SCOTTISH ENVIRONMENT PROTECTION AGENCY
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E-DNA Information Paper

What is DNA analysis?

DNA is present in all living organisms, and fragments of DNA shed by living organisms (e.g., waste products, blood, scales, skin/tissue, mucus, carcasses, eggs & sperm) can be captured in the environment and used to determine the presence of specific species. This type of DNA shed in the environment is called eDNA. DNA analysis is both rapid and sensitive and can pick up everything present in an environmental sample more quickly than conventional techniques could ever hope to do.

How does it work?

DNA analysis has been used in forensics for a number of years, and is increasingly being used in environmental monitoring, although this will be one of the first uses of it in regulatory compliance assessment.

DNA is gathered from the same environmental benthic grab samples required for conventional analysis. Every living species has a unique DNA signal, and families of organisms have many of the same DNA signals. We can sequence eDNA, like in forensic analysis, to detect these DNA signals and look for the differences between commonly found family DNA signals to confirm the presence or absence of individual species without the need to physically examine them using traditional methods. The resulting output is a detailed biological profile, which provides information on what organisms are present in the environment.

How we will use it and the benefits of doing so.

We intend to use eDNA as a regulatory tool to understand the condition of the seabed and thus determine compliance with seabed environmental standards.

At present, SEPA requires operators to conduct surveys which investigate the health of the seafloor. This is currently done by analysing benthic grab samples, counting and identifying which organisms are present in the sample. Based on the relative abundance of organisms, a metric known as the infaunal quality index (IQI) can be calculated. The IQI value directly corresponds to seabed community health and can therefore be used to assess compliance.

Although the currently used methodology is effective, the process of physically analysing a sample is time consuming and requires experienced taxonomists – DNA analysis is much faster at providing consistent and comprehensive analysis. This allows large numbers of samples to be processed quickly, meaning results are made available much sooner after a survey has been conducted, improving compliance assessment timescales.

The science behind eDNA analysis has been lead by SAMS, with the University of Highlands and Islands & University of Kaiserslautern assisting. The project used artificial intelligence to determine IQI, which is then used to assess environmental compliance. The project findings showed that IQI values calculated using this DNA analysis were comparable to IQI values produced using traditional taxonomic methods.

DNA analysis will be used in parallel with traditional analysis and to begin with, the set up will mean that the DNA analysis will overestimate the footprint fish farms on the seabed, meaning it will be used as a precautionary tool. This means that farms that are close to their mixing zone boundary will likely want to use conventional techniques, while those operating well within their mixing zone may choose to use DNA to demonstrate compliance due to its relative speed.