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Assessment of acoustic post-processing software products for fisheries surveys

Science Report: SC030213/SR

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Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

This report is the result of research commissioned and funded by the Environment Agency's Science Programme.

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Professor Mike Depledge   Head of Science

Executive Summary

This document aims to set out current and future software needs of the Acoustic Monitoring Programme of the Environment Agency and to provide a framework for making technical and procurement decisions in support of that programme.

Hydroacoustic techniques have an important role in the Environment Agency's current fisheries monitoring programmes. Data from acoustic fish counters are used to monitor salmon stocks in candidate Special Areas of Conservation (cSACs) for the EU Habitats Directive and provide in-river run estimates to set spawning escapement conservation limits necessary for the Environment Agency's Salmon Action Plans (SAPs). Mobile survey methods comprise mandatory components of the Environment Agency's National Fisheries Monitoring Programme and contribute to area-based discretionary monitoring activities.

Two major developments will influence and potentially transform the acoustic monitoring programmes within the next two years:
- The Water Framework Directive (WFD) requires information on fish abundance in selected stillwaters.Hydroacoustics must have a significant role as a cost-effective, non-destructive sampling method.
- The Environment Agency has also purchased an acoustic camera (DIDSON) to provide information on fish species and key life stages that have proved difficult or impossible to investigate using currently available tools.

All acoustic applications require data processing software. The Environment Agency standardised on a single product, HTI EchoScape, almost by default when the decision was made to adapt HTI hardware as standard. EchoScape is available on the network as a National 'A' application. However, two new products have recently appeared on the market; SonarData Echoview and Sonar5-Pro. The three software products were assessed using the following objectives:

1) To examine the functionality of each product for processing of hydroacoustic fisheries data to appraise the extent that they meet current Environment Agency requirements.
2) To examine future Environment Agency requirements from data processing software and assess the ability of each product to meet these.
3) To assess the relative costs for implementing each product.
4) To assess the practicality of a single software product satisfying all current and projected acoustic data processing requirements.

The products were tested against: representative data files from typical Environment Agency applications for business-relevant functional requirements (23 categories); compatibility with Environment Agency platforms and users; potential for meeting predicted future needs (6 categories). The products were scored for each category in two ways: delivery by product alone; delivery by product plus associated utilities and macros developed in-house. The software manufacturers participated in the project through the provision of guidance and support, and to confirm that the assessment approach was appropriate.

The following conclusions have been made from this study:

1) Based on all functionality criteria and data derived from both Simrad and HTI echosounders, the products ranked; Sonar5-Pro > SonarData Echoview > HTI EchoScape. Considering HTI analyses only, the products were very closely matched but ranked; HTI EchoScape > SonarData Echoview > Sonar5-Pro.

2) The products were assessed for meeting 6 software compatibility requirements. The products were very closely matched again, but ranked; HTI EchoScape = SonarData Echoview > Sonar5-Pro.

3) Based on specific requirements, a product (or products) is recommended for each acoustic programme. A combination of software products would be the best solution for meeting Environment Agency business needs.

4) The relative costs for implementing the recommended products, and viable alternative options, was reviewed.

5) SonarData Echoview alone has the potential to deliver all components of the current and future acoustic programmes. However, the benefits of product convergence must be weighed against relative cost and training issues.

6) The costs of developing associated data analysis utilities and macros can be significant and must be considered when making software procurement decisions.

7) The best product for processing DIDSON data could not be determined during this study.

Finally, recommendations were made for the number of software licences needed for each product, and future development and research priorities to deliver all current and predicted Environment Agency acoustic programmes.

Contents

1 Introduction

A basic understanding of the different elements of the Environment Agency's acoustic monitoring programme is needed to put this project in context. This chapter therefore summarises current and future acoustic activities, the size of the programmes, how they are delivered and their requirements in terms of data processing resources.

1.1 Environment Agency roles for hydroacoustics

The Environment Agency operates scientific echosounders to conduct hydroacoustic fisheries surveys of lowland rivers and lakes. Acoustic equipment is either deployed on boats (termed mobile surveys) or at fixed locations on rivers (when acting as fish counters).

1.1.1 Mobile surveys

On mobile surveys, the transducer is usually mounted on an angle-adjustable frame or rotator at the front of a boat. The acoustic beam can then be directed 'downward looking' for vertical surveys of deep water-bodies, or 'sideways looking' for horizontal surveys of shallow water-bodies. On river surveys, the boat is driven up the side of one bank sampling horizontally towards mid-channel and the far-bank, before returning along the other bank. On lakes surveys, the water body is surveyed through a series of zig-zag transects to maximise coverage. Data from both vertical and horizontal methods use similar analytical procedures, summarised in Figure 1.1.

In situations where the fish are well distributed and at relatively low densities, volume density estimates are calculated using echo-counting (EC) or track-counting (TC) techniques (Kieser and Mulligan, 1984). In vertical surveys, where the fish are closely shoaled together, echo-integration (EI) can be used to provide estimates of volume or area densities (Bodholt, 1990).

Both vertical and horizontal methods are used to conduct quantitative fish stock assessments: providing information on the abundance, distribution and size-structure of pelagic fish communities. Horizontal acoustic river surveys have comprised a mandatory component of the Environment Agency's National Fisheries Monitoring Programme since 2001, which is a principal data source for state of the environment reporting. Currently, 93 sites covering >750 km of river are surveyed each year during the summer survey season (May – October) using HTI (Hydroacoustics Technology Inc.) echosounders. These sites are distributed throughout the regions and the equivalent of 16 users can be processing data at any one time.

Mobile surveys also contribute to area-based discretionary programmes and operational investigations, such as environmental impact assessment and stock assessment of stillwater fisheries.

1.1.2 Fixed location fish counters

Acoustic fish counters are deployed in horizontal orientation to enumerate upstream movement of migratory salmonids as a cost-effective alternative to resistivity counters and traps. The transducer is mounted on a rotator and the beam aimed across the river close to the bottom. A single acoustic counter can sample 24 hours a day generating considerable amounts of data that require rapid processing, but to a consistent standard. Data processing differs from mobile surveys, as there is an increased emphasis on manually or automatically tracking fish and sorting the tracks (Figure 1.2).

Data from acoustic fish counters are used to monitor salmon stocks in candidate Special Areas of Conservation (cSACs) for the EU Habitats Directive 92/43/EEC and the International Council for the Exploration of the Sea (ICES) annual assessment of salmon stocks in England and Wales. This data also provides in-river run estimates to set spawning escapement conservation limits necessary for the Environment Agency's Salmon Action Plans (SAPs) and contribute towards R&D subjects such as flow criteria for salmon migration and developing salmon life-cycle models. Fixed location hydroacoustic techniques can also provide excellent *in situ*, real-time, non-invasive insight into fish behaviour.

Currently there are four acoustic counters in operation on the Rivers Tywi, Teifi, Dyfi and Wye. These counters operate throughout the year and the equivalent of four users can be processing data at any one time.

1.1.3 Research and development

Hydroacoustics is a rapidly developing field in terms of hardware, software, sampling and analytical methodologies. To keep up-to-date with technical advances, a number of in-house acoustic R&D projects have been commissioned over the last twelve years (e.g. Gregory, 2000; Gregory *et al*, 1998; 2002; Hateley, 2002).

In addition to the data processing needs of these R&D projects, spare processing capacity must also be available for specialist surveys (e.g. *ad hoc* stillwater investigations) and reprocessing of historic acoustic datasets. Typically, two users may be involved in R&D acoustic data processing at any one time and at least one of the licences has to be compatible with data from the decommissioned Simrad EY500 echosounders (Hateley, 2002).

1.2 Environment Agency future and developing roles for hydroacoustics

Over the next 10 years, Environment Agency post-processing requirements will change. Principally through the inclusion of data from the Dual Frequency Identification Sonar (DIDSON) and an increased mandatory mobile component resulting from Water Framework Directive (WFD) monitoring of stillwaters. The contribution of these new components need to be estimated to predict future data processing requirements.

1.2.1 DIDSON

DIDSON is effectively a high-resolution acoustic camera, producing good image definition in poor or zero visibility water over relatively short ranges (<20 - 40 m). The DIDSON system offers the potential to routinely monitor species and key life stages that have proved difficult or impossible to investigate using tools currently available. Such problem areas include:

- identification and enumeration of downstream-moving salmon smolts.
- silver eel migration.
- identification and enumeration of upstream-moving shad.
- fish behaviour at obstructions and fish-passes.
- identifying littoral spawning populations of charr.

The Environment Agency will be evaluating a DIDSON system during 2005. It is anticipated that a single user and one data processing licence will be sufficient to deliver the evaluation programme.

1.2.2 Water Framework Directive (WFD)

The Directivewill establish an integrated approach to the protection, improvement and sustainable use of Europe's rivers, lakes, coastal waters and groundwater. The Directive came into force in December 2000 with monitoring (including monitoring for fish) scheduled to commence in 2006 (Environment Agency, 2002).

Although Directive monitoring programme was not established by the end of this project, there is an expectation that hydroacoustics has a role to play in determining fish abundance in stillwaters. Considering current and widespread opposition to destructive sampling methods (for example gill-netting) this role may be significant.

The additional data processing burden of stillwaters remains uncertain. Based on the sizes, depths and accessibility of candidate sites, the maximum number of stillwaters suitable for hydroacoustic surveying in England and Wales will be in the region of 120. The majority of these lakes are situated in

areas that already possess acoustic analytical tools and expertise (North West and Environment Agency Wales). Therefore, only a small increase in data processing capacity is anticipated, estimated to be the equivalent of 2 users.

1.3 Summary of current and future data processing needs

An estimate of future acoustic data processing capacity as number of users is summarised in Table 1.1. The equivalent of 22 users are currently engaged in data processing to meet the mobile, fish counter and discretionary components of the National Fisheries Monitoring Programme. Processing capacity must be increased by the equivalent of 3 users in order to deliver the predicted DIDSON and WFD work programmes.

Table 1.1 also provides a summary of each monitoring programme's key data processing requirements. Clearly, each programme has different functional and compatibility requirements from the data processing software. These principally depend on the type of data collected, the analytical procedures performed and the experience of the users concerned.

Table 1.1 Summary of data processing requirements for each monitoring programme

Programme	Number of users	Survey type	User	Key requirements
Mobile programme	16	Horizontal rivers	Area users (Occasional acousticians)	• User-friendly • File merging / appending • Bottom tracking, echo-counting, track-counting • Data filtering by dB • Volume density output as fish 1000 m^{-3} • Output GIS compatible • Compatible with HTI data
Counter programme	4	Fixed location rivers	Area users (Dedicated acousticians)	• Handles large amounts of data • File merging / appending • Manual and automatic tracking • Track editing • Track filtering • Summary track statistics • Compatible with HTI data
WFD	2	Horizontal and vertical stillwaters	Area users (Occasional & dedicated acousticians)	• As for Mobile programme • Echo-integration • Cruise-track editing • Area density output as fish ha^{-1} • Compatible with Simrad data
R&D	2	All types	Dedicated acousticians	• As for Mobile, Counter and WFD programmes
DIDSON	1	All types	Dedicated acousticians	• Fish counting • Summary fish statistics • Compatible with DIDSON data
TOTAL	**25**			

1.4 Hydroacoustic hardware and software

The Environment Agency has recently standardised on split-beam acoustic hardware. Prior to 2002, three models of scientific echosounder were in use; dual-beam BioSonics 106, split-beam Simrad EY500 and split-beam HTI 240 series. Based on the recommendations of an inter-comparison R&D project (Hateley, 2002) the Environment Agency standardised on the HTI 240 series echosounders, gradually phasing out operation of the Simrad and BioSonics devices.

The Environment Agency has also standardised on a single post-processing software product. EchoScape is manufactured by Hydroacoustic Technology Inc. (HTI) and is currently available on the network as a National 'A' application. However, two other products have recently come to the attention of the Environment Agency (Table 1.2).

Table 1.2 Hydroacoustic post-processing products assessed

Software product	Version(s) tested	Manufacturer
HTI EchoScape	2.11	Hydroacoustic Technology Inc., 715 NE Northlake Way, Seattle, Washington, USA
Sonar5-Pro	5.9.4 - 5	Balk and Lindem, Lindem Data Acquisition, University of Oslo, Norway
SonarData Echoview	3.10	SonarData Pty Ltd., GPO Box 1387, Hobart 7001, Australia

SonarData's Echoview, HTI's EchoScape and Sonar5-Pro offer a choice of products with different levels of functionality, data compatibility, processing methods and diverse pricing structures. As all acoustic monitoring programmes have now been active for up to three years, a clearer picture has emerged of the Environment Agency's current and future needs, and the capabilities of the responsible staff. An R&D Project was commissioned to assess each product in the context of the Environment Agency's current and future data processing requirements.

1.5 Project objectives

The overall project objective is to identify a product or products, and the number of copies of each required, that best meet our business needs over the next 5-10 years. Incorporating an assessment of the relative costs for implementing the products will give direction to future procurement decisions. Ultimately, this will ensure the acoustic components of the National Fisheries Monitoring Programme, WFD, R&D Programme and Fish Counter Programmes can be delivered to a satisfactory and nationally consistent standard.

1.5.1 Principal objectives

1.   To examine the functionality of each software product for processing of hydroacoustic fisheries data to fully appraise the extent to which these products meet current Environment Agency requirements.

2.   To examine future Environment Agency requirements from processing software and assess the ability of each product to meet these.

3.   To assess the relative costs for implementing each product.

4.   To assess the practicality of a single software product satisfying all current and projected acoustic data processing requirements.

2 Methods

The complete assessment protocol is summarised as a flowchart in Figure 2.1.

Figure 2.1 Flowchart summarising assessment protocol
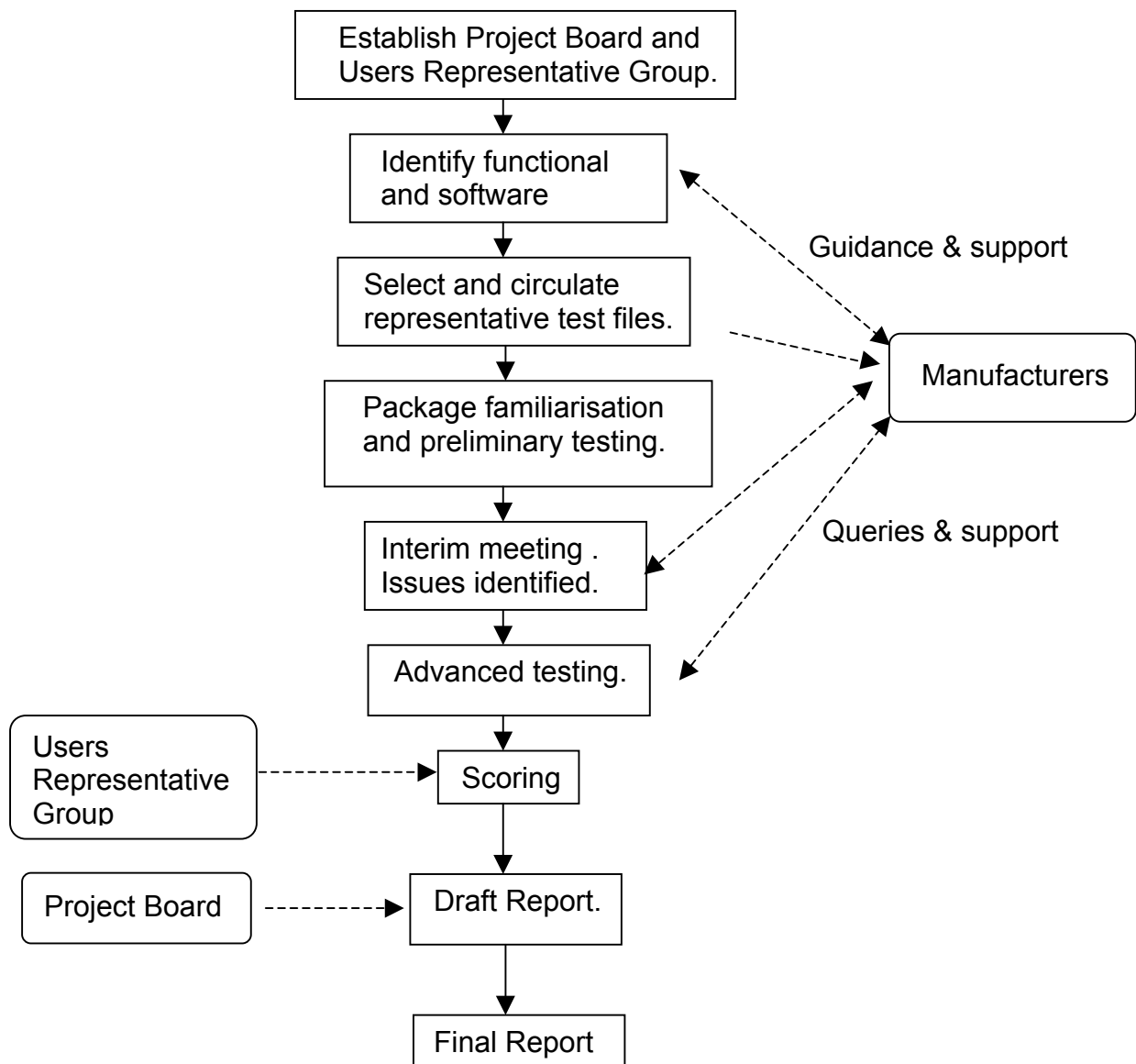
2.1 Project management

The project was managed as follows:

Project Executive: Jim Gregory, National Fisheries Technical Team.
Project Manager: Jon Hateley, National Fisheries Technical Team.
Project Officer: Pete Clabburn, Technical Specialist,
                            Environmental Appraisal Team - Fish Counters, St
                            Mellons.

The Project Board comprised the following:

Jim Gregory   Project Executive
Jon Hateley   Project Manager
Pete Clabburn   Project Officer
Richard Davies   Technical Officer, Environmental Appraisal Team -
                            Fish Counters, St Mellons.
Jim Lyons   Technical Specialist, Fisheries Recreation and
                            Biodiversity, Blandford.
Andy Willo   Ecological Appraisal Officer, Worthing

2.2 Project responsibilities

Based on previous experience and formal training, the following individuals
were responsible for the operation and testing of each software product.
These individuals also assumed responsibility for technical liaison with the
appropriate software manufacturers:

HTI EchoScape   Jon Hateley (Mobile surveys) and Pete Clabburn
                            (Fixed Location surveys)
Sonar5-Pro   Jon Hateley
SonarData Echoview   Pete Clabburn

2.3 Liaison with manufacturers

At the start of the project, it was decided to get the software manufacturers
involved. They were asked to contribute by:

1.   commenting on the legitimacy of the assessment approach;
2.   offering support to the project in terms of technical advise pertaining to
      the functionality of the product;
3.   forwarding levels of service for the product and policies on product
      upgrades, discount for multi-licences, bespoke customisation and
      future product development.

In order to avoid any commercially sensitive issues, manufacturers were
assured of confidentiality with respect to any of the responses received to
point 3.

All three manufacturers agreed to co-operate fully with the project and made invaluable contributions.

The final report was released to the manufacturers on Monday 23 May 2005 for comment and review of the tests, findings and conclusions. Summaries of these comments were subsequently embedded in the text of the document as grey-filled text boxes.

SonarData Comment: It needs to be made clear … that the manufacturers were only party to the general approach taken and not to the specific details. For example, all manufacturers would probably choose a different set of weights to apply to the functionality / ease of use / cost / convergence criteria.   … It's important to be clear that manufacturers were not consulted on the specific form of the assessments.

SonarData Comment: … Manufacturers were not given an indication of their performance (relative or otherwise) against the specific criteria in advance of the publication of the report. This is an important point – that manufacturers were given an opportunity to answer direct questions is not the same point, as those questions may have in some cases been grounded on a tentative knowledge of the software.

2.4 Software functionality and compatibility requirements

The three software products were examined in relation to the following criteria:
• Do they possess the functionality to meet Environment Agency needs?
• Are they compatibility with Environment Agency platforms and users?

These criteria were broken down into a number of assessment categories, summarised below:

2.4.1 Functionality and scoring

The list of essential functional requirements was drafted by the Project Board and modified following discussions with the manufacturers (Table 2.1). A simple scoring method was applied; the software product was given 2 if it fully met, 1 if it partially met, or 0 if it failed to meet each required specification.

Many functions required additional analysis steps to be conducted outside the software product under review in order to produce the desired end-product. As the Environment Agency has suitable utilities and macros in Microsoft

Access and Excel to facilitate these additional steps, a second score of 2, 1 or 0 was given for the 'product including existing utilities / macros'.

Table 2.1 Essential functional requirements

Summary Function	Specific Function	Additional Details	Scoring
1. Accept / convert data from HTI 240 series and Simrad EY500 split-beam echosounders			2. Fully 1. Partially 0. Fails
2. Permit echo-counting (EC) of mobile horizontal, mobile vertical and fixed location acoustic data.		EC: Echoes and beam volumes from all individual pings are each summed to provide an estimate of volume density.	2. Fully 1. Partially 0. Fails
3.	Beam volume calculations based on beam geometry.		2. Fully 1. Partially 0. Fails
4. Permit echo-integration (EI) of mobile vertical acoustic data.			2. Fully 1. Partially 0. Fails
5. Permit track-counting (TC) of mobile horizontal, mobile vertical and fixed location acoustic data.		TC: Fish tracks within wedge of water defined by start point, end point and vertical beam opening angle to provide estimates of volume and area density.	2. Fully 1. Partially 0. Fails
6.	Including advanced tracking parameters.	e.g. minimum track length, maximum ping gap, variable gating range, track directivity, alpha-beta tracker.	2. Fully 1. Partially 0. Fails
7.	Volume calculation methods based on beam geometry.		2. Fully 1. Partially 0. Fails
8.	Summary track statistics.	e.g. mean track TS, time / date of track, velocity.	2. Fully 1. Partially 0. Fails
9.	Variability in TS.		2. Fully 1. Partially 0. Fails
10.	Track directivity.		2. Fully 1. Partially 0. Fails
Summary Function	**Specific Function**	**Additional Details**	**Scoring**
11.	Selection and viewing of tracks.	Facility to move between selected	2. Fully 1. Partially

		tracks in table and on echogram.	0. Fails
12.	Track editing.	Adding / subtracting echoes to and from tracks, splitting and adding tracks.	2. Fully 1. Partially 0. Fails
13.	GPS input for sailed distance.	Required for wedge volume analyses.	2. Fully 1. Partially 0. Fails
14. Allow additional data filtering by beam shape, echo-selection criteria, dB and / or Volts.			2. Fully 1. Partially 0. Fails
15. Generate volume (fish $1000m^{-3}$) and area (fish ha^{-1}) density outputs for all counting techniques.			2. Fully 1. Partially 0. Fails
16. Output density and GPS data to Agency standard GIS applications.		For pictorial presentation of data in ArcGIS v.8.0.	2. Fully 1. Partially 0. Fails
17. Allow bottom tracking and editing.			2. Fully 1. Partially 0. Fails
17. Files can be merged / appended.			2. Fully 1. Partially 0. Fails
19. Allows editing of cruise-tracks.			2. Fully 1. Partially 0. Fails
20. Allow classification.		e.g. TS frequency distribution converted to biomass and length frequency outputs.	2. Fully 1. Partially 0. Fails
21. Display and analysis of sample data.			2. Fully 1. Partially 0. Fails
22. Minimise number of steps in data analysis process.		i.e. Majority of steps are conducted within the software, rather than ancillary products.	2. All within product 1. 1-2 extra steps 0. >2 extra steps.
23. Facility to mark and exclude bad data regions.		Bad regions are excluded from volume calculations.	2. Pelagic & benthic 1. Benthic 0. Fails

2.4.2 Software compatibility and scoring

In addition to the listed functionality, the software products were assessed for their compatibility with existing Environment Agency platforms (computers and networks), users (ease of operation) and future applications (DIDSON). The software compatibility requirements were drafted by the Project Board and amended in consultation with the manufacturers (summarised in Table 2.2).

Table 2.2 Software compatibility requirements

Summary Function	Additional Details	Scoring Weighting (x5)
1. Fully supported by manufacturer.	Including levels of service. i.e. responses to issues, help directory, manuals, speed, availability.	2. Fully 1. Partially 0. Fails
2. Able to run on Win 2000 platforms.		2. Fully 1. Partially 0. Fails
3. User-friendly.	Judged by number of training days required and User Rep opinions.	Rank products: 2. Easiest 1. Middle 0. Hardest
4. Customisation possible.		2. Fully 1. Partially 0. Fails
5. 'Stable'	i.e. few bugs and incidents of the programme crashing.	2. Fully 1. Partially 0. Fails
6. Compatible with future acoustic techniques and equipment.	DIDSON	2. Fully 1. Partially 0. Fails

2.5 Users Representative Group

To assist in the evaluation of 'user-friendliness' in the software compatibility assessment (Table 2.2, item 3), a representative panel of acoustic data post-processing users was established. This panel comprised:

Jim Lyons	Experienced user, mobile surveys.
Richard Davies	Experienced user, fixed location fish counters.
Andy Willo	Limited experience, new user.

The panel drafted a users' scoresheet consisting of nine attributes (Table 2.3) and following demonstrations of the three products, ranked and scored the products for each attribute (best score = 3, intermediate = 2, lowest = 1). These scores fed directly into the assessment of user-friendliness. The panel was also invited to make additional comments on features of each software product.

Table 2.3 Summary of users' scoresheet

Attribute
1. User-friendly / intuitive front-end
2. High levels of automation / few steps in analyses
3. Ease of echo-counting (EC)
4. Ease of track-counting (TC)
5. Ease of fixed location fish counting (C)
6. Ease of echo-integration
7. Advanced functionality / suitability for R&D
8. Level of prior acoustic knowledge required for use
9. How well are analysis steps logged?

2.6 Applications and test files examined

The majority of the Environment Agency's acoustic datasets can be broken down into the following applications and equipment:

1)   Mobile horizontal surveys (rivers and lakes) with HTI equipment.
2)   Mobile horizontal surveys (rivers and lakes) with Simrad equipment.
3)   Mobile vertical surveys (lakes) with HTI equipment.
4)   Mobile vertical surveys (lakes) with Simrad equipment.
5)   Fixed location fish counters (rivers) with HTI equipment.

Representative test files from each of these applications covering a range of environmental conditions, fish communities, background noise levels and data quality were selected and circulated to the manufacturers. These files were processed using each product to compare and score for the functionality and compatibility categories listed in Tables 2.1 and 2.2. Details of the test-files are summarised in Table 2.4.

Table 2.4 Details of test files (EC = echo-counting, TC = track-counting, EI = echo-integration, C = fish counting)

Application	Fish-counting method tested	Files	Description
HTI Vertical	EC, TC, EI	P2662324.raw	Mobile lakes data with GPS. No noise.
		P2662337.raw	Mobile lakes data with GPS. No noise.
		P2320116.raw	Mobile lakes data with GPS. No noise, suitable for EI.
HTI Horizontal	EC, TC	P2412045.raw	Mobile river survey with GPS.
		P2412056.raw	Mobile river survey with GPS.
		H2811926.raw	Mobile river survey. Noisy, short range, corrupt data and intermittent GPS.
HTI Fixed	C	M3072200.raw	Noisy counter data.
		M3072300.raw	Noisy counter data.
		T1150600.raw	Counter data.
		T1150700.raw	Counter data.
Simrad Vertical	EC, TC, EI	09302001.dg3	Mobile lakes data with GPS. No noise.
		09302006.dg3	Mobile lakes data with GPS. No noise.
Simrad Horizontal	EC, TC	10251948.dg9	Mobile river survey with GPS.
		10251953.dg9	Mobile river survey with GPS.

3 Results

3.1 Required functionality

The scoring of the software products by category is displayed in Tables 3.1 to 3.3 and summarised in Table 3.4.

Table 3.1 Scoring of SonarData Echoview for required functionality

Cells marked 'N/a' indicate tests that were not scored, as they were either not relevant or appropriate for the application. Other scores marked with an asterisk have explanatory text in the Function column. Total scores and maximum possible scores for each application are given at the bottom of the table.

Numbers in left of each column = Software including utilities / macros   Right of each column = Software Alone

Function	Specific Function	Meets spec? Scoring	HTI Vertical		HTI Horizontal		HTI Fixed		Simrad Vertical		Simrad Horizontal	
1. Accept / convert data from HTI 240 series and Simrad EY500 split-beam echosounders		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
2. Permit echo-counting (EC) of mobile horizontal, mobile vertical and fixed location acoustic data.		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
3.	Beam volume calculations based on beam geometry.	2. Fully 1. Partially 0. Fails	1	1	1	1	1	1	1	1	1	1
4. Permit echo-integration (EI) of mobile vertical acoustic data.		2. Fully 1. Partially 0. Fails	1	1	N/a	N/a	N/a	N/a	1	1	N/a	N/a
5. Permit track-counting (TC) of mobile horizontal, mobile vertical and fixed location acoustic data.		2. Fully 1. Partially 0. Fails	1	1	1	1	2	2	1	1	1	1
6.	Including advanced tracking parameters.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
7.	Volume calculation methods based on beam geometry.	2. Fully 1. Partially 0. Fails	1	1	1	1	N/a	N/a	1	1	1	1
8.	Summary track statistics.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
9.	Variability in TS.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
10.	Track directivity.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
11.	Selection and viewing of tracks.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2

#	Description		Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
12.		Track editing.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
13.		GPS input for sailed distance.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
14.	Allow additional data filtering by beam shape, echo-selection criteria, dB and / or Volts.		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
15.	Generate volume (fish $1000m^{-3}$) and area (fish ha^{-1}) density outputs for all counting techniques.		2. Fully 1. Partially 0. Fails	1	1	1	1	N/a	N/a	1	1	1	1
16.	Output density and GPS data to Agency standard GIS applications.		2. Fully 1. Partially 0. Fails	1	1	1	1	N/a	N/a	1	1	1	1
17.	Allow bottom tracking and editing.		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
18.	Files can be merged / appended.		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
19.	Allows editing of cruise-tracks.		2. Fully 1. Partially 0. Fails	2	2	2	2	N/a	N/a	2	2	2	2
20.	Allow classification.		2. Fully 1. Partially 0. Fails	1	1	1	1	1	1	1	1	1	1
21.	Display and analysis of sample data.		2. Fully 1. Partially 0. Fails	N/a	N/a	N/a	N/a	N/a	N/a	2	2	2	2
22.	Minimise number of steps in data analysis process.		2. All within product 1. 1-2 extra steps. 0. 2 extra steps.	1	1	1	1	1	1	1	1	1	1
23.	Facility to mark and exclude bad data regions. * May be limitation of laptop?		2. Pelagic & benthic 1. Benthic 0. Fails	2	2	2	2	1*	1*	2	2	2	2
			TOTALS	36/44	36/44	35/42	35/42	30/34	30/34	38/46	38/46	37/44	37/44

SonarData Comment: Items 3 and 7: the 'wedge' volume analysis variable has now been added, and is exported on a per-cell basis along with single target and fish track analyses. This analysis requires GPS data for the distance calculations, which can also be added as a proxy for mean transducer-relative water flow speed for fixed or horizontal applications. Hence vertical applications are directly addressed and the others via a straightforward workaround.

SonarData Comment: Item 21: a reference to the impending addition of sample data as a standard feature of HTI echosounders (and perhaps of its current availability via 'alternative' means) and Echoview's ability to support that data would be a pertinent addition.

Table 3.2 Scoring of Sonar5-Pro for required functionality

Cells marked 'N/a' indicate tests that were not scored, as they were either not relevant or appropriate for the application. Other scores marked with an asterisk have explanatory text in the Function column. Total scores and maximum possible scores for each application are given at the bottom of the table.

Numbers in left of each column = Software including utilities / macros   Right of each column = Software Alone

Function	Specific Function	Meets spec? Scoring.	HTI Vertical		HTI Horizontal		HTI Fixed		Simrad Vertical		Simrad Horizontal	
1. Accept / convert data from HTI 240 series and Simrad EY500 split-beam echosounders		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
2. Permit echo-counting (EC) of mobile horizontal, mobile vertical and fixed location acoustic data.		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
3.	Beam volume calculations based on beam geometry.	2. Fully 1. Partially 0. Fails	1	1	1	1	1	1	2	2	2	2
4. Permit echo-integration (EI) of mobile vertical acoustic data.		2. Fully 1. Partially 0. Fails	1	1	N/a	N/a	N/a	N/a	2	2	N/a	N/a
5. Permit track-counting (TC) of mobile horizontal, mobile vertical and fixed location acoustic data.		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
6.	Including advanced tracking parameters.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
7.	Volume calculation methods based on beam geometry.	2. Fully 1. Partially 0. Fails	2	2	2	2	N/a	N/a	2	2	2	2
8.	Summary track statistics.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
9.	Variability in TS.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
10.	Track directivity.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2

No.	Requirement	Score criteria										
11.	Selection and viewing of tracks.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
12.	Track editing.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
13.	GPS input for sailed distance.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
14.	Allow additional data filtering by beam shape, echo-selection criteria, dB and / or Volts.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
15.	Generate volume (fish $1000m^{-3}$) and area (fish ha^{-1}) density outputs for all counting techniques.	2. Fully 1. Partially 0. Fails	2	2	2	2	N/a	N/a	2	2	2	2
16.	Output density and GPS data to Agency standard GIS applications.	2. Fully 1. Partially 0. Fails	1	1	1	1	N/a	N/a	1	1	1	1
17.	Allow bottom tracking and editing.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
18.	Files can be merged / appended.	2. Fully 1. Partially 0. Fails	1	1	1	1	1	1	2	2	2	2
19.	Allows editing of cruise-tracks.	2. Fully 1. Partially 0. Fails	1	0	1	0	N/a	N/a	1	0	1	0
20.	Allow classification.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	2	2	2	2
21.	Display and analysis of sample data.	2. Fully 1. Partially 0. Fails	N/a	N/a	N/a	N/a	N/a	N/a	2	2	2	2
22.	Minimise number of steps in data analysis process.	2. All within product 1. 1-2 extra steps. 0. >2 extra steps.	2	2	2	2	1	1	2	2	2	2
23.	Facility to mark and exclude bad data regions.	2. Pelagic & benthic 1. Benthic 0. Fails	1	1	1	1	1	1	1	1	1	1
		TOTALS	38/44	37/44	37/42	36/42	30/34	30/34	43/46	43/46	41/44	41/44

Table 3.3 Scoring of HTI EchoScape for required functionality

Cells marked 'N/a' indicate tests that were not scored, as they were either not relevant or appropriate for the application. Other scores marked with an asterisk have explanatory text in the Function column. Total scores and maximum possible scores for each application are given at the bottom of the table.

Numbers in left of each column = Software including utilities / macros   Right of each column = Software Alone

Function	Specific Function	Meets spec? Scoring.	HTI Vertical		HTI Horizontal		HTI Fixed		Simrad Vertical		Simrad Horizontal	
1. Accept / convert data from HTI 240 series and Simrad EY500 split-beam echosounders		2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	0	0	0	0
2. Permit echo-counting (EC) of mobile horizontal, mobile vertical and fixed location acoustic data.		2. Fully 1. Partially 0. Fails	2	1	2	1	2	1	0	0	0	0
3.	Beam volume calculations based on beam geometry.	2. Fully 1. Partially 0. Fails	2	1	2	1	2	1	0	0	0	0
4. Permit echo-integration (EI) of mobile vertical acoustic data.		2. Fully 1. Partially 0. Fails	1	1	N/a	N/a	N/a	N/a	0	0	N/a	N/a
5. Permit track-counting (TC) of mobile horizontal, mobile vertical and fixed location acoustic data.		2. Fully 1. Partially 0. Fails	1	1	1	1	2	2	0	0	0	0
6.	Including advanced tracking parameters.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	0	0	0	0
7.	Volume calculation methods based on beam geometry.	2. Fully 1. Partially 0. Fails	1	1	1	1	N/a	N/a	0	0	0	0
8.	Summary track statistics.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	0	0	0	0
9.	Variability in TS.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	0	0	0	0
10.	Track directivity.	2. Fully 1. Partially 0. Fails	2	2	2	2	2	2	0	0	0	0
11.	Selection and viewing of tracks.	2. Fully 1. Partially 0. Fails	1	1	1	1	1	1	0	0	0	0

#	Description	Criteria										
12.	Track editing.	2. Fully / 1. Partially / 0. Fails	1	1	1	1	1	1	0	0	0	0
13.	GPS input for sailed distance.	2. Fully / 1. Partially / 0. Fails	2	1	2	1	2	1	0	0	0	0
14.	Allow additional data filtering by beam shape, echo-selection criteria, dB and / or Volts.	2. Fully / 1. Partially / 0. Fails	2	2	2	2	2	2	0	0		0
15.	Generate volume (fish 1000m^{-3}) and area (fish ha^{-1}) density outputs for all counting techniques.	2. Fully / 1. Partially / 0. Fails	1	1	1	1	N/a	N/a	0	0	0	0
16.	Output density and GPS data to Agency standard GIS applications.	2. Fully / 1. Partially / 0. Fails	1	1	1	1	N/a	N/a	0	0	0	0
17.	Allow bottom tracking and editing.	2. Fully / 1. Partially / 0. Fails	2	2	2	2	2	2	0	0	0	0
18.	Files can be merged / appended.	2. Fully / 1. Partially / 0. Fails	2	2	2	2	2	2	0	0	0	0
19.	Allow editing of cruise-tracks.	2. Fully / 1. Partially / 0. Fails	1	0	1	0	N/a	N/a	0	0	0	0
20.	Allow classification.	2. Fully / 1. Partially / 0. Fails	1	0	1	0	1	1	0	0	0	0
21.	Display and analysis of sample data.	2. Fully / 1. Partially / 0. Fails	N/a	N/a	N/a	N/a	N/a	N/a	0	0	0	0
22.	Minimise number of steps in data analysis process.	2. All within product / 1. 1-2 extra steps. / 0. >2 extra steps.	1	1	1	1	1	1	0	0	0	0
23.	Facility to mark and exclude bad data regions.	2. Pelagic & benthic / 1. Benthic / 0. Fails	1	1	1	1	1	1	0	0	0	0
		TOTALS	33/44	28/44	32/42	27/42	29/34	26/34	0/46	0/46	0/44	0/44

Table 3.4 Summary scoring table for required functionality

Test (maximum score)	SonarData Echoview	Sonar5-Pro	HTI EchoScape
1. Software functionality (210)	176	187	81
2. Software + utilities / macros (210)	176	189	94
3. Software + utilities / macros HTI applications only (200)	151	150	159

Based on required functionality alone (test 1), the products ranked; Sonar5-Pro > SonarData Echoview > HTI EchoScape. Not surprisingly, the latter scored poorly because of incompatibility with Simrad data. When existing utilities and macros were considered (test 2) the scores for HTI EchoScape and Sonar5-Pro were increased but the rankings remain unaltered.

In 2001, the Environment Agency standardised on the HTI-240 series echosounders for all acoustic applications. As the vast majority of future acoustic data should be in HTI format, a score considering HTI applications alone was calculated to better reflect our predicted data processing requirements (test 3). The three products scored closely, ranking; HTI EchoScape > SonarData Echoview $\geq$ Sonar5-Pro. HTI EchoScape's performance benefited significantly from the development of in-house utilities that increased the overall score by 13 points.

3.2   Software compatibility

The scoring of each product for software compatibility are displayed in Table 3.5.

Table 3.5 Scoring of SonarData Echoview, Sonar5-Pro and HTI EchoScape for software compatibility

Requirement	Meets spec? Scoring.	SonarData Echoview	Sonar5-Pro	HTI EchoScape
Fully supported by manufacturer.	2. Fully 1. Partially 0. Fails	2	2	2
Able to run on Win 2000 platforms.	2. Fully 1. Partially 0. Fails	2	2	2
User-friendly. *User Group opinion*	*Rank products:* *2. Easiest* *1. Middle* *0. Hardest*	*0*	*2*	*1*
Training days required	*Rank products:* *2. Easiest* *1. Middle* *0. Hardest*	*0*	*0*	*2*
Overall	Rank products: 2. Easiest 1. Middle 0. Hardest	0	1	2
Customisation possible.	2. Fully 1. Partially 0. Fails	1	1	1
'Stable'	2. Fully 1. Partially 0. Fails	2	1	2
Compatible with future acoustic techniques and equipment (DIDSON)	2. Fully 1. Partially 0. Fails	2	0	0
	TOTAL	9	7	9

The products scored closely on software compatibility criteria but ranked; HTI EchoScape = SonarData Echoview > Sonar5-Pro.

User-friendliness was assessed by the Users Representatives Group (see Table 3.7) and modified by an estimate of the number of training days needed to establish national expertise (as annual training days per user: HTI EchoScape = 1, Sonar5-Pro = 2, SonarData Echoview = 2). The overall ranking positions of Sonar5-Pro and HTI EchoScape were reversed based on these training requirements.

HTI EchoScape currently operates on the Environment Agency computer network with a small reduction in overall functionality. However, the compatibility of Sonar5-Pro and SonarData Echoview with the network had to be based on guidance from the manufacturers. Sonardata confirmed that SonarData Echoview does run on networks whereas Helge Balk stated that Sonar5-Pro has been run on networks, but there is no guarantee it will work perfectly on all systems.

Only SonarData Echoview can accept DIDSON data formats, however a DIDSON module is required in addition to prerequisite modules.

3.3 Results from Users Representative Group

The Users Representative Group met on Thursday 30 September 2004 and their opinions are summarised in Table 3.6. Despite the very different acoustic backgrounds of the individuals on the panel and small inconsistencies in the scoring of some attributes, all three produced the same overall ranking; Sonar5-Pro > HTI EchoScape > SonarData Echoview. Two users scored Sonar5-Pro and HTI EchoScape very closely (differing by a single point), the third preferring Sonar5-Pro by a large margin.

Table 3.6 Summary of users' scoresheet

Best score = 3, intermediate = 2, lowest = 1.

ATTRIBUTE	SonarData Echoview			Sonar5-Pro			HTI EchoScape		
User	**U1**	**U2**	**U3**	**U1**	**U2**	**U3**	**U1**	**U2**	**U3**
User-friendly / intuitive front-end	1	1	2	2	2	2	3	3	3
High levels of automation / few steps in processes	1	1	1	3	2	2	2	3	3
Ease of echo-counting (EC)	1	1	2	3	2	2	2	3	3
Ease of track-counting (TC)	1	1	2	3	3	2	2	2	3
Ease of fixed location fish tracking	2	1	1	3	2	3	1	3	2
Ease of echo-integration (EI)	2	2	2	3	3	3	1	1	1
Extra functionality / R&D level applications	3	2	3	3	3	2	1	1	1
Level of prior acoustic knowledge required	1	1	1	2	2	2	3	3	3
Analysis log	3	2	3	3	3	3	1	2	1
Totals	**15**	**12**	**17**	**25**	**22**	**21**	**16**	**21**	**20**
Overall Ranking by User	**3**	**3**	**3**	**1**	**1**	**1**	**2**	**2**	**2**

A number of comments were received on two products. These are summarised in Table3.7.

Table 3.7 Additional comments from Users Representative Group

Software	Comment	No. Comments
All	• No software product appears to meet all Agency needs.	1
SonarData Echoview	• If DIDSON becomes a standard method, SonarData Echoview would be preferred.	1
Sonar5-Pro	• For echo-counting and fish counting using HTI data, Sonar5-Pro will require a file and sequence merging facility and be able to handle a large number of files*. (*_subsequently incorporated. See Appendix 1_)	3
	• Need assurances regarding Sonar5-Pro's software support and 'life expectancy'* (* _response in Appendix 1_).	2
	• Tracking facility appears to have good potential for fixed location fish counting.	1

Sonardata Comment: … Echoview is not intended to be used without template EV files for these types of applications, other than when first set up by a high-level user for use by lower-level users.

4 Discussion

4.1 Delivering the current and future acoustic programmes

The first and second project objectives were to examine the functionality of three software products for hydroacoustic fisheries data processing and to appraise the extent that they meet current and future Environment Agency requirements. The three software products were tested against business-relevant functionality and compatibility requirements.

Based purely on functionality, the products ranked; Sonar5-Pro > SonarData Echoview > HTI EchoScape. To better reflect the type of data currently collected, HTI analyses only were also considered. Here the products were very closely matched but ranked; HTI EchoScape > SonarData Echoview $\geq$ Sonar5-Pro. The importance of in-house utilities in the final stages of HTI data processing was shown by HTI EchoScape ranking highest on the strength of in-house Access queries and macros written over the last few years. This highlights the resource implications of constructing and developing such utilities, which should not be underestimated when making software procurement decisions.

The products also ranked very closely when examined on software compatibility criteria; HTI EchoScape = SonarData Echoview > Sonar5-Pro. The most salient features of this assessment in the context of the current monitoring programmes were the relative ease of training and use of HTI EchoScape for typical mobile survey analyses, and the potential Sonar5-Pro offers for fish counting (Tables 3.5 and 3.6).

4.1.1 Recommended products

A product (or products) has been recommended for each of the current monitoring programmes (Table 4.1). All programmes (mobile, counter, R&D, WFD and DIDSON) have different data processing requirements, and the optimum product for one application may be inappropriate for another.

Table 4.1 Recommended software product by acoustic programme

Programme	Specific requirements	Recommended product(s)	Key justifications	Disadvantages
Mobile programme	• User-friendly • File merging / appending • Bottom tracking, echo-counting, track-counting • Data filtering by dB • Volume density output as fish 1000 m^{-3} • Output GIS compatible • Compatible with HTI data	HTI EchoScape	• Meets most requirements. • Very user-friendly. • Compatible with current training base. • Utilities and macros exist to aid data processing.	• Further utility / macro developments required.
Counter programme	• Handles large amounts of data • File merging / appending • Manual and automatic tracking • Track editing • Track filtering • Summary track statistics • Compatible with HTI data	Sonar5-Pro	• Meets requirements. • Excellent fish-tracking facility. • User-friendly.	• Compatibility of Sonar5-Pro tracking output with existing database untested.
WFD	• As for Mobile programme • Echo-integration • Cruise-track editing • Area density output as fish ha^{-1} • *Compatible with Simrad data**	HTI EchoScape *Sonar5-Pro*	• Meets most requirements. • User-friendly • Compatible with current training base and other WFD outputs. • Utilities and macros written to aid data processing.	• Further utility / macro developments required. e.g. Area density output. • Utilities and macros written to aid data processing. • *Not compatible with Simrad data. If Simrad echosounders used, Sonar5-Pro would be recommended.*
R&D	• As for Mobile, Counter and WFD programmes • Compatible with Simrad data	Sonar5-Pro and SonarData Echoview	• Scope and subjects of future R&D projects unknown. Combined functionality of two products maximises flexibility.	
DIDSON	• Fish counting • Summary fish statistics • Compatible with DIDSON data	SonarData Echoview	• Only Echoview compatible with DIDSON data.	• Evaluation against Sound Metrics' own DIDSON software required.

- **Mobile programme**

The relative simplicity of HTI EchoScape was the main reason for its recommendation as the standard product for the mobile acoustic programme. These surveys are generally conducted by area staff with only intermittent exposure to acoustic techniques due to other work pressures. Ease of use and training are essential attributes to maximise programme delivery.

Other factors supporting HTI EchoScape are the current training base (approximately 20 trained users) and an Access query written to simplify volume density calculations. The disadvantage of standardising on this product is the requirement for further utility development (e.g. area density calculations and variable section lengths).

- **Fish counters programme**

Sonar5-Pro was considered to have the best fish-tracking facility of the three products and the best option for the fish counters programme. Particularly useful features include: automatic tracking parameter detection, the speed of automatic tracking, track filtering on a large selection of library features, ease of track QA and the removal of 'stone tracks'.

The disadvantages of moving from HTI EchoScape to Sonar5-Pro are retraining of counter staff (four to six users), ensuring the new outputs are compatible with the Environment Agency's fish counter database ('Anaconda') and further tuning of the product for HTI data.

HTI EchoScape has been used effectively for this programme for up to five years and remains a satisfactory alternative. However, the following improvements would significantly improve processing speed and convenience:
1. An option to move to the next auto-tracked fish in one key-stroke, or alternatively to scroll through the table of tracked fish, with each fish in turn being highlighted on the echogram.
2. Automatically displaying the track on the xy plot when the fish has been selected in the table.
3. Upgrading the auto-tracking algorithm as it cannot handle a sequence containing a track with too many echoes.
4. An option to display times as well as ping numbers on the echogram.

- **R&D programme**

The acoustic R&D programme incorporates formal R&D projects (e.g. Gregory, 2000; Gregory *et al*, 1998; 2002; Hateley, 2002), informal technical investigations (for example comparing analytical approaches) and specialised or advanced fisheries surveys. Historically, the programme studies have been wide and varied and utilised different data sources (for example HTI and Simrad). Also, due to rapid advances in acoustic equipment and techniques and the unpredictability of funding streams, investigations tend to be developed and conducted quickly. Flexibility isthe most critical requirement of

acoustic data processing for the R&D programme. The R&D programme would be best supported by retaining copies of Sonardata Echoview and Sonar5-Pro as they offer the broadest ranges of functionality and acceptable data formats.

- **WFD programme**

HTI EchoScape would probably be the recommended product for the delivery of the WFD stillwater programme. In the mobile programme, area users will be expected to collect and analyse the bulk of the acoustic data and they will need a simple, user-friendly tool. Existing utilities can be used to minimise training requirements and costs.

The main disadvantage of using HTI EchoScape is the need to write additional Access queries that will report fish area densities (fish ha^{-1}) and densities of different TS groups.

There is an assumption HTI echosounders will be available for the stillwater surveys. However, the short acoustic survey season (May – October), inevitable down-time due to adverse weather and overlap with the rivers programme may result in bottlenecks at the data acquisition stage. HTI echosounders could be in short supply and reactivation of decommissioned Simrad EY500 equipment may have to be considered. Under these circumstances, it would be prudent to obtain data processing capacity compatible with both data formats (i.e. 1 x Sonar5-Pro licence).

- **DIDSON programme**

DIDSON data can be analysed primarily for fish counting, using two software products; SonarData Echoview (a DIDSON module is required) and the DIDSON manufacturer's (Sound Metrics) own software. Neither of these products was tested in this study and a detailed examination of them should be a priority. A single DIDSON-compatible licence will then be sufficient to meet Environment Agency research needs.

4.2 Assessing relative costs

The third principal objective of the project was to assess the relative costs for implementing each product. Manufacturers were asked to forward their policies on product upgrades, discount for multi-licences, bespoke customisation, and future product development. To avoid any commercially sensitive issues, manufacturers were assured their response would be treated as confidential. Costs are not shown in this report but large differences between the various options were apparent.

The recommended products for each programme, the number of licences currently owned and the number of additional licences required is summarised in table 4.2. Where applicable, viable alternative products are listed and the relative cost of implementing each option displayed as a ranking.

Table 4.2 Licence requirements and relative cost for implementation of products

Programme	Recommended product(s)	Estimated number of users	Estimated number of licences required (currently owned)	Alternatives (estimated number of licences required)	Relative cost for implementation (in order of increasing cost)
Mobile programme	HTI EchoScape	16	16 (16)	Sonar5-Pro (4) SonarData Echoview (16)	1. HTI EchoScape 2. Sonar5-Pro 3. Sonardata Echoview
Counter programme	Sonar5-Pro	4	1 (0)	HTI EchoScape (0) SonarData Echoview (4)	1. HTI EchoScape 2. Sonar5-Pro 3. Sonardata Echoview
WFD	HTI EchoScape	2	2 (0)	Sonar5-Pro* *(1) NB First choice if Simrad data used.* SonarData Echoview (2)	1. HTI EchoScape 2. Sonar5-Pro 3. Sonardata Echoview
R&D	Sonar5-Pro and SonarData Echoview	2	1 of each (1 of each)		1. Sonar5-Pro = 1. Sonardata Echoview
DIDSON	SonarData Echoview	1	1 (1*) * Requires DIDSON module	Sound Metrics? (1)	?

The estimated number of licences required to deliver a programme varies by product because the licences restrict functionality at different processing stages. HTI EchoScape and SonarData Echoview require hardware keys in order to process or export results, hence one licence is required for each user. Fewer Sonar5-Pro licences are required to deliver the same data processing capability as the hardware key is only required for initial file conversions. Files can therefore be circulated to hardware key holders and the converted files returned for analysis.

- **Mobile and R&D programmes**

The mobile programme and R&D programme are currently fully resourced both in terms of the recommended data processing product and the number of licences. However, the latest version of HTI EchoScape (v2.12) needs to be made available on the network and the Environment Agency copy of SonarData Echoview would benefit from an upgrade from version 3.10 to 3.25 (and future releases).

- **Fish counter programme**

The fish counter programme is currently fully resourced with 4 copies of HTI EchoScape. To change to the recommended product, the Environment Agency would need to buy a single Sonar5-Pro licence (one licence could convert all data-files). However, this would release the HTI EchoScape licences to cover the stillwater components of WFD monitoring.

- **WFD programme**

These licences would be able to deliver the WFD programme provided HTI echosounders are used to collect the data. Some funding will be needed to upgrade existing Access queries to report densities as fish ha^{-1} for different TS bins but despite these costs, HTI EchoScape is the least expensive option.

However, as discussed in section 4.1, there may be a shortage of HTI echosounders for WFD stillwater monitoring during the short survey season. In the interests of standardisation and data continuity it is desirable to avoid the reactivation of the Simrad EY500 echosounders. Simrad data should only be collected as a last resort and would require the purchase of an additional Sonar5-Pro licence.

- **DIDSON programme**

Without a thorough investigation of Sound Metrics' DIDSON software and SonarData's DIDSON module, it is not possible to assess the relative costs for implementing DIDSON compatible data processing products.

4.3 Can one product deliver all?

The fourth objective of this project was to assess the practicality of a single software product satisfying all current and projected acoustic data processing requirements.

Only SonarData Echoview has the potential to deliver all components of the acoustic programmes. It scored equal highest on software compatibility criteria, second highest on overall functionality and accepts Simrad, HTI and DIDSON data formats. However, this convergence benefit must be weighed against the disadvantages of a relatively high cost for implementing the product and developing associated utilities (Table 4.2).

There are also significant user-friendliness and training issues to consider. These can be reduced by the production of a restricted functionality version of the software, making it more suitable for operation by area users (as proposed by the manufacturers).

5 Conclusions

1) Three software products were tested against 23 business-relevant functionality requirements. Based on all criteria, the products ranked; Sonar5-Pro > SonarData Echoview > HTI EchoScape. Considering HTI analyses only, the products were very closely matched but ranked; HTI EchoScape > SonarData Echoview > Sonar5-Pro.

2) The products were also assessed for meeting six software compatibility requirements. The products were very closely matched again, but ranked; HTI EchoScape = SonarData Echoview > Sonar5-Pro.

3) From the results of this study, a product or products could be recommended for each of the acoustic monitoring programmes based on best meeting our business needs (see section 8, Recommendations).

4) The relative costs for implementing the recommended products, and viable alternative options, were considered. Actual costs are not shown but large differences between the various options were apparent.

5) The costs of developing associated data analysis utilities and macros can be significant and must be considered when making software procurement decisions.

6) A combination of products is the best solution for meeting Environment Agency needs.

7) SonarData Echoview alone has the potential to deliver all components of current and future acoustic programmes. However, the benefits of product convergence must be weighed against relative cost and training issues.

8) The best product for processing DIDSON data could not be determined during this study.

6 Recommendations

1) HTI EchoScape is recommended for delivering the mobile acoustic element of the National Fisheries Monitoring Programme. No additional licences are required in the immediate future. The latest version of HTI EchoScape (v2.12) needs to be made available on the network.

2) Following some development work, Sonar5-Pro should replace HTI EchoScape for the processing of acoustic fish counter data. A single Sonar5-Pro licence would be needed.

3) HTI EchoScape is recommended for processing the WFD stillwaters programme. No additional licences will need purchasing as two are available from the fish counters programme. However, if Simrad echosounders have to be used for data acquisition, a further copy of Sonar5-Pro may be needed.

4) Copies of both SonarData Echoview and Sonar5-Pro are recommended for the acoustic R&D programme. No additional licences are required but the Environment Agency version of SonarData Echoview (v3.10) requires upgrading to v3.25 and all future releases.

5) A priority for further work is identifying the best product for processing DIDSON data; Sound Metrics' own software or SonarData Echoview with the DIDSON module. A copy of the latter must be obtained for the evaluation.

6) Additional Microsoft Access queries are needed for the effective delivery of the mobile and WFD acoustic programmes. Utilities that permit variable section lengths, area density outputs (fish ha^{-1}) and the reporting of densities by selected TS groups are development priorities.

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Appendix 1. Summary log of software issues, queries and responses

Software product	Issue or query	Manufacturer's response
SonarData Echoview	• Advice on generating area and volume densities from echo-integration analyses. • Changing beam volume calculations for echo-counting. • Generating template export variables. • Changing units from miles to metres when track-counting. • Automated wedge-volume calculations when track-counting. • Bad cruise-track fixes in test file. • Error message when tracking large data files. • Error message when using 'reduce ping' operand to speed up data processing. • Memory problem when auto-tracking. • Integer overflow message when reading .BOT files. • Sizing of fish in DIDSON files	• Stepwise directions provided. • Substitute a calculated EBA into the calibration page. Could offer more automated route in future. • Through template EV files. • Through grid page in Variable Properties. • Planned for future releases (v 3.30). • Bug in v 3.10 fixed. • Computer memory limitation. • Bug in v 3.10. • Computer memory limitation. • Bug in v 3.10 fixed. • Currently no direct measurements of length, girth etc. Future developments possible.
Sonar5-Pro	• HTI TS data incorrect. • HTI navigation data not converted. • Request for sequence and file merging facility. • Error in 'mean ping' calculation method. • Not all tracks in fish basket used in biomass analysis. • Importation of navigation data into ArcGIS. • Various suggestions for improved fish-tracking e.g. new library features and track markings. • Calculating volume of rectangular beam. • Incorrect fish track times in merged files. • Guarantees of future support and development.	• Bug fixed. • Bug fixed. • Implemented. • Bug fixed. • Bug fixed. • Facility implemented. • Implemented. • Facility implemented. • Ping numbers too large. Changed data-type. • Safety copies of source code. Economical advantages of being small, technical advantages of being users and programmers, appropriate and accessible support, quick and easy upgrades.
HTI EchoScape	• Provision of sample data.	• Scheduled as a future development. Modifications needed to DES processor and EchoScape software.
	• Auto-tracked data not always saved.	• Bug fixed in v 2.12.

> Sonardata Comment: It should be made clear that Echoview's Upgrade and Support Agreement is intended to provide the holder with a key stake in future development and therefore the ability to influence the addition of features to future versions. Hence any shortfall in terms of functionality can be addressed as a condition of purchase.