SUMMARY REPORT OF TECHNOLOGY

Current and Near-Future Technology for a Predator Free New Zealand

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Environment & Conservation Technologies Ltd

Contents

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This report was prepared by Environment & Conservation Technologies Ltd (ECT) for Predator Free 2050 Ltd and OSPRI to provide a high-level overview of current and near-future technology that has the potential to drive detection towards 100% for Brushtail Possum, Pigs and Deer within NZ.

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About the Authors

Environment & Conservation Technologies

Environment & Conservation Technologies Ltd specialises in applied technology for the advancement of conservation and biodiversity. Based in New Zealand and Australia, ECT works closely with a diverse network of suppliers, academics, and OEM to provide practical solutions to advance the tools available for New Zealand and our international clients.

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1 Executive Summary

This Report was commissioned with the intention to identify a likely solution that will improve methods in detecting, identifying, and tracking brushtail possums at scale in NZ for PF2050 Ltd and OSPRI, and additionally pigs, and deer for OSPRI. Recognizing the experience and existing skills deployed within Predator Free 2050 Ltd and OSPRI, research for this report concentrated on the use and development of technology in the wider security and defence arena where similar detection, identification and tracking requirements exist.

While there is some application overlap of mature surveillance platforms for wildlife management, research and engagements with Original Equipment Manufacturers (OEM) of surveillance hardware has demonstrated that advanced technology tends toward application-specific target signatures – specifically metal/man-made objects and structures for radar, human sized targets for optics/thermal, and small arms or artillery fire for acoustic sensors.

The performance gap between commercial and defence surveillance platforms is generally due to military investment in optimizing current technology for military-specific targets. There are exceptions to this in the case of technologies that are actively controlled for national security reasons.

While the investment made by military applications do not immediately translate in to a tangible product for NZ, by understanding the theory of the technologies identified in this report, there are action points that could leverage the research conducted by the military to develop NZ based tools capable of bridging the current gap towards 100% detection.

1.1 Key Findings

1.1.1 Hyperspectral Cameras

The hyperspectral signatures of a possum, pig, and deer has the potential to be dramatically different from the background, which means an aerial platform need only a single pixel, or small cluster of pixels, to get a target match. This represents the highest potential daylight capable Focal Plane Array (FPA) based sensor platform currently available. Given the difficultly in aerial wildlife surveys at night, this is a critical technology for expanding survey operations to landscape scale.

Research is needed to determine the spectral signature of the target species, and what the ideal channel definitions are for the cameras. Lastly, any improvements in channel frame speed need to be implemented in a deployable product to facilitate typical aerial survey speed (10-60 knots).

1.1.2 Deep-Learning Neural-Net Assisted Population Survey

Using a deep learning system to evaluate all the relevant data streams to produce a holistic estimate of population density will facilitate integrating these new sensor platforms without requiring any operational changes to the stakeholders of the legacy systems.

High accuracy population estimating will increase the value proposition for baiting operations by directing resources to areas with more invasive species and obviate resource allocation to areas with low population.

Another potential use of this type of system is as a sophisticated central resource for all PF2050 and OSPRI related survey operations, where the AI-empowered element facilitates merging of disparate data sources into a central repository.

The next step in exploring this technology is to directly engage with the developers to establish clear input and output requirements. A specific trial area could be defined to determine initialization values to minimize training time when deployed nationally.

1.1.3 Ultra-Wideband Synthetic Aperture Radar

If an Ultra-Wideband Synthetic Aperture Radar (UWB SAR) system, of which FOPEN is a variant, was capable of identifying the resonant signature of a possum, the benefits of this system compared to other aerial surveillance platforms are:

- Operation in day or night
- Very large survey area (~10km^2)
- Identification of animals under light canopy
- Identification of partially occluded animals

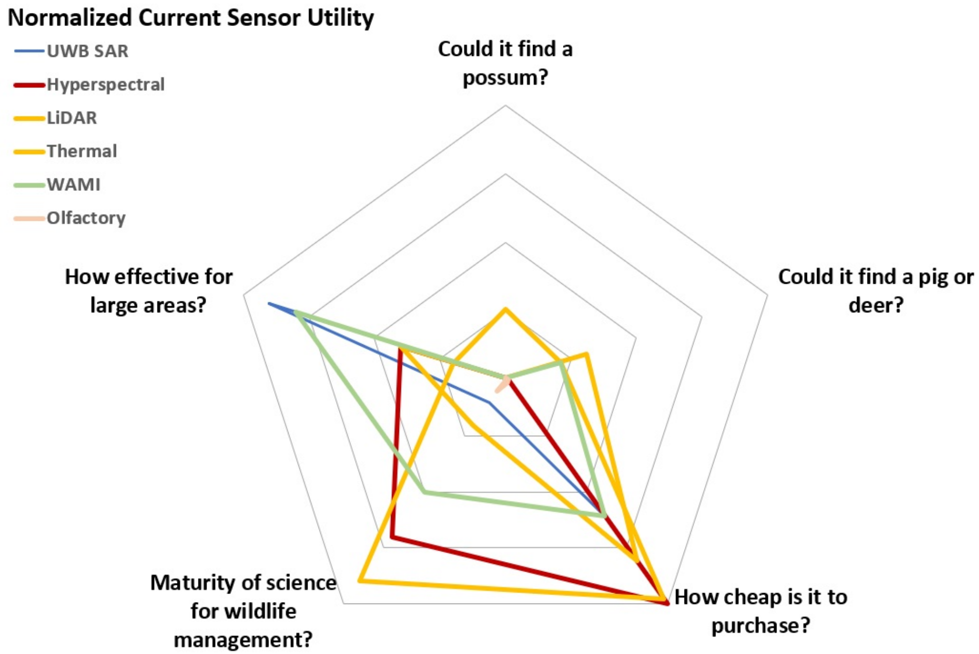
Given the reluctance of commercial Foliage Penetrating Radar (FOPEN) manufacturers to engage in a trial for PF2050 or OSPRI, the next step is to enlist an appropriate contractor to validate an experimental UWB SAR system capable of identifying a possum.

Figure 1 – Airport imaged using UWB SAR

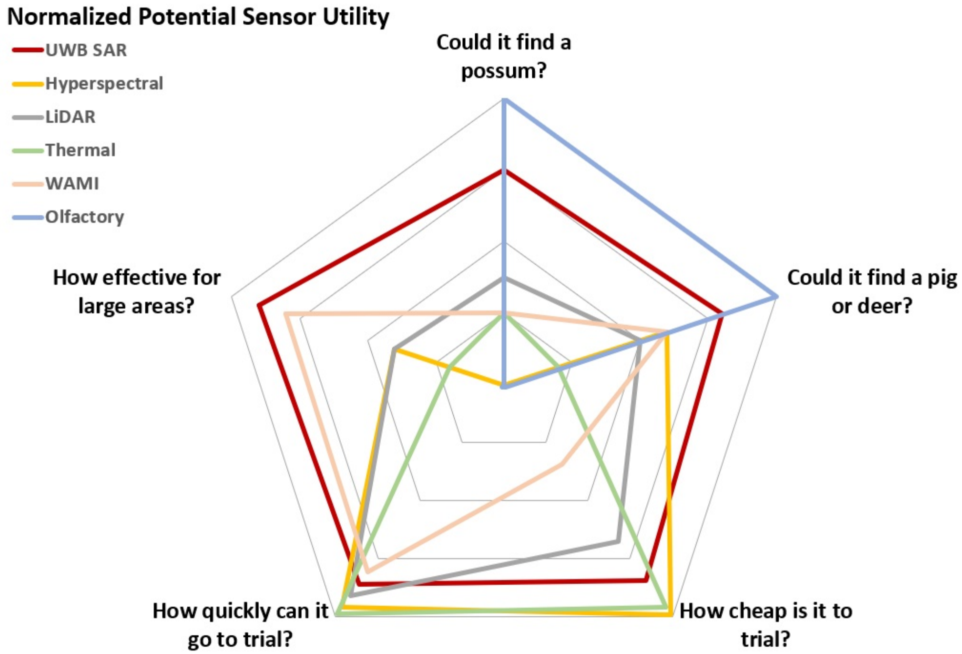
2 Conclusions

The table below summarizes criteria used to score the sensors with respect to utility for PF2050 and OSPRI.

The score reflects a qualitative analysis of each technology based on discussions with manufacturers, review of product literature and original research, and anecdotal discussions with industry partners and stakeholders.



Tech	Area, Ranked
Thermal	0.65
Hyperspectral	0.47
WAMI	0.40
LiDAR	0.24
UWB SAR	0.08
Olfactory	0.00



Tech	Area, Ranked
UWB SAR	1.64
Hyperspectral	0.92
LiDAR	0.79
Thermal	0.69
WAMI	0.71
Olfactory	0.48

Figure 2 – Current and Potential Normalized Sensor Utility

Potential Utility Criteria Data

- For Yes/No questions: 1 indicates positive/yes, 0 indicates negative/no. Fractional (0.5) indicates unknown but possible yes.
- For radar plots, the area under the polygon is a gauge of value/utility

	Criteria	UWB SAR	Hyperspectral	LiDAR	Thermal	WAMI	Olfactory
	Could it find a possum in typical habitat?	0.75	0	0.375	0.25	0.25	1
	Could it find a possum at night?	1	0	1	1	0	1
	Could it find a possum under full canopy?	0	0	0.5	0	0	1
	Could it find a possum under partial cover?	1	0	0	0	0	1
	Could it find a possum under light brush?	1	0	0	0	1	1
	Could it find a pig or deer in typical habitat?	0.8	0.6	0.5	0.2	0.6	1
	Could it find a pig or deer during the day?	1	1	1	0	1	1
	Could it find a pig or deer at night?	1	0	1	1	0	1
	Could it find a pig or deer under full canopy?	0	0	0.5	0	0	1
	Could it find a pig or deer under partial cover?	1	1	0	0	1	1
	Could it find a pig or deer under light brush?	1	1	0	0	1	1
	How cheap is it to trial?	0.84	0.99	0.68	0.96	0.34	0.01
	Estimated cost to initiate field trial (kNZD)	500	50	1000	150	2000	3000
	How quickly can it go to trial?	0.86	0.96	0.91	0.99	0.81	0.01
	Estimated earliest time before initial trial (years)	1.5	0.5	1	0.2	2	10
weight	**How effective would it be for scanning large areas?**	**0.90**	**0.40**	**0.40**	**0.20**	**0.80**	**0.00**
0.2	Could it be deployed on a small drone?	0.5	1	1	1	0	0
0.3	Could it scan > 10 km² in one pass?	1	0	0	0	1	0
0.3	Could it scan > 5 km² in one pass?	1	0	0	0	1	0
0.2	Could it scan > 2 km² in one pass?	1	1	1	0	1	0
	AREAS	1.64	0.92	0.79	0.69	0.71	0.48

2.1 Sensor Summary

2.1.1 Hyperspectral Cameras

- Hyperspectral cameras have improved dramatically in the last 5 years, to where they are very close to having high utility for aerial wildlife survey pigs, and deer.
- For ground-based usage the technology has immediate use potential.
- These cameras support matching patterns off pixel spectrum, instead of a shape

2.1.2 Deep Learning Assisted Population

- Deep learning neural-network computer systems for determining population density have potential for reducing the long-term cost of trapping and baiting operations by leveraging multiple sensor data streams.
- This technology is also fully scalable and can be modified to incorporate new inputs as new sensor technology is introduced.

2.1.3 FOPEN / UWB SAR

- FOPEN Radar is not currently being developed in a capacity that is relevant to wildlife management applications.
- There is potential for UWB SAR (of which FOPEN is a variant) to be an effective survey tool for possums, pigs, and deer, however additional research is required into the resonant response and appropriate frequency bands to resolve targets.

2.1.4 WAMI – Wide Area Motion Imagery

- Uses long range persistent aerial platforms to generate high resolution wide area images.
- There is potential for existing platforms to be tailored specifically to support PF2050 and OSPRI.
- Limitations of optical and thermal cameras apply.

2.1.5 Olfactory Sensors

- Olfactory sensors do not appear to have any market presence currently, however there is development in the field of membrane-protein biochemical sensors that could produce very effective sensors in the 10+ year timeframe.

2.1.6 Thermal Sensors

- The non-cooled thermal sensors available on the market now represent a mature technology, and significant performance increases over the existing product line are not likely.
- Cooled IR sensors have the potential to double in resolution over the next ten years and coupled with their low sensitivity and highly selective bandwidths, these sensors will improve capability with respect to aerial target identification.

2.1.7 LiDAR

- Conventional scanning LiDAR products currently on the market cannot identify possums, pigs, or deer for pattern matching/survey purposes.
- The LiDAR used by NZ Forestry would be an excellent data input for a population density neural network, regardless of utility for directly resolving target species
- Array/Flash LiDAR is a nascent technology that does have potential for directly identifying target species.

2.1.8 Acoustic

- Acoustic sensors for the surveillance and defence industry are generally optimized for locating anthropogenic sounds (gunfire), and as such do not have any direct relevance to PF2050 or OSPRI.