

USERS' PREFERENCES FOR PAM SYSTEMS.

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1 INTRODUCTION

An on-line survey of users' preferences for PAM (Passive Acoustic Monitoring) systems is being conducted as part of an ongoing study to investigate the state of the art in PAM systems and to find out where users consider the gaps in the available capability lie and where further research and development should be aimed to meet their requirements. The survey is still on-line and can be accessed at http://www.surveymonkey.com/s.aspx?sm=EpMS_2b7W2YaFypB6hbeGo9w_3d_3d.

When the survey was initiated, it was advertised widely through mailing lists such as MARMAM [1] and Bioacoustics-L [2], the list associated with this conference, and personal contacts. At the time of this analysis, 113 responses had been received, mainly from either researchers from academic establishments, government research organizations, or consultants/contractors providing PAM and MMO (Marine Mammal Observer) services for the oil and gas industry as shown in Figure 1.

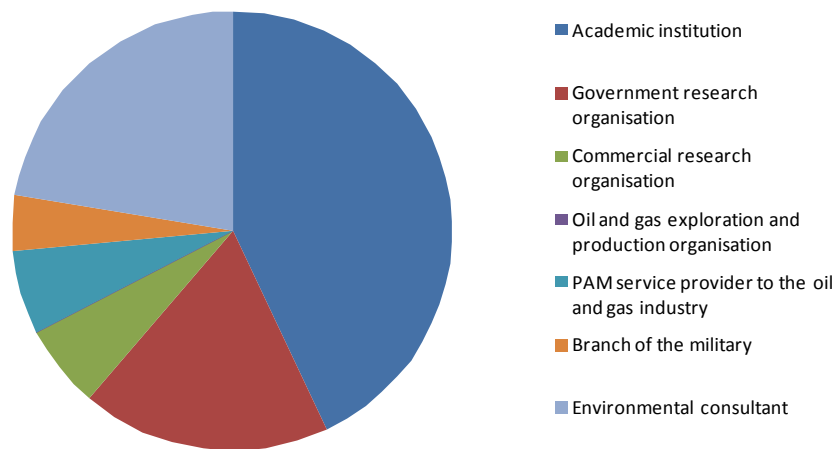


Figure 1: Affiliations of survey respondents.

This paper present a brief summary of the response statistics, along with an analysis of the responders comments, leading to conclusions regarding future directions developers of PAM systems should take.

2 RESPONSE STATISTICS

The questions were divided into four main areas: PAM system applications, type of system, desirable features and general comments. The first three are considered in this section, and the comments will be analysed in the following section.

2.1 PAM SYSTEM APPLICATIONS

The questions asked under this heading were:

- What is your principal application for PAM systems?
- What sounds are you interested in monitoring?
- Which species are of most interest?

The response to the first question was mainly marine mammal research (71.4%), followed by Environmental Impact Assessment/Mitigation (18.4%), with a very few interested in fish research, data collection for information systems and population assessment (8.2% in total).

The answer to what sounds are of interest was essentially “everything”. Responders were allowed to select as many of the listed sounds as they liked, and the result is shown in Figure 2. It was notable that all cetacean vocalizations were of interest, but the requirement to monitor other sounds was not insignificant and 55.1% wanted to monitor ambient and anthropogenic noise along with the biological sounds.

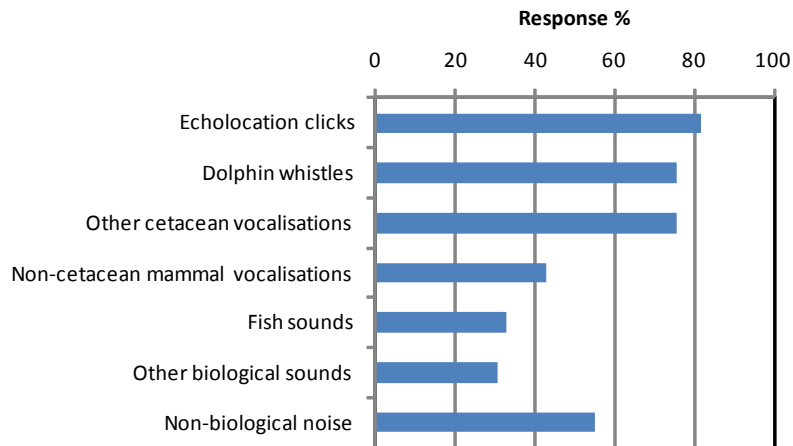


Figure 2: Sounds of interest.

The answer to which species are of interest was overwhelmingly (95.5%) either all species or all cetaceans. The remainder tended to specify just one species or family, usually a small odontocete.

2.2 TYPE OF SYSTEM

The first two questions in this section related to the system hardware and software and whether they were developed by the user or bought in. The third question was about the type of deployment – towed, ship-mounted, moored and so on.

System hardware was developed in-house by 33.3% of responders, bought in by 37.5%, hired by 8.3%, and the remainder said that the source depended on particular requirements for specific applications. The only off the shelf hardware mentioned by name in this answer was the T-POD produced by Chelonia Ltd (see e.g. [3]).

Responses for software were similar: 25.0% used dedicated PAM software, 14.6% used software that was an integral part of a bought or hired system and 29.2% had developed their own. Own software was mostly developed in MATLAB [4], while the specific PAM packages most frequently used were Ishmael [5], Raven [6] and RainbowClick [7]. One responder noted that PAMGUARD [8] is too unstable.

System deployment was mainly moored, tethered or anchored (69.4%), followed by towed (55.1%). Vessel mounted was just 14.3%, as was drifting buoys. Other methods (12.2%) were mostly either bottom mounted or deployed from sea ice.

2.3 DESIRABLE FEATURES

Responders were asked to rank a list of desirable features, and the results are presented in Table 1. The grayed cells represent the strongest response for each feature.

	Very Important	Important	Doesn't Matter Much	Not Important
Ease of deployment	63.8%	31.9%	4.3%	0%
Automatic detection	44.7%	40.4%	14.9%	0.0%
Species identification	36.2%	42.6%	21.3%	0.0%
Localisation in range	52.2%	37.0%	8.7%	2.2%
Localisation in depth	19.6%	37.0%	32.6%	10.9%
Localisation in bearing	47.8%	30.4%	15.2%	6.5%
Remote/autonomous operation	39.1%	28.3%	21.7%	10.9%

Table 1: Important features

It is clear that the most important features, in order of importance, are ease of deployment, localisation in range, localisation in bearing, automatic detection and remote or autonomous operation. Localisation in depth and species identification were considered of lesser importance.

Of the other features suggested, robustness and reliability seemed important, along with indication of detection validity, such as a predicted false alarm rate. There were also a number of interesting comments associated with this question that will be dealt with in the general comments section below.

3 GENERAL COMMENTS

The final question asked for general comments, and a number of responders also added comments in their response to other questions. The most common was that much of the equipment that is currently available is of poor quality and reliability. One response summed it up quite neatly:

If only the equipment was:

- Easy to use
- High performance
- Reliable

But current kit is not any of these!

Again, the only hardware mentioned by name was the T-POD, but the user commented that they would be more useful if calibrated. And again, several responders commented on the instability of PAMGUARD.

These are sensible comments that developers should take into consideration. There were also a number of more naïve comments. One in particular was worrying:

The hardware specs are really not that important and I would get away from calling it 'state of the art', it is not. It is a couple of analog 'phones in an oil filled tube. Apart from the difficulty in assembly, a school science student could wire it up. The really important end is the amplifier and processing software, plus the user's skill.

This user presumably has little understanding of underwater sound or the physics associated with arrays and beamforming. If it really is that easy, it is hard to understand why the Navy uses kilometer-long towed arrays or flank arrays the size of a bus on submarines, rather than “a couple of analog ‘phones”.

Among the other comments of note were a number saying own-ship noise was a problem, and more needs to be done about measuring ship noise characteristics. The answer is to look in the defence literature for ship noise characteristics or, preferably, deploy your sensor further from your vessel. There were also complaints about the lack of training available, but a brief trawl on the internet will find several PAM or PAM related courses.

4 CONCLUSIONS

The main conclusions from this brief survey are that users want more reliable, robust PAM systems that are easy to deploy and preferably autonomous. They should cover the full range of sounds to be heard in the ocean and should be capable of localisation in range, localisation in bearing and automatic detection.

A secondary conclusion some respondents had little understanding of either acoustic propagation or the principals behind sensor arrays. Few seemed to realise that PAM is just passive sonar by another name, and that a vast body of academic research and applied development has been carried out by the defence community, much of which is equally relevant to detecting marine mammals as to submarines or torpedoes.

REFERENCES

1. MARMAM e-mail discussion list for marine mammal research and conservation, run through the University of Victoria. Currently on-line at <http://whitelab.biology.dal.ca/marmam.htm>.
2. Bioacoustics-L mailing list for discussion of any subjects related to the scientific study of sound in the natural world, run through Cornell University. Currently archived at <http://www.mail-archive.com/bioacoustics-l%40cornell.edu/maillist.html>.
3. Baines ME, Tregenza NJC and Pierpoint CJL. Field trials of the POD - a self contained, submersible, acoustic data-logger. European Research on Cetaceans, 13. Valencia, Spain, 1999.
4. See <http://www.mathworks.co.uk/products/matlab/>.
5. See <http://www.pmel.noaa.gov/vents/acoustics/whales/ishmael/>.
6. See <http://www.birds.cornell.edu/brp/raven/RavenOverview.html>.
7. See http://www.ifaw.org/ifaw_international/join_campaigns/protecting_whales_around_the_world/come_ aboard_the_song_of_the_whale/download_cetacean_research_software/rainbowclick_main_features.php.
8. See <http://www.pamguard.org/home.shtml>.