National Aquaculture Association

Policy on Environmental DNA (eDNA)

Background

The detection of deoxyribonucleic acid in the environment (eDNA) through the use of polymerase chain reaction (PCR) techniques is being used for animal research and monitoring purposes (Barnes and Turner, 2016), and has been proposed as a tool for regulation (Collins et al. 2013; Jerde et al. 2013). An increasing number of research studies on various applications for eDNA are being published, ranging from invasive and endangered species detection, to estimating fish biomass, disease organism detection, and for food habit studies. eDNA methods are currently being used for monitoring purposes, for example, to check for Asian carps in the upper Mississippi and Chicago Area Waterway, and for detection of zebra and quagga mussels in western reservoirs. Bait shops have also been checked for Asian carps using eDNA. At least one state department of natural resources has proposed using eDNA to test aquaculture farms and hauling trucks for prohibited species.

Given harsh penalties are possible, the National Aquaculture Association is concerned about the premature use of eDNA for regulatory purposes. Three major concerns are: 1) detection of eDNA does not mean that a live organism is present; 2) false positives are to be expected, 3) detection assays should first be standardized and validated, and 4) laboratories should be accredited and laboratory performance testing should take place.

Research results have highlighted the existence of numerous possible sources of eDNA other than live aquatic animals (Merkes et al. 2014) and the necessity to implement quality assurance, quality control protocols (Goldberg et al. 2016). This means that positive eDNA results do not always mean that live organisms are present. Rates of false positives and negatives must be considered. One concern is the false positive paradox: when eDNA is used for detecting very rare organisms, even highly specific DNA-based methods can give misleading results when the detection rate is near or below the false positive rate.

The Invasive Species Advisory Committee (ISAC), a team of nonfederal experts and stakeholders who provide advice to federal agencies through the inter-agency National Invasive Species Council (NISC), published a white paper on PCR-based assays for eDNA detection of aquatic invasive species (ISAC 2012). The white paper recommendations to NISC were:

1. Encourage and develop funding for the National Academy of Sciences to undertake a review of the reliability and effectiveness of PCR and other DNA-based applications for detecting aquatic invasive species (AIS), focusing on establishment of appropriate validation processes and a framework and

standards for this new and potentially invaluable tool in the early detection, eradication, prevention and control of AIS.

2. Establish and fund an ongoing independent performance testing program for laboratories utilizing DNA-based AIS detection methodologies such as that recently undertaken for evaluating laboratory performance in PCR detection of dreissenid mussel larvae (Frischer et al. 2012). Testing results should be made public so that managers may make informed decisions about the accuracy and reliability of a laboratory's performance when including an eDNA component in an AIS monitoring and early detection system.

3. Utilize lessons learned in establishing a laboratory performance testing system to fully develop a validation/accreditation program(s) for other invasive species eDNA methodologies and laboratories.

In summary, eDNA has tremendous potential as a research tool, and with appropriate safeguards, for monitoring purposes. However, research demonstrates the potential for positive eDNA results when live organisms are not present, and unknown rates of false positives and negatives. Therefore, before eDNA is used for regulatory purposes, methods should be standardized, test assays validated, and laboratories accredited and subject to independent performance testing.

Policy

The NAA:

1. Supports the development of eDNA tools for scientific research to advance commercial aquaculture.

2. Supports the recommendations of the Invasive Species Advisory Committee to the National Invasive Species Council presented in the white paper “Validation of PCR-based assays and Laboratory Accreditation for Environmental Detection of Aquatic Invasive Species”.

3. Recommends that similar protocols (e.g., chain of custody) to those that must be followed for forensic testing of human DNA for law enforcement purposes should be required if eDNA testing is used for natural resource agency enforcement/regulatory purposes.

References

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