



MARINE MEGAFAUNA FOUNDATION

NEW SCIENTIFIC REPORT

In Press: Ecology and Evolution
DOI: 10.1002/ece3.587

Contact: Dr. Andrea Marshall

Phone: +258 84 730 1190

E-mail: andrea@marinemegafauna.org

Multidisciplinary Research At Its Best

Cambridge Professor Christopher Town teams up with Marine Megafauna Foundation to develop a ground-breaking algorithm to automatically match manta ray sighting photos.

Manta Matcher: automated photographic identification of manta rays using keypoint features

Christopher Town¹, Andrea Marshall² & Nutthaporn Sethasathien³

¹*Computer Laboratory, University of Cambridge, 15 JJ Thomson Avenue, Cambridge CB3 0FD, UK*

²*Manta Ray and Whale Shark Research Centre, Marine Megafauna Foundation, Tofo Beach, Inhambane, Mozambique*

³*School of Informatics, University of Edinburgh, 11 Crichton Street, Edinburgh EH8 9LE, UK*

Summary: For species bearing unique markings, such as natural spot patterning, fieldwork has become increasingly more reliant on visual identification to recognize and catalog particular specimens or to monitor individuals within populations. While many species of interest exhibit characteristic markings that in principle allow individuals to be identified from photographs, scientists are often faced with the task of matching observations against databases of hundreds or thousands of images. We present a novel technique for automated identification of manta rays by means of a pattern-matching algorithm applied to images of their ventral surface area.

Automated visual identification has recently been developed for several species. However, such methods are typically limited to animals that can be photographed above water, or whose markings exhibit high contrast and appear in regular constellations. While manta rays bear natural patterning across their ventral

Marine Megafauna Foundation 3024 Frandoras Circle Oakley California 94561 USA

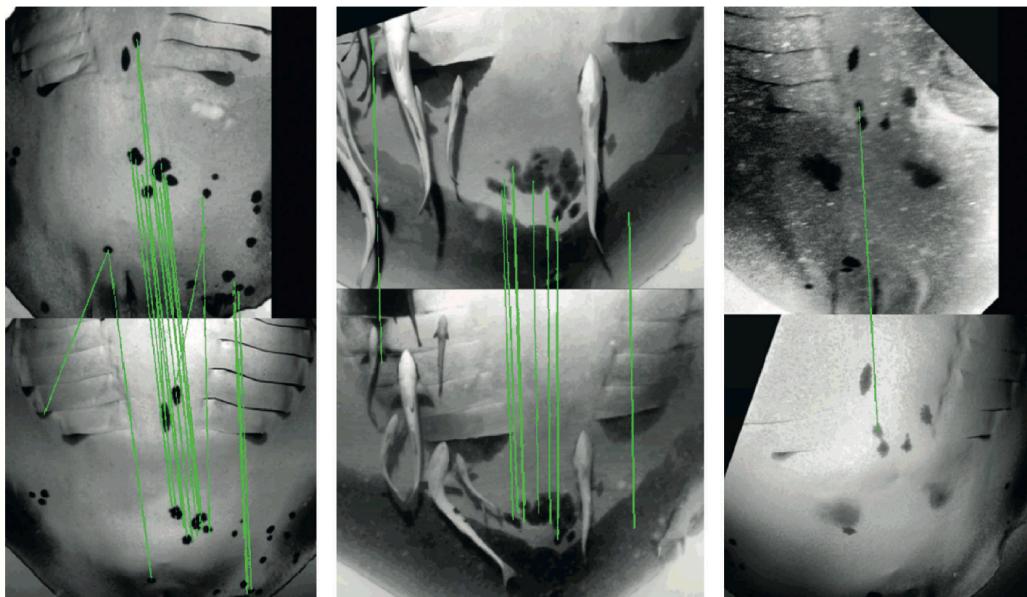
MMF is a tax-exempt non-profit charitable organization under section 501(c)(3) of the US tax code (Tax ID #46-0645082)



MARINE MEGAFAUNA FOUNDATION

surface, these patterns vary greatly in their size, shape, contrast, and spatial distribution. Our method is the first to have proven successful at achieving high matching accuracies on a large corpus of manta ray images taken under challenging under-water conditions.

We developed a highly automated matching algorithm whereby image preprocessing is minimal, characteristic features are extracted automatically, and matching speed is orders of magnitude faster than comparable systems. Our method is based on automated extraction and matching of keypoint features using the Scale-Invariant Feature Transform (SIFT) algorithm. In order to cope with the considerable variation in quality of underwater photographs, we also incorporate preprocessing and image enhancement steps. Furthermore, we use a novel pattern-matching approach that results in better accuracy than the standard SIFT approach and other alternative methods. We present quantitative evaluation results on a data set of 720 images of manta rays taken under widely different conditions.



Above: Manta ray spot patterns being matched between individuals previously identified (first row) and new database additions (second row). Green lines indicate patterns that are true positives. Note that matching is robust to changes in viewing conditions and presence of occlusions (e.g. remoras).



MARINE MEGAFAUNA FOUNDATION

Due to its success, the method has recently been incorporated into a website (mantamatcher.org) which will serve as a global resource for ecological and conservation research on these enigmatic rays. It will allow researchers to manage and track sightings data to establish important life-history parameters as well as determine other ecological data such as abundance, range, movement patterns, and structure of manta ray populations across the world. This is especially important in light of being able to use images submitted by ‘citizen scientists’ or recreational divers to identify individuals as well support a centralized database that can be mined by researchers for years to come.

“This team effort is such a great example of biological problem solving. Combining different skill sets to address an issue and then using the result to create a global resource.” - Dr. Andrea Marshall

Below: A screenshot from the Manta Matcher website (mantamatcher.org)

The screenshot shows a collage of manta ray images and a central informational panel:

- Top Left:** A large image of a manta ray from above.
- Top Center:** The MantaMatcher logo with the text "ECOCEAN MantaMatcher" and "You can help photograph, identify, and protect giant manta!" Below it are navigation links: Home, Learn, Participate, Individuals, Encounters, Search, Administer, Contact Us, and Login.
- Top Right:** A large image of a manta ray from below.
- Middle Left Column:** Three smaller images of manta rays in various orientations.
- Middle Center Panel:**
 - Photographing a Manta:** Text: "Did you know that by photographing a manta ray you can directly contribute to a global effort to better understand and protect these amazing animals?"
 - Taking the perfect ID shot:** Text: "Manta rays are predominantly encountered on SCUBA, however in some areas of the world snorkelers are also able to engage with these gentle giants. For this reason we focus on tips for taking ID shots whilst SCUBA diving." "If you spot a manta ray on a dive and have the opportunity to take an ID picture please do. However please focus foremost on ensuring that you have a good encounter with this animal and that you are following the recommended code of conduct for the region." "When the opportunity arises, try to remain stationary, allowing the manta ray to control the encounter. If you remain stationary, mantas will often approach you and may even pass overhead. Avoid rushing towards a manta as this may scare them away from you, ending the encounter. By positioning yourself below the manta during the encounter you are already set up to take the perfect ID shot."
 - Standardized ID Area:** An image of a manta ray with a dashed rectangular box highlighting the ventral side near the pectoral fins, indicating the recommended area for ID photographs.
- Middle Right Column:** Three smaller images of manta rays in various orientations.
- Bottom Left Column:** Two smaller images of manta rays in various orientations.
- Bottom Right Column:** Two smaller images of manta rays in various orientations.

Marine Megafauna Foundation 3024 Frandoras Circle Oakley California 94561 USA

MMF is a tax-exempt non-profit charitable organization under section 501(c)(3) of the US tax code (Tax ID #46-0645082)