

Appendix 25

Mount Emerald Wind Farm – An Assessment of Utilisation Patterns of Spectacled Flying-fox.

Prepared by RPS



Mount Emerald Wind Farm

An Assessment of Utilisation Patterns of Spectacled Flying-fox on the Proposed Mount Emerald Wind Farm Site

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I.0 Introduction

I.1 Project Summary

RACL proposes to construct the Mt Emerald Wind Farm (MEWF) on elevated land located approximately 20 km SSW of the town of Mareeba on the Atherton Tablelands in north Queensland. The project site occupies a total area of 2422 ha.

The wind farm's electrical energy generation facility and infrastructure will comprise 63 wind turbines and associated tracks for underground cabling and access between the turbine arrays (**Figure 1**). An electricity substation is also proposed and will feed energy generated from the wind farm into the existing Chalumbin to Woree 275 kV transmission line. A conspicuous section of this transmission line more or less dissects the site and closely corresponds with bioregional boundaries.

The wind farm site occurs at the northern extent of the Herberton Range and includes the prominent landmark of Walsh Bluff at the most northern end. Mount Emerald (proper) is located off the site at the southern boundary. The undisturbed landform and vegetation is contiguous with Mt Emerald. Land to the north, east and west is characterised by agriculture and is generally cleared and modified.

I.2 Landscape Features

The proposed MEWF site is situated over mountainous terrain coinciding with the northern extent of the Herberton Range. The site is broadly divided in terms of the degree of surface relief. This has bearing on the landforms, vegetation types and ultimately, the constructability of the project. To the south of the Chalumbin to Woree 275 kV transmission line the land is conspicuously dissected, rugged and characterised by narrow, high ridges and in some instances, precipitous slopes. Heath vegetation and low, windswept sparse woodlands characterise this landform. This area falls into the Wet Tropics bioregion section of the site and corresponds with the highest level of biodiversity in terms of vegetation and conservation significant flora, as well as being the least disturbed. It is a contiguous tract of land with Mt Emerald on the southern boundary and holds high levels of environmental integrity.

The land to the north of the transmission line exhibits less surface relief, dissected ridges and steep slopes become far less frequent, and the landform generally becomes more undulating. Consequently, different vegetation types are hosted; where woodlands are generally taller, more widely represented on a regional basis, and conspicuously fewer conservation significant plants are present. This part of the site corresponds with the Einasleigh Uplands bioregion section of the site, and holds lower environmental values than the Wet Tropics section. From a constructability viewpoint, the Einasleigh Uplands section is least constrained and offers the most opportunities with the potential for notably reduced environmental impacts on important plant habitats and conservation significant plant species.

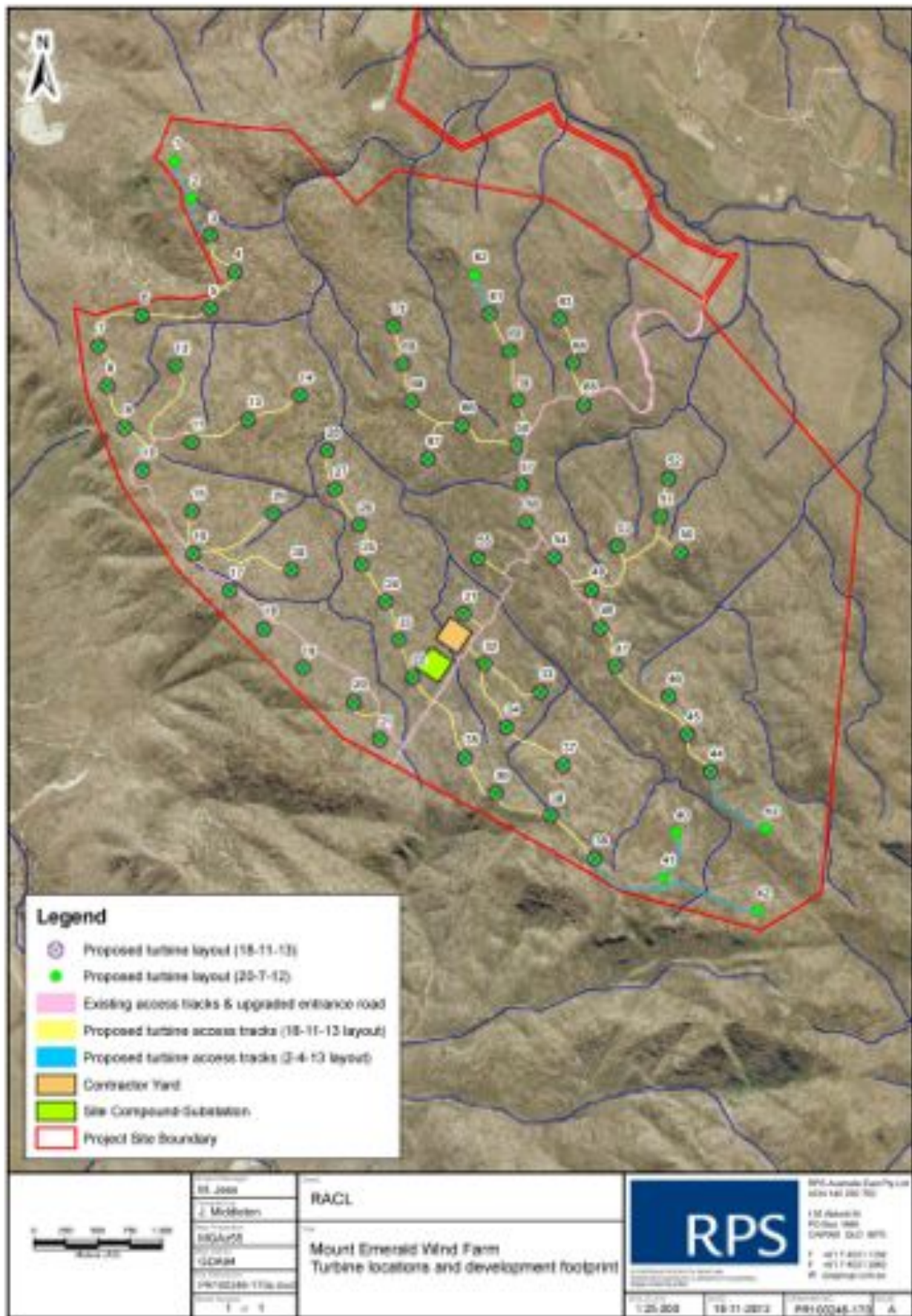


Figure 1 Turbine Locations and Development Footprint

1.3 Assessment of Utilisation Patterns

The high likelihood of the vulnerable EPBC-listed Spectacled Flying-fox (*Pteropus conspicillatus*) occurring on the proposed Mt Emerald Wind Farm (MEWF) site (RPS, 2011) is likely to have been one of the key factors in the project being assessed as a **controlled action** under the EPBC. In particular, the potential for the project to have significant impacts on values of the Wet Tropics World Heritage Area (WTWHA) are most likely related to the potential impacts on the Spectacled Flying-fox, which has been identified as contributing to the World Heritage values of the WTWHA intrinsically.

The Spectacled Flying-fox contributes to the WTWHA values by assisting the maintenance the ecological integrity of the area (ACTFR, 2001), by pollinating flowers and dispersing fruits of rainforest trees (WTMA, 2000 in ACTFR, 2001).

The DotE (formerly SEWPaC) EIS Guidelines for the proposed MEWF request a detailed assessment of the nature, extent, likelihood and consequence of the short-term and long-term impacts of collision risk and barotrauma from turbines on Matters of National Environmental Significance (MNES) fauna species (Section 5.10), including the Spectacled Flying-fox (*Pteropus conspicillatus*). Numerical collision modelling is recognised as the preferred method of assessing risk where sufficient information on the species abundance and number of at risk flights per annum is obtainable (EPHC, 2010).

Various numerical collision risk models have been previously used in wind farm assessments in Europe and North America for birds, for example the Scottish Natural Heritage Collision Risk Model (Band Model) (Band et al., 2007). In Australia, the BIOSIS model (Smales et al., 2013) has been used to model predicted wind turbine numerical collision risk for the following EPBC listed threatened and migratory species:

- Orange-bellied Parrot (Smales et al., 2005),
- Swift Parrot (Smales, 2005a),
- Tasmanian Wedge-tailed Eagle subspecies (Smales and Muir, 2005)
- White-bellied Sea (Smales, 2005b).

There have been few attempts to conduct numerical wind turbine collision risk modelling for any nocturnally active bat species, either microbat or flying-fox, anywhere in the world, due to the difficulties in obtaining the specific input data, particularly flight heights. The only numerical collision risk modelling that has been conducted (to date) anywhere in the world for any flying-fox species is for the Butoni Wind Farm in Fiji (Smales, 2005c).

Two species of flying-fox, the Pacific Flying-fox (*Pteropus tonganus*) and Samoan Flying-fox (*Pteropus samoensis*) were identified as potentially occurring in the vicinity of the wind farm (Smales, 2005c). *P. tonganus* is known to forage during both the day and night, while *P. samoensis* is totally nocturnal. A total of 86 records of *P. tonganus* were recorded during the study within or immediately adjacent to the wind farm site (Smales, 2005c). The surveys were only conducted during diurnal and dusk hours and therefore the survey results are highly likely to have underestimated the activity of the species. On the basis of a four day survey (62 ten-minute point counts made at six locations), the turbine collision risk to *P. tonganus* was determined to be low (<1.1 flights at risk per annum, assuming an avoidance rate of between 98-99%) EPHC (2010) state that the flight behaviours of fruit bats are more similar to that of crepuscular bats and nocturnal birds than other bat taxa and therefore, it may be feasible to obtain data suitable for collision risk modelling using standard point count survey methods typically used for assessing wind farm bird utilisation.

To date, only two wind farms have been constructed within the range of the Spectacled Flying-fox: Windy Hill (near Ravenshoe) and Thursday Island (in the Torres Strait). No systematic long-term mortality monitoring has been undertaken at either location (Terry Johannesen, pers. com.) and, as such, their impact on

P. conspicillatus is not currently known. DoE approval has been granted for Stage 1 of the proposed High Road Wind Farm (near Ravenshoe), in cleared agricultural land adjacent to the extensive wet and dry sclerophyll woodland and forests of the Bluff State Forest. The EPBC referral submitted for the project concluded that there was a low likelihood of *P. conspicillatus* occurring on the site due to the absence of closed rainforest roosting habitat (RPS, 2009). However, *P. conspicillatus* is now known to forage extensively in other vegetation communities such as eucalypt and *Melaleuca* forests (Curtis et al., 2012) including the wet and dry sclerophyll habitats of the Herberton Range adjacent to the proposed High Road and MEWF wind farms (D. Westcott, pers. comm.) and is also known to forage on the fruits of Wild Tobacco (*Solanum mauritianum*) (Eggert, 1994, Spencer et al., 1992), which is an abundant introduced plant occurring in disturbed habitats on the Atherton Tablelands. Several wind farms in Australia have been constructed or are proposed within the distribution range of Grey-headed Flying-fox (similar ecology to the SFF) e.g. Dundonell Wind Farm (Vic) and Capital Wind Farm (NSW). These projects have been assessed as posing low risk to this species as the habitats are not considered to be suitable and no numerical risk modelling was conducted (or required) as part of these assessments (Richards, 2005; BLA, 2010)

Wind turbine collision risk assessment for nocturnally active flying fauna in the US and Europe typically utilises marine radar to obtain accurate data on abundance, flight tracks and flight heights. The only successful use of radar in the southern hemisphere for wind farm bird assessments was conducted at Taharoa Wind Farm in New Zealand (Fuller et al., 2009). The cost of the commercially available systems, capable of tracking small to large-sized targets in three dimensions (e.g. Detect Inc. bird and bat radar system), is in the order of at least \$1million for purchase and/or \$374,000 for a one-year lease (**Attachment A – Detect quote**).

Thermal imaging video and image enhancing night vision devices (binoculars, goggles and scopes) have been previously used in ecological studies of nocturnally active flying-foxes and microbats. Examples of thermal imaging video cameras and/or night-vision devices previously used in survey are;

- to count microbats emerging from cave roosts (Sabot & Hudson, 1995; Betke et al., 2008);
- counting roosting Mariana Fruit Bat (*Pteropus marianus marianus*) from vantage points (USGS, 2010);
- to determine the 3D flight trajectory of microbats (Theriault et al., 2010; Hristov et al., 2008);
- nocturnal bird migration (Fortin et al., 1999; Zehender et al., 2001; Ahlen 2003, Desholm, 2003; Desholm et al., 2006, Gauthreaux and Livingston 2006);
- to assess flight patterns and mortality of microbats around operating wind turbines (Desohlm et al., 2003; Horn et al., 2008).

Although thermal imaging and night-vision devices are still relatively expensive (~\$40K for high resolution and capture rate thermal imaging video, \$2-4 K for night vision device), they are significantly cheaper than commercially available bird and bat radar systems. Both methods are mentioned in the Australian *Draft National Wind Farm Development Guidelines* as being suitable for monitoring bat movements (EPHC, 2010).

It is difficult to determine the height or altitude at which bats fly because of their nocturnal behaviour (Parsons et al., 2008). The only study that provides indirect data on the flight heights of Australian flying foxes was conducted by Parsons et al. (2008), who conducted an analysis of the altitudes of aircraft bat strikes from Australia in the period 1996-2006 using data obtained from the Australian Transport Safety Bureau. Parsons et al. (2008) suggested that the majority of the collisions identified as bats are likely to be flying-foxes (>500g) as smaller microbats are not likely to cause damage to aircraft. Parsons et al. (2008) found the majority of collisions with flying-foxes occurred at approximately 150 m above the ground with only a few collisions occurring at higher elevations up to 1500 m (Parsons et al., 2008). Interpretation of this data should consider the small sample size of 75 bat collisions and that Australian aircraft spend only a very small proportion of their total flight time at low elevations (<300 m).

Some studies have attempted to estimate flight height of migrating birds by using the relationship between the silhouette sizes of the targets images captured with light-enhancing night vision goggles or thermal imaging devices and the flight altitude (Fortin *et al.*, 1999; Leichti *et al.*, 1995).

To make an informed assessment of the impacts of collision risk from turbines on Spectacled Flying-fox habitat utilisation surveys were necessary. As identified above a variety of methods have been trialled on bats internationally but few have provided the necessary information.

The aims of the study were:

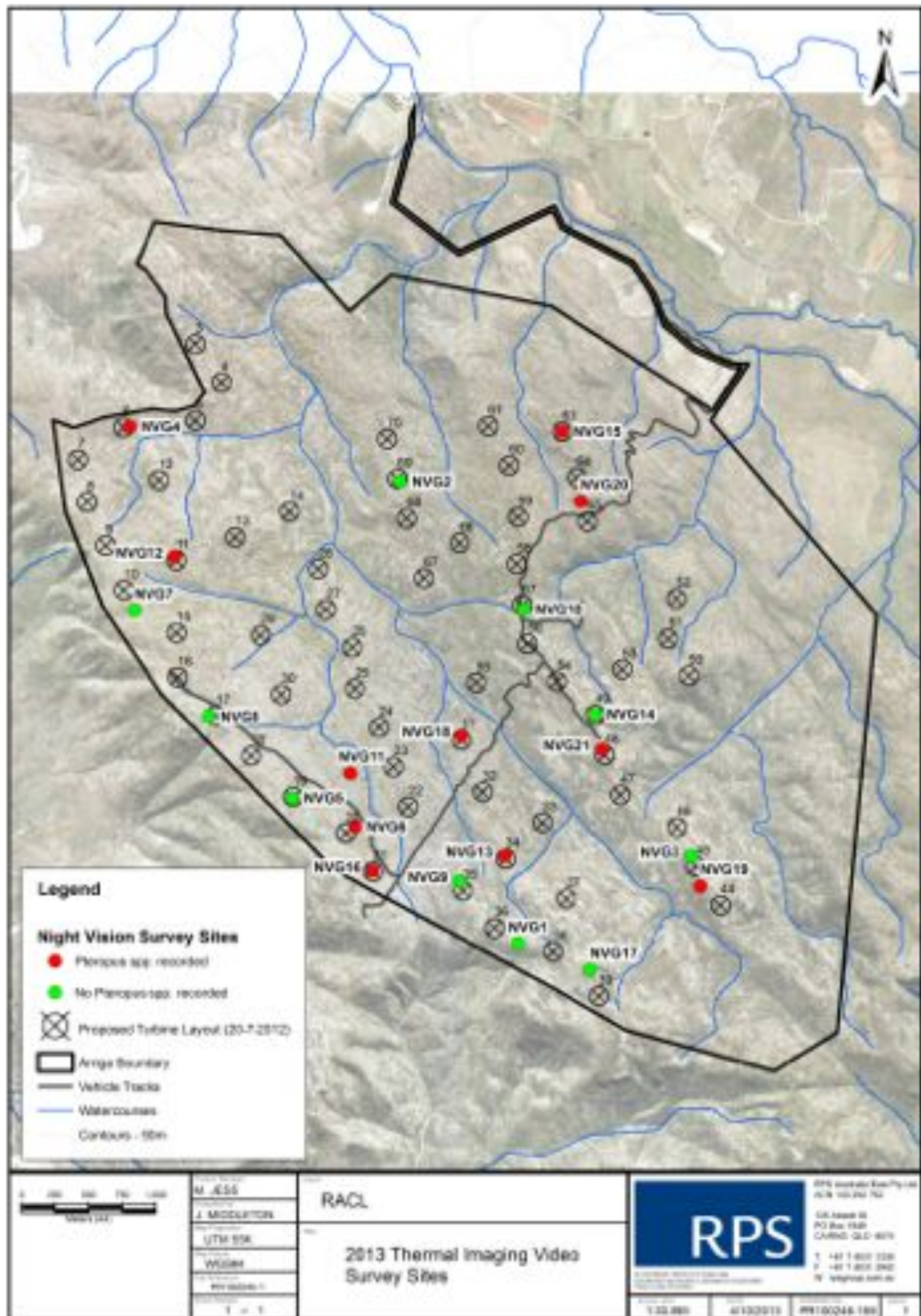
- To confirm the presence of *Pteropus conspicillatus* on the site;
- To examine spatial and temporal utilisation patterns of the species; and
- To collect data suitable for inclusion in a collision risk model such as abundance and flight height.

2.0 Methodology

All opportunistic observations of *Pteropus spp.* on the site during the course of all field work were recorded and relevant information noted (e.g. actively foraging, flying over-head, flight height etc).

2.1 Night Vision Goggle Surveys

A total of 21 survey locations (**Figure 2**) were identified across the site to sample as much of the variation in ridge habitats across the site as was possible given limitations associated with access and safety (i.e. locations were limited to areas within one hours walk of the nearest vehicle access and within mobile phone coverage range). Survey locations were selected to provide unobstructed 360 degree views (where possible) and were located predominately along rocky ridges with low shrubs and few trees. At each site, visual observations were conducted continuously between approximately 30 minutes after sunset to 30 minutes before sunrise by two observers alternating over three hour shifts to minimise fatigue. Each observer was equipped with a pair of NVA 7 HP dual-eyepiece, single lens, helmet mounted night vision goggles with 1 x magnification and a 40° field of view, and a 100W hand-held spotlight fitted with an infra-red filter(to assist with species identification). The survey dates are shown in **Table 1**. Using the methodology of Biosis (2013), once a target was observed, the estimated distance from observers and height of target at first sight was recorded. Where possible, targets were identified to species or if this was not possible into the broader taxonomic groups e.g. waterbird, small to medium sized bird, microbat, etc. Surveys were conducted during periods of high ambient moonlight to aid detection. Surveys were conducted during periods without sustained rain or drizzle to ensure high levels of detectability. All sites, except for NVG 20, were sampled on only one occasion (**Table 1**). A total of 11 observers were used to conduct the surveys. It is accepted that observer biases associated with varying levels of experience was an unquantifiable variable during the surveys.



2.2 Thermal Imaging Video Surveys

The thermal imaging video system consisted of:

- a FLIR A615 thermal camera (640 x 480 pixel resolution @ 50 HZ; 25° horizontal x 19° vertical field of view; spatial resolution = 0.68 mrad) in a weatherproof housing set up on a tripod with the video facing directly vertical and with the top of the lens oriented towards north;
- an Adlink Matrix Industrial PC and two Buffalo 4TB USB 3.0 external hard drives housed in a IP67 rated Pelican 1600 case; and
- an external 12v 20A power supply consisting of 4 x 80 Ah seal gel-cell lead-acid batteries, weighing a total of approximately 60 kg.

Figure 3 shows the three sites where thermal imaging survey were conducted. Sampling was conducted for one continuous evening (from approximately sunset to 0800 hrs) at each of the sites between 12 and 15 February 2013. The footage was saved as 13 one-hour segments (FLIR sequence files) of approximately 66GB of memory each. Analysis of the recorded footage was conducted in the FLIR Research IR Version 3.4.13039.1003 software (FLIR, 2011). A plot of maximum pixel temperature versus time was examined to enable more time-efficient identification of flying fauna. Warm-blooded flying targets were typically visible on the plot as peaks, particularly during periods of no cloud cover when the contrast between the warm targets and the cold sky was most pronounced (**Plate 1**).

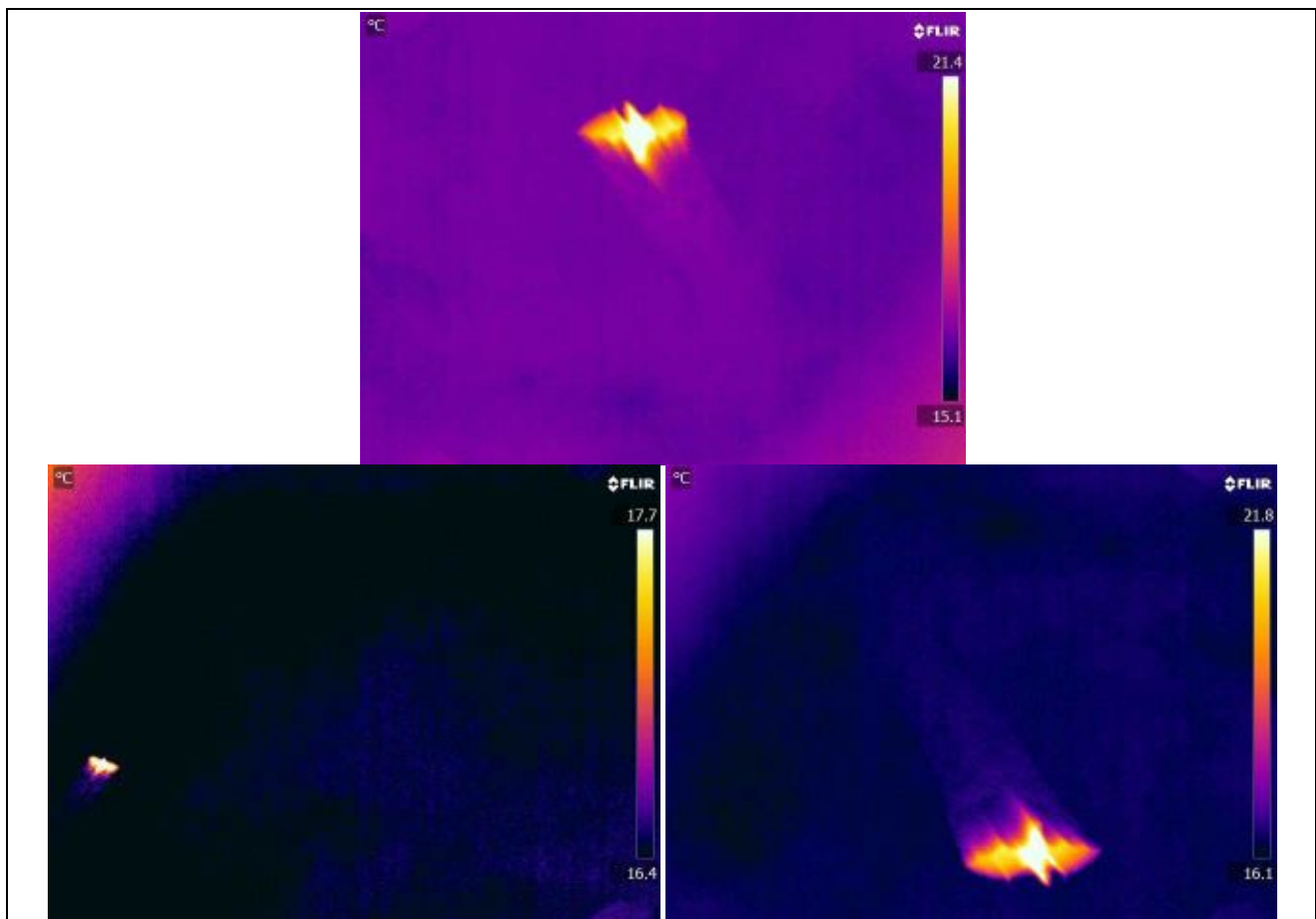


Plate 1 Potential Pteropus spp. FLIR Images

For each flying fauna target identified on the video footage, the following data was recorded:

- Time first visible (hh:mm:ss.000 format),

- Time last visible,
- Flight direction relative to screen (e.g. top middle to bottom right),
- Faunal group identification categorized according to a set of qualitative criteria as a bat, insect, bird, aircraft, or unknown (unidentifiable) object.

Identification criteria included object size, object morphology, estimations of inertia and velocity, evaluation of flight manoeuvres and behaviours and wing-beat frequency. In an effort to reduce false positive identification and observer biases, a highly conservative approach was used when classifying objects, categorizing many objects as “unknown”. The apparent size of the flying targets (with respect to the number of pixels) as viewed with the FLIR Research IR software was highly dependent upon the temperature scale that was selected for the optimal identification of targets. The size of the object decreased as the upper bound of the temperature scale was increased. All analyses were conducted by the same scientist to avoid classification biases.

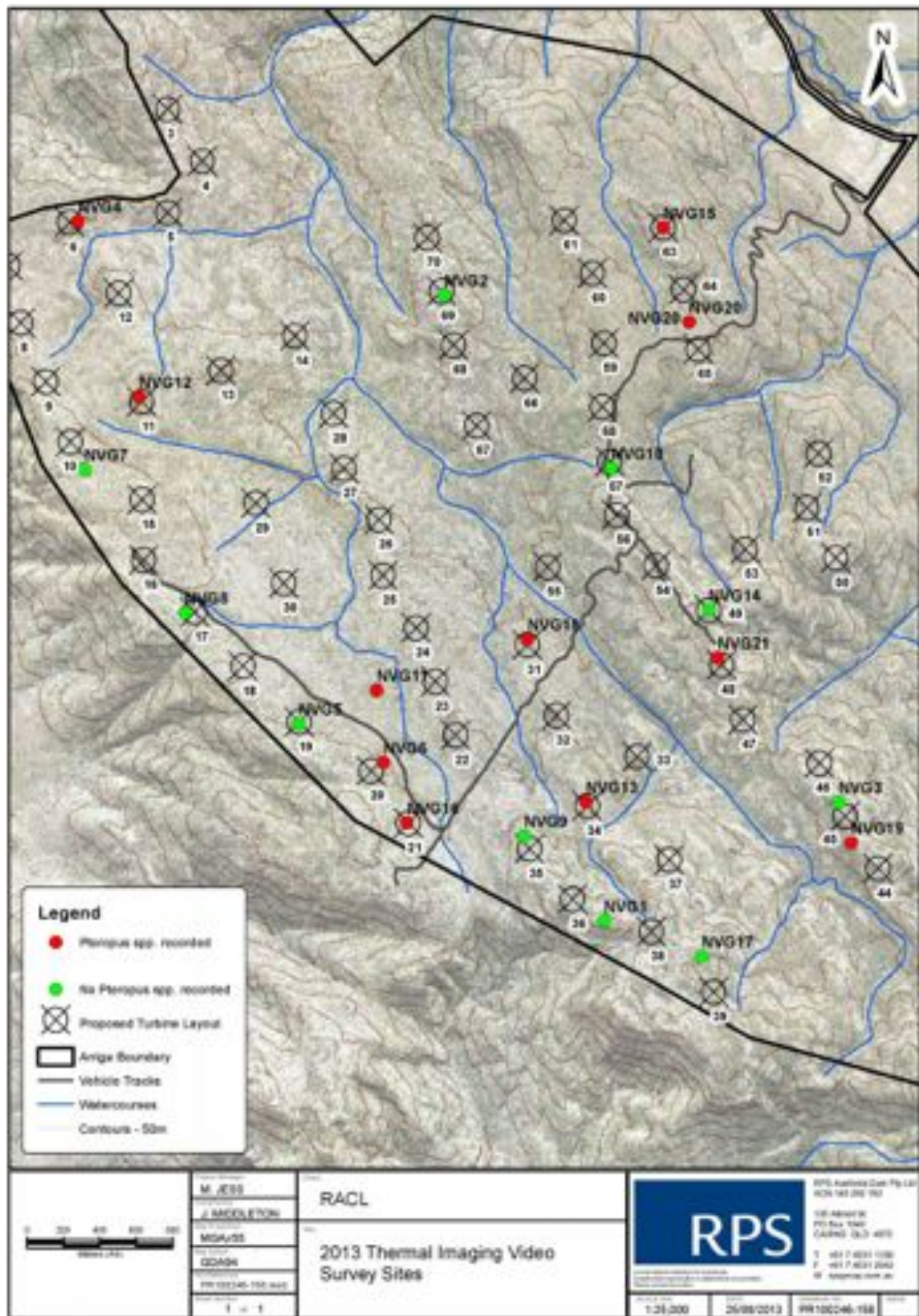


Figure 3 Location of Thermal Imaging Video Survey Sites

3.0 Results

3.1 MEWF Incidental Flying-fox Observations

Two species of flying-foxes were confirmed to occur within the MEWF site. On the 19/3/13 at 2322 hrs, a single Spectacled Flying-fox individual was observed foraging in a flowering *Melaleuca viridiflora* tree ~3m above the ground with a hand-held LED spotlight at c. 326469E 8100237N (UTM WGS 84 55K). The animal flew off when disturbed and flew to a height of ~30-50 m above the ground heading south.

A single freshly dead Little Red Flying-fox (*Pteropus scapulatus*) male was located at c. 328543E 8100734N along the power line access track at 19/12/12 at 0718 hrs. The animal showed no signs of predation (e.g. puncture, tear or bite wounds) and may have collided with the high tension power lines (40m) directly above the animal.

3.2 MEWF Night Vision Surveys

Preliminary observations of flying-foxes alighting from the canopy at the Tolga Scrub roost using the night-vision goggles in October 2012 demonstrated that animals were able to be observed at distances of up to ~150 m under full-moon light conditions with no cloud cover. However, it was not possible to distinguish between *P. conspicillatus* from *P. scapulatus* with any confidence and both species were confirmed to be present during daylight hours.

These observations presented adequate information to continue with night vision goggles as an assessment tool to determine presence/absence of flying foxes on the proposed MEWF, and to attempt to provide estimates of horizontal and vertical distances during surveys.

Pteropus spp. individuals were recorded at 12 of the 21 survey sites (**Figure 2**). A total of 67 individual *Pteropus* spp. were recorded during the surveys, of which only two individuals could be confidently identified as *P. conspicillatus* (**Table 1**). Both of the two positively identified *P. conspicillatus* individuals were observed from very close range (as confirmed by second observer without night vision goggles) and were illuminated with a 30W infrared spotlight so that the distinctive pale eye rings and patches on the head and shoulders were visible with the night vision goggles.

Table 1 Summary of Night Vision Goggle (NVG) Survey Data

Date	Site	Easting	Northing	Number of Individuals Recorded							Total
				<i>Grus</i> spp.	Microbat	<i>Pteropus</i> sp.	Spectacled Flying Fox	Duck	Unidentified Bird	Unknown target	
2/10/2012	NVG1	328467	8098753	0	0	0	0	0	0	0	0
2/10/2012	NVG2	327591	8102189	0	0	0	0	0	0	0	0
2/10/2012	NVG3	329754	8099405	0	0	0	2	0	0	0	2
2/10/2012	NVG4	325581	8102596	0	10	2	0	0	0	1	13
29/10/2012	NVG5	326789	8099837	10	0	0	0	0	0	0	10
29/10/2012	NVG6	327258	8099624	0	0	3	0	0	0	0	3
29/10/2012	NVG7	325617	8101231	0	3	0	0	0	0	0	3
30/10/2012	NVG10	328506	8101239	0	0	0	0	0	0	0	0
30/10/2012	NVG11	327218	8100019	0	1	11	0	0	0	0	12
30/10/2012	NVG8	326167	8100444	0	0	0	0	0	2	0	2
30/10/2012	NVG9	328029	8099220	0	13	0	0	0	0	0	13
26/11/2012	NVG12	325916	8101631	0	2	1	0	0	0	0	3
26/11/2012	NVG13	328367	8099407	0	1	4	0	2	0	0	7
26/11/2012	NVG14	329040	8100460	1	0	0	0	0	0	0	1
26/11/2012	NVG15	328792	8102560	0	0	2	0	0	0	0	2
27/11/2012	NVG16	327386	8099294	0	1	4	0	0	1	0	6
27/11/2012	NVG17	329002	8098559	0	0	0	0	0	0	0	0
27/11/2012	NVG18	328046	8100298	0	0	5	0	0	0	0	5
27/11/2012	NVG19	329823	8099182	0	2	4	0	0	0	0	6
26/02/2013	NVG20	328934	8102042	0	13	20	0	0	0	2	35
27/02/2013	NVG21	329091	8100198	0	7	8	0	0	0	0	15
28/05/2013	NVG20	328934	8102042	0	2	1	0	0	0	0	3

The abundance of *Pteropus* spp. individuals increased from dusk onwards, peaking between 2000 -2200 hr and then declined gradually towards dawn (**Figure 4**).

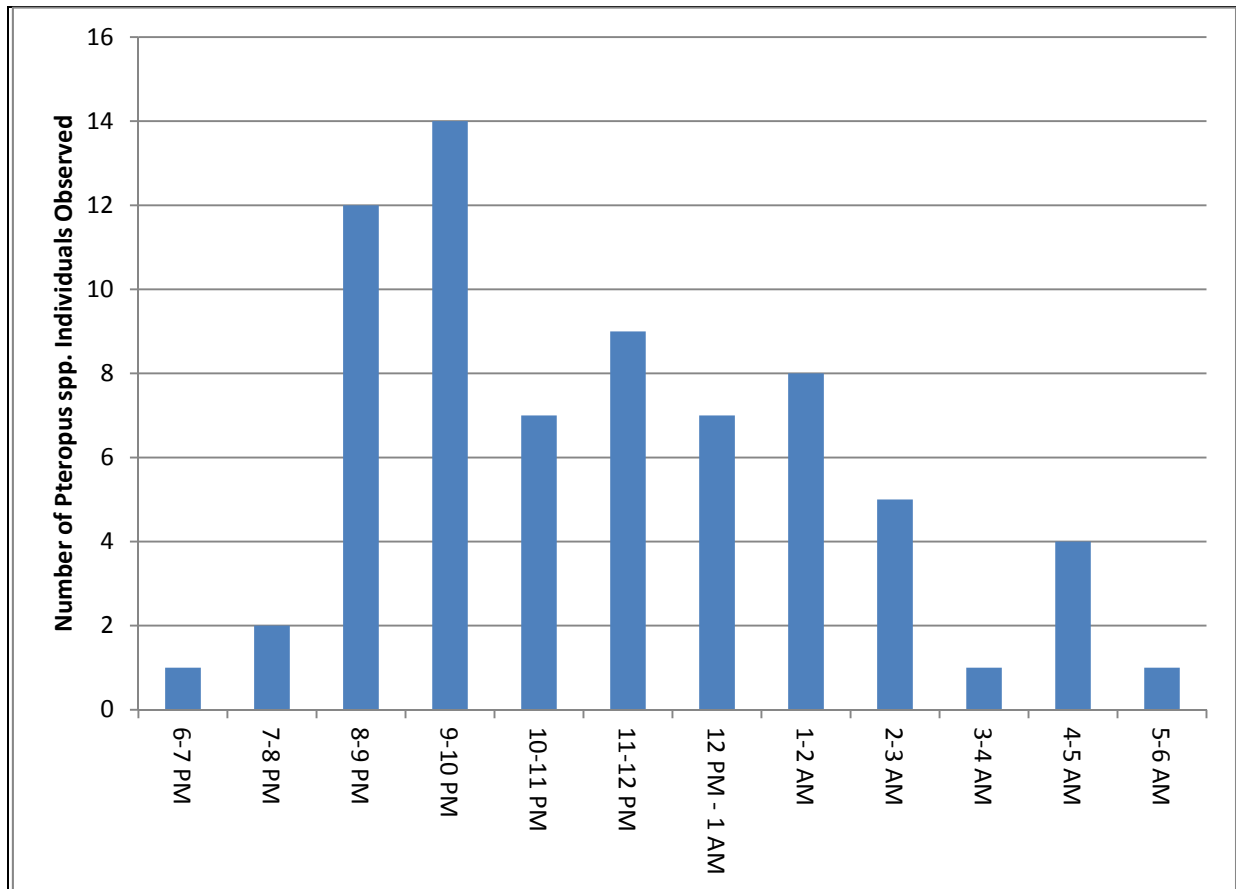


Figure 4 *Pteropus* spp. Abundances Observed during Hourly Time Periods for all Night Vision Surveys Combined

3.3 Thermal Imaging Video Surveys

A total of 111 targets were classified as potentially being *Pteropus* spp. at each of the three sites during the February 2013 surveys (**Table 2**).

A comparison of NVG results to those of Thermal Imaging at the same date, time and location support this method with the same level of classification applied to NVG targets at same data point.

Table 2 Number of Targets Provisionally Classified as *Pteropus* spp.

Site Name	Survey Night Date	Total No. Potential <i>Pteropus</i> spp. Identified
FLIR 1	12/02/13	42
FLIR 2	13/02/13	23
FLIR 3	14/02/13	46

Examples screen shots of targets that were considered to represent *Pteropus* spp. are shown in **Plate 2**.

4.0 Discussion

4.1 Spatial and Temporal Utilisation Patterns

Pteropus spp were identified across the MEWF site at more than half of the survey locations between October 2012 and May 2013. Individuals were observed in both the Wet Tropics Bioregion and the Einasleigh Uplands Bioregions of the site. More specifically, Spectacled Flying-foxes were confirmed to occur on the site on two separate occasions (late dry season and late wet season) during the entire period of our ecological surveys on the site between 2010 and 2013.

Our attempts to examine the species spatial and temporal utilisation patterns on the site using thermal imaging video and night vision goggles were unsuccessful due predominately to the difficulties in reliably obtaining positive species identifications with either of these devices.

Significant effort was placed in the development and conduct of the methodologies with the understanding this was a novel approach, untested in Australia, on a species that has been understudied due to the challenges in obtaining sufficient ecological data. This was recognised as a risk, however every effort was undertaken to provide information to the DoE on the species, and these methods were selected for trial as they were the only affordable method with any potential to obtain the required data. At the time of developing the survey methodologies, commercially available bat and avian radar systems, which were assessed as having the best potential to gather the required data, were deemed not cost effective (in the order of \$1million) and research suggested that cheaper, marine radar systems would not be suitable.

The tested methods proved suitable for collection of presence/absence data on site; however detailed abundance and flight height data proved difficult and were ultimately also not cost effective. The ruggedness of the survey site meant that observers could only travel to a tower location before dusk carrying all equipment on foot (thermal imaging totalled 100kg). Due to the site relief (greater than 15°- 30° over 83% of the site) and the hazardous groundlayer it was not possible to conduct surveys in multiple locations on each night. This limited replication and increased the number of field staff required to assist.

There are several sources of potential variation associated with the night-vision goggle survey data including environmental conditions and observer bias.

- The night vision goggles that were used had a limited field of view of ~40° compared to between 124°- 208° for the human eye, therefore only a small proportion of the total potential detection volume around each observer (~0.005 km³) could be sampled at any one time.
- The need to scan continuously for long-periods was physically and mentally demanding for the observers and it is likely that detectability was not constant during the 3 hour shifts, particularly in the early morning due to observer fatigue.

The night vision goggles surveys were restricted to periods of high lunar illumination to facilitate the detection and identification of *P. conspicillatus*. The influence of moon phase on the activity of any *P. conspicillatus* or other Australian *Pteropus* spp. is not currently understood. Many studies have shown a pronounced *luna phobia* effect in bats. For example, a meta-analysis conducted by Saldaña-Vázquez & Munguía-Rosas (2012), found that the relationship between moonlight intensity and bat activity is negative and significant. Latitude was also found to be positively correlated with *luna phobia* in bats (Saldaña-Vázquez & Munguía-Rosas, 2012). Many species of New World phyllostomatid bats have been shown to exhibit reduced activity during periods of high lunar lamination (Morrison, 1975; Crespo *et al.*, 1972; Gannon & Willig, 1997). Feeding activity of a megachiropteran fruit bat, the Greater Short-nosed Fruit Bat (*Cynopterus sphinx*) on *Calophyllum inophyllum* fruit and leaves of two other plant species was shown to be negatively correlated with the percentage of moonlight each night (Elandgovan & Marimuthu, 2006). This *luna phobia* effect may

be due to increased risk of predation by visually oriented predators (Morrison, 1978) such as owls, as lunar illumination has not been shown to be correlated with resource abundance and distribution or bat social activity (Morrison, 1978). If the Australian *Pteropus* spp. exhibit *luna phobia*, then the abundances recorded during the night vision goggle surveys, which were only conducted during periods of high ambient moonlight to aid detection, may not be representative of “optimum” flying-fox activity across the site, i.e. the counts would be underestimated due to the potential *lunar phobia* phenomenon.

Weather conditions also varied significantly across the site during the surveys, with survey locations above 900 m on the south eastern section of the site often covered in dense low cloud for large periods of the night.

4.2 Effectiveness of NVG and Thermal Imaging Video to Collected Data Suitable for Numerical Collision Risk Modelling Data

Numerical turbine collision risk modelling requires information on the number of individuals that might interact with turbines and the estimated number of their flights that are at risk of collision (EPHC, 2010).

Neither of the methods used in this trial study was determined to be suitable for collecting utilisation data suitable for numerical risk modelling because of

- (a) the inability to accurately identify species (as discussed previously) and
- (b) the inability to accurately estimate flight heights of individuals.

These technologies together with a radar system would provide a more holistic approach to data collection.

The night vision goggles that were used did not permit binocular vision to estimate horizontal and vertical distances. All of the *Pteropus* spp. individuals recorded during the night vision goggle surveys were considered likely to have been flying within or below the rotor sweep area (hub height 90 m, blade length 55 m - 35 m to 145 m above the ground) as it was not possible to discriminate flying-foxes at distances greater than ~150 m with the night-vision goggles. Therefore, even assuming sufficient spatial and temporal replication could be obtained, the estimate of the turbine collision risk obtained from the data is likely to overestimate the risk.

The potential for using thermal imaging to estimate the flight height of any *Pteropus* spp. appears to be limited due to the high degree of subjectivity regarding the positive identification of targets and the influence of the temperature scale selected to view the image on the FLIR Research IR software on the apparent size of the target. It is theoretically possible to estimate the flight height of a target of known size by counting the number of pixels its image occupies on the monitor. It was not possible to keep the temperature scale constant while effectively detecting all targets of interest as the relative brightness of the target against the sky background varied depending upon the presence and amount of cloud cover. There is a significant difference in the average wing span of the species of flying-fox which have been confirmed to occur on the site (*Pteropus conspicillatus* ~ 20-40% greater than *P. scapulatus*), which may be a significant source of error in estimating flight heights based on size of the target on the image (number of pixels).

4.3 Recommended Further Research

It is apparent that radar is the only proven methodology (currently available) to collect accurate data on the flight heights of nocturnally flying animals such as flying-foxes. Avian and bat radar systems are the primary method used in the US and Europe to quantify utilisation and assess the environmental risk of wind energy developments on nocturnally flying fauna (birds and bats) (Davenport, 2010, d' Entremont, 2010; Johnson, 2010 and Svedlow, 2011). These radar systems can provide data on the number of targets passing through the radar beam in a set amount of time, the distance to the target from the radar (either elevation or range depending on whether the radar is used in a horizontal or vertical orientation) and trajectory or flight path

(Duberstein *et al.*, 2012). However, radar systems used on their own may not be sufficient to enable effective differentiation between insects and fauna of interest (birds and bats) (Addy Borst, Robin Radar, pers. comm.). The simultaneous use of both radar and thermal imaging devices have been used successfully to differentiate nocturnal insects, birds and bats, with radar providing accurate distance measurements and thermal imaging assisting with target differentiation (Gauthreaux & Livingston, 2006).

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Attachment A

DeTect Inc. – Quote for MERLIN ARS System – Avian Survey Configuration



environmental systems & services

DeTect ARS-SCADA System Proposal for Ratchaburri Wind Farm

engineering solutions for monitoring the environment





MERLIN Avian Radar System for Bird Activity Monitoring and Mortality Risk Mitigation at Ratchaburri's proposed wind farms in North Queensland - Australia

Introduction

DeTect is pleased to provide this proposal to RPS for provision of a MERLIN Avian Radar System for use at Ratchaburri's proposed wind farms in North Queensland, Australia. The goal is to reduce bird and bat mortality risk from possible collision with the windfarms' planned turbines, using DeTect's MERLIN SCADA avian risk mitigation technology. MERLIN SCADA represents the most advanced active bird mortality risk reduction/mitigation technology available today and is the only system deployed for operational uses for migratory and soaring bird applications.

For proper implementation, the project at the windfarm site will be divided into three phases. The first phase will involve installation of a MERLIN Avian Radar System (ARS) at an area covering the windfarms for the purpose of carrying out an extended avian survey (up to 12+ months may be required) aimed at collecting detailed information regarding the activity levels, behavior and movement patterns of the birds, and at assessing the mortality risk presented by the windfarms to birds. During this phase we will also define the number of radars needed to provide full operational coverage of the windfarms. The survey data is required for the mitigation project design and the data from the survey will be used to define and develop the initial Risk Rules and operational scenarios which can be used to implement automatic Merlin SCADA control of the wind turbines in the second Phase, so as to minimize bird mortality risk.



Figure 1: MERLIN Avian Radar System at Smola Wind Park, Norway (Owner: Statoil)



MERLIN SCADA is a unique technology which utilizes the MERLIN ARS as an 'early warning system' to automatically detect birds approaching the wind farm, determine if they are at risk of collision with the turbines, and automatically activate mitigation responses ranging from issuing operator warnings to automated turbine idling (curtailment), or activation of humane deterrent systems such as LRAD or the laser deterrent unit (LDU). The MERLIN SCADA system is customized for each specific wind farm application via the software GUI interface, with response scenarios programmed based each site's specific issues and requirements. MERLIN SCADA is applicable to mortality risk mitigation for a wide range of scenarios and conditions that include migratory birds, raptors and bats (see attached paper).

Typically, the MERLIN system radars sensors are positioned at points within and/or around the wind farm (see figure 2 below) to meet the operational detection and response requirements. The MERLIN system is connected to the windfarm Supervisory Control and Data Acquisition (SCADA) system via a MODBUS or similar interface to support two-way communication between the MERLIN system, the wind turbines and remote windfarm control centers. The typical operational scenario provides continuous, unattended advance detection of bird movements approaching the wind farm (at ranges out to 4 nautical miles or nm), real-time analysis of bird level, bird altitude, visibility, weather and other variables, mortality risk assessment, and initiation of response actions (automatic, or human-actuated after an alert to operators by the system), and MERLIN includes the capability to automatically restart the turbines after the risk conditions have abated. Ideally, the MERLIN ARS is used for pre-construction survey prior to the wind farm going operational and to support development and testing of the initial MERLIN SCADA risk rule sets used for mortality risk assessment and mitigation measure activation.

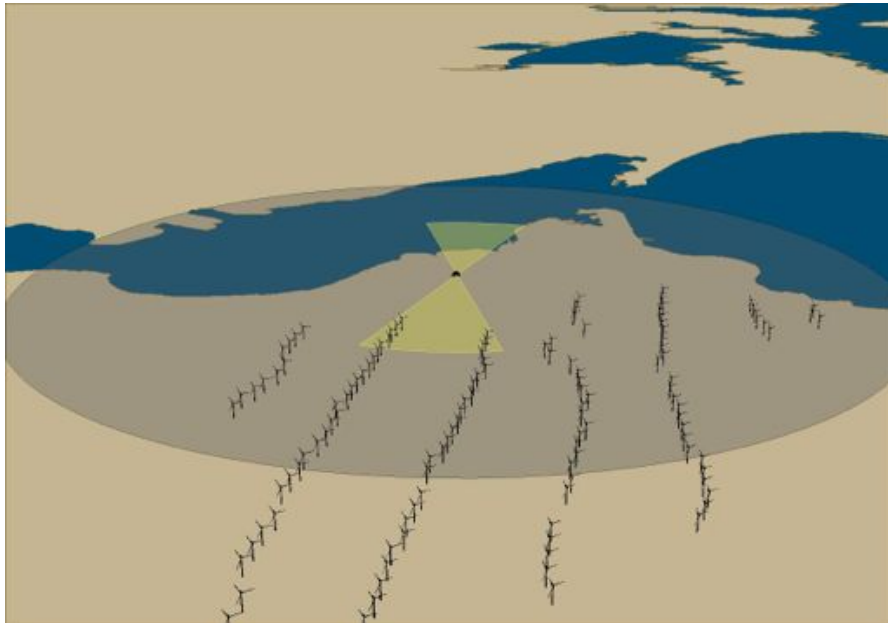


Figure 2: Illustration of MERLIN SCADA deployment at a wind farm providing continuous monitoring of migratory bird movements approaching the windfarm, with horizontal and vertical radar coverage indicated (not to scale).

Wind Farm Bird Mortality Risk Mitigation proposed Scope of Work
for Ratchaburri's Windfarms

1. **Understanding of the Project:** RPS has been engaged by Ratchaburri to conduct an assessment of several of their proposed wind farms in North Queensland, Australia. No preconstruction radar data is known to be available. In order for the bird radar system to provide optimal detection and risk management, the proposed system will include solid-state radars with Doppler processing. The most pressing bird and bat issues are:
 - Sarus Cranes (may fly over site in winter)
 - Wetland birds (may fly over site occasionally)
 - Resident raptors
 - Seasonally foraging flying-foxes
 - Resident microbats (including the critically endangered Bare-rumped Sheath-tail Bat, *Saccolaimus saccolaimus*)



2. Three-Phase Implementation of the MERLIN ARS and MERLIN SCADA, as follows:

- a. **Phase One - Survey:** Deliver and install one or two MERLIN XS25200me Avian Radar System (ARS), together with a laser ceilometer and a meteorological visibility sensor, and commence avian survey work (to begin 4-6 months ARO), with the objective of carrying out up to 12 months of 24-7 bird activity data collection and to develop a comprehensive understanding of the windfarm's specific mitigation requirements, and to develop initial Risk Rule Sets for implementation of MERLIN SCADA. One system will provide only partial coverage of the wind farm, so the client should consider buying two systems to cover the entire WRA. , The avian, cloud height & sky cover and visibility data collected will allow rigorous assessment of how best to utilize MERLIN SCADA to minimize bird mortality risk.

Phase One will also develop detailed radar coverage data for analysis of the windfarm in order to determine the final number of radars needed and placement to satisfy Phase Three operational radar coverage requirements.

Specific objectives during this initial survey phase include:

- Define bird flight patterns and area activity levels,
- Identify precursor risk patterns,
- Quantify avian mortality risk
- Define required response times and appropriate mitigation strategy,
- Determine the operational MERLIN system placement and the eventual number of horizontal and vertical radars required to achieve full coverage of the windfarm,

Note: This assessment requires a minimum of 3 months of on-site data collection *during periods of highest risk* with confirmatory visual observations. Furthermore, up to 12 months of data collection are typically are needed in order to optimize our understanding of bird behaviors and to fully develop the Risk Rules needed for MERLIN SCADA bird mortality risk mitigation. This proposal assumes that a full 12 month radar survey will be carried out.

- b. **Phase Two – Initial SCADA Implementation:** in this phase DeTect will install and test the initial SCADA system configuration over a period of 6-12 months, using the Risk Rules developed in Phase One. This process will provide intensive operational evaluation in order to optimize the mitigation risk rules and responses for optimal avian mortality risk mitigation.
- c. **Phase Three - ARS Coverage Expansion,** using additional Vertical and/or Horizontal Surveillance Radars (VSR's and HSR's) as needed to provide full windfarm coverage and to implement SCADA control of all turbines using optimized Risk Rules. Full SCADA implementation is expected to be completed within 3-6 months after installation of the additional MERLIN radars. DeTect will provide the client with a report projecting the numbers and types of radars needed for this purpose, at the end of Phase One.



3. Radar Survey Description

The proposed system is widely used for this purpose and is optimal for general avian monitoring for the above referenced project. The general objective of an avian survey of this nature is to develop data on bird activity levels and patterns for the study area. The design of the survey and specific scope of analysis of the radar data collected to be supported by DeTect will be determined through direct discussion with the Client, however the scope will generally be in accordance with DeTect's standard methodology for such surveys and will include the following:

- a. Quantifying diurnal and nocturnal bird activity in the area of the survey area to include height distribution, passage rates and composition (target size classes)
- b. Assess flight pattern of birds across the proposed area to include flight paths, flight altitudes, flight directions, flight speeds, and conditions (visibility data to be provided by the Client).

The client's biologists and researchers will be operating the system and DeTect will coordinate with the Client to define the study plan prior to delivery and start-up of the radar, to include defining the specific data analysis and data outputs desired. DeTect will also train the Client's staff on system operation and support.

3.1 MERLIN Avian Radar System Characteristics

MERLIN represents the state-of-the-art and is the most advanced and proven system available, with over 60 systems operating worldwide in aviation safety and bird control, however the technology does have limitations in that radar is a line of sight instrument and the current system implementation is not species specific. The MERLIN technology was originally developed and is currently used by the US Air Force and NASA for aircraft-bird strike risk management and includes advanced, military-grade signal processing software. Please refer to the figure below, illustrating a typical ABAR configuration.

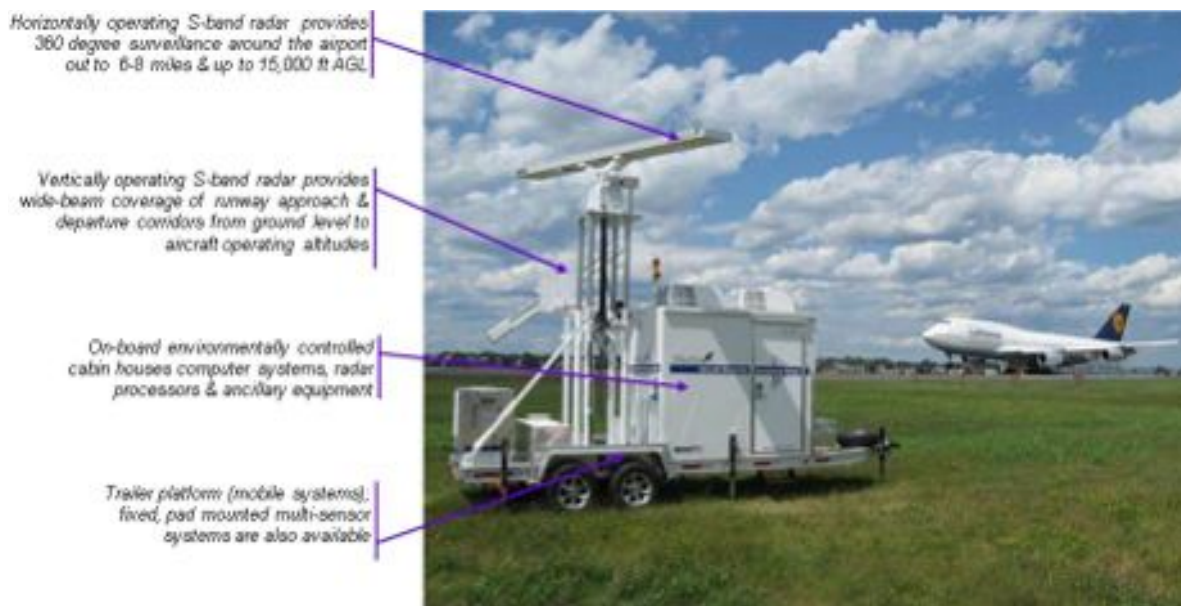


Figure 2: Typical Mobile ABAR Configuration

All radar systems are however susceptible to interference from structures, vegetation, high sea state, and other radars that may limit detection in certain areas and/or environments. The system will require installation in a representative location with a relatively clear line-of-sight of the area of interest and DeTect will assist the client in siting analysis and desktop clutter and coverage modeling as part of its scope of delivery under this proposal.

Data from the X-band (3 cm wavelength, ~22 degree beam angle width in the vertical) vertical scanning radar (VSR) will not generally be available during periods of precipitation. The solid-state S-band (10 cm, ~24 degree beam angle from the horizontal) horizontal surveillance radar (HSR) generally will function in up to moderate precipitation.

The system classifies targets into size classes generally corresponding to small, medium, large and flock size birds, but cannot definitively distinguish species. As such, DeTect recommends that periodic field groundtruthing of the radar system data be conducted by qualified biologists as part of any survey, using the system for data validation and to develop data subsets on species predominant at the survey site (using the MERLIN groundtruth recording feature).

For avian surveys, the recommended range of operation for the vertical scanning radar (VSR) is 0.75-1.0 nautical miles (nm), maximum range is 1.5 nm; and for the horizontal surveillance radar (HSR) recommended range is 1-2 nm (maximum range 3-4 nm).

Table 1: MERLIN Operating Ranges by Application

Radar Type	General Survey	Windfarm Survey	Comments
VSR (X-Band)	1.0 -1.5 nm (1.85 – 2.8 km)	0.75-1.0 nm (1.4 – 1.85 km)	Determined by survey needs.
HSR (S-Band)	3 – 4 nm (5.6 – 7.4 km)	1-2 nm (1.85 – 3.70 km)	Determined by survey needs.

The actual siting for the MERLIN ARS will be defined in a pre-delivery survey, either utilizing the customer's GIS data sets, or a formal site visit.

DeTect will provide standard and custom data analysis to support the Client's monitoring activities. The standard analysis queries included with the system are shown in Table 2 below:

Table 2: Standard Survey Project Queries Included with System.

Query	Description	Classification	Format
1	Total number of bird targets AGL under Good visibility conditions	By size as S, M, L or F	Data table and graphically
2	Total number of bird targets AGL under Low visibility conditions	By size as S, M, L or F	Data table and graphically
3	Total number of bird targets per kilometer (km) of front by hour of the day	By size as S, M, L or F	Data table
4	Total number of bird targets per km of front by hour of the day, normalized to all project days	By size as S, M, L or F	Data table
5	Total number of bird targets per km of front by period - day, night or transition (dusk/dawn)		Data table and graphically
6	Total number of bird targets per km of front by period - day, night or transition (dusk/dawn)	By low or high visibility	Data table and graphically
7	Mean altitude/standard deviation of bird targets by period - day, night or transition (dusk/dawn)		Data table and graphically
8	Number of periods with passage rates exceeding the risk threshold by visibility		Tabular
9	Target count below, within and above the Rotor Swept Zones		Data table and graphically
10	Directional histograms by count by period - day, night or transition (dusk/dawn)		Graphically



3. MERLIN XS25200me Avian Radar System (ARS) Deliverables

The initial ARS delivered to satisfy Phases 1 and 2 will be trailer-mounted dual radar system consisting of one Vertically Scanning Radar (VSR) and one Horizontally Scanning Radar (HSR). The ARS deliverables will include:

3.1 One (1) MERLIN XS25200me Avian Radar System (minimum), to include:

- a. Fully self-contained, CE certified trailer mounted system functional at delivery, including Doppler processing, Visibility Sensor, and Laser Ceilometer.
- b. Country-of-delivery compliant marine-grade aluminum trailer system and equipment platform.
- c. Commercial power plug in and 100 ft cable (110/220 vAC, 60/30 amp service required) with on-board diesel 6 kilowatt (kW) power generator system with extended run fuel tank (supports about 10 24-hour days of operation; oil and filter change required every 250 hours), Uninterruptible Power Supply (UPS) back-ups, and automatic commercial/generator power transfer switch that will start the generator should commercial power fail.

Note: Dual, auto-switch generator systems with high capacity fuel tanks are available as an option for extended runtimes (500 hours) between service.

- d. Dual radar sensor system:
 - i. 200 watt horizontally-operating solid state S-band radar with Doppler processing with 7° tilt-up and ~24 degree beamwidth, mounted on an extendable radar tower.
 - ii. 25kW vertically-operating magnetron X-band with tower and slide-out separator (~22 degree beam width angle).
- e. Environmentally-controlled on-board operator/equipment SIP cabin (~8 x 6 x 6 ft, l x w x h) with window and coded (keypunch) door lockset.
- f. On-board vibration dampered, rack-mounted data processing computer system and network (MS Windows operating system, English version is standard, foreign language versions available at extra cost). Delivery includes radar interface and processor computers for each radar, a network switch, MERLIN WAAS enabled GPS/Compass geo-referenced datum system, and ancillary components.
- g. MERLIN radar operating and processing software to include one (1) full MERLIN system license for MERLIN Administrator, Processor, Display, Remote (remote control and display software), MerlinChart™ and TrackPlot™, and one (1) remote, limited-use system license for MERLIN Administrator, Processor, Display, MerlinChart™ and TrackPlot™ for offsite data analysis.

The MERLIN data processing package Includes raw radar stream recorder for both the HSR and VSR, which allows recording of high resolution, unprocessed (raw) radar datastream for detailed offsite analysis and QA/QC.



- h. MERLIN/SQL data system for archiving and reporting of processed bird track data at the site.
- i. Cellular WWAN uplink system (connectivity service provided by client).
- j. Local wireless network (50-100 ft range) and wireless notebook display computer for recording biologist groundtruth visual data direct to the MERLIN system database.
- k. Ancillary support equipment including a weather station (Davis Weather Wizard), spare tire, wheel chocks, lightning protection, tie-downs and ground anchors, tools and equipment storage box, safety equipment (first aid and Halotron™ fire extinguishers), and safety signage.
- l. All-white, powder coat paint scheme on key components with standard system markings.
- m. Pre-delivery scoping site visit and meeting to occur within 45 days of receipt of order.
- n. Two (2) reproducible digital copies of User Operations & Maintenance (O&M) Manuals (user and technical; one to be installed on main system).
- o. Delivery: CIF, to be shipped to nearest major seaport in client's country. Client pays in-country Inland freight charges, as well as any import duties and related taxes and fees.
- p. System installation support, start-up, initial groundtruthing and user training.
- q. Daily remote QA system check and remote diagnostics with MERLIN FileWatcher
- r. Quarterly site visits by DeTect radar ornithologist/biologist for the first calendar year after start-up to coincide with expected peak activity periods for each season; 3 days per visit to include system inspection and radar groundtruthing
- s. One (1) year data processing and analysis support to include daily monitoring of the system with daily remote system checks and data file downloads via the internet (requires satellite or cellular connectivity).

Report and data products to include tabular, graphical and plot output products to meet the study objectives for bird passage rates, altitudes, flow patterns and quantitative assessment of mortality risk

(Out year data processing is available on a fee contract basis)
- t. One (1) year 24-7 telephone and internet technical support
- u. Attendance at MERLIN Certification/User Training classes held 2-3 per year in Panama City, Florida, USA (space availability is based on first-booked basis)
- v. One year full parts and labor warranty
- w. Three (3) years MERLIN software upgrades



Additional information:

- The system requires installation on a firm, level surface (pavement or gravel pad recommended) and will be anchored with lightning protection installed by at installation.
- The system is designed for unattended, environmental use however in the event of high winds (> 50 mph) may require additional securing and/or temporary removal from the site.



4. MERLIN ARS Coverage Plan

The actual siting for the Phase One MERLIN ARS will be defined in a pre-delivery survey, either utilizing the customer's GIS data sets, or a formal site visit. A preliminary and hypothetical best-estimate of the radar requirements for full coverage of the proposed windfarms (to be determined after completion of Phases 1 and 2), is shown in Figure 4a below, and assumes a MERLIN SCADA layout based on at least 2 MERLIN XS25200me trailer-mounted systems, each consisting of 1 HSR and 1 VSR. As part of Phases 1 and 2, DeTect will conduct a detailed requirements review, based on data analysis, field work and GIS analysis. This information, as well as the 12 month avian survey data, will allow us to characterize and understand bird flight patterns and general use of the environment, and recommend a suitable final operational radar network solution. DeTect has provided a base quotation for additional VSR radars, if needed, to be able to provide total coverage and SCADA implementation.

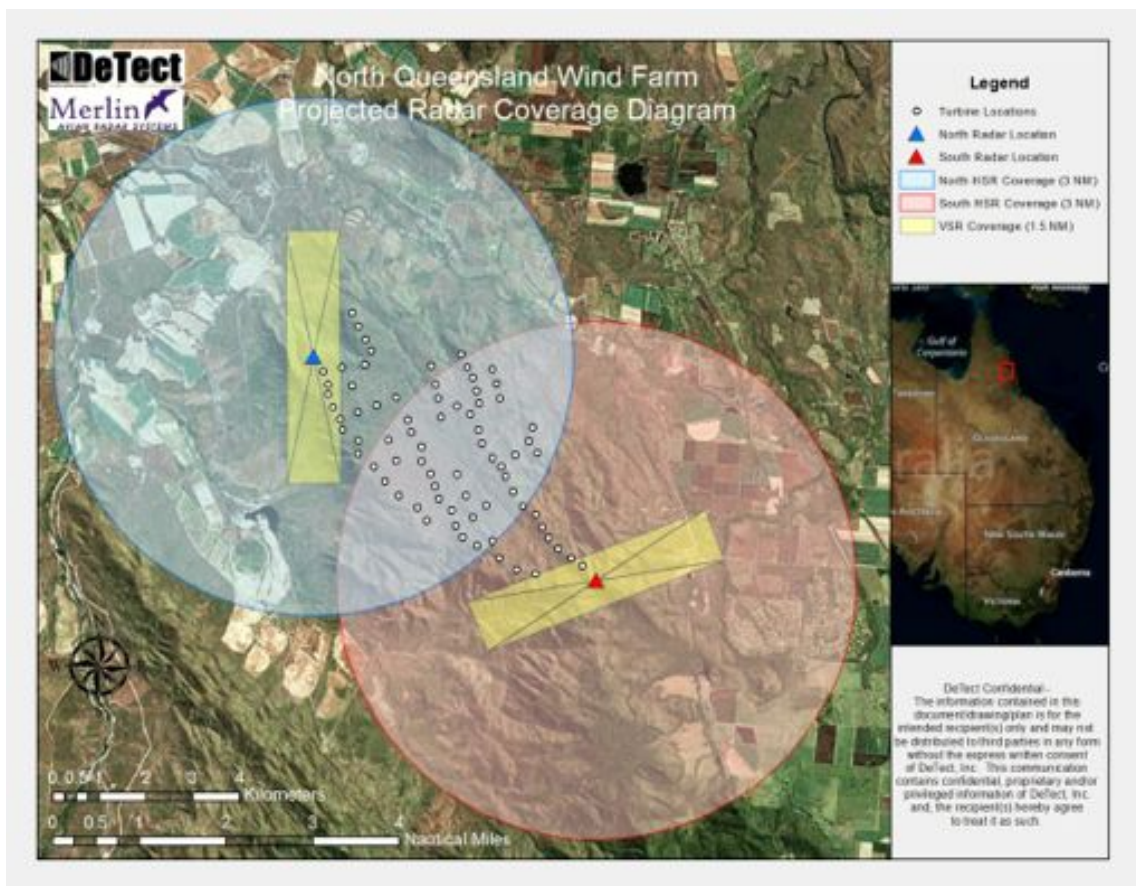


Figure 4a: Conceptual Initial MERLIN ARS Deployment Plan for full coverage of Ratchaburri's Proposed Windfarms (Not to Scale)



5. MERLIN SCADA

The MERLIN SCADA sub-system is an advanced ARS application designed to continuously analyze bird density, altitude, visibility, weather and other key relevant risk factors and automatically idle wind turbines and/or activate bird deterrent devices so as to reduce mortality risk to birds. (Note: up to 12 months of MERLIN avian survey data are typically needed to define the Risk Thresholds used to define the SCADA risk rules for each site). General performance characteristics for the MERLIN system are as follows:

- a. MERLIN horizontal scanning radars (HSR) provide 360° degree horizontal (x-y) detection of approaching bird movements out to 2-3 miles and up to 10,000 feet within line-of-sight.
- b. The vertically scanning radars (VSR) provide vertical detection (y-z) of bird activity out to 1-2 miles within line of sight.
- c. Based on programmed Risk Thresholds, the MERLIN SCADA software will continually analyze the defined risk factors and environmental conditions, initiating full or partial turbine idling and/or deterrent device activation until the risk abates (passes).

6. Terms, Conditions & Qualifiers

- a. All pricing is in U.S. Dollars and the client assumes all foreign exchange risk.
- b. Payment Terms:
 - 30% of contract with order and executed contract
 - 15% payment due 30 days after contract
 - 15% payment due 60 days after contract
 - 15% payment due 90 days after contract
 - 15% payment due prior to shipment
 - Balance in equal payments to be invoiced monthly with 5% due at start-up and the final 5% due within 60 days after startup
- c. Payments are to be made within twenty (20) days of invoice date. Failure to make payments in accordance with the terms and schedule may result in extension of delivery.
- d. The price proposed is exclusive any and all applicable sales taxes, fees, licenses, duties (import or other), operating permits and other costs resulting from the sale, delivery, transfer, installation, and operation of the system and the buyer will be responsible for obtaining and costs related to such items. DeTect will provide available information for applications, permits and licenses as required by the buyer.
- e. Title to the equipment will be transferred to the buyer upon receipt of all payments due from the buyer to DeTect under this proposal and any subsequent contract.
- f. Delivery quoted is CIF nearest major port (customer to arrange customs clearance, transport to project and installation sites).
- g. Start-up to occur upon delivery, and system set-up.



- h. Proposal is valid for 90 days from the date of issue.
- i. Radar is a line of sight instrument and will not detect targets obstructed by structures, terrain, etc.
- j. Specifications are subject to change without notice. Systems will be delivered in general accordance with specifications and design currently in effect at time of order.
- k. DeTect provides a one (1) year full parts and labor warranty that includes repair or replacement of any defective parts for the term of the warranty, exclusive of wear parts. Wear parts are parts which degrade under normal use and include, but are not limited to, motor brushes, tires, and other such components, or parts that fails due to deterioration from adverse environments or chemical exposure. Extended warranty coverage is available at additional cost.
- l. Purchase and delivery the system may be subject to the United States International Traffic in Arms Regulations (ITARs). Non-US government buyers at purchase will be required to execute an agreement acknowledging that: (i) DeTect's MERLIN system (defined as technology, hardware and software) may be governed by the United States ITARs; (ii) the system will be used solely for the intended commercial purpose and will be used in strict compliance with ITARs; (iii) he will implement procedures for restricting access to said system and agrees not to sell, rent, lease or in any manner transfer the system or any component to any country or individual to which such access or transfer is restricted; (iv) will not to export or transfer the equipment outside of the U.S. except as permitted by ITARs and with the express written approval of the DeTect; and, (v) any other use of the system may require advance approval under ITARs, agree to advise DeTect prior to any transfer or such use, and will not proceed with such transfer or use without receipt of approval by both DeTect and any required U.S. Government Agencies. The buyer will be granted a single site user license to use the MERLIN™ and HARRIER™ operating software for the intended purpose only. DeTect will deliver a complete set of the operating software executables with the system and periodically will issue updates and patches to the software. Any other such unauthorized use of the software or transfer of or installation of the software to other systems or computers or transfer to other users, companies or individuals is expressly prohibited. Noncompliance with the license requirements will result in revocation of the user license upon notification of which the buyer will immediately and promptly remove, delete, and destroy all copies of said software, providing written certification of compliance of such removal, deletion, and destruction.
- m. Acceptance of the order by DeTect is contingent on execution of a contract or order in a form acceptable to DeTect. All specifications and delivery schedules are subject to change based on current models offered at the time of the order.

6. MERLIN ARS Software Suite

The MERLIN ARS applications software delivered with the ARS consists of the following modules:

- 6.1 MERLIN Administrator** - basic system configuration software module used to define all basic settings of the MERLIN software and hardware for proper operation, including radar sensor type and power, radar scanning mode (vertical or horizontal), geographic location (latitudinal and longitudinal position), target tracking parameters and all related parameters. The MERLIN Administrator operates as an on-screen Wizard with tabs for quick navigation and set up or adjustment of the system. Specific parameters set and controlled by MERLIN Administrator include:
- a. **Radar Operating Mode** – Surveillance, for Horizontal Scanning Radar (HSR) mode or Vertical, for Vertical Scanning Radar (VSR) Mode.
 - b. **Static Target Filters** – defines clutter filter settings.
 - c. **Variable Sensitivity Threshold (VST)** - Standard Deviation of a given pixel value and multiplier as primary and secondary (includes a -Build Clutter Data” option for manual masking of an area of the image).
 - d. **Radar Location & Datum** – latitude and longitude as set by the MERLIN GPS/Compass WAAS unit that provide continually time and location hacking during operation to maintain system accuracy.
 - e. **Radar Sensor Model and Power** – 2010 standard is 200 watt S-band.
 - f. **Time Zone at the Location** - all MERLIN database records are time stamped according to the user selected time (MERLIN also automatically time stamps all records in Zulu time to provide a consistent reference to time that is not affected by daylight savings time).
 - g. **Clock Time** - as set by the MERLIN GPS/Compass WAAS unit that provides continually time and location hacking during operation to maintain system accuracy.
 - h. **Data Paths and Names** – define location for each type of data produced by the system via a path navigation dialog box for selection of file and directory location including the Display Image Paths, Remote Status Log Paths, Remote User Data Paths, Database File Names, Database Change Times, Auto File Zip option, Remote Status Log (enable or disable), and Maximum Database File Size.
 - i. **Risk Threshold Values** – sets MERLIN ATC Low and High risk thresholds and designates the number of targets seen in a given altitude band in a defined time frame minutes that will trigger the altitude risk bar graph color to change from green to yellow or yellow to red.
 - j. **Network Configuration Settings** - configures the role (interface or processor) and designation (name) of the MERLIN computer or MERLIN network.
 - k. **Radar Operational Settings** – includes settings for the Pulse Filter, Pulse Length (to optimize the radar for biological target detection), CFAR On/Off



(Constant False Alarm Rate for scan-by-scan filter for suppressing radar energy reflected by clutter), CFAR Window Length (represents the number of range bins in a radial that are analyzed to determine the CFAR threshold), CFAR Offset (defines the optimal target detection for a given radar environment), and CFAR Rank.

- l. Range Setting** – set based on the smallest target detection required at operating range and set by the Image Size Calculator Program, which can be found on the MERLIN computer desktop.
- m. Sampling Rate** – sets the sampling rate used to measure the reflected radar energy (voltage); optimized so that the peak signals will be sampled (measured) by the signal-processing card.
- n. Azimuth Samples** – determines the number of azimuth samples taken for each revolution of the antenna.
- o. Maximum Gated Image Size** – sets maximum image size needed to achieve a desired radar range based on the sampling rate and azimuth samples taken.
- p. Radar Display Origin & Center** – set dependant on the Radar Mode selected (HSR or VSR).
- q. Advanced Processing Parameters** – defines settings for Scan, Frequency Time Constant (FTC) Index, Interference Rejection (Wx and radar), and Use Recorded Data (for processing of recorded raw radar data).
- r. Target Size Filters** – sets Max Size and Min Size (maximum/minimum size based on pixel area for all targets tracked by the MERLIN software to filter real-time data to only targets of interest such as larger targets that pose significant strike risk to aircraft); and, Max LF/Min LF (Linear Filter applied to the Max and Min Size value and to compensate for the increase in target size with distance)



Figure 4: MERLIN Administrator on-screen GUI

- s. **Clear Air Threshold (CAT) level** - eliminates the lowest reflectivity values from MERLIN processing and prevents MERLIN from scanning unnecessary pixels associated with background noise of the radar equipment.
- t. **Min Intensity** – defines the increase above the average clutter value for a given location on the display before a target is plotted by the MERLIN software for false target control.
- u. **Clutter Statistic Images** - generates a raw radar image that is stored in the database for calibration, diagnostic and reference purposes.

- 6.2 MERLIN Data Server** - used to communicate with the Radar Interface Computer (RIC) and relay settings configured in MERLIN Administrator. The data server also monitors the radar and collects and outputs data to MERLIN Display. Data is output to the paths set in the MERLIN Administrator software and controls described below:

Figure 5: MERLIN Data Server Status Window

Equipment	Status	Message	Err Files	Err Count	Time End	Time Start
Radar	On	Clear Feeding Off	0	0	9/30/2006 22:49:13	9/30/2006 22:49:13
RIC	On	CHAR Parameters Set	0	0	9/30/2006 22:49:58	9/30/2006 22:41:56
RIC Workstation	On	S-Band Ready	0	0	9/30/2006 22:36:57	9/30/2006 22:36:57
Data Server	On	Untested	0	0	9/30/2006 22:36:57	9/30/2006 22:36:57
Current Status	On	Idle	0	0	9/30/2006 22:49:13	9/30/2006 22:49:13
Remote Speed	On		0	0	9/30/2006 22:49:13	9/30/2006 22:49:13
Processed Time	On		0	0		
RIC Detection	On		0	0		
Final Status	On		0	0		

- Build Ref Data** - for weather (Wx) and Chaff detection Build Ref Data samples 255 zones on the screen to find areas of increased reflectivity from Wx or chaff. The background values for this are held in a file functions to provide users information where weather or chaff interference is affecting bird detection making data in that unreliable for risk management. Build Ref Data runs at each system start-up at a system location and slowly works through the ranges available for the pulse length currently set on the radar.
- Build Clutter Data** - for VST algorithms to map site clutter improving bird detection in high clutter environments and close to ground/water levels.
- Output Stat Data** - produces a selection of statistical images and a dynamic range graph that allows users to determine the severity of the clutter environment at the study site. These images can be useful in selecting the most appropriate clutter suppression algorithm.
- Dynamic Range Graph** - produces a graph showing all the pixel values contained in the raw radar image and used for determining the optimum Clear Air Threshold settings.
- Output CAT Stats** - outputs an image showing every pixel in the raw radar data that is exceeding the Clear Air Threshold value set in MERLIN Administrator and used to determine if too high a number has been used by visually checking whether clutter in the image with higher values are being eroded or if there appears to be no background noise in the image.
- Data Collection** - starts data collection (recording of MERLIN track data).



6.3 MERLIN Display – Displays MERLIN processed bird tracks onto the user screen. The display will start at settings based on the last settings used by the system in the previous session. The MERLIN Display Administrator software is used to change the display format and to select user specific options. A wide variety of standard and custom user display formats are available in MERLIN:

Figure 6: Screenshot of MERLIN Horizontal surveillance radar (HSR) display of offshore wind farm site with custom underlay showing radar platform and positions of proposed wind turbines (from Talisman Beatrice MERLIN ARS offshore of Aberdeen, Scotland).

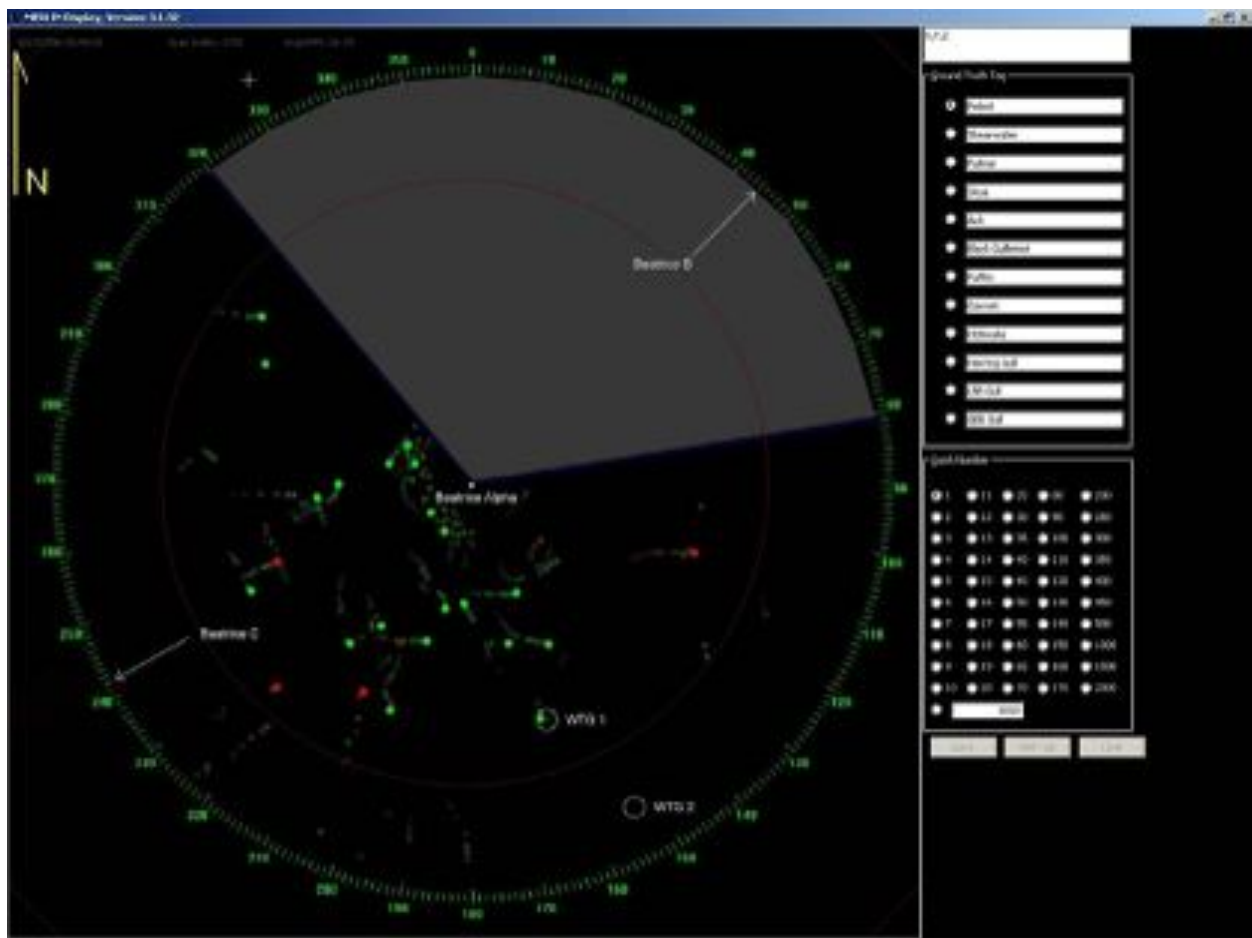
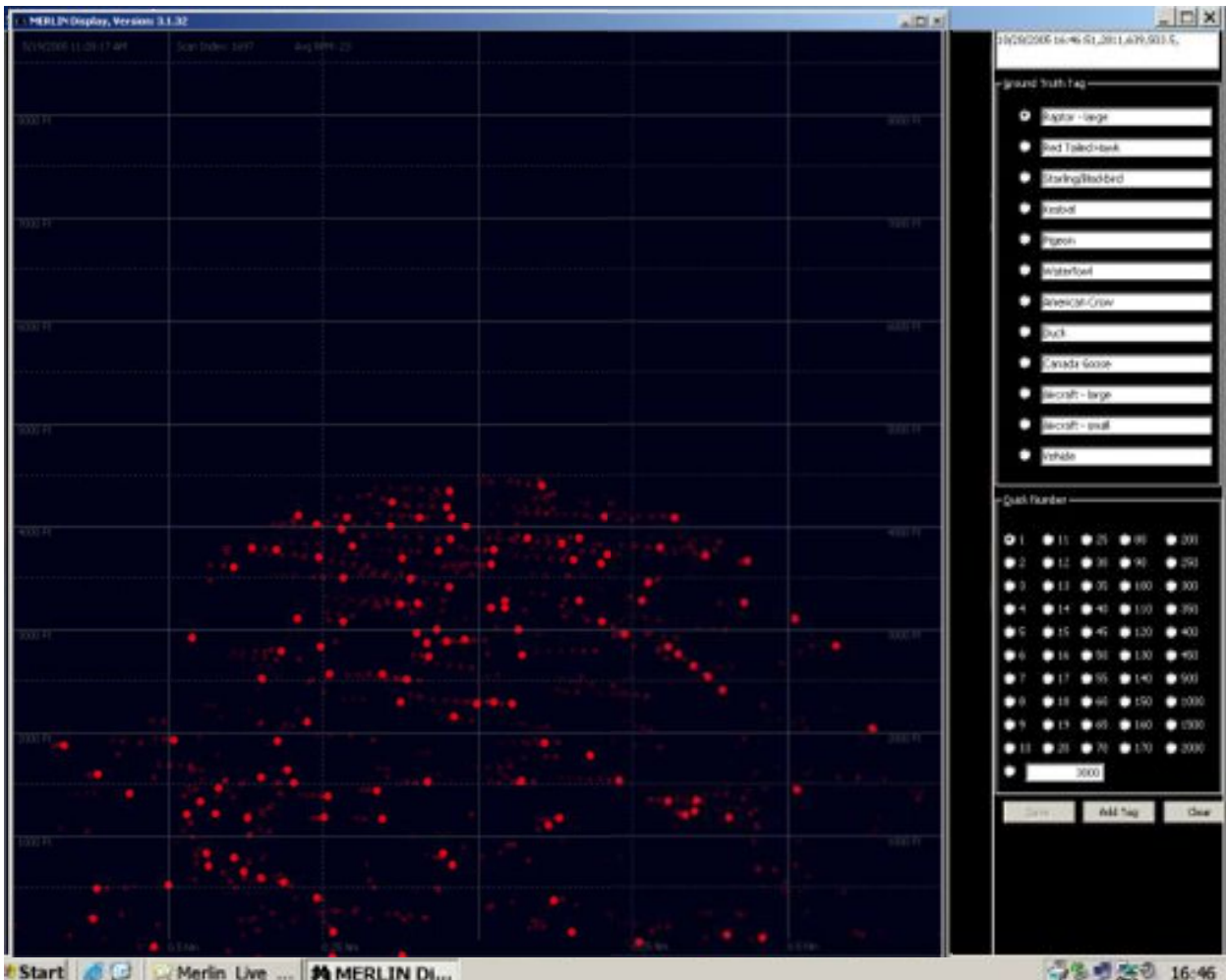


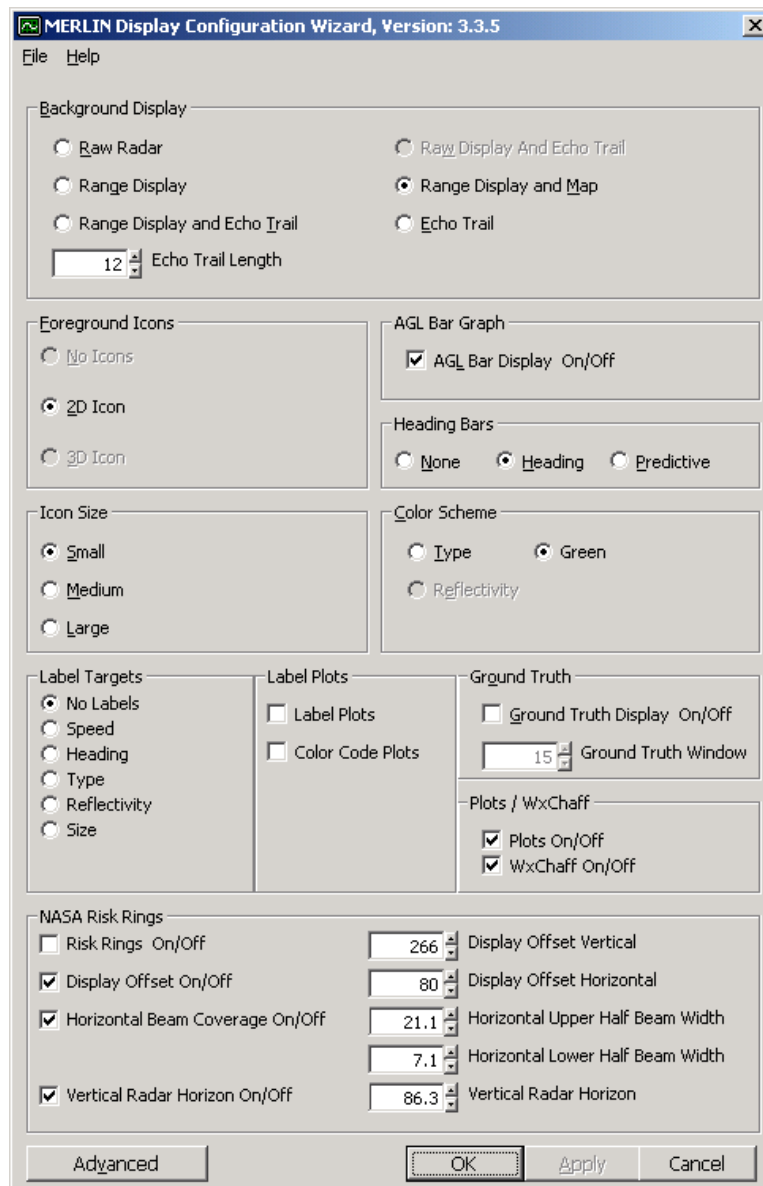
Figure 7 : MERLIN vertical scanning radar (VSR) display with Groundtruth Bar and target tags (size) and Heading Bars enabled during heavy migration (from Cornell Lab of



Ornithology proposed wind farm site survey).

- 6.4 MERLIN Display Administrator** – Activates GUI to configure different MERLIN display options (vertical or horizontal) and set parameters and features required by each user including display type, underlay, tags (speed, size, quality, heading, reflectivity), heading bar (actual or predictive), and the sidebar type (vertical activity or groundtruthing).

Figure 8: MERLIN Display GUI Window



- 6.5** The real-time data from MERLIN's radars (HSR or VSR) can be combined to display on a single computer monitor, or each can be displayed on two separate monitors, depending on the user's application.
- 6.6** The Raw Radar option displays the grayscale "raw" (unprocessed) radar image as viewed in the source radar signal behind the MERLIN target tracks (green or red "dots") and is typically only used by more experienced operators during radar set-up and groundtruthing (tracking and target verification).



- 6.7 The –Groundtruth Sidebar” option allows operators to record visually confirmed target information (species, number of birds, flight characteristics, etc.) to the MERLIN database for that target.
- 6.8 Display configuration and options include:
- a. **Range Display** - display with range rings (for the HSR) or altitude bands (for the VSR) with a black background based on the radar operational setting. This display is the standard display for the vertical radar in a two monitor configuration and shows the full horizon-to-horizon –sweep” of the vertical radar beam. In this display, the radar position is at the bottom center of the screen with distance from the radar and above the radar indicated on the x- and y- axes respectively.
 - i. In the Range Display, the Groundtruth Bar can be activated on the right side of the screen or, optionally, the Vertical Risk Bar (AGL Bar Graph), can be displayed.
 - ii. The Vertical Risk Bar indicates the level of target activity above ground level (AGL) in 50 foot (ft) increments and shows the relative risk based on a cumulative running count of the targets counted in each band by the radar over the previous 299 radar scans.
 - iii. As the count increases within the bands, the count scale at the bottom of the risk bar will change to reflect the current maximum and the colors of the bars will change reflecting pre-set activity levels.
 - b. **Range Display & Echo Trail** - This display provides the same background as Range Display but also displays the raw radar echoes that are exceeding the clutter threshold set in the MERLIN Administrator software, and typically is only used by technicians for system calibration and performance diagnostics.
 - c. **Range Display and Map** - This display is the most common format used for display of horizontal radar data and allows a background underlay map (produced by the end user or by DeTect) to be displayed under the radar tracks shown generated by the MERLIN software. The background map standard is 1024 X 1024 pixels in size. The display software allows an underlay image in Vertical mode that allows reference points on the ground to be indicated on the display.
 - d. **Echo Trail** - Displays only the radar echoes that have exceeded the background threshold levels (the echo trail length can be set from 1 to 20).
 - e. **Icon Size** - Changes the size of the display icons (symbols).
 - f. **Label Targets** - Allows one parameter of each target tracked on the screen to be displayed alongside the icon.
 - g. **AGL Bar Graph** - Allows a dynamic bar graph (Vertical Risk Bar) of the past 299 radar scans of the vertical scan data to be displayed along the right side of the display window. (This can be shown on both the vertical and horizontal displays). The Vertical Risk Bar indicates the level of target activity above ground level (AGL) in 50 foot (ft) increments and shows the relative risk based on a cumulative



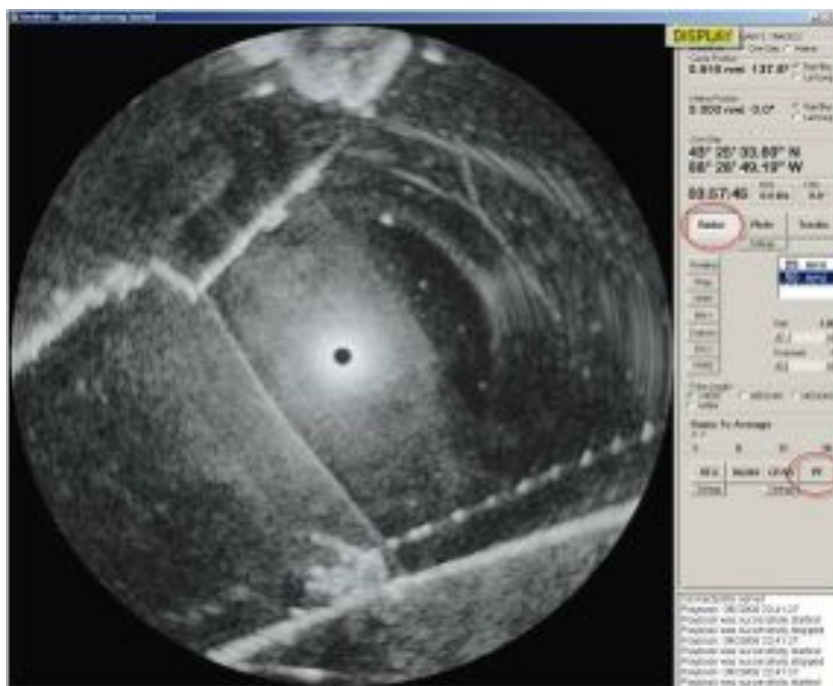
running count of the targets counted in each band by the radar over the previous 299 radar scans.

- h. **Heading Bars** - Turns heading bars ON or OFF. Heading means that the heading is shown as calculated from the previous scan. Predictive uses information from the previous 4 scans to predict how the target is maneuvering to provide a predicted path. The length of the bar is indicative of the relative speed of the target.
- i. **Ground Truth Display** - Using the ON/OFF checkbox allows a ground truth window to be shown on the right side of the display screen. Clicking on the display screen near a target icon will allow the operator to enter information about that target into a text file that is linked to the data for that track in the MERLIN database. The Ground Truth Window size determines how close to a target the mouse must be clicked for the software to determine the target being designated for ground truth information recording.
- j. **Plots/WX Chaff** - Allows other icons to be shown on the MERLIN display. If '-Plots On' is checked, then yellow squares will be visible on the screen in locations where a target is being seen by the radar but has not yet been tracked for sufficient scans for the MERLIN software to record it as a target. If WX/Chaff is checked hatched blue blocks will be shown on the display if weather or chaff is being detected by the radar.
- k. **Label Plots** - This allows target plots to be labeled with Reflectivity, Size and Distance in pixels from the radar. These labels are useful when setting up target size filters, linear filters and other target parameters in MERLIN Administrator.

6.9 MERLINRecorder - The MERLINRecorder software allows for raw (unprocessed) radar recording and playback to support detailed data analysis and recordkeeping. Retention of radar signal data requires large amounts of disk space for storage (100+ gigabytes of storage per 24 hour period depending on the level of resolution of the retained data) and hard drive storage capacity of one terabyte (TB) is included.



Figure 9: MERLINRecorder Record and Playback Control Window



6.10 MERLIN GPS/Compass - Each MERLIN radar sensor unit is equipped with its own WAAS enabled MERLIN GPS/Compass unit to maintain high spatial and temporal data quality:

- a. Positional accuracy and correlation of the total MERLIN system.
- b. Time synchronization and computer drift correction between all system Computer clocks.
- c. Parameters controlled by MERLIN GPS/Compass include the radar North Up (Fixed Reference Point), Magnetic North (Variable) and Heading Offset (True North).

6.11 MERLINRemote - remote system control interface and allows users to remotely control and monitor all critical system components from enabled remote user display workstations.

- a. Key MERLIN system features and functions are activated via the remote control panel installed at each radar sensor package.
- b. The MERLINRemote suite allows users to control, monitor and display the software over a Local Area Network, Wide Area Network, via the Internet or a SCADA system.

Figure 10: MERLINRemote dashboard GUI (configured for each installation)



- c. **The MERLINRemote interface is the MERLIN dashboard** – a software application that allows for control and monitoring of a MERLIN system from a single GUI.
 - i. The GUI provides tabs for each of the elements of the hardware, software, controls and sensors to provide an overview of remote operations.
 - ii. Standard control and Health & Status Monitoring (HSM) functions included are power (commercial, UPS and backup), radars (transmit, start/stop, test, operational settings), computers (start/stop, status), and environmental primary and secondary (AC, internal, external temperature, humidity).
- 6.12 MERLINReporter** - MERLIN Reporter is the suite of data analysis and reporting applications for the MERLIN system. The suite of analytical and reporting tools in MERLINReporter includes:
- a. MERLIN Trackplot - subroutine that works with Horizontal & Vertical Radar Databases (separately) with a primary function is to visualize bird track data that was written to the MERLIN database archives.
 - b. Trackplot product outputs are images in the form of JPEGs (.jpegs) consistent to the MERLIN Display formats (horizontal and vertical). Trackplot is operated via a simple on screen user window that allows the user to select the data file for analysis, the time period, the data parameters (e.g. size classes) and other parameters.

Figure 11: MERLIN Trackplot GUI window



Merlin Track Plot

File Help

Database: [Q:\NewComstock\Data\byhour\MERLIN_11_10_2000_Verical.MDB]
Underlay: [S:\3nm(out).jpg]
Output Name: [Q:\NewComstock\Data\byhour\MERLIN_11_10_2000_Verical.MDB]
Status:

☒ Multiple Images ☐ Single Image

Time Period Options:

☐ Monthly [10]
☐ Daily [11]
☒ Hourly [17]
☐ Minute [Interval]
☐ Second [Combo]

Misc Options:

☐ Display Image
☐ Auto Mode
☐ Batch Mode
☐ Shrink Vertical Image
☐ Exclude speeds >

Time Options:

☒ Local
☐ Zulu

Table Options:

☐ Horizontal
☒ Vertical

Display Options:

☐ Heading ☐ Reflectivity
☒ Size ☐ Speed

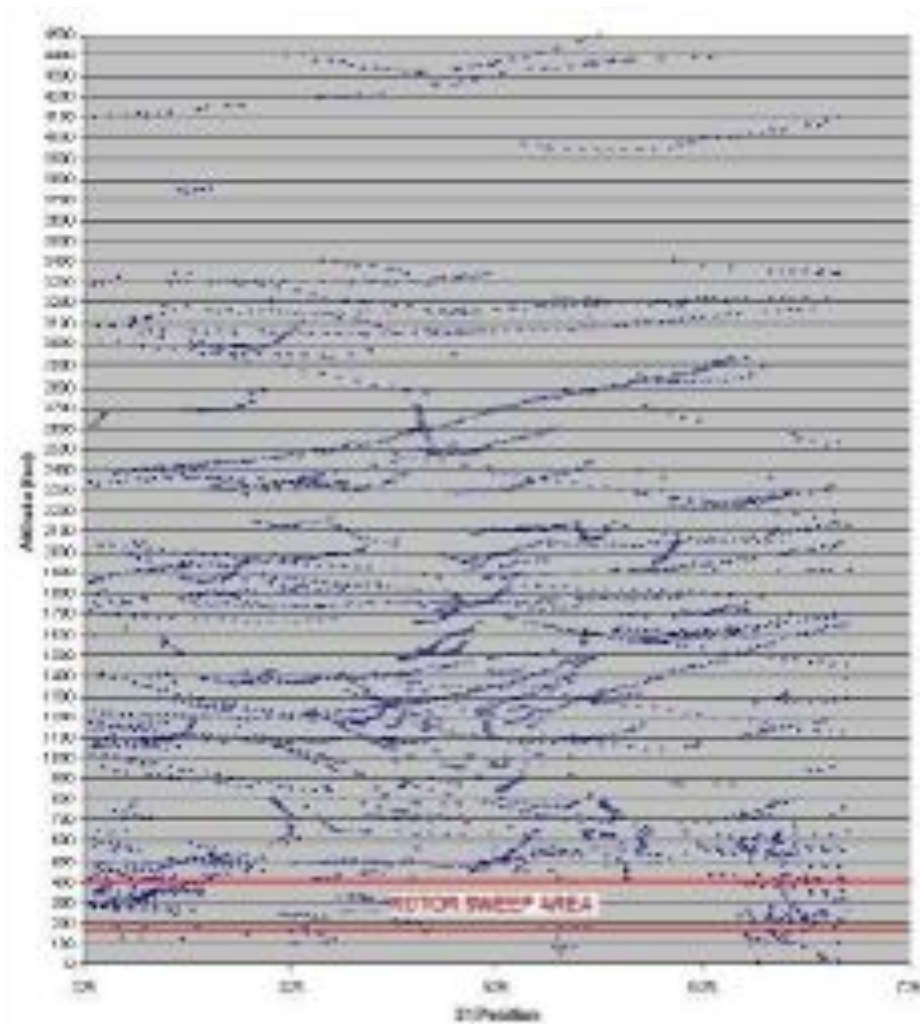
Visible Target Sizes:

☒ Small ☒ Large
☒ Medium ☒ Flock

Run Save Speed Units
Exit



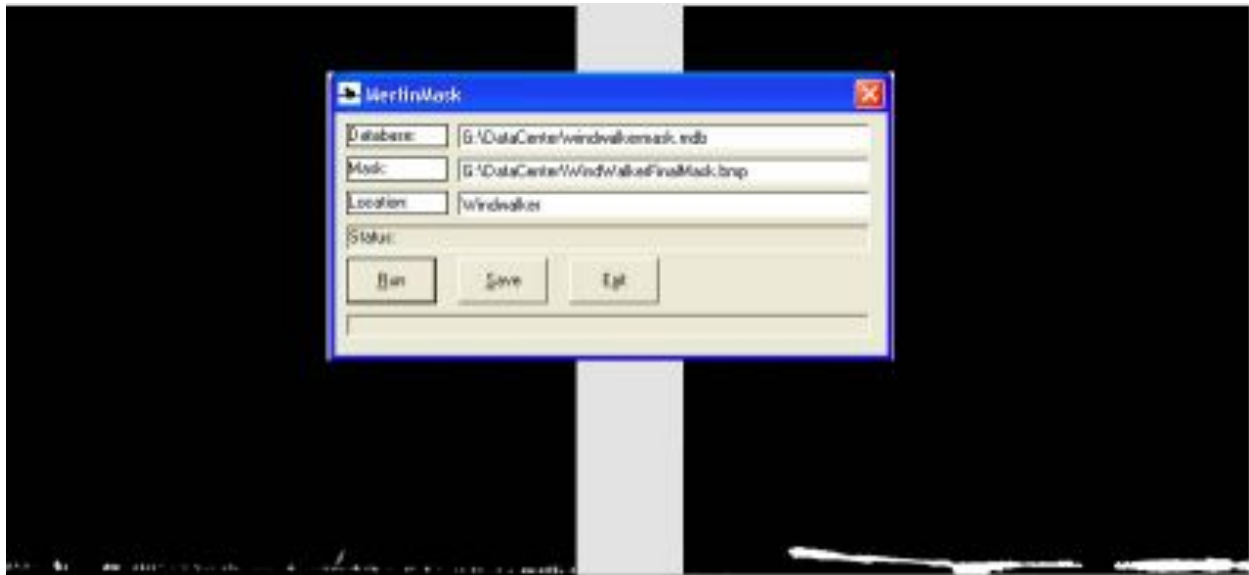
Figure 12: MERLIN Trackplot vertical data





- 6.13 MERLINMask-** allows exclusion of areas where persistent ground clutter tracking exists (i.e. from trees, brush, wind turbines, ships, etc.).
- a. MERLINMask - automatically converts a .bmp into a table of a 1024 x 1024 matrix to account for every pixel combination (1,048,576 rows of data with pixel values of 1 for black, 0 for white) and permits quantification of how much a target is clear of clutter (in a sense a -filter”).
 - b. The current MERLIN build utilizes both static and dynamic clutter maps that allow radar technicians to manually edit static clutter maps while still reaping the benefits of a dynamic clutter map.
 - c. The MERLINMask is operated via an on-screen GUI and automatically creates the static mask.

Figure 13: MERLINMask GUI with before and after mask.

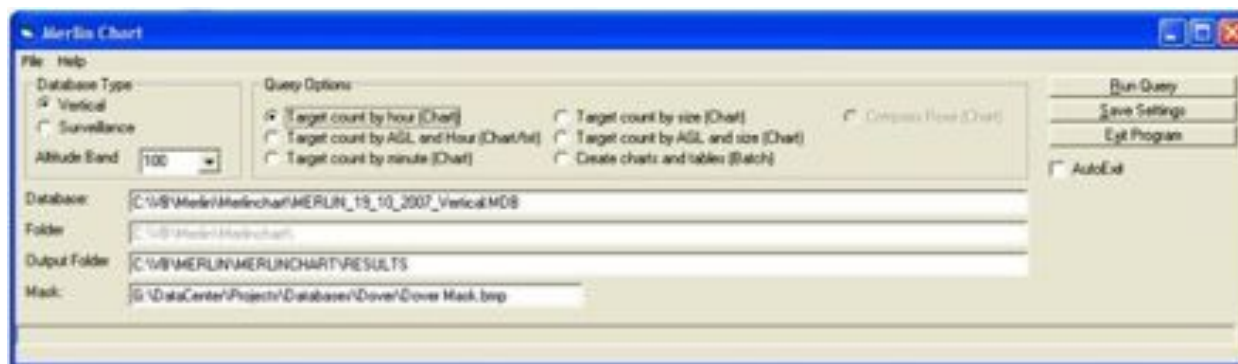




6.14 MerlinChart - works with both horizontal and vertical MERLIN databases (separately) and its primary function is to produce a quick analysis and visualization of archived historical vertical and horizontal data (generated as text files, images and charts).

- a. The output is used typically for flight and bird control planning and to identify peak activity and altitudes of bird activity.
- b. MERLINChart is run through a simple on-screen GUI. The application can be run in batch mode on multiple databases in a folder.

Table 14: MERLINChart GUI



All system data is recorded to internal MS Access and SQL compatible databases with all target parameters recorded.



9. Proposed Project Support Staff

For this project DeTect/TRG will provide a project support team of top avian radar experts with direct, relevant experience in development, supply, installation and support of the equipment and services required for this tender. This includes DeTect staff members who have installed and supported MERLIN Avian Radar Systems for terrestrial and offshore wind energy projects in Europe with requirements very similar to those required by this tender. Resumes of the DeTect staff members who will support project can found in the following pages.



NAME: T. Adam Kelly

TITLE: Chief Scientist/Principal Biologist, DeTect, Inc.

EDUCATION: Master of Science, Conservation Biology, University of Kent, England (1993); Advanced University Diploma in Raptor Biology with Merit (1992)

YEAR EXPERIENCE: 26 **CURRENT POSITION:** Principal Biologist

Introduction:

Mr. Kelly is a highly experienced Wildlife Biologist specializing in avian biology, bird and bat mortality risk assessment, bird control and radar ornithology. He is a member of the World Working Group on Birds of Prey and Owls, the Wilson Ornithological Society and the Bird Strike Committee USA/Canada. He has conducted captive raptor propagation projects, airfield and industrial bird control programs, telemetry studies, avian radar surveys, mortality risk assessments and mitigation programs on projects in value up to \$5 million (USD) in the USA, the United Kingdom, Canada, Europe, New Zealand and Mauritius. Supervisory experience includes training and managing teams of over 30 biologists and bird control specialists in survey, bird control and bird-strike investigation.

Mr. Kelly is a leading world expert in development of sophisticated signal processing techniques for radar remote sensing systems for bird, bat and aircraft detection, tracking and mortality risk assessment and mitigation. Mr. Kelly is currently the Chief Technology Officer/Chief Scientist with DeTect, Inc. (www.detect-inc.com) and heads the company's programs for on-going development and field application of advanced methods and systems for bird and bat remote sensing, radar tracking, mortality risk modeling, risk assessment and risk mitigation for aviation safety (bird-aircraft strike avoidance) and for projects with avian mortality issues such as wind farms, communication towers, mine tailing ponds, industrial waste impoundments, oil and gas tanks and commercial landfills.

At DeTect, Mr. Kelly has been the Principal-in-Charge of development and field application of the MERLIN™ Aircraft Birdstrike Avoidance Radar system, the MERLIN Avian Radar System, the MERLIN *detect & deter* Bird Control Radar system, and the VESPER Fixed-beam Vertical Profile Radar. MERLIN is currently the most widely used bird and bat radar with over 60 units operating worldwide. He has been responsible for virtually every major first in bird radar technology including the first ...

- Custom bird radar waveform & antenna (MERLIN *SharpEye*, 2009)
- All weather solid-state bird radar system (MERLIN *SharpEye*, 2009)
- Automated Wind Farm radar monitoring and risk mitigation system (MERLIN SCADA, 2008)
- Automated birdstrike risk alerting bird radar in a commercial airport control tower (2008, Durban Airport, South Africa)
- Automated birdstrike risk alerting bird radar (2006, USAF, Dover AFB)
- Bird radar system installation at commercial airport (2003, Augusta Regional Airport, Georgia)

- On-airfield bird detection radar in control tower (2003, Royal Air Force Base, Kinloss Scotland)
- Biological target detection algorithm for radar (2001)
- Automatic vertical scanning radar for bird detection (2000)
- Large-scale fully automated bird strike risk management radar network (1999, AHAS, www.usahas.com, USAF)
- Airbase bird avoidance model (1997, USAF)
- Computer-based mission planning model for use by pilots to reduce bird strike risk (1996, USAF)
- Year-round remote sensing studies of bird activity (1995, USAF)

Relevant Experience:

He currently heads DeTect's avian radar system research and deployment group supporting client projects in the US, Canada, Europe and Africa. On-going projects include development of advanced algorithms and radar systems for automatic detection and tracking of birds and bats on NEXRAD and small mobile radars for the US Air Force (USAF), US Air National Guard, National Aeronautical and Space Administration (NASA), US Fish and Wildlife Service (USFWS), US Environmental Protection Agency (USEPA), the Governments of Canada and the United Kingdom and various commercial aviation, mining, industrial and wind energy clients. Mr. Kelly is a world recognized expert in BASH and radar ornithology, has published numerous research papers, frequently presents at subject related conferences, and routinely provides expert testimony at regulatory hearings. Specific areas of expertise include

- Radar ornithology
- Bird and bat radar, acoustic and thermal survey
- Risk assessment and mitigation planning
- Migratory research and studies
- Radio and satellite telemetry
- Bird trapping and banding
- Airfield bird and wildlife control
- Bird-aircraft strike hazard (BASH) management
- Aircraft mishap investigation
- Protected species surveys and habitat assessment
- Avian radar computer algorithm and system design and development

Mr. Kelly is the lead scientist and developer for two Bird Avoidance Models (BAM) for the USAF; the USAF Avian Hazard Advisory System (AHAS, see www.usahas.com), a NEXRAD radar-based system that tracks bird activity in real-time for the continental US, Alaska, Hawaii, Guam and Korea; and, the first automated bird and bat detection and tracking radar systems (MARS and MERLIN). In 2006, the AHAS system was expanded to provide near real-time (every six minutes) biological density imagery in 3-D and he is directing expansion of the system to process Level II NEXRAD data which will increase system resolution by an order of magnitude. The AHAS system archived data includes over 10 years of 24-7 biological density data for the



continental U.S. and Mr. Kelly has developed techniques to use this data to support preliminary risk assessments for proposed wind farm sites.

Since June 2006, Mr. Kelly has also been the Program Manager for DeTect supporting the U.S. space agency, NASA, in birdstrike launch prevention for the US space shuttle from Kennedy Space Center (KSC), Florida USA using a custom designed DeTect MERLIN Avian Radar System. Mr. Kelly has been the lead advisor to NASA for bird strike risk mitigation for space shuttle launches from July 4, 2006 to the present and has personally been on-site at the KSC providing expert radar ornithology and birdstrike risk management and advisory support to NASA for fourteen launches of space shuttle.

Representative Project Experience:

Principal Biologist/Radar Ornithologist, Gulf Wind I Windfarm, Texas USA (Pattern Energy) 2006-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System for avian mortality risk monitoring at the wind farm located on the Texas Gulf Coast. The system was installed in the fall of 2006 and collected two years of 24-7 data on avian activity that was used to project potential risk to migratory and resident birds in the proposed wind farm areas and in 2008 oversaw installation of the system as a permanent monitoring system for the operating wind farm. Currently the system uses the MERLIN SCADA avian mortality risk mitigation software developed by Mr. Kelly which allows the bird radar to function as an early-warning risk mitigation system for birds at the wind farm providing advance detection of elevated bird activity and automatically idling the wind turbines when birds are detected under high mortality risk conditions. The MERLIN SCADA installation at the Gulf Wind I Windfarm is the first use of automated avian radar technology for risk mitigation at a wind farm in the world.

Principal Biologist/Radar Ornithologist, Penāscal Wind Farm, Texas USA (Iberdrola Renewable) 2008-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System as a permanent monitoring system for this operating wind farm that is located adjacent to the Gulf Wind I wind farm. The system uses the MERLIN SCADA avian mortality risk mitigation software developed by Mr. Kelly which allows the bird radar to function as an early-warning risk mitigation system for birds at the wind farm providing advance detection of elevated bird activity and automatically idling the wind turbines when birds are detected under high mortality risk conditions. Along with Gulf Wind I, the MERLIN SCADA installation at the windfarm is the first use of automated avian radar technology for risk mitigation at a wind farm in the world. The systems are currently being integrated into a wider network of bird radars with though a VPN to expand the early warning capability of each individual radar.

Principal Biologist/Radar Ornithologist, Nordwindzee Offshore Windfarm, The Netherlands (Shell/NUON) 2003-present. MERLIN XS2530e Avian Radar System installed in 2003 on an offshore research platform, collected two years of pre-construction survey data. The system is currently installed on the met-mast tower and provides 24-7 monitoring of the operating wind farm with remote administration from the shore via fiber optic network. The system is operated by the project environmental consultant, Bureau Waardenburg bv and in 2009 a secondary ship traffic radar was upgraded with a MERLIN bird radar processor to provide expanded detection of bird activity at the windfarm site.



Principal Biologist/Radar Ornithologist, Beatrice Offshore Wind Park, Aberdeen, Scotland (Talisman Energy/University of Aberdeen) 2005-present. Multi-year avian radar survey of offshore wind turbines off the coast of Scotland in the North Sea. The MERLIN system is installed on an oil platform near the test turbines and is operated by biologists with the University of Aberdeen. Mr. Kelly provided senior biologist oversight and radar data QA/QC for the project.

Principal Biologist/Radar Ornithologist, Plum Island Offshore Wind Park, New York, USA (Deepwater Wind LLC) 2007-present. MERLIN XS2530e Avian Radar System conducting two year pre-construction survey of the first US offshore wind farm. For year One, the radar was installed on-shore and surveyed three near shore turbines sites. For year Two, the radar system will be reinstalled onto the met mast tower 6 miles offshore to collect preconstruction data for the offshore windfarm.

Principal Biologist/Radar Ornithologist, Westfield-Ripley Windfarm, New York, USA (Babcock & Brown) 2007-present. MERLIN XS2530e Avian Radar System conducting pre-construction survey of proposed wind farm site in northern New York state. The radar was installed in the fall of 2007 and is collecting data 24-7 for one year pre-construction. The project site is located in the US Great Lakes flyway and is considered a key resource area.

Principal Biologist/Radar Ornithologist, Smola Windpark, Norway (Norwegian Institute for Nature Research) 2008-present. MERLIN XS2530e Avian Radar System supporting Sea eagle mortality study at operating wind farm. The system is collecting data 24-7 to determine usage patterns for the Sea eagles at the site to develop mortality risk mitigation implementation of the MERLIN SCADA mortality risk system.

Principal Biologist/Radar Ornithologist, Lake Ostrowo Wind Farm, Poland (Dong Energy/KAPPA) 2007-present – MERLIN XS2530e Avian Radar System conducting 2 year post-construction survey at Poland's largest wind farm located on the Baltic coast. The system is operated by the University of Szczecin with data analysis, processing, QA/QC and general consultation provided by DeTect under Mr. Kelly's direction.

Principal Biologist/Radar Ornithologist, Various Windfarms, New Zealand (Meridian Energy Ltd.) 2008-present – MERLIN XS2530e Avian Radar System operated by New Zealand's largest wind farm developer to assess migratory bird risk for coastal wind farm sites. The system is operated by the developer's consultants with data analysis, processing and risk assessment support provided by DeTect under Mr. Kelly's oversight.

Senior Biologist/Radar Ornithologist, proposed Easthaven Wind Farm Avian Radar Survey, Easthaven, Vermont, USA (Vermont Fish and Wildlife Department) 2004. Conducted a limited avian radar survey of the proposed Easthaven Wind Farm in November 2004 under contract to the Vermont Fish and Wildlife Department. Under the contract, Mr. Kelly directed a four week survey of the proposed wind farm site with a DeTect-owned MERLIN X10 bird detection radar system. The work included system operation, data groundtruthing, data analysis and expert testimony for assessment of mortality risk to bird activity from the proposed wind turbine site.

Senior Biologist/Radar Ornithologist, PdV Wind Farm Avian Radar Survey, Kern County, California, USA. 2005-7 In support of the developer's consultant, Sapphos Environmental, Inc., provided two-phase avian risk assessment of proposed wind farm site in the Mojave area of California. Phase I provided pre-assessment of the site using processed US NEXRAD data. Historical processed NEXRAD data for the site (24-7 data updated every six minutes) was



extracted covering a three-year period for the project site and surrounding area and analyzed for levels of bird activity, with specific focus on nighttime migration period in low visibility. Data was also compared to a known bird habitat resource area and conclusions developed as to the relative level of bird activity and mortality risk expected for the project site. For the fall of 2006, DeTect provided a company-owned MERLIN XS1030e avian radar system to Sapphos biologists for collection of data 24-7 during the fall migratory season. Sapphos biologists were trained on system operation and DeTect provided full remote technical support and data QA/QC. Mr. Kelly also managed data processing and analysis for the risk assessment report developed by Sapphos.

Senior Biologist/Radar Ornithologist, Buffalo Mountain Wind Farm Bat Radar Survey, Oak Ridge, Tennessee, USA. 2005-6. Conducted Phase I bat survey with a MERLIN XS1030e radar system with thermal imaging cameras at the Buffalo Mountain Wind Farm in Oak Ridge, Tennessee in August 2005 under contract to the Tennessee Valley Authority (TVA) and the Electric Power Research Institute (EPRI). Project tasks included supply and operation of a DeTect-owned MERLIN Avian Radar System, thermal imaging equipment, operators, field biologists, data analysis and expertise to investigate bat mortality at the site and provide recommendations for the Phase II study and a post-construction monitoring program to address the bat kills at the site. The data developed from this study was used to identify specialized radar requirements for bat mortality risk mitigation and led to the current research effort for DeTect's VESPER Fixed-beam Vertical Profile radar system.

Senior Biologist/Radar Ornithologist, Neda Mine/Butler Ridge Wind Farm Bat Survey, Fond du Lac, Wisconsin, USA. 2005-6. Conducted a radar bat survey at the proposed Butler Ridge wind farm near the Neda Mine in Wisconsin under contract to the Wisconsin Natural Resources Foundation with funding from the US Fish and Wildlife Service (USFWS) and the US Environmental Protection Agency (EPA). DeTect provided a MERLIN XS1030e Avian Radar System, thermal imaging equipment, operators, data analysis and expertise to investigate the potential for bat mortality at the site relative to the proposed wind farm site. Tasks included detailed analysis and correlation of the radar data with acoustic data from Anabat detectors deployed during the radar survey by staff of the Wisconsin Department of Natural Resources (DNR) and programming of custom algorithms to analyze potential to automatically differentiate bird and bat targets within the radar system in real-time.

Senior Biologist/Radar Ornithologist, Avian Survey and Assessment of proposed Wind Turbine Project, Cape Cod Community College, Hyannis, Massachusetts. April 2005 to 2006. Supported data collection and assessment of bird activity at the proposed wind turbine site. Operated a MERLIN XS1030e Avian Radar System during the fall of 2005 and spring 2006 migratory seasons. Supported data post-processing and analysis in DeTect's data center in Panama City, Florida and developed avian impact report based on the data collection.

Senior Biologist/Radar Ornithologist, Avian Survey and Assessment of proposed Wind Turbine Project, Town of Orleans, Massachusetts. April 2005 to 2006. Supported data collection and assessment of bird activity at the proposed wind turbine site. Operated a MERLIN XS1030e Avian Radar System during the fall of 2005 and spring 2006 migratory seasons. Supported data post-processing and analysis in DeTect's data center in Panama City, Florida and developed avian impact report based on the data collection.

Senior Biologist/Radar Ornithologist, Avian Radar Survey, Cape Wind Offshore Windfarm, Nantucket Sound, Massachusetts. 2002-3. Designed the avian radar software and hardware for the Geo-Marine Mobile Avian Radar System (MARS) and supported data



collection (May – June 2002 from an offshore test platform, and August – September 2002 on Martha's Vineyard) and analysis for the proposed Capewind windfarm site in the Nantucket Sound off the Massachusetts coast. The Capewind site is the first US proposed offshore wind energy development. Work included software development, field radar data collection, data analysis and production of the report on the data collection in 2003.

Principal Biologist/Radar Ornithologist, Central Science Lab (now the Food and Environment Research Agency) Avian Radar System, United Kingdom. January 2003 through 2009. Mr. Kelly managed development, programming and delivery of a Geo-Marine Mobile Avian Radar System (MARS) to the United Kingdom (UK) government Central Science Lab (CSL) Birdstrike Avoidance Team (BAT) in 2003. The CSL BAT is a world leader in research and management of bird hazards to aircraft and in assessment of projects with avian impact issues such as windfarms. The system is used by the CSL to collect bird activity data for a variety of bird detection projects, specifically related to bird hazards to aircraft and bird collisions with wind power structures. In 2006, Mr. Kelly managed delivery and support of a custom DeTect XS2530ex MERLIN Avian Radar System to the CSL and upgrade of the old MARS unit to the MERLIN avian radar system software. In 2008, he supported the CSL in assessment and development of offshore

Prior Experience:

Mr. Kelly started his career as a biologist as a licensed falconer. His prior experience includes telemetry tracking of raptors working as a technical advisor on an Institute for Terrestrial Ecology radio telemetry study on the Common Buzzard. He has successfully applied the telemetry backpack harness technology developed from this study to projects on Turkey and Black Vultures, Canada Geese, Tundra Swans, Red-bellied Woodpeckers, and Sandhill Cranes. Mr. Kelly worked in Mauritius on the endangered Mauritius Kestrel restoration project and applied his experience in captive propagation of raptors and use of hacking techniques for successful release of these birds into the wild. Mr. Kelly also worked with the endangered pink pigeon and echo parakeet and assisted a film crew in locating wild Mauritius Kestrels for a documentary on the species.

Mr. Kelly managed a team of bird control specialists to successfully keep a factory in the UK free of one-half million pied wagtails while a new roof was installed. The team contributed ideas to the roof design process and monitored construction to ensure the new roof sealed birds out of the building and denied any opportunity for roosting. Mr. Kelly also devised an innovative feral pigeon control program at Ise Brook Hospital, Wellingbrough, Northants, UK that was successfully concluded with no noise disturbance to patients at the hospital and no lethal means or trapping.

He worked for twelve years with Longwings, Ltd. as the Bird Control Program Manager at a variety of military and industrial situations. As Manager of the USAF-Europe Bird Control Program, he directed bird control operations at eight RAF bases in the United Kingdom (UK) advising on passive control of birds through habitat management at each installation. This included direct supervision of the bird control operations at RAF Mildenhall which included research into the effects of trained falcons on bird species hazardous to aircraft operations, an analysis of 20 years of bird control operations at the airfield, and the first use of a hybrid Peregrine-Merlin falcon for starling control. The USAF Bird-Aircraft Strike Hazard (BASH) Team consistently rated this program as one of the finest bird control programs worldwide. Additional work with the USAF included research on the effects of thermal conditions on the occurrence of



USAF bird strikes with Red-tailed Hawks and Turkey Vultures and investigation of Bird Avoidance Modeling (BAM) methodology.

From 1994 through 2003, Mr. Kelly worked as the lead Radar Ornithologist for Geo-Marine, Inc. supporting BASH and avian survey projects for the USAF and other clients in the aviation, communications and wind energy industries. While with Geo-Marine, he designed and programmed the avian radar data processing system for the Geo-Marine MARS (mobile avian radar system)



NAME: Andreas Smith

TITLE: Senior Radar Ornithologist/Project Biologist

EDUCATION: B.S., Fisheries & Wildlife Science, North Carolina State University, 1994

YEARS EXPERIENCE: 12

PROJECT POSITION: Radar Ornithologist/Field Technician Europe

INTRODUCTION

Mr. Smith is a Radar Ornithologist/ Biologist with DeTect based in Europe and supporting MERLIN Avian Radar Systems throughout Europe and the United Kingdom. For the past 12 years, Mr. Smith has specialized in radar ornithology, avian radar systems and avian risk management for airports and other projects with avian mortality issues. Prior to his moving to Europe, he supported development and application of advanced avian remote sensing technologies including work on development of the US Air Force (USAF) Avian Hazard Advisory System (AHAS), computer-based Bird Avoidance Models (BAM), and mobile radar systems for bird and bat survey, detection and risk management. Mr. Smith has also work on avian survey and BASH management plan development projects for the USAF, the US Air National Guard (US), commercial airports, landfills and wind farms at sites throughout the US and Europe.

Recent Experience:

Mr. Smith currently manages and supports field projects for DeTect for bird and bat survey and risk assessment related to aviation safety and environmental management. His areas of expertise include:

- Radar remote sensing and ornithology
- Thermal imaging and acoustic monitoring of birds and bats
- Avian radar research, installation, operation and user training
- Bird-aircraft strike hazard (BASH) management and Bird Avoidance Model development
- Avian Radar System operation and maintenance
- Airfield and landfill bird control
- Field ornithology
- Radio and satellite telemetry
- Protected species surveys
- Bird nest surveys and trapping and banding
- Bird and bat population surveys and habitat assessment

Over the past six years, Mr. Smith has been a key team member on design, construction, testing and operation of mobile avian radar systems and on short- and long-term bird and bat survey and assessment projects for airports, wind farms, landfills and mines. This includes installation, operating and scientific support for two major off-shore wind energy avian survey projects in the North Sea (Scotland and The Netherlands) and USAF birdstrike avoidance radar



installations in the US. He is a Certified Radar Technician and has a broad range of knowledge and experience in system design, testing and field deployment having personally operated and maintained systems on multi-year surveys both on-shore and off-shore.

SELECTED RELEVANT EXPERIENCE:

Nordwindzee Offshore Windfarm Avian Radar Survey, The Netherlands. Mr. Smith installed, operated and continues to support a MERLIN XS2530e Avian Radar System that was initially installed in 2003 on an offshore research platform and collected two years of pre-construction survey data. He also provided data processing and analysis support in DeTect's data lab that included query development for the risk model and assessment report. In 2006, he reinstalled the system on the met-mast tower at the operating wind farm that 24-7 monitoring of the operating wind farm with remote administration from the shore via fiber optic network. The system is operated by the project environmental consultant, Bureau Waardenburg bv for the owner Shell/NUON with operational and data analysis support from DeTect.

Beatrice Offshore Wind Park Avian Radar System, Aberdeen, Scotland. Mr Smith installed and currently supports the MERLIN avian radar system for a multi-year avian radar survey of offshore wind turbines off the shore of Scotland. The MERLIN system is installed on an oil platform near the turbines and is operated by biologists with the University of Aberdeen for the project owner Talisman Energy. He also provided data processing and analysis support in DeTect's data lab that included query development for the risk model and assessment report.

Smola Windpark MERLIN Avian Radar System Survey, Smola Norway. Mr. Smith installed, started up and supports a MERLIN XS2530e Avian Radar System at the wind farm to that is being used to develop data on Sea eagle activity around the wind resource area as part of a bird mortality study at the operating wind farm. The system is operated on a day-to-day basis by the Norwegian Institute for Nature Research (NINA) and is collecting data 24-7 to determine usage patterns, flight altitudes and periodic and seasonal population for the Sea eagles at the site to develop a mortality risk mitigation implementation plan to possibly include DeTect's MERLIN SCADA system that automatically idles the turbines when high risk conditions are detected. Mr. Smith provides on-going support to NINA and make regular site visits, provides data QA/QC and technical consulting.

Lake Ostrowo Wind Farm MERLIN Avian Radar System Survey, Poland. Mr. Smith installed, started up and supports a MERLIN XS2530e Avian Radar System that is conducting 2 year preconstruction survey for the developers Dong Energy/KAPPA at Poland's largest wind farm located on the Baltic coast. The system collects data 24-7 and is operated by the University of Szczecin with data analysis, processing, QA/QC and general consultation provided by DeTect. Mr. Smith provides on-going support to NINA and make regular site visits, provides data QA/QC and technical consulting.

Radar Ornithologist. Multi-year MERLIN Avian Radar System Survey, Risk Assessment & Bird Control Program, Louisville International Airport/Waste Management Outer Loop RDF, Louisville, Kentucky USA. Supported a three year, 24-7 MERLIN avian radar survey, monitoring and risk assessment program required by the US FAA for expansion of the Louisville IAP runways. A landfill facility operated by Waste Management, Inc. is located directly south of the main runway at the airport and, under the permit approval agreement to expand the runway between the FAA, the Louisville IAP and Waste Management, a comprehensive BASH plan and



bird control program was required to include installation and operation of an avian radar system to monitor and manage bird-aircraft strike risk. The Louisville, as the North American hub for United Parcel Service (UPS) air operations, is the fourth busiest airfreight airport in the world. In addition to commercial, civilian and UPS flight operations, the Louisville IAP also is a co-location for the Kentucky Air National Guard C-17 fleet. Mr. Merritt directed the BASH Plan implementation that included installation and operation of MERLIN Avian Radar System that provides 24-7 bird detection, monitoring and risk alerting to the airport and landfill operators. The avian radar data is additionally used to monitor bird activity with a running comparative analysis with the background bird activity levels for areas the airport. Mr. Smith provided Avian Radar System set up, calibration, groundtruthing and operation and maintenance support for the project.

Radar Ornithologist, Wildlife Hazard Assessment, Avian Radar Survey & Management Plan, Proposed New Conway Municipal Airport, Arkansas USA. Mr. Smith supported a year-long wildlife and MERLIN Avian Radar Survey of the area proposed for the new municipal airport and surrounding airport district in Conway, Arkansas that included field operation of the MERLIN Avian Radar System used for the data collection. The scope included 24-7 supply, delivery, operation and support of a MERLIN Avian Radar System to collect data on bird activity, movement and density at the site for one year. DeTect's services for this project were under contract with the airport design engineering firm, Huitt-Zollars, and work was coordinated with a third party consultant BASH, Inc. with the MERLIN radar operated on a day-to-day basis by a local consultant with the University of Arkansas. Mr. Smith also provide data analysis support, analyzing the data from DeTect data lab in Panama City, Florida that included query development, data processing, data modeling and data quality control/quality assurance.

Field Biologist/Radar Ornithologist. US Avian Hazard Advisory System (AHAS), USAF BASH Team, Kirtland AFB, New Mexico USA. Mr. Smith support DeTect's contract for AHAS providing field biology/radar groundtruthing and system data quality control/quality assurance and validation using mobile MERLIN Avian Radar Systems. AHAS provided daily forecasts of hazardous conditions along specified low-level routes and ranges as well as hourly updates based upon near real-time radar observations (updates every six minutes) processing data from over 150 radar sensors across the continental US, Alaska, Hawaii and Guam 24-7. The AHAS system is a neural computer network located in DeTect's Panama city, Florida office and processes the radar data 24-7 in real-time using custom software developed by DeTect and delivering risk advisories through the Internet (www.usahas.com) in tabular and Google Earth visual formats. The system also archives all data (currently with 8 years of data for the US) and can be queried for historical activity and risk levels to support future mission planning. The AHAS concept is now under consideration for development in other regions of the world including Europe and the Middle East, and DeTect recently completed the radar network assessment and developed the concept plan for a similar system for the United Kingdom.

Radar Ornithologist/Field Technician. NASA Avian Awareness Device MERLIN Radar System Development & Space Shuttle Launch Support. Supported development, testing and delivery of the Avian Awareness Device (AAD) MERLIN Radar System (MRS) supporting the US space agency, NASA, in birdstrike launch prevention for the US space shuttle from Kennedy Space Center (KSC), Florida using a custom designed DeTect Merlin Avian Radar System. The space shuttle struck a Turkey vulture in the summer of 2005 and NASA concluded that represented the second highest safety risk for shuttle launches due to possibility of damage to heat shielding tiles from birdstrikes. In 2006, NASA evaluated available technologies and selected the DeTect MERLIN Avian Radar System for future launch support, taking delivery of a



system that first used on the Return-to-Flight launch on July 4, 2006. NASA subsequently ordered a second system in 2008 and the MERLIN units have been used to support bird-strike launch flight safety on nine space shuttle missions to date (STS-121, STS-115, STS-116, STS-117, STS-118, STS120, STS-122, STS-123 and STS-124). Mr. Smith participated in the initial deployment of the prototype NASA MERLIN system in 2006 and assisted in system installation, start-up, testing and operation for the July 2006 shuttle launch.

Central Science Lab Avian Radar System, United Kingdom. Mr. Smith supports two MERLIN Avian Radar Systems purchased by the to the United Kingdom (UK) government Central Science Lab (CSL) Birdstrike Avoidance Team (BAT). The CSL BAT provides research and management consulting for bird hazards to aircraft. The system is used by the CSL to collect bird activity data for a variety of bird detection projects, specifically related to bird hazards to aircraft and bird collisions with wind power structures in the UK.

PRIOR EXPERIENCE:

Mr. Smith prior experience as a Natural Resource Assistant with the U.S. Fish and Wildlife Service (USFWS) performing duties on various wildlife surveys and management projects. He was responsible for supervising a group of resource assistants on several projects for the Mattamuskeet/Swan Quarter/Cedar Island National Wildlife Refuges. These projects ranged from waterfowl capture and banding programs to nest surveys of several bird species. Mr. Smith is a member of The Wildlife Society, the Nature Conservancy, the Natural Resources Defense Council and Wild Rivers.



NAME: Edward J. Zakrajsek
TITLE: Senior Biologist – QA/QC, DeTect, Inc.

EDUCATION: M.S., Wildlife Biology, Utah State University, 2001; B.S., Wildlife Management, West Virginia University, 1990

YEAR EXPERIENCE: 16 **CURRENT POSITION:** Operations Manager

Introduction:

Mr. Zakrajsek has over 16 years of experience in wildlife biology, threatened and endangered species management, radar ornithology, bird and bat survey and risk assessment, and Bird Aircraft Strike Hazard (BASH) management. This experience includes project management and scientific support on a variety of projects using advanced radar technologies to detect, track, monitor and assess bird activity that could be hazardous to aircraft or present mortality risk from strikes with wind turbines or communication towers. He has worked extensively on development and application of advanced bird and bat remote sensing radar technologies that has included the USAF Avian Hazard Advisory System (AHAS), computer-based Bird Avoidance Models (BAM), and mobile bird and bat radar detection systems. Mr. Zakrajsek has conducted numerous bird and bat radar surveys and risk assessments in the US and Europe. He also has developed BASH management plans for the USAF, Air National Guard and commercial airports at sites throughout the US.

Relevant Experience:

Mr. Zakrajsek currently manages projects for DeTect for bird and bat survey and risk assessment related to wind energy projects, airports, industrial sites and landfills. His areas of expertise include:

- Radar remote sensing and ornithology
- Thermal imaging and acoustic monitoring of birds and bats
- Avian radar research, installation, operation and user training
- Bird-aircraft strike hazard (BASH) management and Bird Avoidance Model development
- Aviation Mishap Investigations
- Airfield, landfill and industrial bird control
- Field ornithology
- Radio and satellite telemetry
- Protected species surveys
- Bird and bat population surveys and habitat assessment

Over the past ten years, Mr. Zakrajsek has been a key team member on design, construction, testing and operation of mobile avian radar systems and on short- and long-term bird and bat survey and assessment projects for airports, wind farms, landfills and mines as well as for automated bird control at industrial waste ponds and landfills. He has a broad range of knowledge and experience in system design, testing, field deployment and data analysis having personally operated systems and managed projects on multi-year surveys both on-shore and off-shore.



Representative Project Experience:

Project Biologist. Bat Survey and Mortality Risk Assessment, Neda Mine Wisconsin. June 2005 – January 2006. Conducted endangered bat surveys in the area around the Neda Mine in Wisconsin. The Neda Mine contains one of the largest bat hibernacula in Wisconsin with a population estimated at over 50,000 bats. Survey was conducted using a MERLIN avian radar system, acoustic detectors and thermal imaging cameras to assess bat activity and mortality risk in the vicinity of a proposed wind energy farm development.

Radar Ornithologist. Easthaven Wind Farm Avian Radar Survey, Easthaven, Vermont. October through February 2004. Conducted an avian radar survey of the proposed Easthaven Wind Farm in November 2004 under contract to the Vermont Fish and Wildlife Department. Operated a MERLIN X10 Environmental Surveyor bird detection radar system for data collection and supported data analysis for assessment of bird activity at the proposed wind turbine site.

Radar Ornithologist. Avian Survey and Assessment of proposed Wind Turbine Project, Cape Cod Community College, Hyannis, Massachusetts. April 2005 to present. Supported data collection and assessment of bird activity at the proposed wind turbine site. Operated a MERLIN Environmental Surveyor bird detection radar system during the spring and fall 2005 migratory seasons. Supported data post-processing and analysis in DeTect's data center in Panama City, Florida and developed avian impact report based on the data collection.

Radar Ornithologist. Avian Survey and Assessment of proposed Wind Turbine Project, Town of Orleans, Massachusetts. April 2005 to present. Supported data collection and assessment of bird activity at the proposed wind turbine site. Operated a MERLIN Environmental Surveyor bird detection radar system during the spring and fall 2005 migratory seasons. Supported data post-processing and analysis in DeTect's data center in Panama City, Florida and developed avian impact report based on the data collection.

Project Manager. Cape Wind Associates Avian Radar Survey, Nantucket Sound, Massachusetts. May 2002 - May 2003. Managed avian survey project for the Capewind offshore wind project to support the first U.S. off-shore wind park in the U.S. Included management of data collection during the two field seasons, data analysis, and project reporting.

Project Manager. Bureau Waardenburg Avian Radar System, The Netherlands. September 2003 through 2005. Managed delivery, installation, start-up, operation and data analysis for a DeTect MERLIN XS2530 bird detection radar system to operated by the environmental consultant, Bureau Waardenburg bv, for a conduct a multi-year study of a proposed wind turbine farm to be located eight miles off of the Dutch coastline in the North Sea. Mr. Zakrajsek directed the preconstruction site assessment and installation and start up of the system on an offshore research platform located eight km off the Dutch coast near Meetpost Nordwijk. The system has operated since late 2003 collecting data on bird movements in the area. In 2005, Mr. Zakrajsek supported post processing and analysis of the data collected since inception for development of the study report.

Project Ornithologist, Aircraft Birdstrike Avoidance Radar Installation and Operation, Tyndall, Air Force Base, Florida, USA, 2004 to present. Mr. Zakrajsek supported the project team for the design, construction, delivery, installation and start-up for a MERLIN Aircraft Birdstrike Avoidance Radar at the airbase to support the U.S. Air Force's next generation stealth



fighter, the F-22 Raptor. The system is installed on the base main runway and provides real time detection and tracking of bird activity within 6 nm of the runway. Information is provided to the base bird control units and operations office to manage aircraft operations and reduce birdstrike damage. The system delivered is a MERLIN XS2530 I series.

Project Scientist. USAF Avian Hazard Advisory System (AHAS) Operation, Development and Refinement. September 1998 to present. AHAS is a nationwide, radar-based system that continuously (24-7) detects and monitors avian activity across the U.S., including Alaska, Hawaii and Guam in near-real time and provides bird hazard advisories through the Internet to all USAF and other military flying units. AHAS processed weather data from the U.S. national network of 168 next generation radars (NEXRAD) to isolate biological targets in near-real time (updated every six minutes) and the National Weather Service data to forecasting bird activity on or near airfields and in military training air space. Mr. Zakrajsek supports the AHAS project team in directing field verification and calibration of AHAS using mobile MERLIN radar systems.

Assistant Project Manager. Outlying Landing Field Avian Radar Survey, U.S. Navy, North Carolina. March - April 2003. Mr. Zakrajsek assisted the management of an avian radar survey of a proposed outlying landing field (OLF) to support the F/A-18 Super Hornet in North Carolina. The site of the proposed OLF was near the wintering grounds of a great number of Snow Geese, Tundra Swans, and other waterfowl, which pose a severe hazard to aircraft. The avian radar system provided bird activity data to support the decision process to select or eliminate the site for development.

Project Technician. Central Science Lab MARS, United Kingdom. January 2003 - June 2003. Mr. Zakrajsek managed the production and delivery of a mobile avian radar system to the UK government's Central Science Lab (CSL). The Birdstrike Avoidance Team, an office of the CSL, is a world leader in research and management of birdstrikes to aircraft. They will use the radar system to collect bird activity data for a variety of bird detection projects, especially for bird hazards to aircraft and collisions with wind power structures.

Radar Ornithologist. RAF Kinloss Bird Detection System, Kinloss Scotland. August 2002 - June 2003. Mr. Zakrajsek supported this project to provide to the Royal Air Force the first real-time airport bird-detection radar system in the world. RAF Kinloss has a severe birdstrike hazard caused by large flocks of wintering graylag geese that transverse the airfield during operations. The bird-detection system tracks birds and aircraft in the airport vicinity to allow air traffic controllers to direct aircraft safely or cease operations when the situation becomes overly hazardous. He oversaw the acquisition of system components and the delivery of the system to the UK. He also oversaw the systems US operations including the installation of a mirror test facility, technical support services, and parts inventory.

Assistant Project Manager. Bird Detection System Development, Transport Canada, Canada. January 2002 - June 2003. Mr. Zakrajsek assisted the management of this multi-year, multi-phase project to develop a full-time airport bird detection system for use at Canadian airports. This system uses a 3-dimensional, phased array, Doppler weather radar. The system will have more functionality than the one delivered to RAF Kinloss (above). Transport Canada recognized the need to fund the development of this system to assist in the management of birdstrike hazards in Canada. He managed all lab and field operations in both the US and Canada.

Project Manager. Cape Wind Associates Avian Radar Survey, Nantucket Sound, Massachusetts. May 2002 - May 2003. Mr. Zakrajsek managed an avian radar survey for the



wind energy development industry. His bird-radar experience to date had been in the field of bird hazards to aircraft. For over 20 years bird fatalities due to collisions with wind-power structures have been of much interest to the industry, citizens groups, and government regulatory agencies. The bird-radar surveys were to support Cape Wind Associate's Environmental Assessment for their proposed development of the first off-shore wind park in the U.S. He managed the data collection during the two field seasons, data analysis, and project reporting.

Prior Experience:

Project Biologist. U.S. Fish & Wildlife Service, Alligator River National Wildlife Refuge, Manteo, North Carolina. May 1991 - May 1994. Project biologist at the Alligator River National Wildlife Refuge managing and assisting in a number of field surveys including: American alligator spotlight counts, black bear track & scat counts, waterfowl ground & aerial counts, beach nourishment impact sampling, sea turtle nest surveys and relocations, moist-soil vegetation sampling, Atlantic white cedar vegetation sampling, red-cockaded woodpecker surveys, and white-tailed deer track counts. He captured and banded wood ducks, brown pelicans, and common, Caspian and least terns. He assisted trapping and collecting data on black bears and reintroduced, endangered red wolves. He assisted with control efforts during a Fowl Cholera outbreak in the Chesapeake Bay. During fire season he was in charge of the wild land fire-crew and oversaw both prescribed burns and wildfire suppression efforts both on and off the refuge.

Field investigator. Red-Cockaded Woodpecker Survey and Long Term Management Plan, Marine Corps Base Camp Lejeune, North Carolina. 2001-2 Conducted protected species survey for the endangered Red-Cockaded Woodpecker (RCW). He collected forest ecology data for the RCW Habitat Evaluation Procedures and conducted a search for undocumented RCW clusters and cavity trees on the base.



10. DeTect ARS Project References

10.1 ARS Project Overview - Over 50 MERLIN systems are currently in use worldwide. Representative wind energy projects that use MERLIN include:

- Royal Belgian Institute of Natural Sciences (RBINS) - Management Unit of the North Sea Mathematical Model (MUMM)
- El Pino Wind Farm - TORSA Renovables, SL - Los Barrios, Cadiz, SPAIN
- Gulf Wind I Windfarm, Texas & Westfield-Ripley Windfarm, New York, USA (Babcock & Brown Renewables; Gulf Wind I includes MERLIN SCADA)
- Nordwindzee Offshore Windpark, The Netherlands (Shell/NUON)
- Butler Ridge Wind Farm Bat Survey, Wisconsin, USA (US Fish & Wildlife Service/US Environmental Protection Agency/Wisconsin Department of Natural Resources)
- Buffalo Mountain Wind Farm Bat Mortality Study, Tennessee, USA (Electric Power Research Institute/Tennessee Valley Authority)
- Beatrice Offshore Wind Demonstrator, Aberdeen, Scotland (Talisman Energy/University of Aberdeen)
- West Wind Windfarm, Wellington, New Zealand (Meridian Energy Ltd)
- Peñascal Wind Farm, Texas, USA (Iberdrola Renewables; includes MERLIN SCADA)
- Plum Island Offshore Wind Park, New York, USA (Deepwater Wind)
- Smola Windpark, Norway (Norwegian Institute for Nature Research)
- Lake Ostrowo Wind Farm, Poland (Dong Energy/KAPPA)
- Plum Island Offshore Wind Park, New York, USA (Deepwater Wind)

Other MERLIN users include the U.S. Air Force (seven systems purchased to date); the US space agency, NASA (two systems purchased for use on space shuttle launches), the U.S. Geological Survey (USGS, purchased for migratory bird research), the United Kingdom Central Science Lab (two systems used for wind farm and airport studies and monitoring), and the Texas A&M University Cesar Kleberg Wildlife Research Institute (purchased two systems for migratory research).



10.2 Detailed Windfarm Project Summaries

Summaries of two key representative windfarm MERLIN ARS projects follow:

10.2.1 The Near Shore Windpark avian radar survey, risk assessment & post-construction monitoring

DETECT SCOPE: Delivery, installation, system start-up & support for MERLIN™ Avian Radar System for offshore wind energy project avian survey, risk assessment, and post-construction monitoring and mitigation

CLIENT: Bureau Waardenburg b.v., The Netherlands

OWNER: Royal Dutch Shell/NUON Energy

The Near Shore Windpark (NSW) is a joint project of the Dutch government and Royal Dutch Shell to construct 36 wind turbines 10-15 kilometers (km) off the coast of Egmond, the Netherlands. Bureau Waardenburg (BuWa) is the project natural resources consultant to the owner and was tasked to conduct a base line study to assess the effects of offshore wind turbines on birds, specifically focused on the risk of bird mortality, influence on flight patterns and other ecological impacts, and to develop and implement a risk mitigation plan for the project. The long-term assessment research followed a 'BACI' approach, where data are collected before and after the construction of the wind farm in order to more directly assess impact. The pre-construction assessment started in September of 2003 with the installation of a MERLIN XS2530e Avian Radar System (MERLIN, the radar or the system) on the research platform 'Meetpost' located 10 km off the coast of Noordwijk, The Netherlands. The MERLIN system operated 24-7 for 16 months collecting data on bird activity, flight patterns and behavior. The radar data was processed by DeTect and used to develop the risk assessment for the wind farm. Post-construction monitoring started in December of 2006 with re-installation of the MERLIN avian radar system on a monopole near the wind turbines.

DeTect was contracted by BuWa on behalf of the project owner to design, construct, deliver, install, start-up and support a custom engineered and constructed MERLIN™ Avian Radar System for the project. The scope of DeTect's contract was to provide all required hardware, software, peripherals, technical, data processing and radar ornithology consultation support for a fully functional, avian radar system for continuous monitoring, tracking, recording and analysis of bird data for the pre-construction survey and post-construction risk mitigation phases of the project.



MERLIN system HSR (foreground) and VSR (rear) installation on Meetpost research platform (2003)

The MERLIN configuration included dual radars: a 25 kilowatt (kW) vertically-operated X-band scanning radar (VSR) and a 30 kW horizontally-operated S-band scanning radar; custom radar



towers and base plates for mounting to the research platform; custom computer-radar interfaces and workstations; data processing workstations; software licenses; voltage and power regulators; installation and training; and, telephone and Internet technical support. Initial delivery of the system to the project site was made under an accelerated schedule of 30 days after contract award in order to have the system installed and operating in time for the fall 2003 migratory season.

The project had several unique requirements necessitating customization of the system hardware and software to meet specific project needs:

- The MERLIN system was to be installed on an unmanned offshore research platform and was equipped with the ability for remote administration from the mainland via a telephone link.
- The VSR used for height measurement and enumeration of bird targets passing over the study area was equipped with a custom engineered enclosed tower designed to accommodate a servo-motor to allow the radar to be remotely rotated to change the direction of the radar beam.
- The DeTect MERLIN bird detection software included custom modules to provide remote, unattended operation and recordation of bird data to a database for offsite analysis and archiving that included a custom computer communication workstation with removable hard drives and internal modems for use with landlines.
- The system design included hardened components for reliable operation in the adverse environment of the North Sea.
- The system was re-engineering in 2006 for re-installation on a monopole at the operating wind turbines with new functionality including upgrade of the MERLIN avian radar software; addition of advanced remote control features for expanded system control and monitoring from the shore via fiber-optic connection.

DeTect successfully delivered the system in less than 30 days and was able to have the system installed and on-line in time to begin data collection for the fall 2003 migratory season. The MERLIN system operated near continuously 24-7 through 2003 and 2004 collecting data on bird movements in vicinity of the platform. In 2005, DeTect assisted BuWa in data compiling and analysis to develop detailed statistical data on bird distribution, size categories, altitudes, and movements.



The MERLIN system was re-installed on a Monopole in 2006 as an avian monitoring system for the windfarm

Data processing by DeTect in its data center in Panama City, Florida, USA included development and application of specialized track quality control algorithms and supplemental clutter suppression to address specific sea state clutter issues related to this site in the North Sea. The processed data and resultant queries were provided to BuWa for incorporation in their 2005 project report. The MERLIN system continued to operate collecting additional baseline data through project construction, and in the last quarter of 2006 the system was installed on a monopole to provide



post-construction monitoring for the operating wind farm. In September 2007, MERLIN processors were added to a ship collision avoidance radar at the wind farm to provide a second avian radar system for expanded bird detection range.

DeTect provided engineering, programming and on-site re-installation support for the monitoring system that included design review of radar custom radar mounts for the monopole; re-installation QA/QC; specification of custom magnetrons to eliminate in-band interference from other marine radars in the project area; delivery of a new, expanded capability remote control interface; delivery and installation of MERLIN avian radar software upgrades; development of automated data processing software for the monitoring phase of the project; updated user training to BuWa; radar installation and calibration; and, data processing and quality assurance.



10.2.2 Beatrice Wind Farm, Offshore Avian Radar Survey, Scotland

DETECT SCOPE: Delivery, installation, system start-up & support for MERLIN™ Avian Radar System for offshore wind energy project avian survey, risk assessment, and post-construction monitoring and mitigation

CLIENT: Talisman Energy, Ltd.

OWNER: Talisman Energy/Scottish and Southern Energy

The Beatrice Wind Farm is the flagship project for offshore wind energy development in Scotland, the UK and Europe. The €41 million project aims to install two demonstrator wind turbines adjacent to the Beatrice oil field, 25 km off the east coast of Scotland. The project is owned by Talisman Energy and Scottish and Southern Energy, who contracted the University of Aberdeen to conduct an avian survey of the proposed installation area.

In 2005, Talisman purchased a Furuno 25 kW S-band marine radar for the University to use to conduct an avian survey and mortality risk assessment for the proposed wind farm. The radar was installed by the Talisman and the University on the Talisman Beatrice oil platform off the Scottish coast and operated in a horizontal scanning mode. After the radar was installed, the University determined that manual interpretation of standard marine radar display and data did not provide sufficiently reliable data to support the survey and risk assessment.



Furuno marine radar on the Talisman-Beatrice platform (top unit - blue); the MERLIN processor was installed in the equipment console to the left.

The University contacted DeTect and requested a feasibility proposal for DeTect to upgrade the Furuno radar to DeTect's MERLIN™ avian radar processor. DeTect was contracted by Talisman Energy in early 2006 to provide a project assessment and deliver, install and start-up hardware and software, to automate the radar data collection and processing. DeTect added the MERLIN computer equipment and software, including the MERLIN avian radar processing software, to the Furuno radar in March 2006 and the system was operable and automatically collecting data 24-7 in time for the spring 2006 migratory season. DeTect provides on-going data analysis, processing, interpretation, QA/QC and radar ornithology consultation to the University and Talisman for the project.

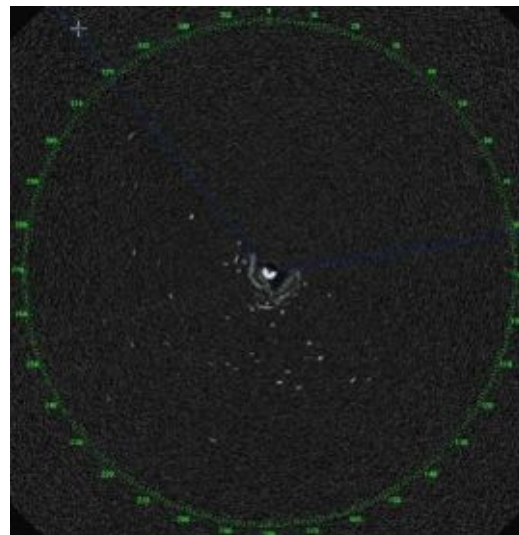
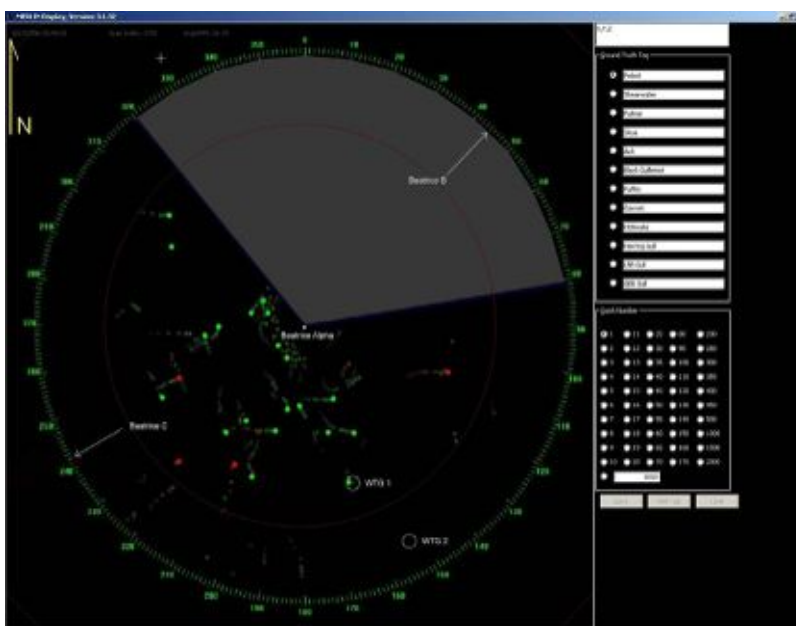
After inspecting the project site and reviewing the assessment plan developed by the University, DeTect recommended additional of a vertical scanning X-band radar (to collect altitude data on the survey area), installation of internet connectivity (to the radar to provide remote data access and system control), and addition of a radar shield to the horizontally scanning S-band radar (to reduce sea clutter interference). In November, 2006, DeTect's contract was expanded to include addition of the recommended upgrades and to provide long-term advisory and avian biology support services to the University and Talisman for the project.

The MERLIN processor addition in 2006 provided the University biologists with real-time processed bird track data in a presentation format that is usable to the study researchers. The MERLIN system additionally automatically records all radar system and bird track data directly into the MERLIN database for offsite analysis and use in risk determination.

The photo to the right is a screen photo of the pre-MERLIN upgrade standard (unprocessed) Furuno S-band radar display as installed by the University in 2005. The small white -spots" in the image from south-southeast to the west are bird targets being tracked by the radar. The white semicircle at the center of the display is reflectivity clutter from the metal oil platform structure. The lighter white -smearing" near the center is sea state (wave top) clutter interference. With this display, the biologist must continually monitor the screen, decide which targets are birds, determine the sizes of the birds and attempt to count and record the targets. Additionally the presence of clutter obscures some bird targets reducing the reliability of the data.

The bottom photo is the same date after being processed by the MERLIN software. The MERLIN system removes the interference clutter with its custom clutter suppression algorithms; identifies, tracks and converts the bird targets in to readily discernible symbols with -trails" indicating the historical path of the bird; and adds a custom -map" reference underlay showing

Right photo– the Furuno raw radar image before MERLIN processing.
Bottom photo – the same data displayed by the MERLIN radar processing software





the radar position (screen center), bearing, relative distance (red 1 nm range ring), and the bird targets in relation to other features (WTG 1 & 2 – the proposed turbine locations).

All information on each target (track ID#, target size, speed, bearing, etc.) is also continuously recorded by the MERLIN software to the system's internal database – this data can be queried with the software's standard programs to develop density and passage rate values for mortality risk calculation. The MERLIN display also shows the MERLIN Groundtruth Bar (the right panel of the screen) that allows biologist observers on the platform to visually confirm bird targets tracked by the radar and append observational data such as species, quantity, flight behavior, etc. to the specific target track in the database.



10.3 Radar Survey Project References

A list of additional representative wind farm survey project that have used the MERLIN Avian Radar System follows:

Block Island Offshore Wind Park, Rhode Island, USA (Deepwater Wind LLC) 2008-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System for a yearlong pre-construction survey the proposed offshore wind farm. For the first year, the radar was installed on-shore and surveyed near shore turbines sites. DeTect's work also included supply and installation of four Anabat bat detectors to develop data to identify bat activity in the MERLIN radar data. For year Two, the radar system will be reinstalled onto a met mast tower 4 miles offshore to collect preconstruction data for the offshore windfarm installation. In the fall of 2009, the survey was supplemented by installation of a DeTect VESPER Fixed-beam Vertical Profile Radar to develop data on bat activity at the site. The VESPER deployment is funded by a grant from the U.S. Department of Energy. DeTect provides bird radar study technical design, consulting and data processing and analysis support working with the owner's environmental consultants, Tetrattech, Inc. and Pandion Associates.

Plum Island Offshore Wind Park, New York, USA (Deepwater Wind LLC) 2007-2008. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System for a yearlong pre-construction survey the proposed offshore wind farm. For the first year, the radar was installed on-shore and surveyed three near shore turbines sites. For year Two, the radar system will be reinstalled onto the met mast tower 6 miles offshore to collect preconstruction data for the offshore windfarm. DeTect provides bird radar study technical design, consulting and data processing and analysis support working with the owner's environmental consultant, ecology & environment, Inc.

Buffalo Mountain Wind Farm Bat Radar Survey, Oak Ridge, Tennessee, USA. (Tennessee Valley Authority and Electric Power Research Institute) 2005-2006. DeTect conducted a Phase I bat survey with a MERLIN XS1030e radar system with thermal imaging cameras at the Buffalo Mountain Wind Farm in Oak Ridge, Tennessee in August 2005 under contract to the Tennessee Valley Authority (TVA) and the Electric Power Research Institute (EPRI). Project tasks included supply and operation of a DeTect-owned rental MERLIN Avian Radar System unit, thermal imaging equipment, operators, field biologists, data analysis and expertise to investigate bat mortality at the site and provide recommendations for the Phase II study and a post-construction monitoring program to address the bat kills at the site. The data developed from this study was used to identify specialized radar requirements for bat mortality risk mitigation and led to the development of DeTect's VESPER Fixed-beam Vertical Profile radar system.

Cape Cod Community College Wind Turbine, Hyannis, Massachusetts (Massachusetts Technology Collaborative) 2005-2006. Supported data collection and assessment of bird activity at the proposed single wind turbine site including delivery, operation of a MERLIN XS1030e Avian Radar System during the fall of 2005 and spring 2006 migratory seasons. DeTect also provided data post-processing and analysis in DeTect's data center in Panama City, Florida and developed avian impact and risk report based on the data collection.

Central Science Lab Avian Radar Systems, York, England, United Kingdom (Food and Environment Research Agency, fera) 2003-present. DeTect has supplied and supports two



MERLIN XS2530e Avian Radar Systems used by fera for wind farm and airport avian surveys and support throughout the United Kingdom. Included a MERLIN XS2530ex system with an extended height expandable tower and upgrade of a Geo-Marine MARS bird radar unit to the MERLIN avian radar system software. In 2008, DeTect supported the fera in assessment and development of offshore avian radar survey methodologies to set standards for the European Union.

Comstock Wind Farm, Reno, Nevada (Great Basin Wind/Oak Creek Energy) 2008-2009.

DeTect supplied and supported operation of a company-owned MERLIN XS1030e Avian Radar System for survey and assessment of bird activity at the proposed wind turbine site for the fall 2008 and spring 2009 migratory seasons. The owner's consulting biologists, Klein elder, Inc., were trained on system operation and maintained system operation and data collection during the 4 week survey periods for each season. DeTect provided full remote technical support and data analysis, QA/QC, bird mortality risk assessment and reporting.

Easthaven Wind Farm Avian Radar Survey, Easthaven, Vermont, USA (Vermont Fish and Wildlife Department) 2004. Conducted a limited avian radar survey of the proposed Easthaven Wind Farm in November 2004 under contract to the Vermont Fish and Wildlife Department. Under the contract, DeTect conducted a four week survey of the proposed wind farm site with a DeTect-owned rental MERLIN X10 bird detection radar system. The work included system operation, data groundtruthing, data analysis and expert testimony for assessment of mortality risk to bird activity from the proposed wind turbine site.

Gulf Wind I Windfarm, Texas USA (Pattern Energy, formerly Babcock & Brown USA) 2006-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System for avian mortality risk monitoring at the wind farm located on the Texas Gulf Coast. The system was installed in the fall of 2006 and collected two years of 24-7 data on avian activity that was used to model potential risk to migratory and resident birds in the proposed wind farm areas. In 2008 the system was installed as a permanent monitoring system for the operating wind farm with the MERLIN SCADA avian mortality risk mitigation software which allows the bird radar to function as an early-warning mortality risk mitigation system for migratory birds providing advance detection of elevated bird activity and automatically idling the wind turbines when birds are detected under high mortality risk conditions. The MERLIN SCADA installation at the Gulf Wind I Windfarm is the first use of automated avian radar technology for risk mitigation at a wind farm in the world. DeTect provides bird radar study and monitoring technical design, consulting and data processing and analysis support working with the owner's environmental consultants, SWCA, Inc. and Texas ESA.

Lake Ostrowo Wind Farm, Poland (Dong Energy/KAPPA) 2007-present – Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System conducting multi-year post-construction survey at Poland's largest wind farm located on the Baltic coast. The system is operated by the University of Szczecin with on-going data analysis, processing, QA/QC and general consultation provided by DeTect.

Neda Mine/Butler Ridge Wind Farm Bat Survey, Fond du Lac, Wisconsin, USA. 2005-2006. Conducted a radar bat survey at the proposed Butler Ridge wind farm near the Neda Mine in Wisconsin under contract to the Wisconsin Natural Resources Foundation with funding from the US Fish and Wildlife Service (USFWS) and the US Environmental Protection Agency (EPA). DeTect provided a MERLIN XS1030e Avian Radar System, thermal imaging equipment, operators, data analysis and expertise to investigate the potential for bat mortality at the site



relative to the proposed wind farm site. Tasks included detailed analysis and correlation of the radar data with acoustic data from Anabat detectors deployed during the radar survey by staff of the Wisconsin Department of Natural Resources (DNR) and programming of custom algorithms to analyze potential to automatically differentiate bird and bat targets within the radar system in real-time.

Penãscal Wind Farm, Texas USA (Iberdrola Renewables) 2008-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System as a permanent monitoring system for this operating wind farm that is located adjacent to the Gulf Wind I wind farm south of Corpus Christi, Texas in Kenedy County. The system uses the MERLIN SCADA avian mortality risk mitigation software which allows the bird radar to function as an early-warning risk mitigation system for migrating birds at the wind farm providing advance detection of elevated bird activity and automatically idling the wind turbines when birds are detected under high mortality risk conditions. Along with Gulf Wind I, the MERLIN SCADA installation at the windfarm is the first use of radar technology for migratory bird mortality risk mitigation at a wind farm in the world. The systems are also integrated into a wider network of bird radars with though a VPN to expand the early warning capability of each individual radar between each wind farm. DeTect provides bird radar study technical design, consulting and data processing and analysis support working with the owner's environmental consultants, SWCA, Inc., Texas ESA and WEST, Inc.

PdV Wind Farm Avian Radar Survey, Kern County, California, USA. 2005-7 In support of the developer's consultant, Sapphos Environmental, Inc., DeTect provided a two-phase avian risk assessment of proposed wind farm site in the Mojave area of California. Phase I provided pre-assessment of the site using processed US NEXRAD data with DeTect's BirdMap technology. Historical processed NEXRAD data for the site (24-7 data updated every six minutes) was extracted covering a three-year period for the project site and surrounding area and analyzed for levels of bird activity, with specific focus on nighttime migration period in low visibility. Data was also compared to a known bird habitat resource area and conclusions developed as to the relative level of bird activity and mortality risk expected for the project site. For the fall 2006 migratory season, DeTect provided a company-owned rental MERLIN XS1030e avian radar system to Sapphos biologists for collection of data 24-7 during the fall migratory season. Sapphos biologists were trained on system operation and DeTect provided full remote technical support and data analysis, QA/QC, bird mortality risk assessment and reporting.

El Pino Wind Farm, Spain (Torsa Renovables) 2009-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS25200me Avian Radar System equipped with a solid-state MERLIN*SharpEye* horizontal scanning radar supporting a vulture mortality risk mitigation study at operating wind farm. The system is collecting data 24-7 to determine usage patterns for the vultures at the site to develop mortality risk mitigation implementation of the MERLIN SCADA mortality risk system. DeTect is providing the study design, field installation oversight, system startup, field biology support, consulting and data processing and analysis support working with the owner's biologists.

Ross Island Windfarm, New Zealand (Meridian Energy Ltd.) 2008-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System operated by New Zealand's largest energy company and wind farm developer to assess migratory bird risk for the Antarctic coastal wind farm site. The system is operated by



the developer's consultants, Boffam Miskell, with data analysis, processing and risk assessment support provided by DeTect.

Town of Orleans Wind Turbine, Massachusetts (Massachusetts Technology Collaborative) 2005 to 2006. Supported data collection and assessment of bird activity at the proposed single wind turbine site including delivery, operation of a MERLIN XS1030e Avian Radar System during the fall of 2005 and spring 2006 migratory seasons. DeTect also provided data post-processing and analysis in DeTect's data center in Panama City, Florida and developed avian impact and risk report based on the data collection.

Smola Windpark, Norway (Norwegian Institute for Nature Research) 2008-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System supporting Sea eagle mortality risk mitigation study at operating wind farm. The system is collecting data 24-7 to determine usage patterns for the Sea eagles at the site to develop mortality risk mitigation implementation of the MERLIN SCADA mortality risk system. DeTect provides bird radar study technical design, consulting and data processing and analysis support working with the owner's consultants, NINA and SINTEF.

Tetrattech, Inc. MERLIN Avian Radar Systems, Portland, Maine USA (Tetrattech, Inc.) 2003-2009. DeTect has supplied and supports two MERLIN XS2530e Avian Radar Systems used by a leading international environmental and engineering consulting firm, Tetrattech, for wind farm and airport avian survey projects. The MERLIN system delivered in 2008 includes the extended scissor-lift option that elevates the radar sensors to 38 feet above ground level.

Westfield-Ripley Windfarm, New York, USA (Babcock & Brown) 2007-present. Design, delivery, installation, start-up and operational support of a mobile MERLIN XS2530e Avian Radar System conducting pre-construction survey of proposed wind farm site in northern New York State. The radar was installed in the fall of 2007 and is collecting data 24-7. The project site is located in the US Great Lakes flyway and is considered a key resource area. DeTect provides study technical design and data processing and analysis working with the owner's environmental consultant, ecology & environment, Inc.



10.4 Commendations

DeTect's MERLIN Avian Radars are used at facilities and project sites worldwide with a proven record of exceptional performance, reliability and operability, with over 500,000 hours of operating experience. The company has a strong record of repeat business: the USAF has purchased seven DeTect systems to date based on a documented record of improved aircraft safety, and NASA after conducting intensive market research and competitive testing of available technologies, in 2006 selected DeTect technology to support launch safety for the \$2 billion space shuttle during the July space shuttle Return-to-Flight (NASA subsequently ordered a second DeTect system in 2008 for the Kennedy Space Center).

DeTect routinely receives commendations from its clients for its high level of customer service and technology ...

Mike Leinbach, NASA Space Shuttle Launch Director ...

Your system worked like a champ and allowed us to launch the Space Shuttle Discovery safely July 4, 2006 on her STS 121 Mission to the International Space Station. Thank you very much.

Anthony Griffith, NASA JSC Sub-Orbital Debris Radar Program Manager ...

You guys should be justifiably proud that while radar was a late comer to the bird abatement party, it is one of the few remaining systems fielded for flight support among dozens of alternatives that were investigated after STS-114. Quite an accomplishment.

Bruce MacKinnon, Transport Canada, Manager Security and Safety ...

I know that the staff of Vancouver International Airport share my high regard for the DeTect team. We believe that the DeTect team is the only group capable of delivering the results that we seek.

Stephen J. Payne, NASA Shuttle Test Director, Launch and Landing Division ...

Thanks for your excellent support of the STS-118 launch. You have become a regular feature at our launches and it is always a pleasure to work with you.

Rick Greiner, Babcock & Brown Renewable Holdings, Permitting Manager ...

[B&B] has, since 2005, contracted with Detect for equipment and services on projects in Texas and New York. We are convinced that the MERLIN Avian Radar Survey methodology is the best on the market today. The level of service provided by Detect and the reliability of their equipment is very high. We continue to rely on Detect for radar equipment and services for many of our most critical projects. It has been our experience that the staff at Detect Inc. has always been very responsive to our project needs.

Michael Kujawa, Winergy Power, Director Research & Analysis ...

The DeTect MERLIN system has surpassed our expectations as to the depth of detail, digital processing, and data mining capabilities that we needed. A similar response has been voiced by all government regulators regard such data as a critical determinant for granting of the permits for the project. We are highly satisfied by DeTect's prompt and sustained support and willingness to quickly develop new solutions to meet unforeseen challenges that we faced by placing the unit in such a remote location. Finally, we greatly appreciate the level of professionalism and depth of knowledge that has been displayed by DeTect support personnel. It would be hard



to image a better combination of state of the art technology and organizational backing.



DeTect Inc.
Mr. Gary Reynolds
3160 Airport Road
Panama City, Florida 32405 USA

May 6, 2008

Dear Mr. Reynolds:

We understand that DeTect avian and bat detection radar is being considered for environmental monitoring for a project in New Zealand.

Winergy Power Holdings LLC ("Winergy") is a leader in the development of an offshore wind energy industry in the coastal waters of the United States. We are in the process of obtaining the final permits for the first offshore wind demonstration project in the USA and, simultaneously, applying for permits for offshore meteorological and environmental monitoring towers and State-requested offshore wind farm projects.

The DeTect Merlin avian and bat monitoring system that we have installed on an island adjacent to our offshore wind energy demonstration project site has surpassed our expectations as to the depth of detail, digital processing, and data mining capabilities that we needed. A similar response has been voiced by all government regulators regard such data as a critical determinant for granting of the permits for the project.

We are highly satisfied by DeTect's prompt and sustained support of the Merlin system, and willingness to quickly develop new solutions to meet unforeseen challenges that we faced by placing the unit in such a remote location.

Finally, we greatly appreciate the level of professionalism and depth of knowledge – both technology and biology – that has been displayed by DeTect support personnel. It would be hard to imagine a better combination of state of the art technology and organizational backing than we have received thus far.

Sincerely,

Michael Kujawa

Director – Research and Analysis
Winergy Power

110 Motor Parkway, Suite 421, Hauppauge, NY 11788 USA
(815) 434-0100 | (815) 239-4888
detect@winergyllc.com | www.winergyllc.com



BABCOCK & BROWN

Babcock & Brown LP
1600 Smith Street - Suite 4025 - Houston TX 77002 USA
T 713 571 8900 - F 713 571 8004 - www.babcockbrown.com



May 6, 2008

RE: Letter of Recommendation for Detect Inc. MERLIN Avian Radar Survey
services and equipment

To whom it may concern,

Babcock & Brown Renewable Holdings Inc. has, since 2005, contracted with Detect Inc. for equipment and services on projects in Texas and New York. We are convinced that the MERLIN Avian Radar Survey methodology is the best on the market today. The level of service provided by Detect and the reliability of their equipment is very high.

We continue to rely on Detect Inc. for radar equipment and services for many of our most critical projects. It has been our experience that the staff at Detect Inc. has always been very responsive to our project needs. We look forward to continuing our working relationship on future projects.

Sincerely,

John F. (Rick) Greiner, CPG
Permitting

Trinity
Washington
Baltimore
San Francisco
San Diego
Dallas
Houston
New York
Columbus
Austin
Miami
London
Paris
Louisville
Alaska
Mexico
International
Global
Kuala Lumpur
Singapore
Hong Kong
Tokyo



4 September 2008

Gary Andrews
Principal in Charge
DeTect Inc.
1902 Wilson Avenue
Panama City
Florida 32405
UNITED STATES OF AMERICA

Dear Gary

Delivery, setup and initial support of Meridian Energy's MERLIN radar system

This letter is to advise you that the delivery, setup, calibration and training of field operators for the MERLIN radar has been completed to Meridian's satisfaction.

Further, we would like to acknowledge the outstanding work of Jon Bortle in achieving this. At times issues relating to achieving this outcome were challenging and required patience, communication and negotiation.

Meridian was very impressed with Jon's professionalism, enthusiasm and dedication in ensuring Meridian's best interests were maintained at all times.

On another note, Meridian is extremely pleased with the MERLIN radar and we can clearly envisage that it will be a crucial tool in evaluating avian ecological issues, for gaining wind farm consents.

We look forward to Jon's return to New Zealand for the next phase of monitoring.

Please pass on our sincere thanks to Jon, his work was truly appreciated.

Kind regards

Graeme Mills
Wind Investigation Manager

Marise Metrick
Resource Monitoring

Meridian Energy Limited

Level 1, 33 Customhouse Quay
PO Box 10-040
Wellington 6143, New Zealand

Phone +64-4 381 1200
Fax +64-4 381 1272
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10.5 MERLIN SCADA Papers

A Quantitative Methodology for Determination of Migratory Bird Mortality Risk at Windfarms

Authors: Ronald L. Merritt, Principal Biologist, DeTect, Inc.; T. Adam Kelly, Chief Scientist, DeTect, Inc.; Gary W. Andrews, Scientist, DeTect, Inc.

Presented at the American Wind Energy Association, Windpower 2008 Conference in Houston, Texas, USA June 1-5, 2008

Abstract.

Assessment of migratory bird mortality risk at windfarm sites to date has relied mostly on traditional biological techniques - visual surveys and literature reviews — resulting in at best qualitative estimation of risk. The subjectivity and indeterminacy inherent in this approach subsequently leaves the conclusions open to vigorous debate between the project stakeholders. Radar is increasingly being used to conduct bird surveys at wind farm sites based on its ability to extend the distance the biologist can "see" as well as its capability to detect and track birds at night. Radar techniques to date however have primarily relied on conventional radar ornithological methods where a trained biologist monitors a radar screen visually deciding which "blip" on the radar screen is a bird and manually recording the number of birds and other data. This technique, while more reliable than visual surveys alone, is still highly subjective and results can vary greatly by operator and technique.

Since the 1980's, the U.S. Air Force has led development of specialized avian radar systems to detect and track birds to reduce aircraft-bird collisions (strikes) and has developed complex programs and mathematical models to predict and manage strike risk. A variant of these models has been applied to the communication tower and wind energy industries that uses data from modern avian radar and meteorological systems to collect detailed data activity and more accurately model bird movements in project areas and to quantitatively predict bird mortality risk from collisions with the structures. The objectivity in the data and model provides the wind energy industry with a new tool to more accurately predict and assess potential risk, evaluate project impacts, and address core developer and stakeholder issues.

Additionally, the current generation of advanced avian radar systems now on the market can be integrated with windfarm control systems to continuously monitor bird activity around the windfarm applying the model in real-time to provide active risk mitigation through a variety of response measures that can include selective idling of turbines during periods of high mortality risk conditions. Recent studies have indicated that the economic impact to the wind energy project from this technological approach is minimal as the high risk periods typically occur during times of low wind and/or non-peak demand resulting in a manageable mitigation cost.

Bird Survey Methods.

Assessment of migratory bird mortality risk at windfarm sites to date has relied mostly on traditional biological techniques - visual surveys and literature reviews — resulting in at best a



highly subjective, qualitative estimation of risk. Visual survey techniques include point counts, where the biologist periodically "count" birds within a view 360 degrees around a reference point (figure 1) and other methods that similarly rely on the skill and visual acuity of the field biologist to see, count and project the number of birds in a project area.



Figure 1: Traditional point count bird survey

Radar Ornithology.

Radar ornithology is being increasingly being used for bird surveys at wind farm sites based on the ability of radar to extend the distance the biologist can "see". Radar ornithology offers several advantages to the study of bird movements as it can sample large volumes of airspace continuously and consistently and can track birds of all sizes, well beyond the capabilities of an observer with a spotting scope (Eastwood, 1967; Blokpoel, 1976).

Even during conditions of good visibility, small, highflying or distant birds that often are missed by visual observers can be detected by radar (Korschgen et al., 1984). Radar also allows study of nighttime, dusk, and dawn bird movements when visual observations are unreliable or not possible and radar operates well in fog when typical visual techniques are ineffective (Gauthreaux, 1994). Radar provides highly reliable information on the movements within a range of a few kilometers (Williams et al., 1972; McCrary et al., 1981; Cooper et al., 1991) with small marine radars (10 kilowatt [kW] power) able to reliably detect individual small birds (swallows) out to 1.2 km (0.75 mi.) and single larger birds out to 2.4 km (1.5 mi) (Gauthreaux, 1994).

Virtually any radar can detect and track birds with birds appearing as small "blips" in the radar display (figure 2). Radar bird surveys typically have a trained biologist monitor the radar screen visually deciding which blip on the radar screen is a bird and manually recording the number of birds and other data such as estimated bird size, speed, direction and altitude.

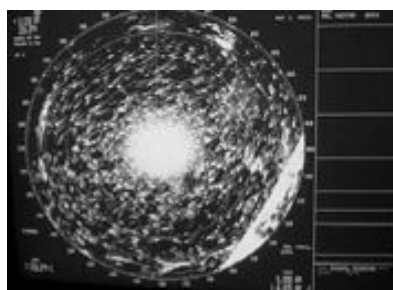


Figure 2: Unprocessed "raw" marine radar display during migration

The most commonly used radar for bird surveys is the "fan beam T-bar marine radar" (figure 3) which ranges from low cost, low power units widely that are typically used on recreational boats to more expensive, industrial grade systems that are used on commercial, oceangoing ships. Some efforts have been directed to improve the manual interpretation process by recording the radar display and post analysis of image or video, but the method is still highly reliant on manual interpretation of the base radar imagery. While more reliable than visual survey, "manual" radar ornithology is highly labor intensive and very costly for long term survey or operational monitoring.

Manual Radar Ornithology Data Error.

Manual radar ornithology is subject to a high level of error in data reliability due to a number of factors that include, but are not limited to operator proficiency, inter-and intra-operator variability, fatigue, count limitations, equipment capabilities, and, methodology. Observer fatigue in air traffic control radar operation is well studied and is directly analogous to radar ornithology (*Fatigue in Air Traffic Controllers*, Transport Canada, TP 13457, July 2000). Likewise, count error introduced by a high number of bird targets is obvious (figure 2) as during peak activity periods there can be simply too many targets for the operator to accurately assess and count. Low activity periods however also can be demanding as watching a radar display during periods of low activity involves intense concentration while waiting for "something to happen".

Measurement accuracy is also a leading error cause that includes count errors (over- or under-counting or mis-identification of a bird target), target detectability, and equipment sensitivity. Marine radar data is normally rendered to a data display as a Plan Position Indicator (PPI) display (see figure 2). The raster image of a PPI display can be visualized as a piece of graph paper: the larger the piece of graph paper and the smaller the grid squares, the finer the detail that can be rendered in scale. The lower cost, recreational marine radars that are used for many bird surveys have small screens and with few colors or shades (of grayscale) with far lower resolution than the higher cost, larger high resolution displays in more expensive industrial marine radars. Recreational marine radar systems are additionally rarely capable of rendering radar target intensities at more than 16 levels and, even when they can, only 2-3 levels of variability can be perceived by the human eye. Video or screen image recording of the display further compresses the detail resulting in more lost data and introduced artifacts.



Figure 3: T-bar type marine radar in horizontal surveillance scanning position

Manual radar ornithology typically uses the "echo trail" function to show the target "track". During migration with a significant number of bird targets moving at one time, the screen can quickly become saturated with bird targets and trails complicating target counting (figure 2). It is not unusual for the ornithologist to simply stop counting targets during high activity conditions resulting in significant undercounts and data gaps.

Many manual radar ornithology surveys also use only a single radar to survey both the vertical (y-z) and horizontal planes (x-y) with samples for each collected for short periods of time (typically 15 minutes) by "flipping" the radar from the horizontal survey mode (figure 4) onto its side into the vertical mode (figure 5) where the radar antenna spins in a windmill manner scanning from horizon-to-horizon (figure 6, Harmata et al. 1999). The resultant data gaps from the horizontal and vertical must be extrapolated introducing data gap bias into the data.



Figure 4: Marine radar in the horizontal scanning position Figure 5: Marine radar in the vertical scanning position

Many radar bird surveys also use data from the radar in the horizontal scanning position to project bird counts and "passage rates" with altitude estimated based on calculation, not actual measured height of the target above the ground. In the horizontal mode the amount of the radar display lost to ground clutter (terrain, vegetation) is generally high (see figure 2). When the ground clutter level gets too high and saturates the radar receiver, or is so high that the addition of a small target such as a bird does not significantly change the signal, the target is cannot be "seen" by the observer on radar screen and is not counted (is "lost" in the clutter). In contrast, scanning in the vertical mode, mostly looks at clear air and only scans the ground



clutter near the horizontal plane and up to the height of the terrain, so that the majority of the bird targets are clear of clutter. Imaging small targets against clear air results in a greater contrast than when imaging targets against a background of clutter, and accordingly, vertical scanning has a significant advantage over horizontal radar for detecting and counting the actual number of targets passing through a survey area.

The physics of insect contamination in radar data is also widely not completely or misunderstood. In manual radar ornithology, targets moving under 4 meters/seconds (m/s) in the data are frequently simply discarded as insects and not included in the bird target count based on misinterpretation of conclusions from studies with military tracking radars (Larkin 1991, *Flight speeds observed with radar, a correction: slow "birds" are insects*). Although pencil (tight) beam marine radar can detect insects, those that use the T-bar antenna start at a performance disadvantage. Under the right conditions, insects are readily detectable and observable when the marine radar is set to the shortest range setting (0.25 nm). But as the range setting is increased, the numbers of small targets visible is reduced significantly with this same "scaling effect" occurring with larger targets such as birds and bats with the result that valid bird targets are often rejected as insects in manual ornithology.

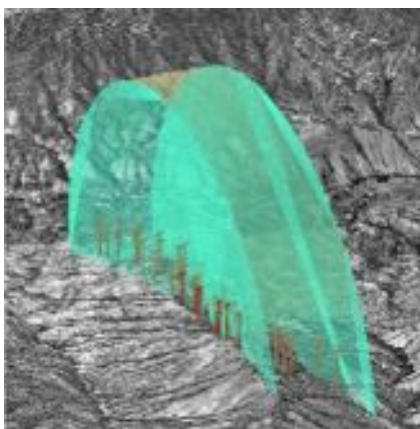


Figure 6: Vertical scanning coverage for wind farm survey

Automated Avian Radar Systems.

Since the 1980's, the U.S. Air Force has led development of specialized, highly automated avian radar systems to detect and track birds to reduce aircraft-bird collisions (strikes) and has developed complex programs and mathematical models to predict and manage strike risk. These advanced avian radar systems (figure 7) have recently become available on the commercial market and are seeing increasing use for environmental survey and scientific research. The systems generally include high-end, high-resolution industrial radars scanning simultaneously in both the vertical and horizontal planes and sophisticated, real-time radar data processing computer algorithms that automate clutter suppression and bird target identification, tracking and counting reducing or eliminating many of the deficiencies inherent in manual radar ornithology. The more advanced systems additionally can operate unattended 24-7, cost-effectively collecting detailed datasets on bird activity at project sites that can be used to assess bird activity and model mortality risk.



The current generation avian radar systems can also be integrated with windfarm control systems to continuously monitor bird activity around the windfarm applying the risk models in real-time to provide active risk mitigation through a variety of response measures that can include selective idling of turbines during periods of high mortality risk conditions. Recent long term studies have indicated that the economic impact to the wind energy project from this technological approach is minimal as the high risk periods typically occur during times of low wind and/or non-peak demand.

Quantitative Bird Mortality Risk Analysis for Wind Farms

A variant of the military birdstrike models has been developed for the communication tower and wind energy industries that uses data from these modern avian radar and meteorological systems to more accurately model bird movements in project areas and quantitatively predict migratory bird mortality risk. The objectivity in this model provides the industry with a new tool to more accurately predict and assess potential risk, evaluate project impacts, and address core developer and stakeholder issues.

Bird avoidance of obstacles such as tall structures, radio towers, communication towers, and wind turbines during day and night periods (including dawn and dusk) is near 100% as evidenced by the



Figure 7: Advanced avian radar system developed by DeTect, Inc. of Panama City, Florida, model MERLIN XS2530e

fact that significant bird kills are generally not observed daily near buildings, forests, towers, wind farms, and other similar structures. Mortality risk appears however to increase during nocturnal movements under conditions of low visibility (generally defined as visibility of less than 1/3 mile) such as heavy fog and haze (Kruse 1996, Kemper 1996, Larkin 2000, WT Docket No. 03-187 2004). Accordingly, migratory bird collision mortality risk analysis for wind farms is typically focused on periods when risk conditions of low visibility (e.g. fog) occur at night. The level of avoidance of birds to obstacles under conditions of low visibility at night is not well understood however and some avoidance is likely to exist even under these conditions.



The commonly applied methodology for normalizes the bird passage rates across a 1 kilometer (km) front at the height affected by the turbine rotor — the Rotor Swept Zone (The RSZ is defined as the turbine blade reach area from the lowest sweep point of the turbine blade to its highest sweep point) - over the period of one hour. Automated radar technology scans the full 1 km surface area at a sample rate of approximately 24 observations per minute with sampling in both the vertical and horizontal simultaneously and continuously. Subsequently, survey data, including passage rates of birds across areas of concern, can be analyzed at higher resolution time frames to provide maximum insight into the dynamics of bird activity at the site as well as mortality risk.

Evaluation of a risk considers:

- (1) the specific risk,
- (2) probability of occurrence, and
- (3) resultant consequences.

Risk assessment is the relationship of exposure to the risk versus the consequence(s) of the risk. The specific risk to birds presented by a proposed windfarm is collision (strike) of birds with the wind turbine components (tower, hub, blades) resulting in serious injury or mortality. The majority of studies of wind farm bird collisions have recorded relatively low levels of mortality (Drewitt, et al., 2006). As discussed previously, migratory birds generally have good visual powers to "see and avoid collisions" with static or moving objects, however bird visual acuity is compromised during conditions of low visibility conditions at night. Low visibility conditions occur during fog, sea mist and low cloud conditions, or occasionally from other obscurants such as smoke, and are exacerbated at night.

This probability analysis model is based on the model originally developed and used by the USAF for calculating aircraft-bird strike risk (Meyer, George E, 1975; Tucker, V.A. 1996). This model calculates the risk of a bird collision with turbine components based on the frontal zone presented by the target relative to the bird targets passing through the zone and provides a quantitative basis for estimation of risk.

In this model, the radar scanned zone is the total area in which the radar collects data (Figure 8; yellow shaded area). Data for the 1 km front is the area within the radar scanned zone 0.5 km to either side of the radar (Figure 8; green shaded area). The rotor swept zone (RSZ) is the 1 km wide area within the 1 km front area from the bottom most sweep of the turbine blade to the topmost extent of the rotor blade sweep (Figure 8; red shaded area). The Rotor Swept Area (RSA) is the circular area "swept" by the blades of a turbine during operation.

The moving parts of the wind turbine (the blades) present the most strike risk to birds, but birds can collide with any part of the wind turbine structure, including the support tower (figure 9) and the central hub of the nacelle (hub).

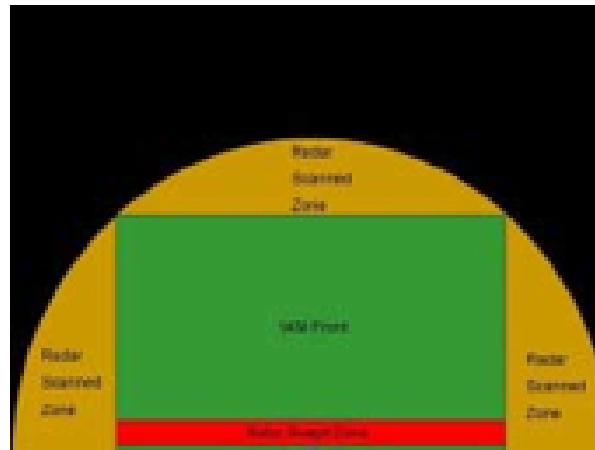


Figure 8: Illustration of the radar scanned zone, the 1 km front, and the rotor swept zone

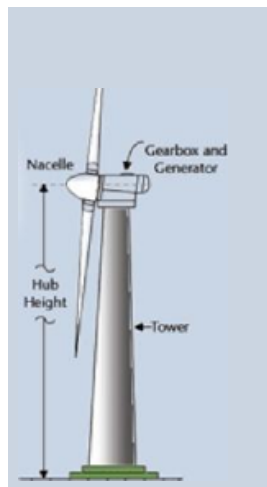


Figure 9: Components of a typical wind turbine

The RSA and RSZ can be calculated for each specific project from the turbine manufacturer data. For a single turbine installation, the Rotor Swept Area occupies only a very small portion of the 1 km front, and the blades only occupy a small percentage of the swept area at any given time. The Frontal Area presented by the turbine includes the frontal area of the tower, the generator, gearbox, blades and nacelle, and are included in the calculated value for the Frontal Area used for risk analysis (expressed as an area in square meters; Figure 10).

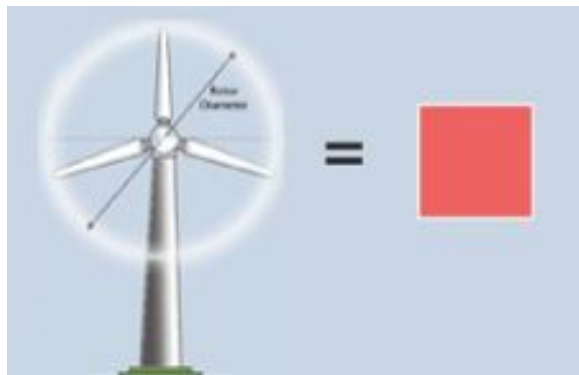


Figure 10: The frontal area of a wind turbine can be expressed as an equivalent frontal area in square meters.

Using the frontal area, the number of discrete pathways within the RSZ can be determined with a Discrete Pathway being equal in area to the frontal area of the wind turbine. The total number of Discrete Pathways (Figure 11) in the RSZ for a single wind turbine is calculated as:

Rotor Swept Zone Frontal Area of the turbine structure



Figure 11: Array of discrete pathways in the rotor swept zone with one of all the Discrete Pathways blocked by a wind turbine

The calculated number of Discrete Pathways for a project results in a 1 in "x" chance (with "x" being the Number of Discrete Pathways) that a target passing through the Rotor Swept Zone will have to change its flight path to avoid a component of the turbine structure. Accordingly, if the Passage Rate of targets (number of bird targets/hour/1 km front) as measured by the radar does not exceed the number of discrete pathways, then statistically no single target crosses the probability "Risk Threshold" of having to see and avoid any turbine component. This model assumes a worst case scenario of zero avoidance of obstacles by birds during low visibility at night conditions, so that the actual risk is most likely lower than the risk projected.

Conclusion

The advantage of this model is that the data is highly quantitative and objective, providing a means to develop standardized data for the wind energy industry to more reliably compare projected results with the actual mortality at the operating wind farm. Data developed by the model can also be used with advanced avian radar system technology as a risk mitigation



system where the radar integrated with windfarm control systems to continuously monitor bird activity around the windfarm applying the model in real-time to provide active risk mitigation responses that can include selective idling of turbines during periods of high mortality risk conditions. Recent studies have indicated that the economic impact to the wind energy project from this technological approach is minimal as the high risk periods typically occur during times of low wind and/or non-peak demand resulting in a manageable mitigation cost.



11. System Warranty and Operation & Maintenance Costs

11.1 MERLIN ARS Characteristics

The MERLIN ARS is proven, highly reliable technology with over 50 systems operating worldwide since 2003. The technology was originally developed for the US Air Force and the US space agency, NASA, and has been engineered to deliver superior performance and the highest level of system reliability as a critical flight safety system component. The USAF has to date purchased seven MERLIN systems, including a theater deployed system for Afghanistan, based on a documented history of birdstrike reduction and high system reliability. NASA, purchased two MERLIN systems to date and carefully assessed MERLIN system reliability as part of its acquisition process, certifying MERLIN for operational support of the \$2 billion space shuttle based on its validated performance and highest level of reliability (birdstrikes are NASA's second highest safety risk to the shuttle and NASA will not launch the space shuttle without MERLIN system support).

Other government agencies that include the British government and international airports have similarly selected the MERLIN system for flight safety support and MERLIN is the most widely used bird radar technology for wind energy project preconstruction survey and operational wind farm monitoring and risk mitigation. The oldest MERLIN system at an operating wind farm is the system installed at the Near Shore Wind Park (Nordwindzee) wind farm off of the Dutch coast that was installed in September 2003. The system has operated unattended at the remote offshore site nearly continuously since 2003 which includes 2 years of preconstruction survey and continuous monitoring operation when the wind farm went on line in 2006. This system used the older magnetron-based radar systems (not the state-of-the-art solid state radars proposed for this tender) yet has had very low system downtime (less than 2%) and service costs (under 16,400 euro). In 2008, the first round of DeTect recommended system upgrades was implemented which included replacement of the system processing computer units.

11.2 DeTect Warranty Terms

MERLIN is designed and manufactured by DeTect, Inc. of Panama City, Florida USA (a U.S. Corporation) and is supported by DeTect through a network of worldwide representatives. The systems are engineered and constructed to meet US industrial, MILSPEC and other US and international standards for durability, reliability and performance under continuous 24-7 operation and in high demand, adverse operating conditions.

DeTect provides a full parts and labor warranty with system that includes DeTect repair or replacement of any defective parts for the term of the warranty, exclusive of wear parts. *For this offer a one-year parts and labor warranty is included for all system components - DeTect will replace any covered parts that fail in the first year at its expense, which includes parts and labor.*

Note: The only components excluded from this warranty are wear parts are parts which degrade under normal use and include, but are not limited to, motor brushes, generators, tires, and other such components, or parts that fail due to deterioration from environmental or chemical exposure conditions. In 2009, DeTect significantly improved system reliability by upgrading the



MERLIN technology to all solid-state radar sensors with 50,000 hour MTBF manufacturer ratings (replacing magnetron based sensors that had 3000 hour MTBF manufacturer ratings).



Date: October 19, 2011 **Quotation:** QDT-111005D

To: RPS **Validity:** 90 Days
North Queensland, Australia

Via: **Tim Cookes - ES&S**

Ex Works DeTect, Inc.

Ref: Migratory Bird Mortality Risk Mitigation for Ratchaburri's Windfarms in North Queensland - Australia

MERLIN ARS System - Avian Survey Configuration

Item	Description	QTY	Unit Price (US\$)
1.0	Phase 1 - MERLIN XS25200me Avian Radar System See Item 3. MERLIN XS25200me Avian Radar System (ARS) Deliverables of our Technical Proposal QDT-111005D.	1	\$553,900
2.0	Phase 2 - MERLIN SCADA Risk Rule Development and Implementation (if deemed applicable)	1	\$138,600
TOTAL SYSTEM - CIF Australia			\$692,500

Radar Coverage Extension (Phase 3)

3.0	Additional MERLIN XS25200me Avian Radar System (same configuration as Item 1)	1	\$553,900
4.0	Additional 25KW VSR radars (skid mount) as needed for full windfarm coverage (final quantity to be determined at the end of Phases 1 and 2) *Note: Radar locations, number of and type of radar units/sensors and radar range settings are all subject to change based on further analysis and site visit(s) by DeTect Inc.	1	\$270,000

All pricing is in U.S. Dollars and the client assumes all foreign exchange risk.
Delivery quoted is CIF nearest major seaport (customer to arrange customs clearance,
import duties, and local transport to project and installation sites).

Payment Schedule & Terms:

- 30% of contract with order and executed contract
- 15% payment due 30 days after contract
- 15% payment due 60 days after contract
- 15% payment due 90 days after contract
- 15% payment due prior to shipment
- Balance in equal payments to be invoiced monthly with 5% due at start-up and the final 5% due within 60 days after startup

Payments are to be made within twenty (20) days of invoice date.
Failure to make payments in accordance with the terms and schedule may result in extension of delivery.

MERLIN ARS System - Avian Survey Configuration

Item	Description	QTY	Unit Price (US\$)
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Delivery Lead Time:

6-8 months after receipt of order

General Terms & Conditions:

1. Specifications are subject to change without notice. Systems will be delivered in general accordance with specifications and design currently in effect at time of order.
2. The price proposed is exclusive any and all applicable sales taxes, fees, licenses, duties, operating permits and other costs resulting from the sale, delivery, transfer, installation, and operation of the system and the buyer will be responsible for obtaining and costs related to such items. DeTect will provide available information for applications, permits and licenses as required by the buyer.
3. Title to the equipment will be transferred to the buyer upon receipt of all payments due from the buyer to DeTect under this proposal and any subsequent contract.
4. The buyer will be granted a single site user license to use the MERLIN™ operating software for the intended purpose only. DeTect will deliver a complete set of the MERLIN operating software executables with the system and periodically will issue updates and patches to the software. Any other such unauthorized use of the software or transfer of or installation of the software to other systems or computers or transfer to other users, companies or individuals is expressly prohibited. Non-compliance with the license requirements will result in revocation of the user license upon notification of which the buyer will immediately and promptly remove, delete, and destroy all copies of said software, providing written certification of compliance of such removal, deletion, and destruction.
5. Client user to provide required infrastructure for system in advance of delivery to include equipment pads, power connections and connections for remote system control and display via client fiber optic (or similar) network.
6. Purchase and delivery the system may be subject to the United States International Traffic in Arms Regulations (ITARs). Non-US government buyers at purchase will be required to execute an agreement acknowledging that: (i) DeTect's MERLIN system (defined as technology, hardware and software) may be governed by the United States ITARs; (ii) the system will be used solely for the intended commercial purpose and will be used in strict compliance with ITARs; (iii) he will implement procedures for restricting access to said system and agrees not to sell, rent, lease or in any manner transfer the system or any component to any country or individual to which such access or transfer is restricted; (iv) will not to export or transfer the equipment outside of the U.S. except as permitted by ITARs and with the express written approval of the DeTect; and, (v) any other use of the system may require advance approval under ITARs, agree to advise DeTect prior to any transfer or such use, and will not proceed with such transfer or use without receipt of approval by both DeTect and any required U.S. Government Agencies. The buyer will be granted a single site user license to use the MERLIN™ and HARRIER™ operating software for the intended purpose only. DeTect will deliver a complete set of the operating software executables with the system and periodically will issue updates and patches to the software. Any other such unauthorized use of the software or transfer of or installation of the software to other systems or computers or transfer to other users, companies or individuals is expressly prohibited. Noncompliance with the license requirements will result in revocation of the user license upon notification of which the buyer will immediately and promptly remove, delete, and destroy all copies of said software, providing written certification of compliance of such removal, deletion, and destruction.
7. Acceptance of the order by DeTect is contingent on execution of a contract or order in a form acceptable to DeTect. All specifications and delivery schedules are subject to change based on current models offered at the time of the order.



Environmental Systems & Services Pty Ltd
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Hawthorn
VIC 3122
Australia

www.esands.com
esands@esands.com

Standard Terms and Conditions of Trade

To the fullest extent legally possible, all dealings between Environmental Systems & Services Pty Ltd ACN: 006 349 122 ("ESS") and any Customer ("the Customer") relating to any products or services are subject to the following Terms & Conditions of Trade ("these Terms") unless otherwise agreed in writing.

1. Payments to be within 30 days of invoice date without deduction, unless otherwise agreed.
2. Interest is payable on overdue accounts at ESS' election at the rate prescribed under the Penalty Interest Rates Act 1983 (Vic) plus an additional 3% per month.
3. Property:
 - a. Property in products shall not pass until payment in full of all monies owed to ESS on any basis
 - b. ESS reserves the right to take possession & dispose of products as it sees fit at any time until full payment & the Customer grants permission to ESS to enter any property where any product is in order to do so with such force as necessary
 - c. Immediately upon delivery the Customer accepts liability for the safe custody of products
 - d. A certificate signed by an officer of ESS identifying ESS products & certifying that monies are owing to ESS shall be conclusive evidence of ESS' title thereto
 - e. Upon sale or disposition of products prior to payment in full the Customer agrees to hold all proceeds Upon Trust for ESS in a separate bank account agrees not to mix proceeds with any other monies & will upon request immediately account to ESS therefore even if ESS may have at any time granted any credit facility &/or time to pay
 - f. Until full payment the Customer agrees
 - i. to keep all products as fiduciary and Bailee for ESS & store them in a manner which shows ESS as owner
 - ii. only to sell products in its usual course of business
 - iii. sale on terms, at cost or less than cost shall not be "in the usual course"
 - g. Clause 3 is not intended to create a charge & shall be read down to the extent necessary to avoid being a charge
 - h. if the Customer uses or incorporates any products in any production, process, manufacture or construction or combines them with anything to create a finished or combined new thing for disposition by the Customer then upon such disposition prior to payment in full of all monies owing, the Customer agrees to hold such part of the proceeds thereof (& until payment is received by the Customer, that part of any applicable book debt of the Customer) as equals the costs of the products used and/or incorporated therein (at the prices invoiced by ESS to the Customer for them) Upon Trust for ESS until payment in full of all monies.
4. Limitation Of Liability:
 - a. The Customer will limit any claim upon ESS relating to products, to the cost of replacement of products or the supply of equivalent products and relating to services, to the cost of having services supplied again
 - b. ESS will not be liable in any way for any contingent consequential direct indirect special or punitive damage arising whether due to ESS's negligence or otherwise & the Customer acknowledges this limit of liability & agrees to limit any claim accordingly
 - c. No other term condition agreement warranty representation or understanding whether express or implied in any way extending to or otherwise relating to or binding upon ESS is made or given
 - d. ESS will not be liable for any claim re any alleged fault or defect caused or contributed to by the Customer or any 3rd party nor for any transport installation rectification labour or other cost.
5. Returns:
 - a. Any products which are accepted by ESS as defective may be returned and
 - i. be replaced free of charge or
 - ii. be the subject of a credit for the invoiced value. Replacement free of charge does not include labour transport or material costs.
6. Specific Orders. Customer specific orders may be rejected by ESS at its election, unless accompanied by a non-refundable deposit of at least 50% of the total order price.
7. Placement Of Orders:
 - a. if any dispute arises concerning any order (& including any measurement quality quantity identity or authority or any telephone facsimile e-mail or computer generated order) the internal records of ESS will be conclusive evidence of what was ordered
 - b. each order placed shall be & be deemed to be a representation made by the Customer at the time that it is solvent & able to pay all of its debts as & when they fall due
 - c. failure to pay in accordance with these Terms shall be & be deemed to be conclusive evidence that the Customer had no reasonable grounds for making the representation referred to in 7.b) & that the representations were unconscionable, misleading and deceptive
 - d. when any order is placed, the Customer shall inform ESS of any material facts which would or might reasonably affect the commercial decision by ESS to accept the order &/or grant credit in relation thereto. Any failure to do so shall create & be deemed to create an inequality of bargaining position shall constitute & be deemed to constitute the taking of an unfair advantage of ESS & to be unconscionable, misleading and deceptive.
8. Delivery:
 - a. ESS accepts no responsibility for delivery but may elect to arrange delivery at its discretion & without any liability & at the Customer's costs & responsibility in all things
 - b. ESS reserves the right to charge for any delivery
 - c. the Customer shall be deemed to have accepted delivery & liability for the products immediately ESS notifies that they are ready for collection or when they are delivered to a carrier or to the Customer's business premises or site whether attended or not
 - d. a certificate purporting to be signed by an officer of ESS confirming delivery shall be conclusive evidence of delivery as shall any signed delivery docket
 - e. ESS will not be liable for delay, failure or inability to deliver any products
 - f. once the Customer has been notified that products are ready for collection, the Customer agrees to pay all costs of holding or handling products
 - g. Frustrated Delivery: If the time spent in attempting to or effecting delivery exceeds 30 minutes or requires more than one attempt, the Customer agrees to pay all costs relating thereto together with a loading of 10% to cover administration costs.
9. Variation or cancellation of any order dealing or arrangement must be agreed in writing
10. Purchase Price:
 - a. All sales are made by ESS at its quoted price at the time of order placement
 - b. government imposts and any GST ("imposts") will be to the Customer's account
 - c. ESS's price lists exclude imposts unless expressly noted thereon.
11. Exclusions:
 - a. No dealing with the Customer shall be or be deemed to be a sale by sample or description
 - b. If ESS publishes material about its products & prices, any part which is incompatible with these Terms is expressly excluded
 - c. the Customer will rely on its own knowledge & expertise in choosing any product for any purpose
 - d. Any advice or assistance given for or on behalf of ESS shall be accepted at the Customer's risk & shall not be or be deemed given as expert or adviser nor to have been relied upon.
12. Default or breach by the Customer of these Terms or in any dealings with ESS will entitle ESS to retain all monies paid, call-up all monies owing, cease further deliveries & recover from the Customer all loss of profits without prejudice to any other of its rights.
13. Severability: Any part of these Terms can be severed without affecting any other part.
14. Products:
 - a. ESS may update modify make substitution or alter any of its products or any component or raw material incorporated in or used in forming any party of any products as part of its ongoing business. The Customer agrees to accept current products in substitution for any products ordered provided they are not materially different
 - b. ESS disclaims any responsibility or liability relating to any products
 - i. processed or made to designs drawings specifications or measurements etc or with materials which are provided or approved (whether in part or fully) by or on behalf of the Customer
 - ii. utilised stored handled or used incorrectly or inappropriately
 - c. The Customer agrees to check products for compliance with all applicable Standards & regulatory bodies before use, on-sale or application & only to use on-sell or apply products in accordance therewith and with any manufacturer's or ESS' recommendations & directions as well as with sound commercial practice.
15. Other Terms & Conditions & Notice: No terms &/or conditions sought to be imposed by the Customer upon ESS shall apply unless agreed in writing by ESS.
16. Recovery Costs: The Customer will pay all costs & expenses of ESS, its legal advisers, mercantile agents & others acting on its behalf in respect of anything instituted or being considered as a result of any breach of these Terms or of any dealings with ESS.
17. Attornment: To give effect to its obligations arising under in these Terms the Customer hereby irrevocably appoints any solicitor for ESS from time to time, as its attorney.
18. Customer Restructure: The Customer will notify ESS of any change in its structure or management including any change in director shareholder management partnership or trusteeship or sale of any material part of its business within 7 days of any such change.
19. Jurisdiction: All contracts made with ESS shall be deemed to be made in Victoria & the parties submit to the jurisdiction of the appropriate Courts in or nearest Melbourne.
20. Credit Limit: ESS can vary or withdraw any credit facility or limit at any time at its discretion & without any liability to the Customer or any other party.
21. Waiver: If ESS elects not to exercise any rights arising as a result of breach of these Terms it shall not constitute a waiver of any rights relating to any subsequent or other breach.
22. Notice: The Customer will be deemed to have notice of any change to these Terms, immediately they are adopted by ESS in its business.
23. Security For Payment: The Customer
 - a. agrees on written request to charge in favour of ESS
 - i. by way of a fixed charge, all its books of account goodwill documents of title & current & later acquired real & intellectual property &
 - ii. by way of a floating charge the whole of the Customer's other undertaking property & assets with payment of all monies owed to ESS
 - b. grants a lien to ESS over any of its property in the possession or control of ESS for any monies due and owing to ESS under these Terms or otherwise.
24. Force Majeure: ESS will not be in default or breach of any dealing with the Customer as a result of Force Majeure (ie: anything beyond ESS' reasonable control).
25. Patents etc : If ESS utilises any design patent or intellectual property or follows any instruction provided by or on behalf of the Customer the Customer indemnifies ESS against any claim proceeding damages or liability for any loss cost or expense arising as a result whether for any alleged infringement of any intellectual property or otherwise.
26. Specifications:
 - a. Any illustration drawing or specification supplied by ESS ("Specs") are drafts and approximates
 - b. Any tangible or intellectual property rights in Specs shall remain the property of ESS and may be recalled at any time
 - c. Specs to be treated at all times as confidential and not made use of without the prior written consent of ESS.
27. Materials: All materials supplied by the Customer must be shipped by the Customer to the factory or site nominated by and in accordance with ESS instructions & at the cost and risk of the Customer. Such materials will remain at the Customers risk at all times.
28. Stock Discretion: ESS has a continuing discretion to allocate available stock and gives no warranty as to certainty of supply unless expressly agreed in writing in advance.
29. Partial Delivery/Forward Orders: If the Customer places forward orders or request partial or instalment delivery, the Customer agrees
 - a. to pay for so much of any order as is from time to time delivered by ESS
 - b. that no delay or failure to fulfil any part of any order shall entitle the Customer to cancel or vary any order or delay or reduce any payment.
30. On-Sale: The Customer agrees that upon on-sale of any products to inform any third party involved of these Terms and in particular the provisions of clause 4 and sub-clause 4.
31. Indemnity: The Customer indemnifies ESS against any claim or loss arising from or related in any way to any contractor dealing between ESS & the Customer or anything arising therefrom or arising as a result of or subsequent to any breach of these Terms Insurance: The Customer agrees to insure ESS from any liability claim or damage arising in any way; whether directly or indirectly under part VA of the Trade Practices Act, these Terms, which insurance will note the insured interest of ESS

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