

Population health

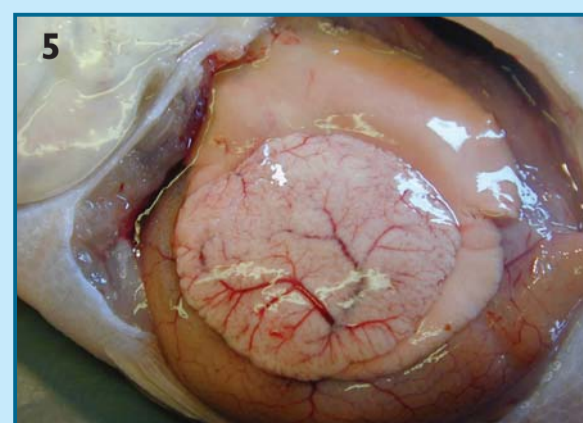
The UK National Marine Monitoring Programme (NMMP) offshore sentinel species is the flatfish dab (*Limanda limanda*). Dab are abundant, relatively easy to capture and express biomarkers of potential contaminant exposure (including liver cancer and intersex). Gross diseases and liver pathologies are recorded according to internationally agreed criteria (e.g. ICES, BEQUALM) to provide an indicator of health status at the population level. Using a multivariate statistical approach (Primer™) it is possible to discriminate specific sampling sites based upon the prevalence of gross and liver pathologies in dab from these sites. Further, we have identified specific disease profiles in dab populations found at particular NMMP sites. Using such data, site-to-site, season-to-season and year-to-year changes in health status can be monitored. Population health data can now be aligned with data for exposure biomarkers and chemistry to better understand the exposure-effect pathway in marine systems.



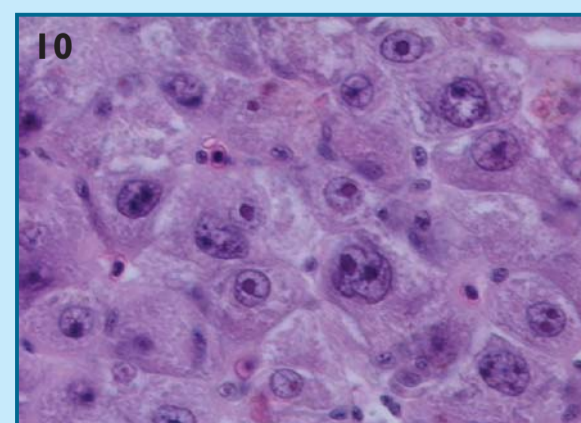
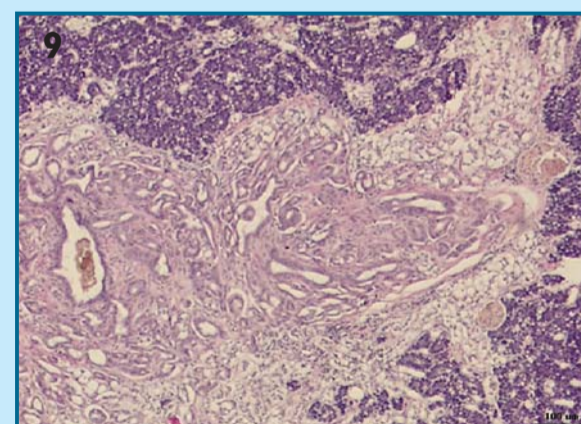
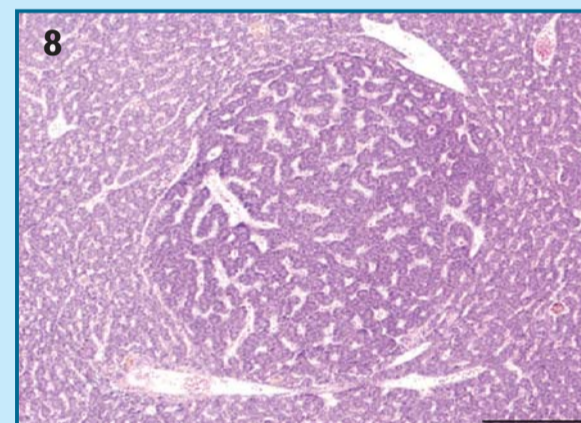
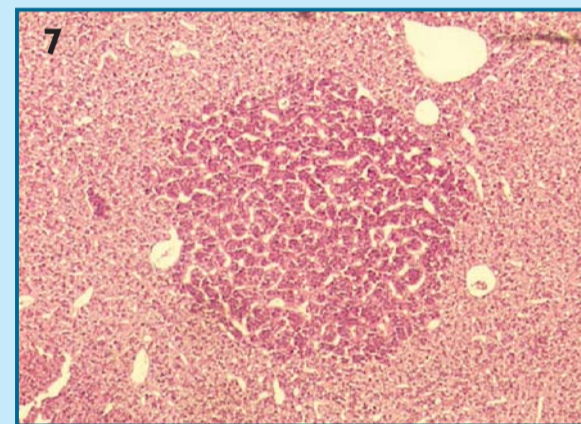
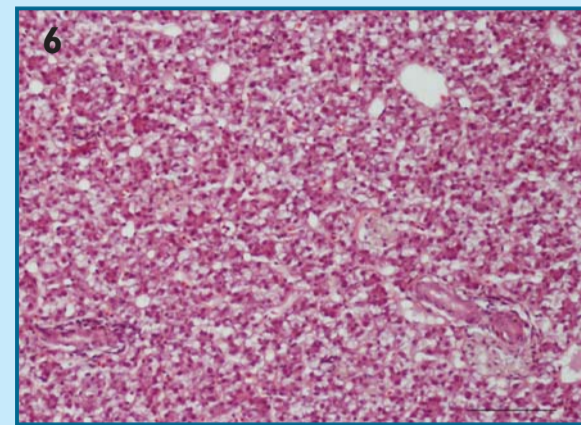
Figure 1-5: Gross Diseases categories. (1) Epidermal papilloma; (2) Lymphocystis; (3) Epidermal hyperpigmentation; (4) Ulceration; (5) Liver tumour

Figure 6-10: Liver pathology. (6) Normal liver parenchyma; (7) Focus of cellular alteration (FCA); (8) Hepatocellular adenoma; (9) Cholangiocellular carcinoma; (10) Nuclear pleomorphism in a hepatocellular carcinoma.

Gross Disease

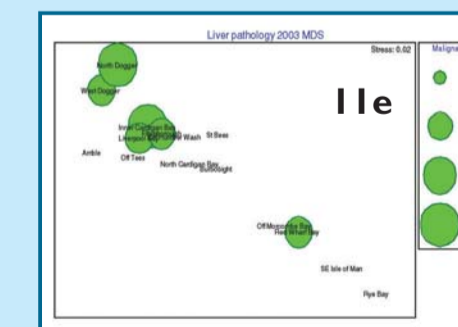
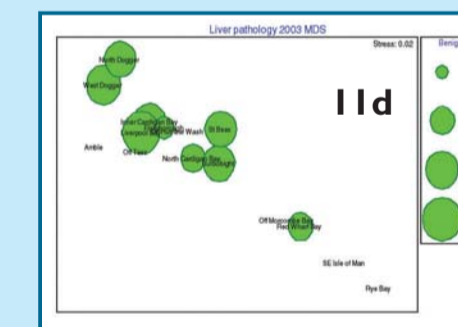
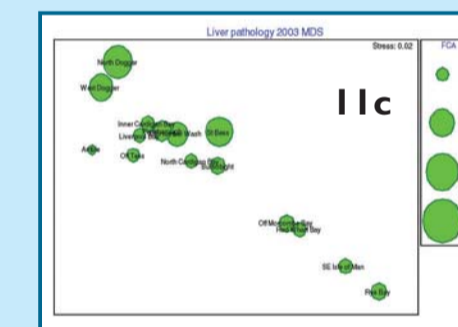
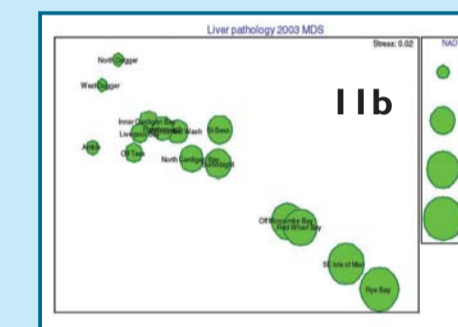
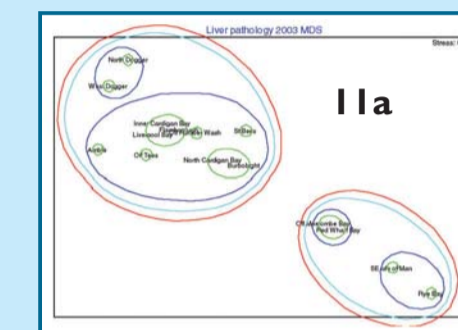


Liver pathology

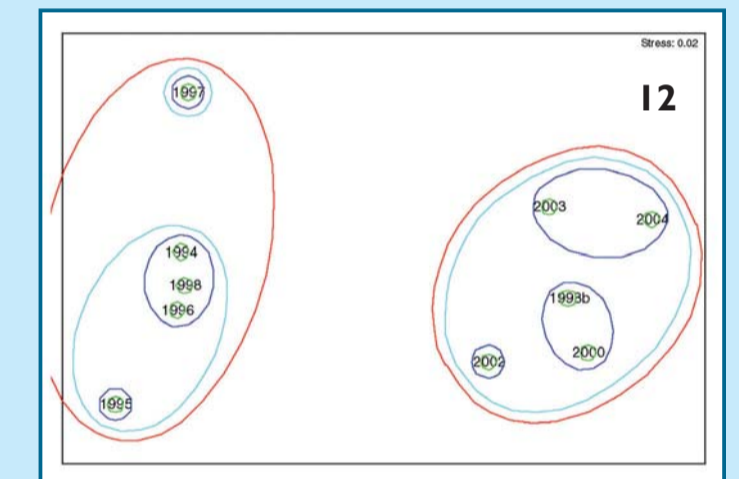


From individuals to populations

Site-to-site differences: Multi-dimensional scale (MDS) plots are generated using multivariate disease data from dab (Figure 11a). The pattern depicts the discriminatory nature of disease profiles between discrete sites. Overlaying individual lesion categories over this MDS pattern establishes the key feature differences between sites (11b-e). Using liver pathology data from the 2003 NMMP cruise, it is possible to generate a spectrum of sites based upon prevalence of fish with livers that were 'normal' (11b), or contained 'FCA' (11c), benign neoplasms (11d) or malignant neoplasms (11e).



Season-to-season differences: MDS plots generated using multivariate gross disease data from dab from a single site (Figure 12) show that sampling season is an important feature in population discrimination using disease. Sampling up to 1998a occurred during the winter while all sampling thereafter occurred during the summer. The predominate factor for this seasonally shifted pattern was a higher prevalence of skin ulceration during summer cruises.



Where next? Multivariate analysis of complex data pertaining to ecosystem health is now recognised as a necessity if aquatic systems are to be classified appropriately and if monitoring effort and intervention is to be directed efficiently. However, the inclusion of all available data (e.g. for health, biomarkers and chemistry etc) into single MDS analyses are unlikely to provide clear discriminatory patterns. We suggest that MDS plots should instead be generated using 'top-level' effect markers (e.g. tumours), with 'exposure' markers and chemistry data overlain to seek correlative relationships.

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