The starry smooth-hound shark meets acoustic telemetry: Visualising movements of *Mustelus asterias* for non-scientists to promote policy-making

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The starry smooth-hound *Mustelus asterias* (Cloquet 1819, Carcharhiniformes: Triakidae) is a demersal elasmobranch reaching up to 130 cm in length (Farrell *et al.*, 2010a). The species exhibits sexually differentiated seasonal distributions on the continental shelves of the Greater North Sea, the Celtic Seas and the Bay of Biscay and the Iberian Coast (Brevé *et al.*, 2020; ICES, 2022, chapter 21.1). In 2015, its IUCN conservation status was changed from “Least Concern” to “Near Threatened” (Nieto *et al.*, 2015). Elasmobranchs urgently need protection and sustainable management strategies because late maturity and low offspring numbers result in high vulnerability to anthropogenic threats such as fisheries and habitat destruction (Stevens *et al.*, 2000; Dulvy *et al.*, 2017). Moreover, species with geographic variability of life-history traits like the starry smooth-hound are potentially more prone to human exploitation (Kuparinen and Merilä, 2007). Until now, no stock management plan for *Mustelus asterias* exists although rising bycatch rates and population collapses of related species in the Mediterranean have been reported in recent years (Silva and Ellis, 2019; Colloca *et al.*, 2017, respectively). Successful species management strategies for the starry smooth-hound not only require comprehensive knowledge on the reproductive biology and life history (Farrell *et al.*, 2010a,b, 2014), but information on spatial distribution and information on movement ecology also have to be obtained.

To close this knowledge gap, seasonal distribution patterns of *Mustelus asterias* have been assessed by Brevé *et al.* (2016, 2020) in a tag-recapture study. Apart from the tag-recapture method, another widely used approach for studying the movement of marine animals is acoustic telemetry, i.e., the acquisition of detailed spatiotemporal observations of animal movements by fitting the animals with an electronic acoustic tag which can be detected by specific equipment placed in the water (Reubens *et al.*, 2019). To carry out research through tagging, the Permanent Belgian Acoustic Receiver Network (PBARN, Reubens *et al.*, 2019) was established in the Belgian Part of the North Sea (BPNS) in 2014 which is part of the European Tracking Network (ETN) since its establishment in 2017. In order to successfully implement management strategies for vulnerable species such as the starry smooth-hound, the results of biological data have to be comprehended and recognised by all four pillars of the so-called quadruple helix (Rotter *et al.*, 2020, fig. 4 therein): experts (scientists), innovators (industry partners), policy makers (politicians), and users (the general public). Displaying complex information in a visual form instead of continuous text increases the recipients’ comprehension (Dechsri *et al.*, 1997).

30 individuals of Mustelus asterias where marked with Acoustic Data Storage (ADST) Tags by the Flemish Marine Institute (VLIZ) from 2018 to 2019. The goal was to track the animals’ movements using the available network of acoustic receivers able to detect those tags which are deployed in the BPNS and the Scheldt Estuary.

The main objectives of the proposed master thesis are firstly, to analyse the tracking data of the 30 tagged individuals of *Mustelus asterias* to assess the presence and movement of the species in the deployment area in the BPNS and the river Scheldt and the Scheldt Estuary between 2018 and 2019. Secondly, these data shall be visualised in an informative yet comprehensible data product, preferably in an interactive way. The data visualisation application can serve as an information source for policy makers and industry partners concerned with developing and implementing stock management plans for *Mustelus asterias*, and the general public.

Literature Sources

- Brevé, N. W. P., Winter, H. V., Van Overzee, H. M. J., Farrell, E. D., and Walker, P. A. (2016). Seasonalmigration of the starry smooth-hound shark *mustelus asterias* as revealed from tag-recapture data of an angler-led tagging programme. Journal of Fish Biology, 89(2):1158–1177.

- Brevé, N. W. P., Winter, H. V., Wijmans, P. A. D. M., Greenway, E. S. I., and Nagelkerke, L. A. J. (2020).Sex differentiation in seasonal distribution of the starry smooth-hound *mustelus asterias*. Journal of Fish Biology, 97(6):1870–1875.
- Colloca, F., Enea, M., Ragonese, S., and Di Lorenzo, M. (2017). A century of fishery data documenting the collapse of smooth-hounds (mustelus spp.) in the mediterranean sea. Aquatic Conservation: Marine and Freshwater Ecosystems, 27(6):1146–1155.
- Dechsri, P., Jones, L. L., and Heikkinen, H. W. (1997). Effect of a labratory manual design incorporating visual information-processing aids on student learning and attitudes. Journal of Research in Science Teaching, 34(9):891–904.
- Dulvy, N., Simpfendorfer, C., Davidson, L., Fordham, S., Bräutigam, A., Sant, G., and Welch, D. (2017). Challenges and priorities in shark and ray conservation. Current Biology, 27(11):565–R572.
- Farrell, E., O'Sullivan, N., and Sacchi, C. (2014). Multiple paternity in the starry smooth-hound shark *mustelus asterias* (carcharhiniformes: Triakidae). Biological Journal of the Linnean Society , 11(1):119–125.
- Farrell, E. D., Mariani, S., and Clarke, M. W. (2010a). Age and growth estimates for the starry smooth-hound (*mustelus asterias*) in the northeast atlantic ocean. ICES Journal of Marine Science, 67(5):931–939.
- Farrell, E. D., Mariani, S., and Clarke, M. W. (2010b). Reproductive biology of the starry smooth-hound shark mustelus asterias: geographic variation and implications for sustainable exploitation. Journal of Fish Biology, 77(7):1505–1525.
- Flávio, H. and Baktoft, H. (2021). actel: Standardised analysis of acoustic telemetry data from animals moving through receiver arrays. Methods in Ecology and Evolution, 12(1):196–203.
- Hussey, N. E., Kessel, S. T., Aarestrup, K., Cooke, S. J., Cowley, P. D., Fisk, A. T., Harcourt, R. G., Holland, K. N., Iverson, S. J., Kocik, J. F., Mills Flemming, J. E., and Whoriskey, F. G. (2015). Aquatic animal telemetry: A panoramic window into the underwater world. Science, 348(6240):1255642.4
- Kuparinen, A. and Merilä, J. (2007). Detecting and managing fisheries-induced evolution. Trends in Ecology & Evolution, 22(12):652–659.
- Reubens, J., Verhelst, P., van der Knaap, I., Wydooghe, B., Milotic, T., Deneudt, K., Hernandez, F., andPauwels, I. (2019). The need for aquatic tracking networks: the permanent belgian acoustic receiver network. Animal Biotelemetry, 7(1):1–6.
- Rotter, A., Klun, K., Francé, J., Mozetiˇc, P., and Orlando-Bonaca, M. (2020). Non-indigenous species in the mediterranean sea: Turning from pest to source by developing the 8Rs model, a new paradigm in pollution mitigation. Frontiers in Marine Science, 7.
- Silva, J. F. and Ellis, J. R. (2019). Bycatch and discarding patterns of dogfish and sharks taken in english and welsh commercial fisheries. Journal of Fish Biology, 94(6):966–980.
- Stevens, J., Bonfil, R., Dulvy, N., and Walker, P. (2000). The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. ICES Journal of Marine Science, 57(3):476–494.1.2

Other sources

ICES (2022). Working group on elasmobranch fishes (WGEF). Technical report, Copenhagen, Denmark.Nieto, A., Ralph, G., Comeros-Raynal, M., and Heessen, H. (2015). European red list of marine fishes.Technical report, Luxembourg.

Keywords
Acoustic Telemetry; North Sea; Mustelus asterias; Movement Ecology; Policy Making; Species Management Plans