two angles are used to define the direction in which the acoustic axis is pointing (either elevation and azimuth angles or alongship and athwartship angles). A third angle called the rotation defines the direction of the minor axis[12] of the transducer relative to a vertical plane passing through the beam axis[13]. The rotation of the transducer can only be determined after the definition of the beam direction.

Elevation and Azimuth

The angles are defined as follows:

- **Elevation** is the angle between the beam axis and the positive Z axis. Valid range is 0° to 180°.

[10] http://support.echoview.com/WebHelp/Windows_and_Dialog_Boxes/Dialog_Boxes/Transducer_Properties_dialog_box.htm#Orientation_page
[11] http://support.echoview.com/WebHelp/Windows_and_Dialog_Boxes/Dialog_Boxes/Transducer_Properties_dialog_box.htm
[12] http://support.echoview.com/WebHelp/Reference/Glossary.htm#Minor-axis
[13] http://support.echoview.com/WebHelp/Reference/Glossary.htm#beam_axis

0°	defines a vertically downward pointing beam
90°	a horizontal beam
180°	a vertically upward pointing beam

- **Azimuth** is the angle between the beam axis and the positive X axis (measured clockwise when viewed in the positive Z direction).
  Valid range is 0° to 360° .

0°	defines a northward (or forward) pointing beam
90°	eastward (or starboard) pointing
180°	southward (or aft) pointing
270°	westward (or port) pointing

If the elevation is 0° or 180° then Azimuth is equivalent to a rotation.

Along and Athwartship (Mobile Platform only)

The angles are defined as follows:

- **Alongship** is the angle between the beam axis and the Y-Z plane.
  Valid range is -180° to 180° .

0°	defines a downward pointing beam in the Y-Z plane
-90°	a horizontal aft pointing beam
90°	a horizontal forward pointing beam
-180°	an upward pointing beam in the Y-Z plane
180°	an upward pointing beam in the Y-Z plane

- **Athwartship** is the angle between the beam axis and the X-Z plane.
  Valid range is -180° to 180° .

0°	defines a downward pointing beam in the X-Z plane
-90°	a horizontal port pointing beam
90°	degrees a horizontal starboard pointing beam
-180°	an upward pointing beam in the X-Z plane
180°	an upward pointing beam in the X-Z plane

Note: Not all combinations of Alongship and Athwartship angle are valid. If one angle defines a downward pointing beam (-90° to 90°) and the other an upward pointing beam (-180° to -90° or 90° to 180°) they cannot be describing the same direction!

Rotation

- **Rotation** is the angle between the positive minor-axis[14] of the transducer and the vertical plane running through the beam axis (measured in the clockwise direction as seen from the transducer).

Valid range is 0° to 360°.

0°	an upward pointing positive minor-axis
180°	a downward pointing positive minor-axis

In Summary

To determine the three coordinates defining the beam orientation do the following:

1. Determine the pointing direction of the beam axis

   Use your choice of either elevation-azimuth angles or alongship-athwartship angles.

[14] http://support.echoview.com/WebHelp/Reference/Glossary.htm#Minor-axis

2. Determine the rotation angle of the transducer

   Remember that the zero reference for the rotation angle is the vertical plane running through the beam axis and therefore that the rotation coordinate can only be meaningfully determined after you have defined the orientation of the beam axis.

Examples:

- A transducer beam pointing to starboard at an angle of 45 degrees with the positive minor axis of the transducer pointing forward is defined by either:
  elevation = 45° , azimuth = 90° , rotation = 270°
  -OR-
  alongship = 0° , athwartship = 45° , rotation = 270°
- A transducer beam pointing to port at an angle of 45 degrees with the positive minor axis of the transducer pointing forward is defined by either:
  elevation = 45° , azimuth = 270° , rotation = 90°
  -OR-
  alongship = 0° , athwartship = -45° , rotation = 90°

Notes:

- You may define the pointing direction of the transducer with whichever pair of angles is most convenient for your application but the rotation angle will be the same, whichever pair of angles you choose to define the pointing direction.
- For a transducer with an elevation of 0° (that is, vertically downward pointing), the azimuth angle is logically equivalent to the transducer rotation. Echoview does not adjust the rotation angle on the dialog if you specify an azimuth without any elevation. We recommend, for clarity, that you do not use a non-zero azimuth with a zero elevation.

Appendix D. Beam geometry

This Appendix was reproduced with permission from the Echoview 5.1 help file (see also www.echoview.com[1])

Echoview uses three axes in describing beam geometry: beam axis, minor axis and major axis. Range from the transducer is measured along the beam axis and position in the beam is measured from the beam axis (along the minor and major axes). Minor and major are axis naming conventions, and different manufacturers have adopted different naming conventions for the two axes. Equivalent axis terminology for leading brands of echosounders are:

Manufacturer	**Preferred Minor Axis Terminology**	**Preferred Major Axis Terminology**
BioSonics	Minor	Major
HTI	Up-down	Left-right
Simrad	Alongship or Longitudinal	Athwartship or Transversal
Precision Acoustic Systems	y	x

Figure 1 below illustrates the axis system.

[1] http://www.echoview.com

Appendix E. List of participants

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References

Some temporary citations cite:[simmonds2005,foote1987] because of a bug in asciidoctor, whereby citations inside tables are not seen (https://github.com/asciidoctor/asciidoctor-bibtex/issues/39).

bibliography::[]

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Revisions

Version 1.04. 21st August 2014

Added new category of attributes, 'data' which describe the data type being stored and its dimensions (i.e. cell size).

Altered obligations on attributes from Mandatory (M) or Mandatory if Applicable (MA) to recommended (R) for ship_breadth, ship_tonnage, ship_engine_power, ship_noise_design and ship_acknowledgements.

Changed term data_processing_transceiver_gain to data_processing_on_axis_gain

Changed term data_processing_transceiver_gain_units to data_processing_on_axis_gain_units

Minor edits to improve readability in “Purpose of this document” section.

Added new attribute of “Convention” to the Metadata category.

Version 1.10. 10th May 2016.

The ICES Data Centre (Hjalte Parner, Nils Olav Handegard) are constructing an Acoustic Trawl Survey database with the intention of implementing the ICES Acoustic Metadata Standard. Through this process a number of new and existing attribute fields were discussed. This revision documents the consequent changes that were made as described below.

Add

Category: Cruise attributes: cruise_summary_report attribute.

Add

Category: Ship attributes: ship_platform_code using ICES database

Add

Category: Ship attributes: ship_platform_class using ICES database

Add

Category: Data processing: data_processing_triwave_correction

Minor edits to wording of Category Mooring: mooring_uplimit, mooring_downlimit, mooring_z_units.

Minor edits to wording of Category Transect: transect_uplimit, transect_downlimit, transect_z_units.

Minor edits to wording of Category Dataset: uplimit, downlimit and z_units.

Add

Category: Metadata record: convention_version

Revised convention version. Previous versions were using a decimal number series - e.g. version 1.01, 1.02 etc. limiting the minor number series to 99 revisions. This revision alters the convention to follow the more common convention in the computer world where the version number is described by two integers separated by a full stop. Thus following this convention our previous version 1.05 would now be version 1.5, that is the 5^{th} revision in version 1 series. This version 1.10 is the 10^{th} revision of the version 1 series.

Revised

Category: Data attributes: data_range_axis_interval to data_range_axis_interval_type for consistency with attribute for vertical dimeionsion: data_ping_axis_interval_type.

Add

Category: Data attributes: data_range_axis_interval_value