First use of the I³S Pattern photoidentification application as a preliminary and complementary tool for tiger shark *Galeocerdo cuvier* identification

Francesca Romana REINERO[1], Benedetta MAGNANI[1], Nadia SGAMBARO[1], Matthieu BEKAERT[1], Primo MICARELLI[1]

[1]Sharks Studies Center-Scientific Institute, 58024 Massa Marittima (GR), ITALY

INTRODUCTION

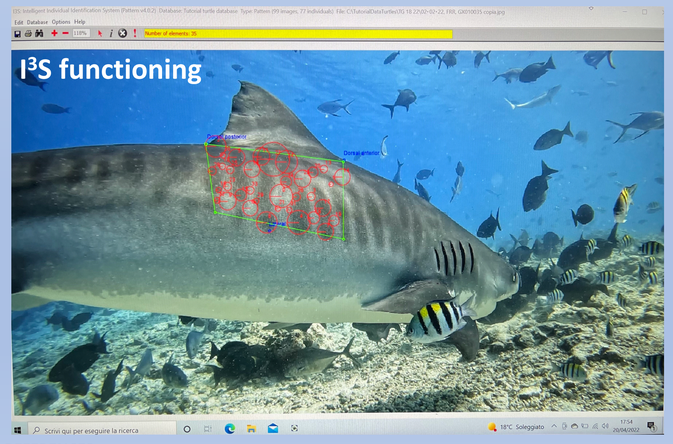
Tiger shark *Galeocerdo cuvier* (Peròn & Lesueur, 1822) is an apex predator in many tropical and warm-temperate ecosystems around the world (Heithaus, 2001). Its common name derives from the particular dorsal pattern that it's grey above with vertical black to dark grey bars and spots. Stripes are bold in young but fade in adults (Ebert *et al*., 2021). This characteristic pattern remains also unvaried after they reach sexual maturity at around 4-13 years (Clua *et al*., 2013). In addition to this distinctive body pigmentation, tiger sharks can show natural marks and wounds, particularly on their first dorsal fin and body, making this species suitable for the photoidentification approach through the comparison of different pictures, and the obtained data can be used to infer species abundance, surving rates, geographical distribution, and migrations (Marshall & Pierce, 2012). I³S Pattern is an Interactive Individual Identification System (http://reijns.com/i3s/) and totally free computer-aided photoidentification application that relies on natural marks to identify individual animals, helping the researcher to extract the body pattern and then compares it against all animals in the database, showing to the researcher the most relevant results. I³S pattern has been first developed just for turtles, but it can now be applied to other animals with particular signs and a recognizable pattern such as tiger sharks.

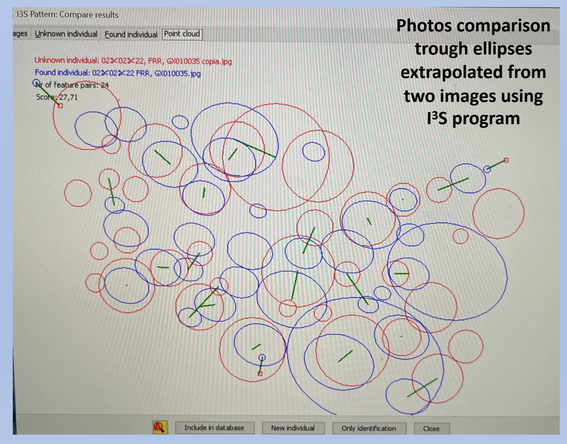
MATERIALS AND METHODS

The Sharks Studies Center-Scientific Institute (Grosseto, Italy) carried out a Scientific expedition in February 2022 in Fuvahmulah Island (Gnaviyani Atoll), Maldives, reaching the tiger sharks' dive sposts (Spot 1 and 2) just out of the harbour with the logistic support of the Fuvahmulah Scuba Club to film and take underwater pictures of these animals useful for the identification. Photos and videos of both sharks' side were taken in horizontal position, with a slight angle from the bottom to the surface, and possibly when the animal stayed stationary. After a first photoidentification based on the body marks, scars, size, and sex, the best frames have been analyzed through the I³S Pattern. I³S Pattern uses three reference points (blu spots) to establish an area of comparison between pictures, and inside this area ellipses are automatically drawn around and between the various spots and stripes. The unique pattern of each specimen is saved into the database and compared with the others just saved and available. In particular, the program compares each group of points extrapolated from the stored images and assign a score to each pair of images. The same two pictures have a score of 0.00; almost certain matches present scores below 20.00, while scores comprehended from 20.00 to 30.00 must be evaluated from the operator considering image quality, accuracy of the chosen spots, presence of wounds or particular marks, and visual observation. Scores higher than 30.00 are probably indicative of unmatched individuals. Although the body pattern on tiger sharks tends to be preserved for a long time, younger specimens (TL < 300 cm) could undergo significant changes due to fast growth, thereby compromising the correct match. It is also possible, if available, to add other metadata to filter the results, like size, sex, or the side of the body.

RESULTS, DISCUSSIONS, AND CONCLUSIONS

In total, 33 sharks (26 females, 4 males, and 3 unsexed) were identified both from distinctive bodily features, such as natural marks, scars, size, and sex and from their stripped and spotted pigmentation using the I³S Pattern program. It is important to remember that there are some issues with photoidentification in general, especially in a marine environment: quality of the images can be poor because of water turbidity and distance from the animal, resulting in loss of spots; animals swimming over the interested region may also hide spots; when the shark is swimming close to the surface, sunlight may create reflections on the body that can be easily mistaken for spots and lastly the movement of the shark may stretch or compress the skin and the placement of the animal may not be perpendicular to the operator which may result, in both instances, in a distortion of the distance between the points in the picture. For this reason, it is always important for the operator to review eventual matches and be aware of possible missing matches from the program, which is to be used just as a complementary tool to help manage and filter out the overwhelming number of images accumulated, and not as a definitive answer. Due to its subjectivity, the reviewing and analysis of the collected videos need to be always performed by the same operator. Unfortunately, this technique is not yet standardized at international level because of non-negligible margins of error (Clua *et al*., 2013) and despite the value of this method for the estimation of abundance is assumed for small populations, the combined efforts of *in situ* observation and subsequent analysis could still underestimates the real abundance of sharks. However, *bias* could be minimized through good quality photographs and capture-and-release programs, which can integrate other important information (Urian *et al*., 2014).





REFERENCES

-Clua E., Chauvet C., Read T., Werry J.M., Lee S.Y., 2013. Behavioural patterns of a Tiger Shark (*Galeocerdo cuvier*) feeding aggregation at a blue whale carcass in Prony Bay, New Caledonia. Marine and Freshwater Behaviour and Physiology, 46(1): 1-20. https://doi.org/10.1080/10236244.2013.773127.

-Ebert D.A., Dando M., Fowler S., 2021. Sharks of the World. Princeton University Press, UK, 568.

-Heithaus M.R., 2001. The biology of tiger sharks, *Galeocerdo cuvier*, in Sharks Bay, Western Australia: sex ratio, size distribution, diet, and seasonal changes in catch rates. Environmental Biology of Fishes, 61: 25-36. https://doi.org/10.1023/A:1011021210685.

-Marshall A.D. & Pierce S.J., 2012. The use and abuse of photographic identification in sharks and rays. Journal of Fish Biology, 80(5): 1361–1379. https://doi.org/10.1111/j.1095-8649.2012.03244.x.

-Urian K., Gorgone A., Read A., Balmer B., Wells R.S., Berggren P., Durban J., Eguchi T., Rayment W., Hammond P.S., 2014. Recommendations for photo-identification methods used in capture-recapture models with cetaceans. Marine Mammals Science, 31(1): 298-321. https://doi.org/10.1111/mms.12141.