The use and standardisation of hydroacoustics for the assessment of fish populations in lakes and reservoirs

Ian J. Winfield, Matthias Emmrich, Jean Guillard, Thomas Mehner, Atle Rustadbakken

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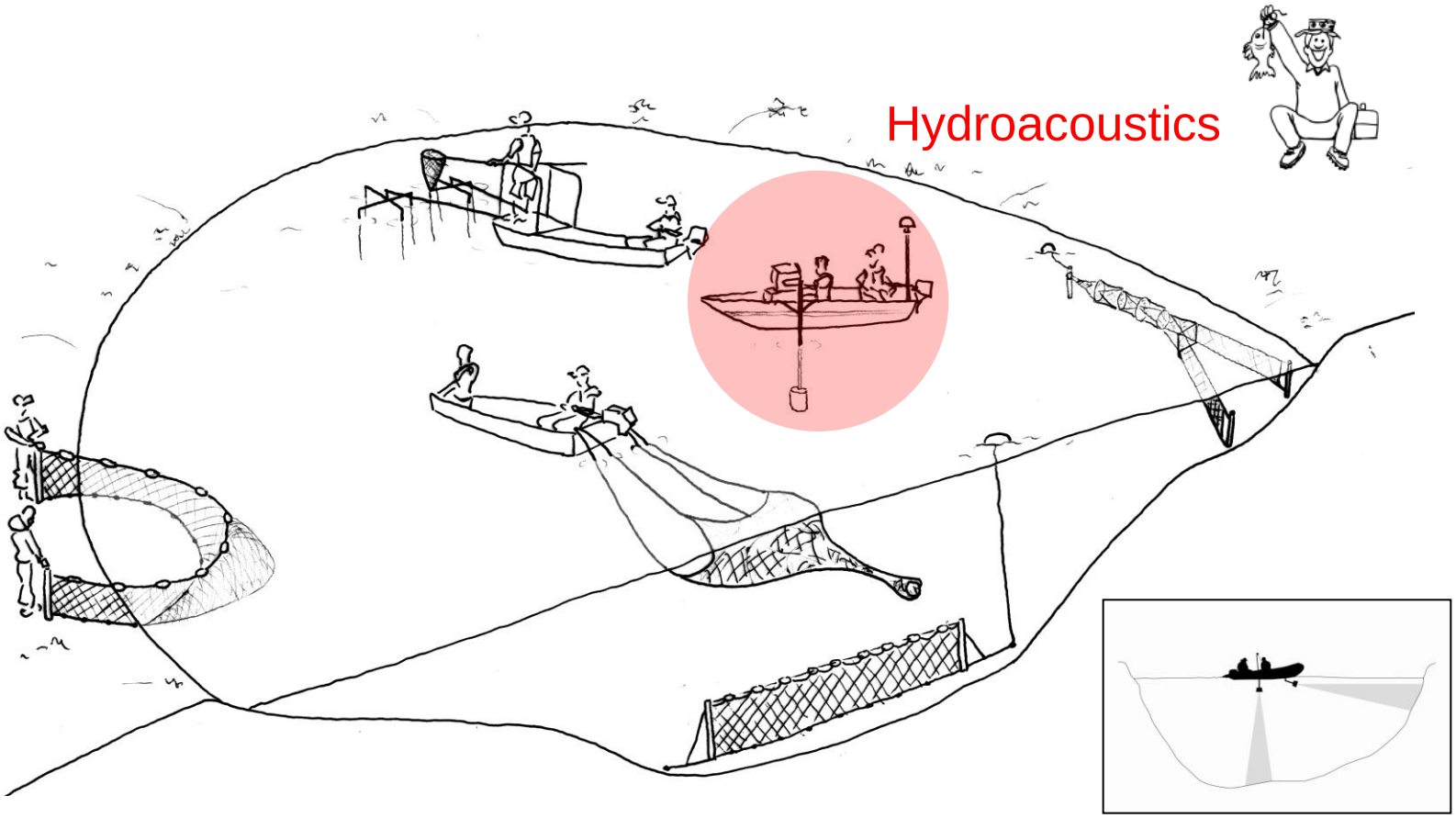
Structure of presentation

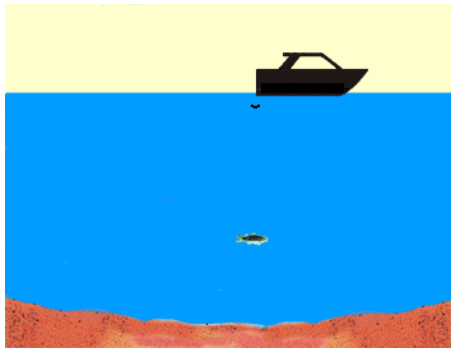
- Introduction
- Equipment
- Examples of applications
- Standardisation and guidelines
- Summary

Introduction

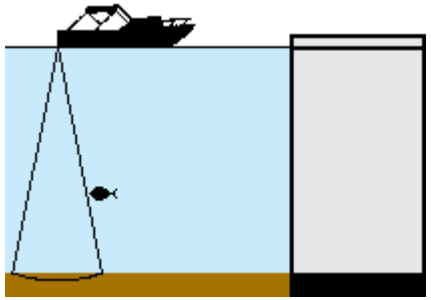


Introduction

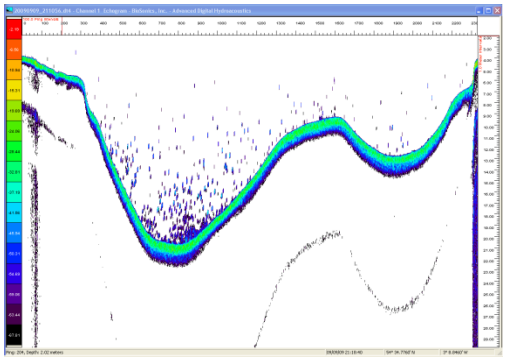
- Hydroacoustics ≈ echo sounding ≈ sonar
- Origins in marine environment
- Subsequent transfer to fresh waters



Sound generation, propagation and recording

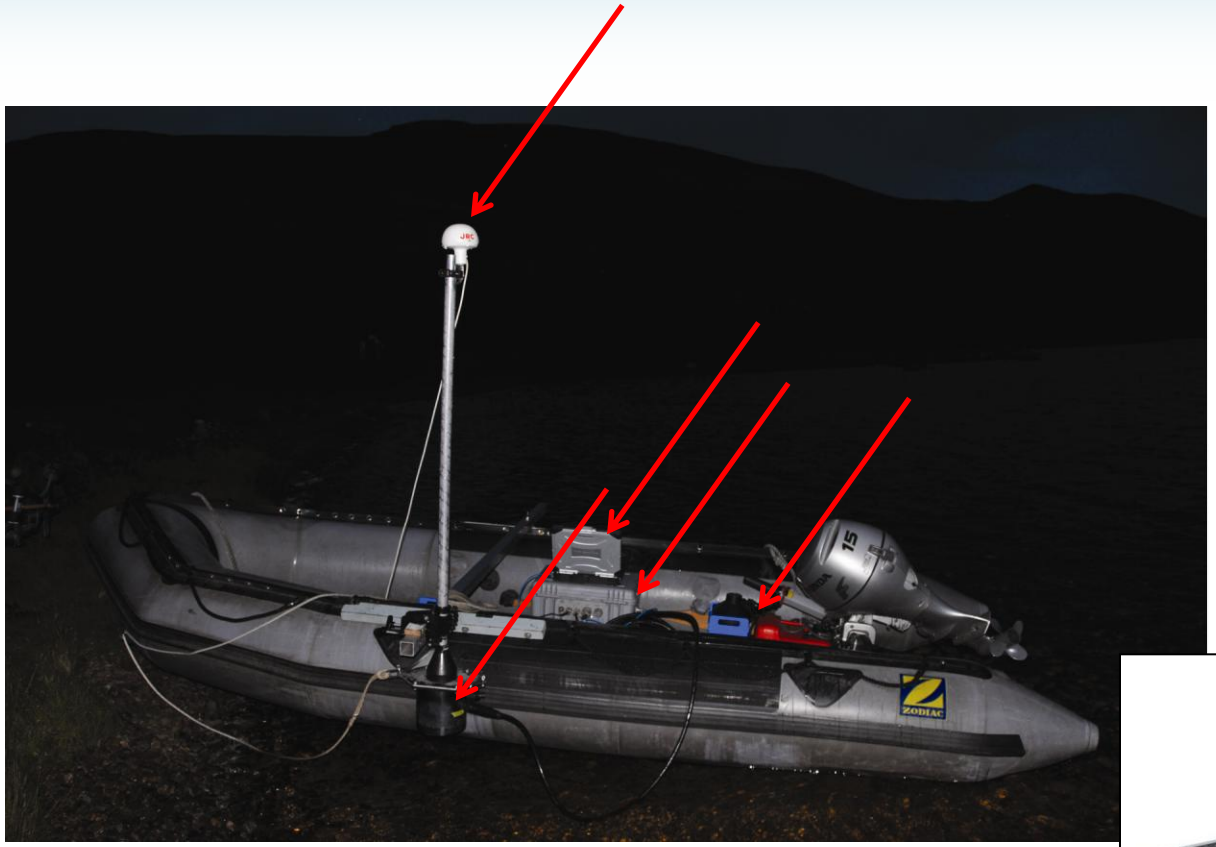


Survey



Data analysis and interpretation

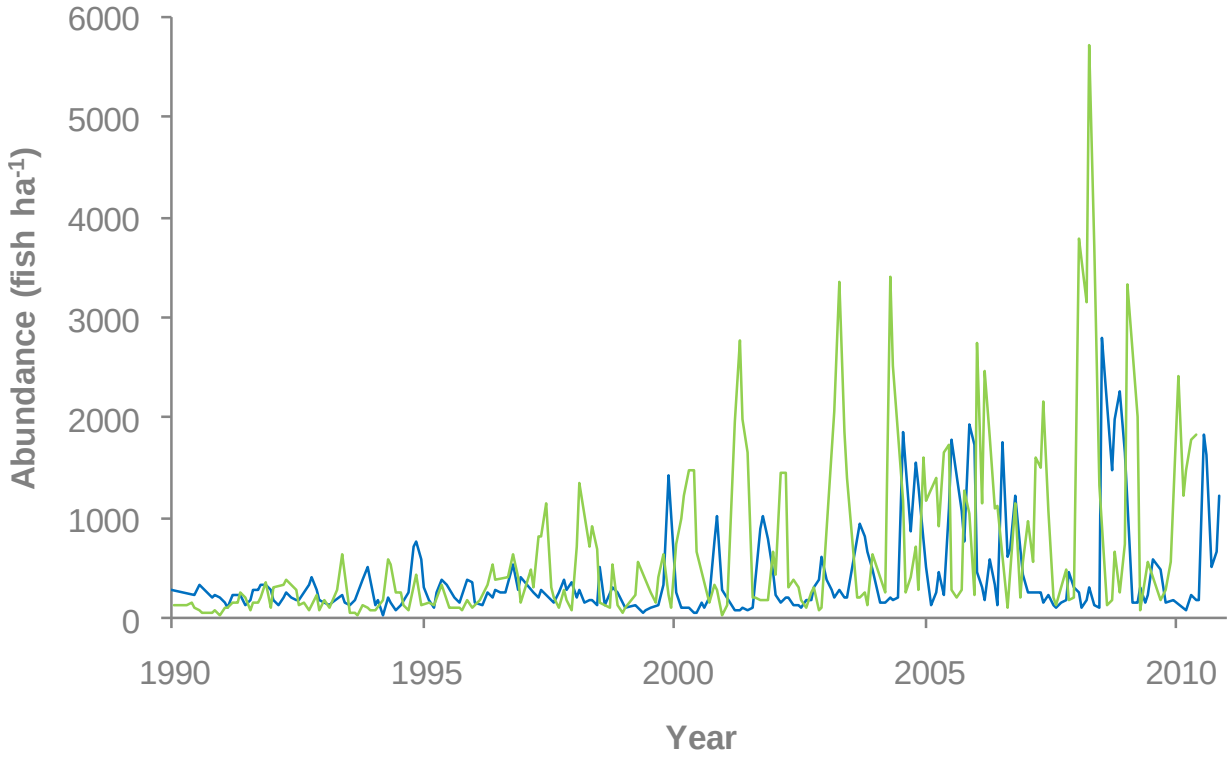
Equipment



Examples of applications

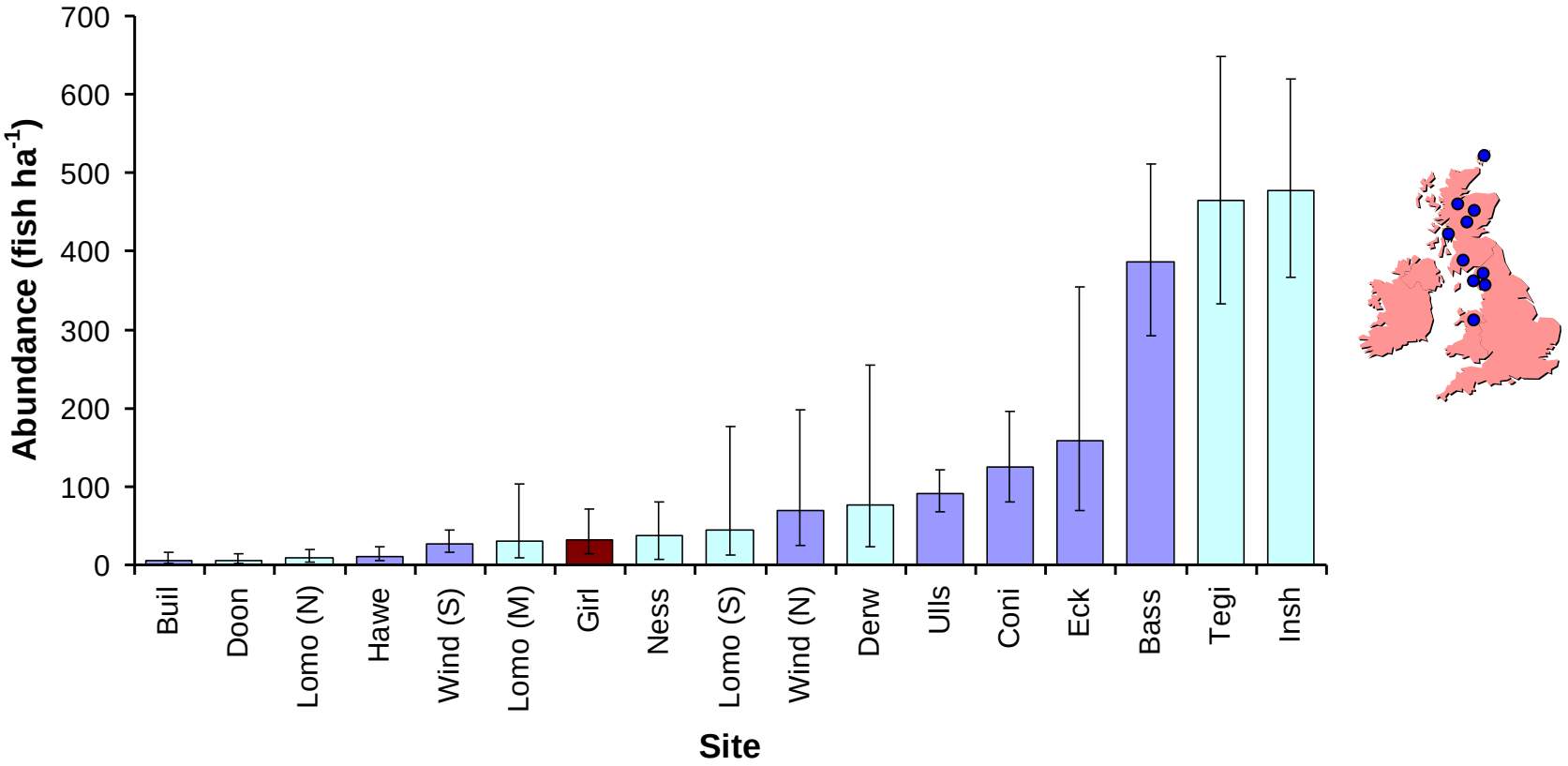
- Fish abundance
- Fish distribution
- Fish size structure
- Fish assessment

Fish abundance



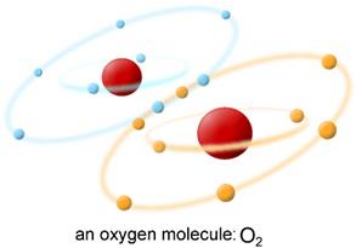
Winfield *et al.* (2008a) and Winfield *et al.* (unpublished data)

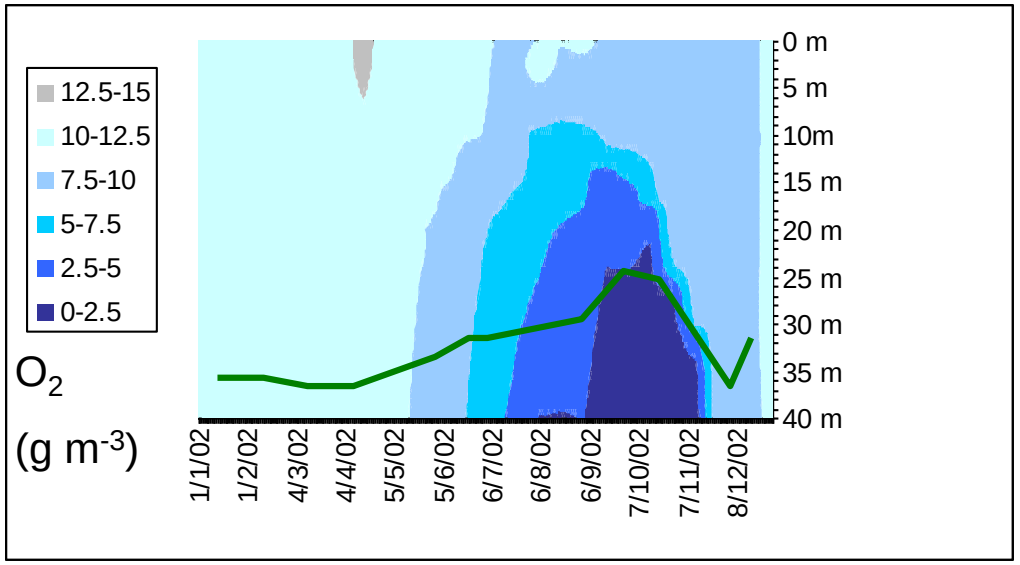
Fish abundance



Winfield *et al.* (unpublished data)

Fish distribution

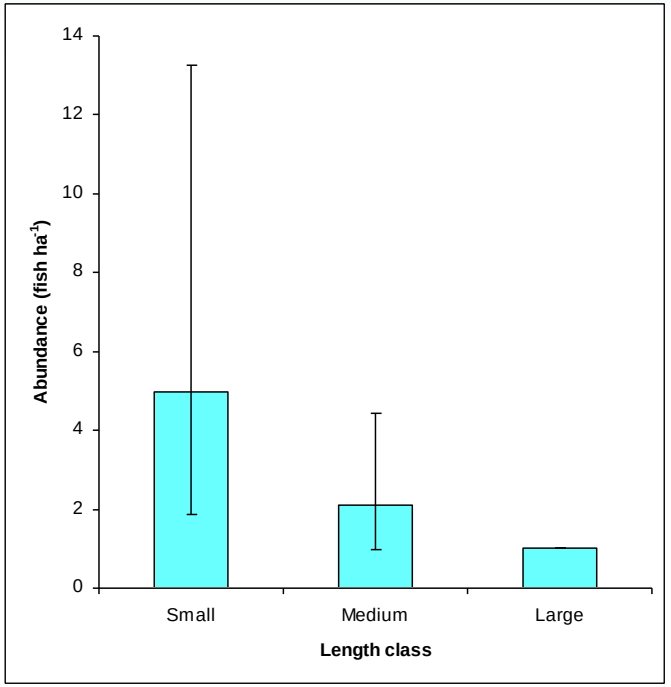




Lower limit of water column containing 90% of fish

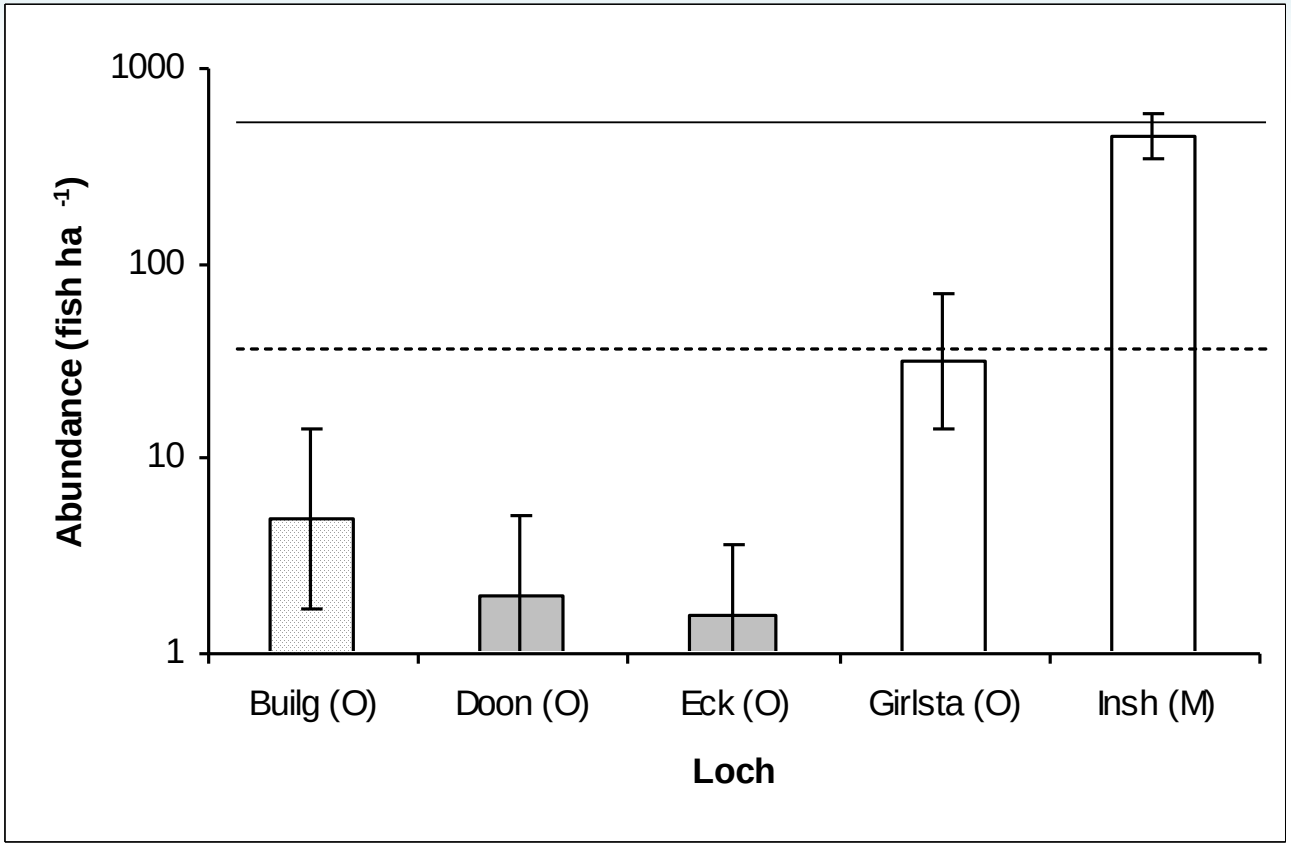
Jones *et al.* (2008)

Fish size structure



Winfield *et al.* (2008b)

Fish assessment



O, broken line = Oligotrophic; M, solid line = Mesotrophic

Winfield *et al.* (2008b)

Standardisation and guidelines

- Benefits
- Scepticism
- Guidelines

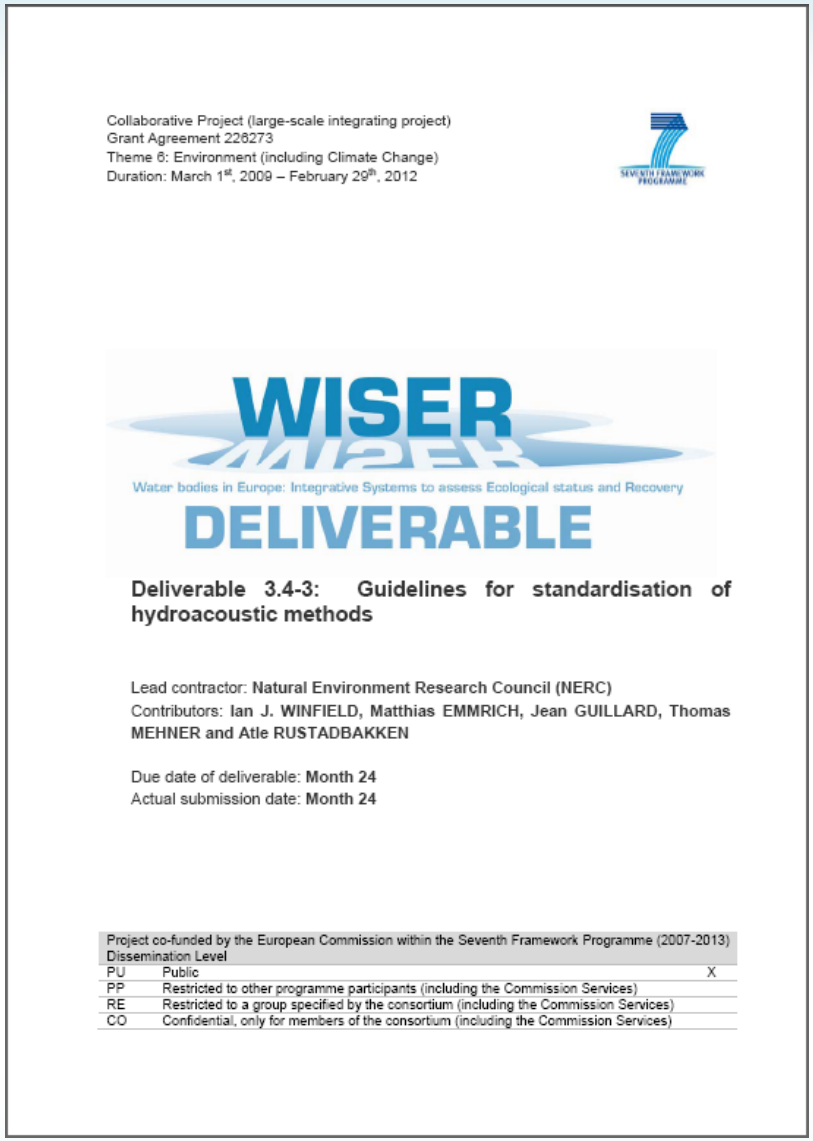
Standardisation benefits

‘Standardization across large regions would allow for measurement of large-scale effects of climate or geography on fish populations; larger sample sizes to evaluate management techniques; reliable means to document rare species; easier communication; and simpler data sharing. With increased interaction among fisheries professionals worldwide, reasons for wide-scale standardization are more compelling than ever.’

Bonar *et al.* (2009)

Standardisation scepticism

Standardisation and guidelines



Collaborative Project (large-scale integrating project)
Grant Agreement 226273
Theme 6: Environment (including Climate Change)
Duration: March 1st, 2009 – February 29th, 2012

WISER

Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery

DELIVERABLE

Deliverable 3.4-3: Guidelines for standardisation of hydroacoustic methods

Lead contractor: **Natural Environment Research Council (NERC)**
Contributors: **Ian J. WINFIELD, Matthias EMMRICH, Jean GUILLARD, Thomas MEHNER and Atle RUSTADBAKKEN**

Due date of deliverable: **Month 24**
Actual submission date: **Month 24**

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013) Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Standardisation and guidelines

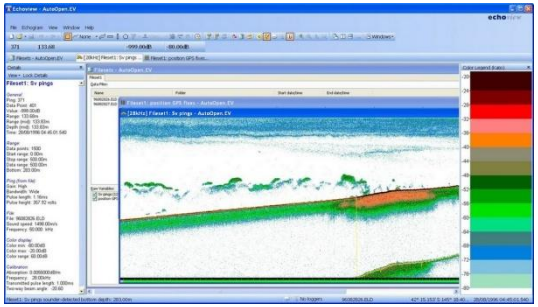
- Equipment
- Pre-survey planning
- Survey and data acquisition
- Post-survey data analysis
- Reporting and data archiving

Equipment

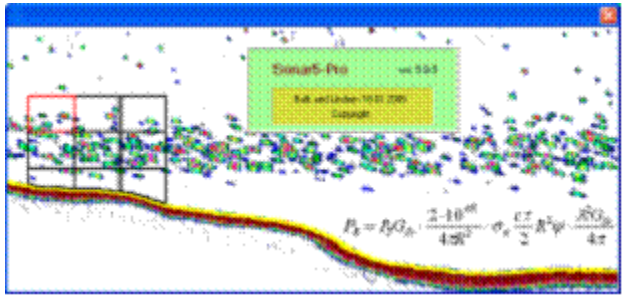
BioSonics

HTI

Simrad

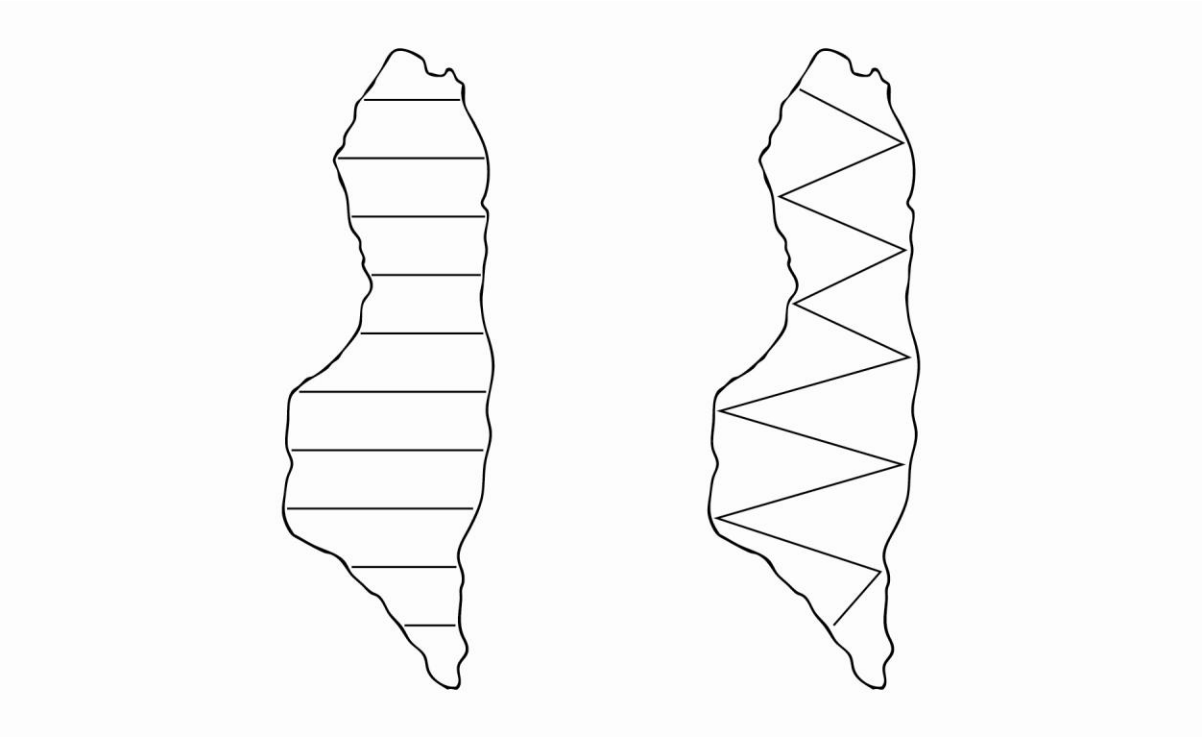


Echoview



Sonar5-Pro

Pre-survey planning



Background information, timing, survey route, sound transmission and recording parameters, logistics and safety

Survey and data acquisition

System assembly and installation, water temperature, field target test, test run, field notes, monitor the system, back-up data

Post-survey data analysis

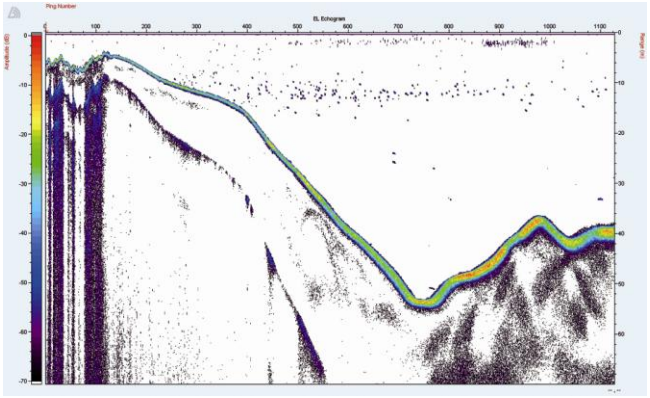


Table 1: Examples of published target strength (TS, in decibels) and total length (TL, in centimetres or millimetres) relationships for a range of fish taxa insonified vertically by different sound frequencies (f) in dorsal aspect.

Relationship	Fish taxon	Total length range and units	Sound frequency (kHz)	Reference
TS = 19.1*log (TL)-0.9*log(f)-62	Mixture of species	1.5 to 100 cm	Various	Love (1971)
TS = 19.39*log (TL)-62.63	Mixture of species	10 to 39 cm	70	Borisenko *et al.* (1989)
TS = 20.63*log (TL)-65.11	*Coregonus lavaretus*	20 to 39 cm	70	Borisenko *et al.* (1989)
TS = 31.88*log (TL)-76.3	*Perca fluviatilis*	18 to 36 cm	70	Borisenko *et al.* (1989)
TS = 21.2*log (TL)-62.87	*Rutilus rutilus*	13.5 to 25.4 cm	70	Borisenko *et al.* (1989)
TS = 21.15*log (TL)-84.95	Mixture of species	72 to 690 mm	120	Frouzova *et al.* (2005)
TS = 25.5*log (TL)-70.9	*Coregonus albula*	3 to 20 cm	120	Mehner (2006)
TS = 24.4*log (TL)-89.44	*Salmo trutta*	72 to 259 mm	120	Frouzova *et al.* (2005)
TS = 20.79*log (TL)-86.41	*Perca fluviatilis*	10 to 41 mm	120	Frouzova & Kubecka (2004)
TS = 33.11*log (TL)-110.68	*Perca fluviatilis*	101 to 290 mm	120	Frouzova *et al.* (2005)
TS = 18.11*log (TL)-77.96	*Rutilus rutilus*	117 to 305 mm	120	Frouzova *et al.* (2005)
TS = 14.371*log (TL)-77.15	*Perca fluviatilis*	12 to 41 mm	420	Frouzova & Kubecka (2004)

QA, visually inspect echograms, SNR, bottom detection, perform SED, EDSU, TS to TL relationships, echo counting, trace counting, echo integration, summary statistics, geostatistics, GIS

Reporting and data archiving

- CEN (2009) gives extensive recommendations on reporting
- Analytical steps between raw data files and final outputs must be unambiguously described
- Hydroacoustic surveys typically produce >>100 MB of data so a substantial data archiving system is essential

Summary

- Following its origins in marine environment, hydroacoustics has been successfully transferred to fresh waters
- Highly portable, rapid and quantitative
- Hydroacoustics can provide information on fish abundance, distribution and size structure
- Standardisation desirable on equipment, survey design, data acquisition, data analysis, reporting and data archiving

Acknowledgements

- Examples of applications were funded by Centre for Ecology & Hydrology, Environment Agency, Environment Agency Wales, Natural England, Scottish Natural Heritage and United Utilities
- The standardisation guidelines were produced within the project WISER funded by the European Union (contract No. 226273)