Chelonia Limited
Wildlife Acoustic Monitoring

F-POD advantages

Conventional WAV files are structured to allow the use of the Fourier Transform (as FFT) to give frequency spectra. Very short sounds like cetacean clicks are not in fact well suited to the FFT which also 'loses' half the information it receives. It's not really lost, but is in a set of phase values that is of such limited practical use that it is rarely even mentioned. But it contains the information on *when* things happened in the click i.e. the time domain. The F-POD doesn't support FFT analysis except of the full waveform capture data. WAV file instruments logging below 1 MHz cannot be upsampled to match the F-POD – we have tried this and the downsweep in NBHF clicks is lost in the sample noise. So there is an interesting contrast here between what can be achieved by each approach. Our research suggests that the greater power in the train detection from the high-resolution time domain data is the deciding factor in favour of that approach, with the fast analysis, low data volume, etc. as huge secondary benefits.

If you are considering using a WAV file logger, see below for the main differences between the F-POD and WAV file logging systems (e.g. SoundTrap, SM2M, etc. and Pamguard software):

Data

Feature	**F-POD**	**WAV file recorder processed through Pamguard**
Data volume	Low. The SAMBAH project data set was <0.5TB.	High. Continuous logging for the SAMBAH project would have produced 12,000 TB of data requiring more than a year of downloading time.
Click detect only	Yes. This is the normal mode of operation.	Yes. Done using a variable threshold that includes a time constant that can be set at levels (>0.5 ms) that could interfere seriously with any future train detection.
Data format	Dedicated file structure that packages metadata with acoustic data to give fast and reliable data management in projects. .FP1 and .FP3 files. Open source formats. Code to unpack these formats is directly available from the CPOD.exe app.	Standard .wav file formats.
Data features	Summary data on ultrasonic (>17 kHz) clicks and tones only. No data on dolphin whistles, etc.	Frequency range defined by sampling rate and hydrophone. Generally, this will include lower frequencies than the C-PODs and will allow studies of dolphin whistles, broadband calls, etc.

The Barkhouse, North Cliff, Mousehole, Penzance, Cornwall, TR19 6PH, UK
Tel: +44 (0)1736 732462 Email: team@chelonia.co.uk Web: www.chelonia.co.uk
Company Registered in UK, no. 5472768 VAT no. GB795 0905 96

Feature	F-POD	WAV file recorder processed through Pamguard
Full waveform capture.	A simple real-time train detection routine can trigger capture of up to 21 cycles of a click. This has provided the new insights on the frequency slopes of narrow-band-high-frequency clicks in 6 different species already. A waveform can be constructed from this for FTT analysis, but will only be representative for longer clicks such as NBHF clicks.	All clicks have the same sampling regime, which is ideal for spectral analysis using the FFT.
Noise monitoring	Some noise indices are available but are not yet evaluated.	Formal noise metrics usually possible.
Automated analysis method	Click train detection and classification processes within CPOD.exe software. No beam forming processes.	Click spectrum classification. Coherent beam angle sequences from towed pairs of hydrophones add power to the classifier.
Strengths	Extensive experience in many countries of using this system has shown no major discrepancies from visual surveys where those are possible. Gives click rates in trains. This behavioural information is of value. False positive rates from pure automated analysis are low. In SAMBAH the combination of train classification and a previously developed Baltic data encounter classifier – 'Hel1' achieved a false positive rate of < 1 FP second per year.	Fits traditional spectral analysis approaches.
Weaknesses	No logged information on low frequency sounds.	For NBHF species (porpoises and some dolphins) false positives from moving fine sand and other sources can be serious and may not be recognised by human analysts. For dolphins, spectral analysis is generally very weak and requires human editing of most detections, which is very costly, and requires quality control.
Validation	Multiple published studies with visual observation have all showed good results.	Very limited observational verification. Some alarming results. (see 'comparing instruments' in Chelonia downloads.)
Error messages	The automated analysis flags up error risks in the results from a file.	No warnings.
Temperature	Recorded every minute	no
Angle	Recorded every minute. Provides a measure or currents and identifies some deployment problems	no
Detection performance	Our tests indicate that for porpoises the threshold is lower and at comparable false positive rates it is much lower. Good independent sea tests would be valuable.	
Sonar filtering	Yes. To control data volumes, two independent sonar filters can operate in each minute.	No. If data recording is continuous this does not increase data volumes.

Hardware

Feature	F-POD	WAV file recorder processed through Pamguard
Hydrophone	Hydrophone with characteristics similar to a B&K 8103 hydrophone.	See manufacturer's website.
Calibration	Radial sensitivity at two frequencies for each instrument when made. See example below.	See manufacturers, websites.
Running time	Approx. 4 months on alkaline cells, or approx. 8 months + on lithium primary cells. The quality of the alkaline cells is significant. 2 months plus on rechargeable batteries in C-POD-LF. All can be multiplied up by not recording every 2nd or 5th minute as the deep sleep mode is very deep.	Generally lower and limited by data storage requirements and batteries. Vary between devices. Part of minute only etc from some systems. This is a major issue for some projects.
Servicing interval	Determined by running time.	Determined by running time or memory size.
Robustness	Very high. Individual hydrophones have withstood being thrown against rocks many hundreds of times and shown no measurable change in calibration!	?
Buoyancy	Positive. This facilitates deployment and recovery, especially when moorings are interfered with or lost – over 100 recoveries have been made via the http://www.phonehome.org.uk/ website.	

Software

Feature	F-POD	WAV file recorder processed through Pamguard
Software	CPOD.exe handles data from the C-POD and F-POD. Analyses, displays filters and exports. Designed to support rapid accurate validation, with visualization options, editing tools, sampling point allocation, feature reporting etc.	Various: Raven, Pamguard, Ishmael, Audacity, Matlab, R etc.
Software cost	Free, including all upgrades	Various packages, some free.

Costs

Feature	F-POD	WAV file recorder processed through Pamguard
Hardware Costs	3k GB pounds, with 50% discounts for some academic and conservation projects.	See manufacturers. Generally higher for longer running instruments.
Automated analysis speed	Typically > 3 days of data per minute read (from SD card) and analysed to classify to cetacean group.	Typically relatively very slow.

Feature	F-POD	WAV file recorder processed through Pamguard
Analysis time	Very low. Visual validation of a sample of data is required. If this passes, which is usual, the data can be used without further time costs.	Very high. Visual checking of all detections is commonly needed.

Projects

Feature	F-POD	WAV file recorder processed through Pamguard
Project support	Free data quality reporting. Design discussion/advice.	See manufacturers, websites.

Empirical testing

Feature	F-POD	WAV file recorder processed through Pamguard
	Various papers have compared POD data with visual data. All have shown good agreement.	