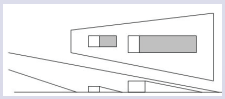
Detection and mapping of zebra mussels using high resolution imaging sonar technology and image enhancement and mosaicing software

The DIDSON™ (Dual frequency IDentification SONar) is an imaging sonar or "Acoustic Camera" that gives near video quality images for inspection and identification of objects underwater. Technically it is a multibeam sonar, operating with 96 beams and providing a field of view of 29º (horizontally) by 14º (vertically).

It is used as a surrogate for optical systems in turbid water. The standard DIDSON™ operates at two frequencies (1.8 MHz and 1.1 MHz) and provides images of objects from 1 m to over 30 m in range.

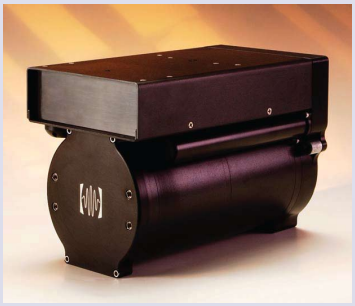


Correct Orientation strikes the bottom at a shallow angle and ensonifies the entire area of interest.

The images obtained with the DIDSON™ imaging sonar can be viewed in real time through the acquisition software. They can be saved as video files (AVI) and can be post-processed with specific software.

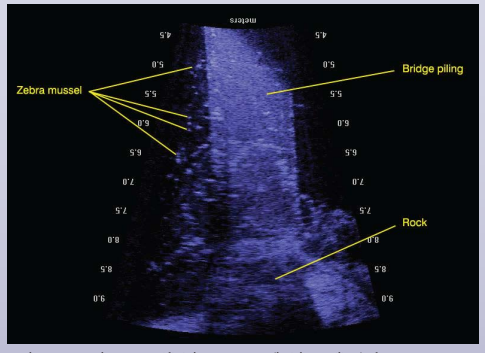
ClearSight™ software (AcousticView, Israel) is mosaicing software that allows to create mosaics from a series of individual images (up to 1000 frames) generated by the imaging sonar.

Using the redundant information contained in multiple images of the same object, the mosaicing technique provides enhanced images. The ClearSight™ software performs detailed geometric modeling of the collection of sonar frames. It then modifies the image following a shift of the camera to a common location and performs a global optimization on the mosaic created by the sequence of frames. Super resolution is obtained by the shift of the camera vs. the target by sub-pixel values, potentially increasing resolution up to 10 times.

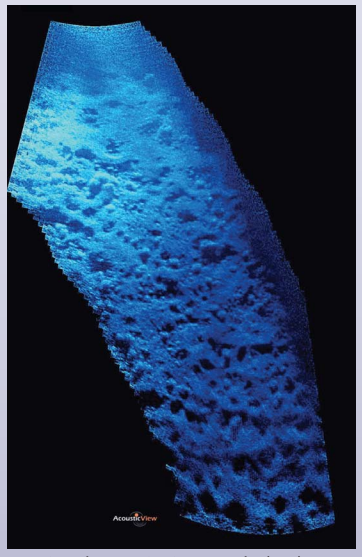


Standard DIDSON (300m depth rating)

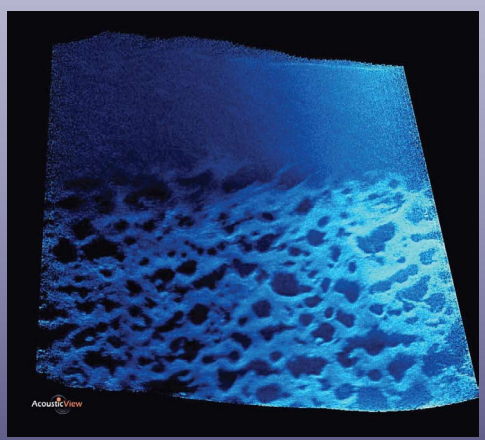
Appearance of the area with zebra mussel agglomerations that remained on dry land after a decrease in water level. The same pattern continues under water. (Image courtesy of Miquel Angel López)



Zebra mussels on artificial structure (bridge piling) from a screen capture of the DIDSON™ acquisition software. The image has been reversed to reflect real-world orientation. Visibility is about 10cm.



Mosaic of acoustic images of the bottom, Mequinenza reservoir. Different structures can be seen.



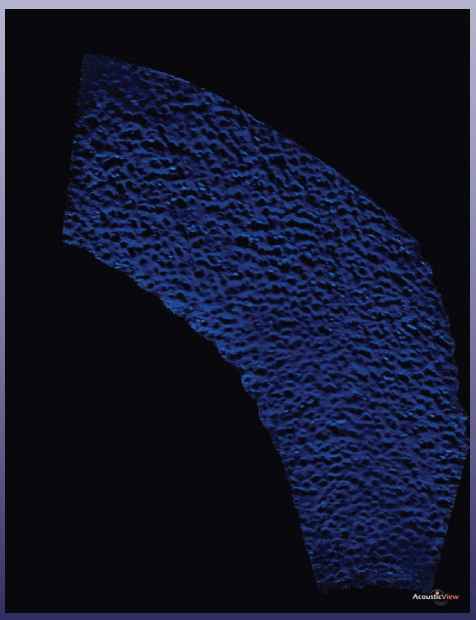
Mosaic of acoustic images of the bottom, Mequinenza reservoir. Similar patterns as pictured above can be observed.

Images captured from underwater video, showing clusters of zebra mussel.

The identification of zebra mussel clusters on varying substrate still requires further investigation and testing, but this preliminary study has clearly shown the advantages of acoustic imaging with image enhancement through mosaicing techniques over optical methods. With visibility between 10-20cm and often less, video techniques cover a very limited area of the bottom.

Acoustic imaging potentially allows to obtain images from a greater distance, thus providing an instant field of view about hundred times the size of that of an optical camera, with comparable resolution. Improvements in the identification of mussel clusters could be obtained by varying the observation angle as well as through the use of different acoustic lenses (concentrator lenses, etc.) available for the DIDSON™ acoustic camera.

Further trials are planned between November 2009 and February 2010.



Mosaic of acoustic bottom images showing a larger area of the bottom (Mequinenza reservoir). The technique potentially allows to create an image of the entire bottom of a reservoir, lake or river.

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