Observations on the ectoparasite community of an endangered elasmobranch, the flapper skate (*Dipturus intermedius*)

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Elasmobranchs are hosts to a diverse community of parasitic species, with varying degrees of parasite-host specificity. High parasite burdens can indicate physiological stress among hosts, potentially mediated through environmental pressures. Parasites are therefore increasingly used as biological indicators to monitor impacts of anthropogenic pressures such as pollutants, as well as wider environmental changes (e.g. Morley et al. 2006). Ectoparasitic species, by their nature, can often be observed and sampled non-invasively. Understanding ectoparasite diversity and infestation rates among elasmobranch hosts is therefore crucial, but baseline data are unavailable for many species.

In the present pilot study, we report on initial observations of the ectoparasite community found among a population of Flapper skate (*Dipturus intermedius*), a Critically Endangered species (Brander 1981; Dulvy et al. 2006). A total of 15 adult skates (9 males, 6 females) were sampled for ectoparasites in October 2018 during a recreational catch-and-release fishery inside the Loch Sunart to Sound of Jura (LS-SJ) Marine Protected Area off western Scotland (Scottish Government 2016). While skates were on deck (<5 minutes), ectoparasites on the skates' dorsal sides were photographed in situ and sampled (fixed in 70% ethanol) for subsequent identification in the laboratory, using a camera-equipped stereo microscope. Observations on the prevalence of leech bitemarks and dermal irritations, where present, were also recorded.

All examined skate carried one or more species of ectoparasites, with communities being dominated by large individuals of the marine leech *Pontobdella maritima* and the copepod ("sea louse") *Trebius caudatus*, an elasmobranch specialist. Observed infection rates of *T.caudatus* were notably higher among male skate (males: avg. 30.9 sea lice observed vs. females: avg. 9.6 sea lice observed; single-factor ANOVA: F=5.06897; p=0.042). No clear effects of observed ectoparasite burdens on skates' health were apparent. Given ongoing opportunities to sample flapper skate through the recreational fishery, recurring visual/photographic assessment of ectoparasite burdens is recommended as part of efforts to monitor the health status of this flapper skate population.

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Citizen-science monitoring of harbour porpoises in Shetland

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Harbour porpoises (*Phocoena phocoena*) are frequently observed around Shetland but there are significant data gaps around the fine-scale use of sites which impedes the introduction of conservation measures for this species.

Harbour porpoise occur year-round in small groups around Shetland's coast but unusually large aggregations of 500 to 100 individuals have also been observed in some locations. However, porpoise sightings are under-reported and there is little data on the seasonal variation of sightings. Research into the social dynamics of this species is limited, partly due to difficulties in observing the surface behaviour of this species.

To address these data gaps, a citizen-science project was established to identify the temporal and spatial variability of harbour porpoise presence and use of coastal areas around the Shetland Islands, and to improve understanding of the behavioural interactions occurring when large aggregations are observed.

Shore-based observations were collected in collaboration with the Shorewatch programme[1] organized by Whale & Dolphin conservation at three sites where high numbers of porpoises have previously been reported (Mousa Sound, South Nesting Bay, and Quendale Bay). Behavioural footage was collected by local drone pilots with experience of videoing cetacean species.

Shore-based observations show that higher numbers of porpoises are observed in the autumn and winter months, with smaller groups observed over a wider area during the spring and summer months. Rushing behaviour was observed from the shore at multiple locations around Shetland, but for shore-based observations viewing distance and angle was insufficient to provide detailed observations of this behaviour. Drone footage has shown that this rushing activity includes mating behaviours which have been seldomly reported on in the literature. Belly displays can be seen in footage from October 2019, with rushing behaviour preceding mating attempts observed in footage from February 2022. This is the first known drone footage of porpoise mating collected, highlighting the importance of this area for porpoise populations in the northeast Atlantic.

Data from this project will contribute to informing marine planning and marine protected area designation and management to aid in developing conservation measures for this protected species.

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Modelling salmon lice infection pressure from fish farms Expert opinion on knowledge gaps

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A strong scientific evidence base is needed to underpin the continued growth of the blue economy. Sustainability of aquaculture relies in part on ensuring assessment of environmental impact for regulation of sea lice dispersing from open pen salmon and trout farms. We reviewed international research to understand the key stages in the sea lice infection process to support modelling of lice on wild salmon in relation to those on farms. This process is split into five stages: production of larvae; transport and survival of larvae; exposure and infestation of new hosts; development and survival of the attached lice stages; and impact on host populations. The most pressing research gaps for salmon lice infection pressure from fish farms were identified and rated by international experts in sea lice-aquaculture-environment interactions at an international workshop**, hosted as part of the MAST ASM 2021**, with a focus on sea lice dispersal modelling and data requirements for management needs. The contributors included experts based in Scotland, Norway, Ireland, Iceland, Canada, the Faroe Islands, England and Australia employed by governments, industry, universities and non-government organisations. We highlight research for synergistic international collaboration. During our workshop a total of 47 research gaps were identified, 5 broad themes emerged with 13 priority research gaps highlighted as important across multiple sectors. Traditional issues of sea lice dispersal modelling included sea lice larval survival in the environment, improved validation of hydrodynamic models, and assessment of sea lice connectivity between farms. The workshop participants concluded that it is important to understand how well models represent realised larval distributions, and define host behaviour and sensitivity to infestation. This will provide an accessible and useful summary of the sea lice distribution and abundance research to date, identify the areas of research where various stakeholder interests overlap to help them locate relevant research information efficiently. This may be useful for guiding the prioritisation of resources in this field for future research in this area.

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Microbial degradation of polystyrene microplastics in seawater analysed by stable isotope tracing techniques

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Microplastics, which range from 0.001 – 5 mm in size, are an urgent and growing threat to the marine environment, with negative impacts across all trophic levels of the ecosystem. Polystyrene, which is widely used to produce disposable food containers, dining ware, and packaging foam, is one of the most dominant polymers identified amongst the millions of tonnes of plastic debris in the ocean. While some studies have demonstrated microbial degradation of polystyrene in terrestrial samples, very few have considered biodegradation by marine microorganisms. In this study, we took seawater from the northeast Atlantic and amended it with ^{12}C- or ^{13}C-labelled polystyrene microparticles (~150 µm diameter) to demonstrate biodegradation and identify the microbial taxa directly involved in its metabolism. Complementing this, we also identified breakdown products via gas chromatography with mass spectrometry and isotope ratio mass spectrometry. A time series over several months provided insight into the rate of polystyrene biodegradation. Taken together, these results can contribute to models for predicting the fate and longevity of polystyrene microplastic particles in the ocean.

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