**Table SM.5.3.** Summary of surveillance and diagnostic technologies for invasive alien species management

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| Biosensors and nanotechnology sensors | Combine a biological component with a physicochemical detector (“bioreceptor”) to identify chemical substances and thus aid in monitoring many aspects of plant, animal and human health. Biosensors could play a significant future role in the prevention, detection and management of emergency animal disease outbreaks (Neethirajan et al., 2017), with likely comparative benefits for outbreaks of invasive alien species. Nanomaterials can improve the mechanical, electrochemical, optical and magnetic properties of biosensors, leading toward single-molecule biosensors within high-throughput biosensor arrays, one of the challenges of this technology (Mehrotra, 2016). Other challenges include the development of means by which to enhance the signal-to-noise ratio, and ways to enhance transduction and amplification of the signal.  These technologies are in their infancy for invasive alien species applications, so it is hard to understand future constraints. They may be related to policy and regulatory issues and animal ethics issues. |
| CRISPR diagnostics | Microbial CRISPR and CRISPR-associated (CRISPR-Cas) adaptive immune systems contain programmable endonucleases that can be leveraged for CRISPR-based diagnostics. CRISPR diagnostics is likely to be quickly adopted for the rapid and accurate identification of infectious diseases of plants and animals. Gootenberg et al. (2017) found that specific high-sensitivity enzymatic reporter unlocking (SHERLOCK), an in vitro nucleic acid detection platform, was also able to detect Zika virus in clinical isolates (serum, urine or saliva). Further laboratory and clinical work are required to evaluate the performance of CRISPR-based diagnostics in a range of settings – including multiplex point-of-care, which may prove to be its most powerful application. |
| Multiplexed diagnostic  real-time handheld tools | Multiplexed point-of-care testing describes the simultaneous on-site detection of different analytes from a single specimen (Dincer et al., 2017). This approach has recently gained increasing importance for clinical diagnostics, with emerging applications in resource-limited settings such as found in remote locations. Plant and animal disease diagnostics can be undertaken in real time in field settings including a capacity to test for a range of diseases at the same time. Ideally, the system should be able to analyse different types of compounds simultaneously – for example, RNAs, metabolites, proteins, exosomes and cells – and should provide accurate results in all cases. Handheld portal devices have now come in the market that can be used for aspects of this approach (e.g., MinION for portable real-time device for DNA and RNA sequencing). |
| Disease mRNA biomarkers | A biomarker is a signal released as a component of an organism’s response to a particular pathogenic agent or pathogenic process, and thus indicative of the presence of that pathogen or process. Complex biomarkers have now been identified for the sensitive detection of diseases or processes at a stage when they may otherwise have been difficult to identify. Biomarkers are naturally linked to biosensors. Biosensors use a bioreceptor to identify the biomarker, and a transducer to transmit the signal to a receiver that can then interpret and display the outcome. Biosensors based on biomarkers could be deployed alone, or in complex sensor networks. They could also be deployed on unmanned ground-based, aerial or underwater vehicles. Examples by Cowled et al. (2017) and Barkema et al. (2018) show application in animal diseases. Potentially, the approach could also be applied to the rapid detection of some key plant diseases, as miRNA responses are known to occur for viral infections (Zhou & Luo, 2013), bacterial infections (Fahlgren et al., 2007), fungal infection (Campo et al., 2013) and nematode parasitism (X. Li et al., 2012). Collectively, these advancements are likely to mean that biomarkers become increasingly prominent as tools for invasive alien species applications. |