ICES TRAINING COMMITTEE

Report of the Training Course on Principles and Methods of Broadband/Wideband Technologies: Application to fisheries acoustics

8-12 December 2017, Bergen, Norway

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Contents

Summary

The training course on "Principles and Methods of Broadband/Wideband Technologies: Application to fisheries acoustics" was held on board a Norwegian vessel, RV G. O. Sars, from 8 to 12 December 2017. The participants were on board on 7 December in Bergen, Norway and got off the vessel either in the evening on 12 December or 13 December. The number of participants was 20 from 13 countries, representing 19 organizations. There were also 5 instructors and 2 technical and logistic assistants.

With the rapid advances in technologies, broadband acoustic systems such as Simrad EK80 echosounder and EdgeTech towered and vertically deployable systems have become commercially available. The potential advantages of these systems over the currently widely used narrowband, multifrequency systems in target detection, acoustic characterization and classification of marine targets such as fish and zooplankton have made them increasingly popular and accepted within the fisheries acoustic community at a pace much quicker than expected.

To help colleagues to efficiently and accurately conduct surveys and researches in fisheries acoustics using these newly developed broadband acoustic systems, we proposed this training course to be held on board a research vessel. The overall objective of this course was to provide participants the knowledge and skill of collecting, interpreting, and processing acoustic broadband/wideband data with confidence, and to be well prepared for moving broadband/wideband technology forward into routine acoustic research and survey applications in fisheries science.

The course materials and associated information on the training course can be found at the websitehttps://i-marine.d4science.org

(this VRE link is a place holder, where all the course materials and related information have been uploaded, and needs to be modified so that it will be available for general public).

1 Course Descriptions

1.1 Contents

The course covered both the theoretical background and how to apply the theory to actual fisheries acoustics through case studies and exercises with synthetic, previously recorded, and real-time data collected during the training course.

A number of Simrad EK80 echosounder systems, including systems mounted on the ship drop keel, on TSprobe (a vertically deployable system that can be deployed up to 1500 m depth), and WBAT (an autonomous EK80 recording system), were calibrated and operated during the class. Every participant had a chance to independently conduct the operation to gain hands-on knowledge and experiences.

1.2 Objectives

The overall objective of this course was to provide participants the knowledge and skill of interpreting and processing acoustic broadband/wideband data with confidence, and to be well prepared for moving broadband/wideband technology forward into routine acoustic research and survey applications in fisheries science.

By the end of the course, the participants could:

i) Understand the fundamental differences between narrowband and broadband acoustic systems;

ii) Interpret broadband/wideband echograms correctly;

iii) Understand the spatial and temporal characteristics of the broadband/wideband systems;

iv) Understand the techniques of spectral analysis such as pulse compression processing;

v) Process broadband/wideband raw and pulse-compressed (complex) data.

1.3 Level

The training course was an advanced course in fisheries acoustics. The participants were assumed to have moderate (college level) knowledge in algebra, calculus, and experience with narrowband echosounders, such as Simrad EK60. In addition, programming ability (Matlab, R, etc.) was required.

2 Course programme

Due to the room-space limitation on the vessel, the participants were divided into two groups. The two groups were taught essentially the same course contents but dealing with a slight different echosounder systems (different frequencies). Two groups had different course schedules as listed in the course Agenda (Annex 2).

Every evening, there was a two-hour discussion session. During this discussion session, some questions, problems, and suggestions for the next day(s) were raised, answered, solved, or recorded. Some of the questions did suggest future projects. All instructors were available during this time.

The host of the training course was Egil Ona (Institute of Marine Science - IMR, Bergen, Norway), who was the Chief Scientist or Project Leader on this G. O. Sars cruise. The IMR provided many necessary organizational and logistical supports. The funding to support this 5-day G.O. Sars operation was provided by IMR and University of Bergen.

3 Accomplishments

a) Theory on broadband technologies (Dr Chu)

   i) Background on narrowband and broadband signal

   ii) Understanding the temporal, spatial, and spectral aspects of the complex broadband signal

b) Overview of the specifications and data flow of commercially available and most commonly used broadband systems – Simrad EK80 (Drs Korneliusen, and Macaulay)

c) Knowledge of EK80 system operation and hands-on experiences (Drs. Ona and Macaulay)

   i) System configurations

   ii) Calibration procedures

   iii) Data collection and preliminary processing

d) Data collection (Drs Ona and Macaulay)

   i) EK80 WBT data with transducers mounted on the ship drop keel

   ii) EK80 WBT data with transducers mounted on the TSprobe, a vertically deployable system from the ship winch

   iii) EK80 WBT-mini data from a WBAT.

e) Data Processing (Drs Korneliussen, Macaulay, and Anderson)

   i) Calibration quantities as a function of frequency

   ii) TS(f) of tracked individual targets

   iii) Sv(f) of a scattering layer

4 Recommendations

Some useful comments and recommendations from the course evaluation questionnaire (see Annex 3).

This year's course was one day shorter than last year's due to reduced ship time. Many course participants felt the need to have more time on EK80 data processing. If there are training courses on the broadband technology in future, it is recommended to allocate more time to data processing.

5 Acknowledgements

We would like to thank the Institute of Marine Research and the University of Bergen for their generous support of the Training Course with 7 days of ship time onboard the RV G. O. Sars. It allowed the course participants to have hands-on operation on the newly developed broadband echosounders for real field applications. It is the only ICES training course that has be carried out onboard a ship.

Annex 1: List of participants

Name	Institute	E-mail
Dezhang Chu (Instructor)	Northwest Fisheries Science Center (NWFSC), NOAA/NMFS United Stated	dezhang.chu@noaa.gov
Lars N. Andersen (Instructor)	Simrad-Kongsberg Maritime	lars.nonboe.andersen@simrad.com
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Egil Ona (Instructor)	Institute of Marine Research Norway	egil.ona@imr.no
Rolf J. Korneliussen (Instructor)	Institute of Marine Research Norway	rolf.korneliussen@imr.no
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Toby Jarvis	Echoview Software	toby.jarvis@echoview.com
Tomohito Imaizumi	National Research Institute of Fisheries Engineering. Japan Fisheries Research and Education Agency Japan	imat@affrc.go.jp
Tonje Nesse Forland	Institute of Marine Research Norway	tonje.nesse.forland@imr.no

Annex 2: ICES 2017 Training Course Agenda

Course Title: Principles and Methods of Broadband/Wideband Technologies: Application to fisheries acoustics
Time: 8 - 12 Dec 2017
Location: On Board RV G.O. Sars; Pier: Nykirkekaien 1, Bergen, Norway
Course Organization:

G.O. Sars does not have a room capable of holding 20 participants who will take notes. We therefore divide the 20 participants in two groups. Both groups will have the same classes.

Question and Discussion Session:

This session is to help people understand class contents, to solve problems associated with the class and discuss broadband topic. There will be a Questions/Discussions session from 7–9 pm every evening. All instructors are available during this time.

Meals on G.O. Sars:

Meals are free and the meal times for breakfast, lunch, and dinner are:

Breakfast: 7:30 – 8:30 am

Lunch: 12:30 am – 1:00 pm

Dinner: 5:30 – 6:30 pm

In addition to the three meals, hot/cold drinks, snacks, and self-help food are provided 24 hours

Pre Training Course (7 Dec):

Check in on Board RV G.O. Sars. For those who couldn't get a Norwegian approved Fishermen Medical Certificate near where you live need to contact Egil Ona (egil.ona@imr.no) for making a doctor's appointment in Bergen on 7 Dec.

Day 1 (8 Dec):

Morning: Check-in and sea safety training for both groups

Afternoon: Introduction: an overview of the training class and the EK80 hardware and software with participants divided into 2 groups

Evening: Discussion (Groups 1 and 2)

Day 2 (9 Dec):

Group 1: Theory 1 (morning) and Ship board calibration of the EK80 systems (afternoon)

Group 2: Ship board calibration of the EK80 systems (morning) and Theory 1 (afternoon)

Evening: Discussion (Groups 1 and 2)

Day 3 (10 Dec):

Group 1: Theory 2 (morning) and Data processing 1 (afternoon)

Group 2: Data processing 1 (morning) and Theory 2 (afternoon)

Evening: Discussion (Groups 1 and 2)

Day 4 (11 Dec):

Group 1 Data processing 2 (morning) and Data collection 1 (afternoon)

Group 2: Data collection 1 (morning) and Data processing 2 (afternoon)

Evening: Discussion (Groups 1 and 2)

Day 5 (12 Dec):

Group 1 Data collection 2 – TS probe/WBAT (morning) and Data processing 3 (morning to early afternoon)

Group 2: Data processing 3 (morning) and Data collection 2 – TS probe/WBAT morning to early afternoon)

Later afternoon: Both groups - Course conclusion

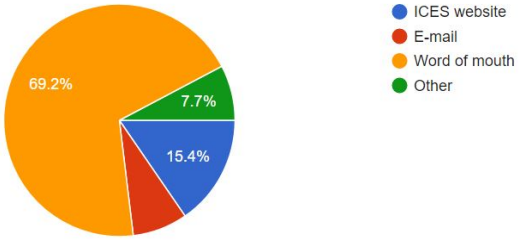
Day 6: (13 Dec):

Get off the vessel and on your own.

Annex 3: Results of course evaluation questionnaire

How did you hear about this course?

13 responses



Comments

2 responses

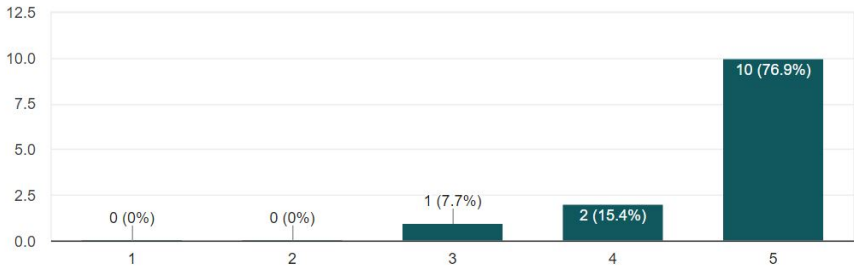
Advertised at the 2017 WG-FAST meeting

WGFAST

Course content

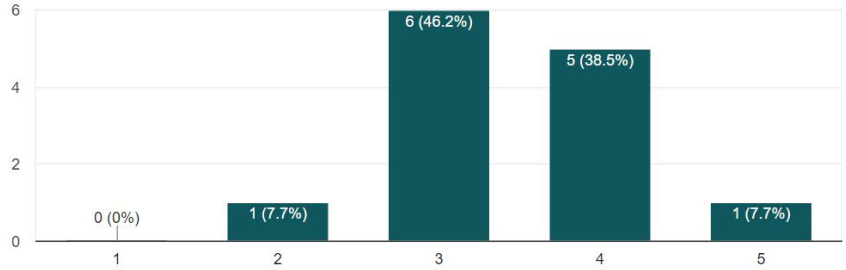
Did the Training course meet your expectations?

13 responses



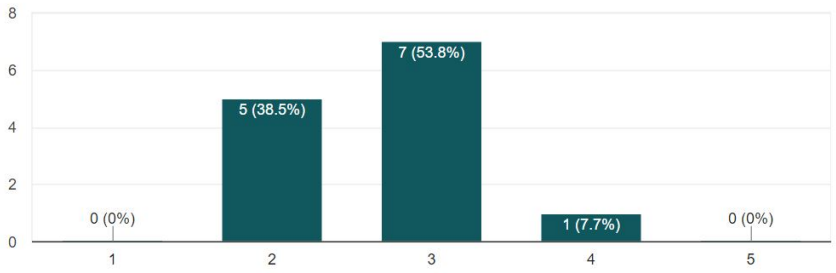
Was the level of instruction appropriate?

13 responses



Was the length of the training course appropriate?

13 responses



Comments

4 responses

As with any course, there was a level of prior knowledge required for each of the key topics covered by this course (physics, maths, electronics, data processing etc.). It would be helpful to be explicit about these levels well in advance of the course, and to provide learning resources for each (e.g. suggested reading, useful web links etc.) so that the students can get up to speed in areas where they may be lacking (it was the maths in particular for me).

One more day would have allowed the students to complete the exercises.

A bit more time with handling and analysing data would have been nice

Course covered about the right amount, but it's a very interesting and useful topic and I would happily sign up for more

What did you like best or find more useful about the training course?

11 responses

You can't really get much better than having experts in the subject field 'captive' aboard one of the world's most advanced research vessels :-)

To see how different types of signal processing (CW or FM), works for different types of measurements (Regular EK80, TS-probe, WBAT). This gave a good overwiev over what types of measurements that is possible to do, and also a understanding of the limitations.

The instructors are all experts in the field. I appreciated having access to them for informal discussions. The venue on a vessel was really an asset - we were able to combine lecture with real-word practical examples.

combination of fundamentals and practice

It was great to be onboard a vessel and experience practical applications

Theory

The hands-on and analysis of data as this is what I will primarily be using in the future

The calibration procedure and the theory explanation.

The hands on experience

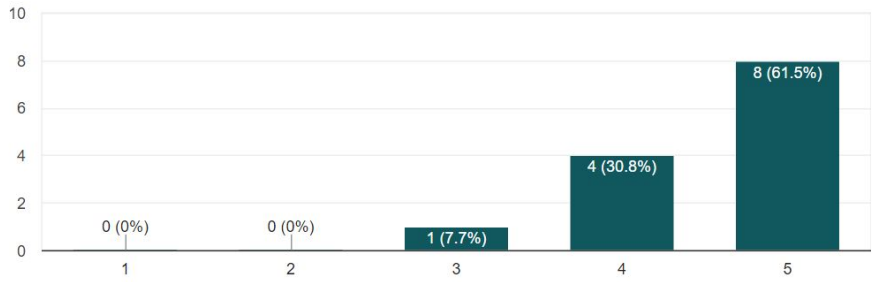
theory of broadband acoustics, practicals on Go Sars, informal discussion with instructors and trainees onboard

Speaking with the course leaders during group chats about things relevant to my work/research

Course Organization

Inscription to the training course and communication with organizers were efficient.

13 responses



Comments

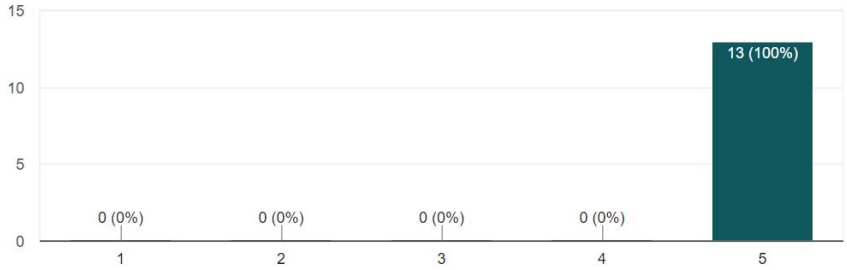
5 responses

The information required for registration and travel logistics was all available and clear. Subsequent comms regarding where/when to meet for the medical in Bergen didn't make it through for some reason. It would also have been helpful to provide information about the network setup aboard the ship, to manage expectations around email availability while aboard and what cables/adapters to bring.
It was a bit unclear when the course started and ended.
Overall, communication was great. There was a long pause in communication between selection of applicants and the next communication - an email a few weeks out from the course would have been helpful when planning travel, etc.
There was a long period of "silence" where communication would have been appreciated
Very well organised

Teaching and Learning Support

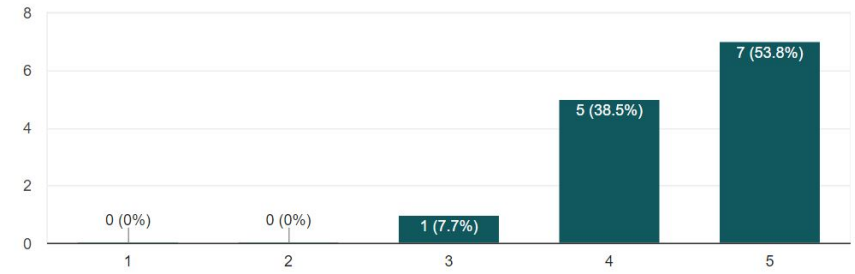
The instructors were helpful, informative, and approachable.

13 responses



The working documents were presented in a way that facilitated learning.

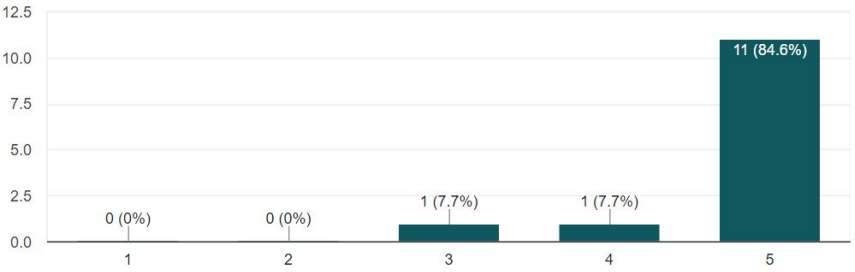
13 responses



Overall Evaluation

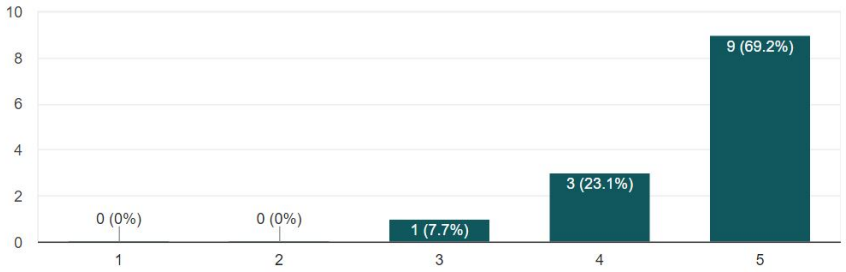
Overall, how would you rate this training course?

13 responses



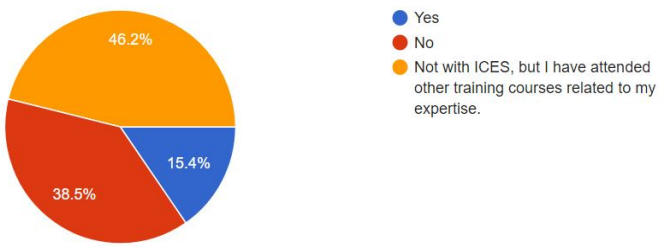
Overall, how would you rate the quality of the teaching?

13 responses



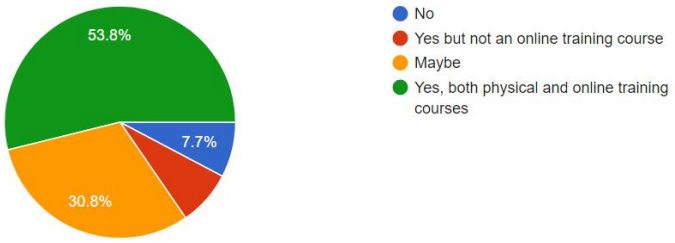
Have you taken any other ICES training courses?

13 responses



Would you be interested in another training course within ICES?

13 responses



If yes, which topic would you be interested in?

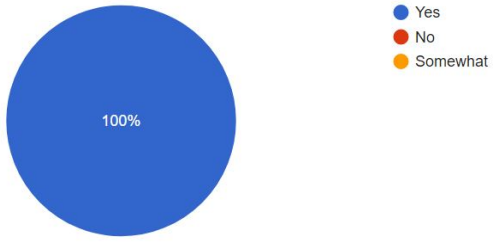
8 responses

Acoustics (2)
Maybe more on wideband data collection and processing if/when there are additional developments. I'd also be potentially interested in any courses on multibeam data collection and processing for water-column applications (both 2D and 3D systems, e.g. EM series, SU90, MS70 etc.).
Topics on advanced statistics and processing
Acoustic theory, acoustic data analysis
Fisheries acoustics
Bayesian Statistics, Ecosystem modelling, Simulations in fisheries research
Underwater acoustics, especially broadband systems

Social Event

Do you feel that you have benefited from networking opportunities on the course?

13 responses



General comments on the Training Course

10 responses

Overall the course provided a fantastic opportunity to spend time with experts and colleagues aboard a world-class research vessel in perfect conditions. Many thanks for an exceptional effort by the course organisers, teachers and ship's crew. Perhaps there could have been greater focus on the teaching delivery and the learning materials, to ensure that the key concepts for each topic are clearly laid out and understood.

I learned a lot during this course. It was very nice learn both the theory and to get some practical training. The theory sessions was very good, but maybe a bit dry. The LSSS-sessions was fun, but somewhat difficult to follow because the demonstation was done so fast. Maybe it would have been better to demonstrate first, and then let the students try to repeat what was done after (for short and simple examples). The EK80 demonstations were interesting, Espessially the student cruiseleader excercise was very useful for getting the impression of what is actually done on a cruise. It was a bit chaotic and unclear what to do and people got spread everywhere with different tasks. It would have been useful to make a summary at the end of this excescise in order to know what each of us had done. It was too little time to do this properly, but evenso it was interesting and fun.

This was a first-rate course. The best I have ever attended.

The instructors are all luminaries in the field, with deep experience. Lectures and exercises were well-prepared and thought out. I appreciated the opportunity to learn from them. There was a good balance of formal lectures and practical work. Attending this course has given me the capability to bring new techniques to my home institution.

Having the course on a research vessel was a major asset as we were able to put the lecture material into practice to collect and process data. ICES should recognize that the Institute of Marine Research has provided substantial support for this course in the form of ship time, room and board for students, use of advanced acoustic equipment, and staff time to teach the course and configure instrumentation for the practical exercises. This was a non-trivial contribution and I am very grateful.

Having the group together on a ship led to interesting formal and informal communications, among both instructors and the students – we were learning from the time we got up in the morning until we went to sleep. In summary, this was an outstanding course, and ICES should support this course in the future if the organizers are keen to repeat it. Thank you for hosting it, it has been very valuable.

This course was very well organized and informative. The instructors were very competent and easy to work with. The processing of data was limited to only one available software package (the most advanced to date), but this could change in the future. In my opinion there should be a bit more focus on the overall approach to processing such data (what we're trying to achieve and step-by-step descriptions) rather than on the specifics of one software package (these concepts were somewhat merged in the course, but sometimes it seems we were focused on some specific software troubleshooting rather than on the basics of processing).

think that it is good if all the members can do the analysis more slowly in the lecture of data processing.

I found the theoretical part a bit difficult and somehow lacked that this part would be put into a more applied context.

This course is very useful to me, it both theoretical and practical. Especially it was hold on board a research vessel, after we learned the theory we have the chance to practice just like the real fisheries acoustic survey.
I also extend my social network from this course, there may be some cooperation in future.
I believe it will benefit me for my whole research career.

Excellent course, the G O Sars was an incredible venue for the course.

Excellent course, field work, accomodation, and people. Many thanks to the instructors, IMR and ICES

Thank you for organising this great training course. I really enjoyed my time there and learned a lot. All of the course leaders were so friendly and helpful. It was my first experience of the ICES community and I felt very welcome.