New and Emerging Technologies

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Reality Check! – There are no new basic technologies available for wildlife management!

There are new and innovative applications of existing technologies that are improving wildlife management!

Wildlife management elements benefiting from technology:

- Habitat assessment
- Birds and other wildlife target detection
- Data/Information/User Interfaces

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Technology categories:

I will focus on these technology categories today:

- Radio frequency – Radar
- Light
  - Lidar
  - CCD/EO cameras, image enhancement
- Thermal
- Data Management, Information Flow
- Analytics, Modeling, Machine learning
- User Interfaces

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Wildlife management presents a complex system of varying needs with multiple paths for technology application.

In general, in airport applications the emphasis is on solution of specific problems where there is an unfortunate mismatch between expectations of what the technology will do and what the technology can actually do (particularly at low cost!).

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New opportunities for technology use in wildlife management exist when need is specifically matched with capability.

A cautionary note, we must not overlook the utility of technologies designed for purposes other than wildlife management (e.g. FOD detection) and potential for integration of existing safety technologies in wildlife management.

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Our focus today is on technologies for wildlife management, which in my experience, means different things to different players in the airport game.

For airport wildlife managers it means improving management success to advance safety.

For most other airport professionals, and the public, it means stopping bird strikes.

Improving safety using wildlife management techniques may challenge technology but applicable systems tend to maintain/require a strong human interface and have longer time frames for application (hours to seasons) placing less emphasis on sense and alert. In wildlife management technology provides a valuable supplement to wildlife management activities.

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Stopping bird strikes has stringent timing and accuracy requirements that stretch the capabilities of sensor systems. Stringent requirements lead to automation, short response times, and low to absent false alarm rates. In addition human operators must still be in the loop as decision makers. This is complicated!

Let me state very clearly at this point in time technology will not stop wildlife/aircraft collisions – not a silver bullet!

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Let’s consider the state-of-the-art and new developments

What I will now do is present an incomplete review of new technologies, or innovative applications of existing technologies, in wildlife management. I can only provide limited detail to meet presentation time limits.

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Habitat

A critical part of wildlife management is understanding what habitat is where in relation to aircraft movements. A number of tools are available here. The spatial characterization of habitat is achieved through a wide range of geographic information sciences tools.

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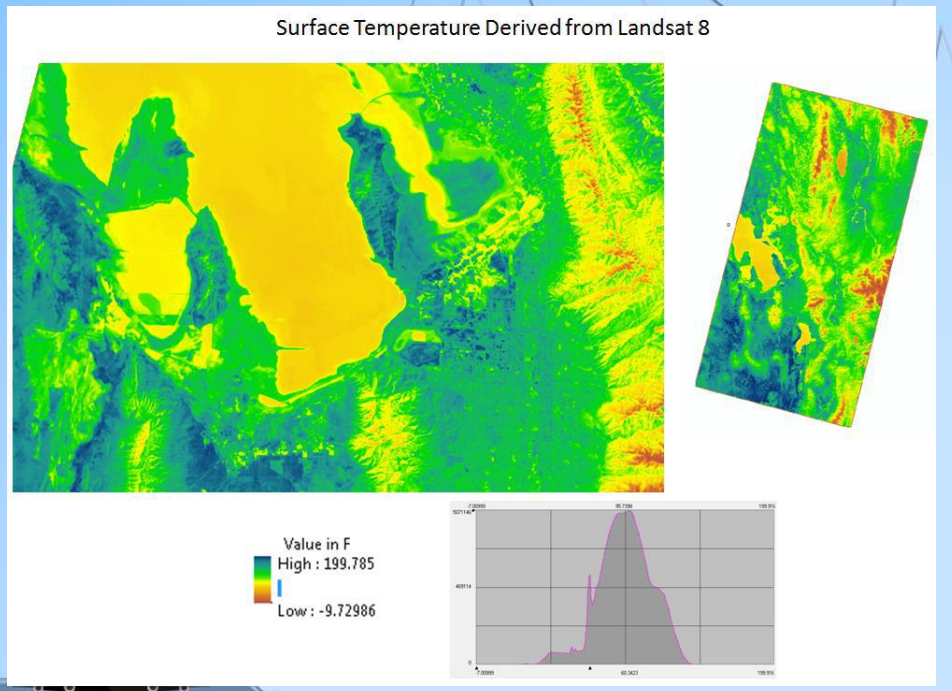
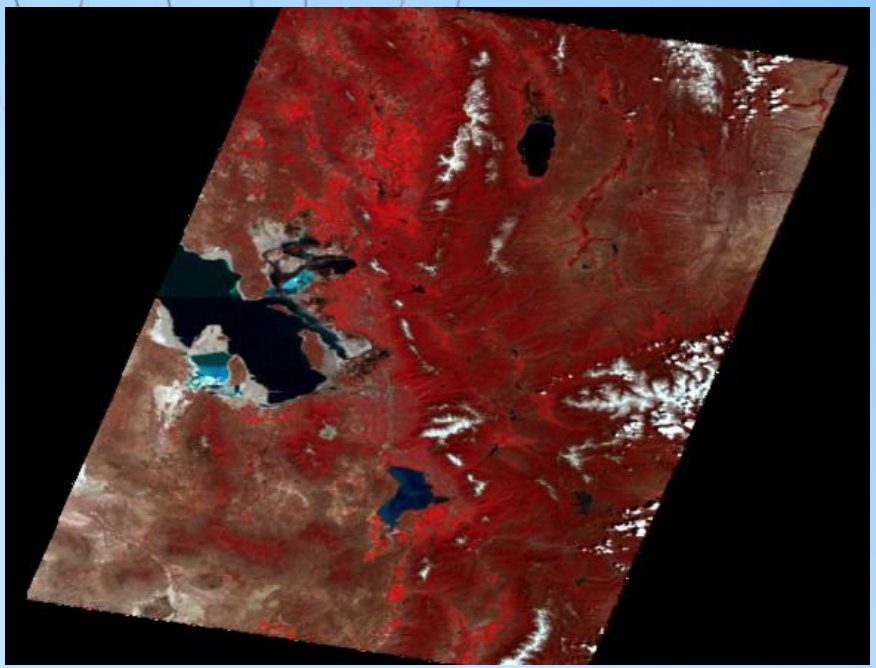
Satellite-based remote sensing:

Long history but new satellites and new imaging technologies supplement long standing imagery.





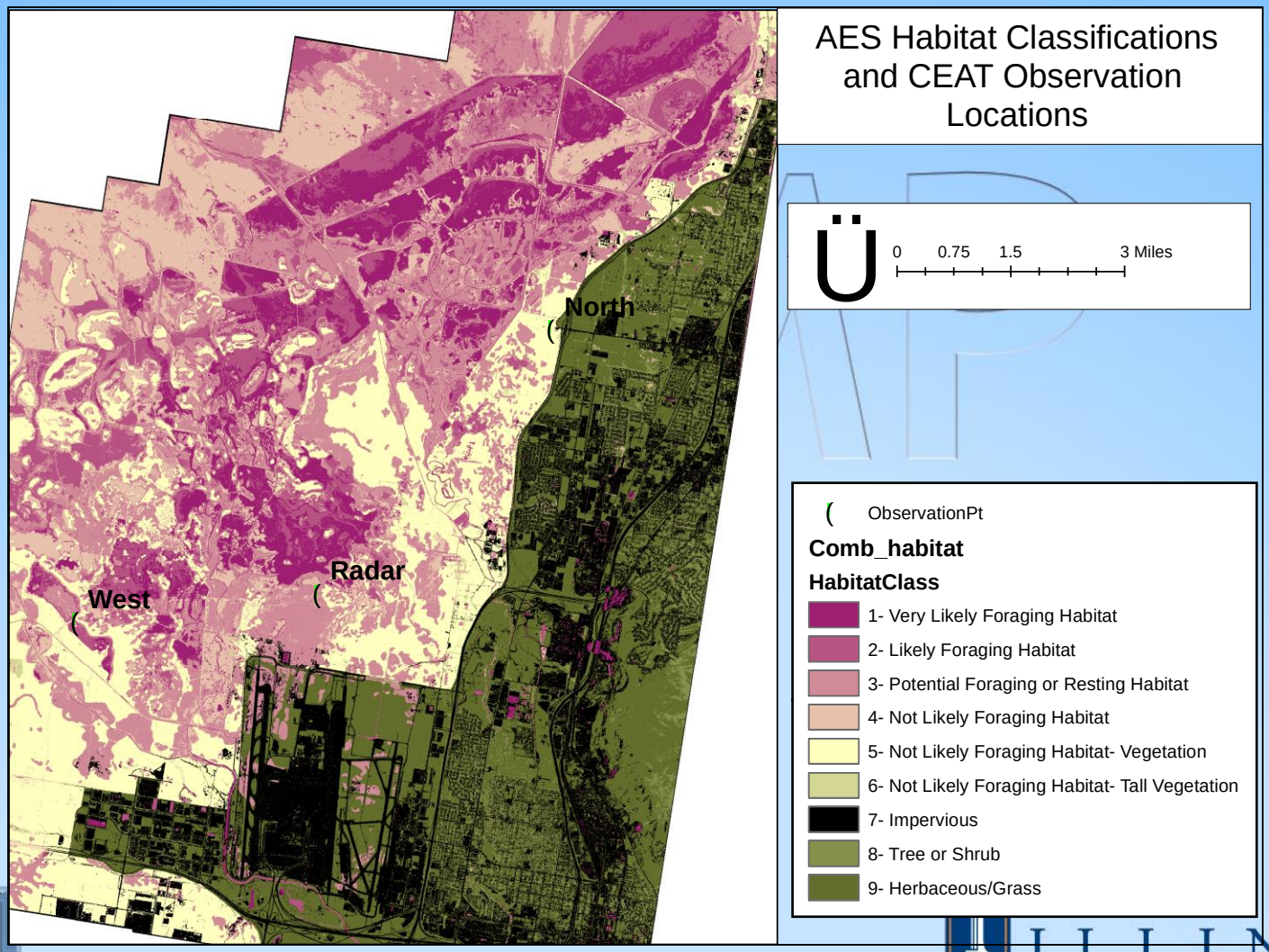
Multispectral imaging:

Now available from aircraft at lower altitudes with military technology now commercially available.

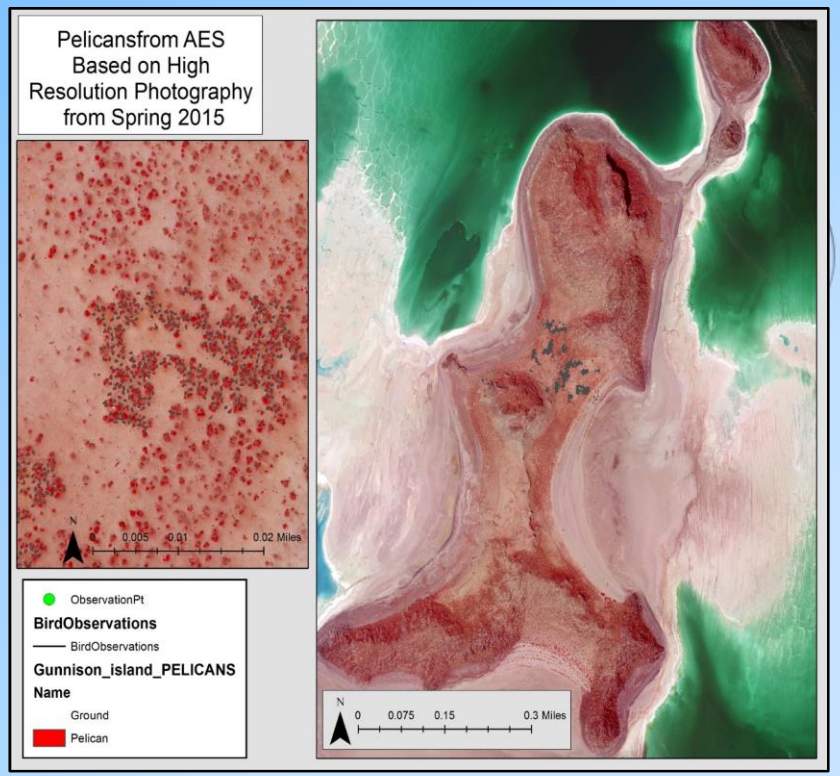
Full bandwidth

Infared

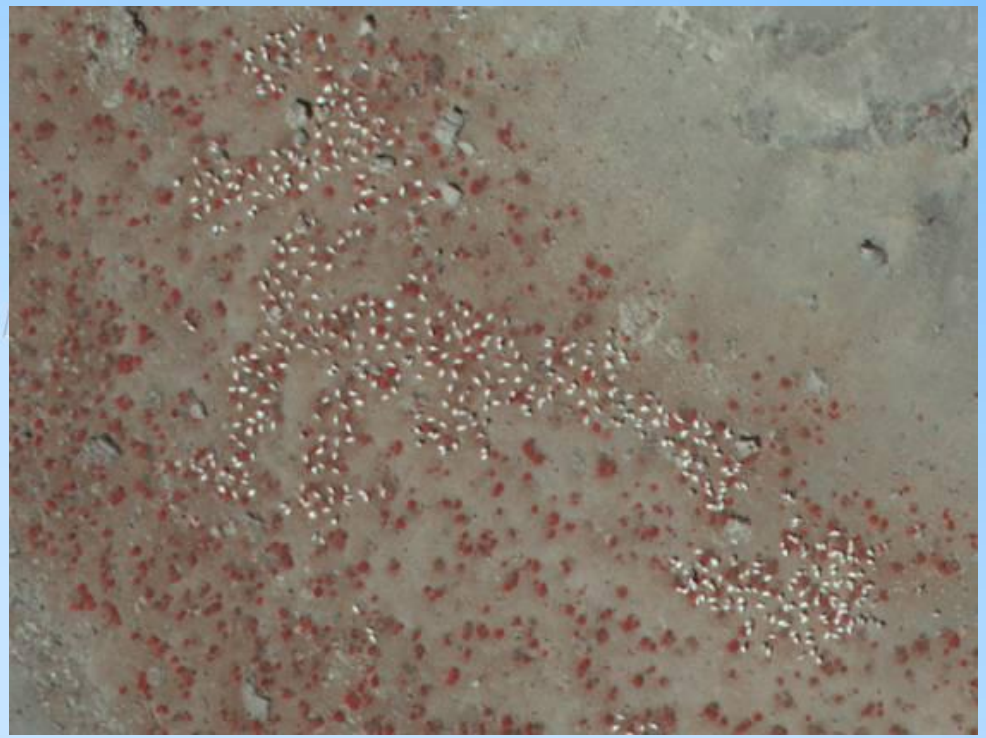
Capabilities exist to classify habitat using remote sensing to identify attractants for management focus



It is also possible to actually count wildlife numbers. Here American White Pelican on Gunnison Island, UT.

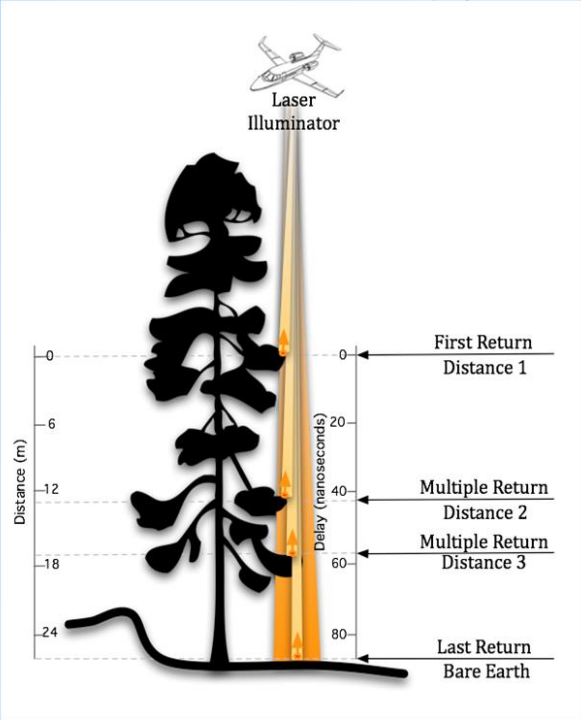


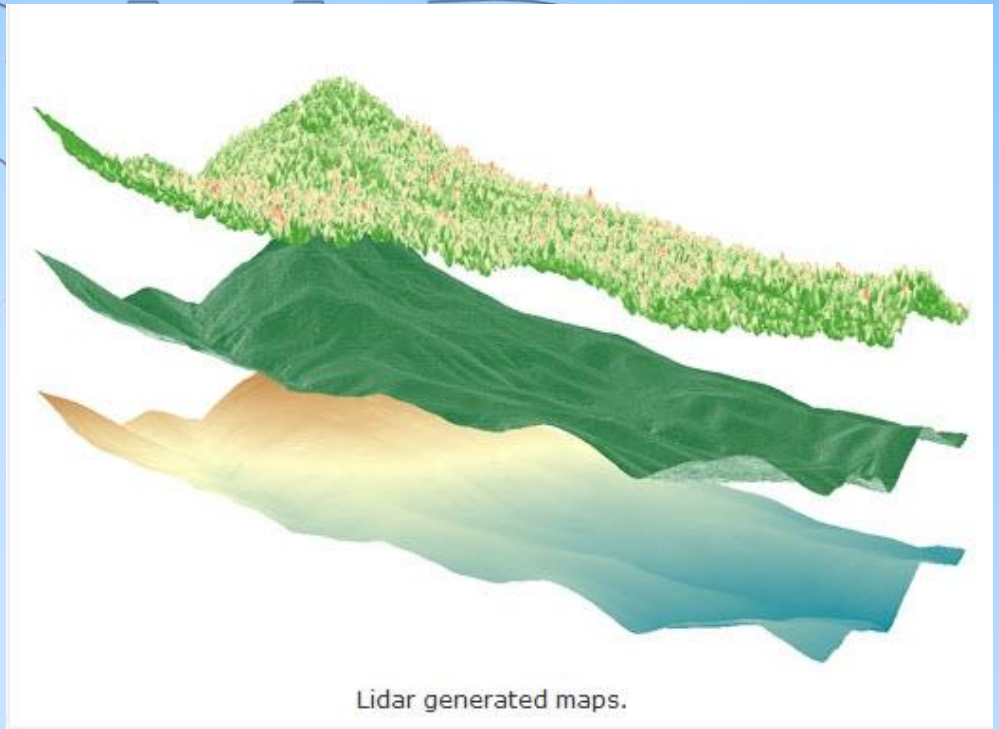
3 inch resolution infrared



Lidar:

There is an extensive literature on the use of Lidar for habitat assessment.

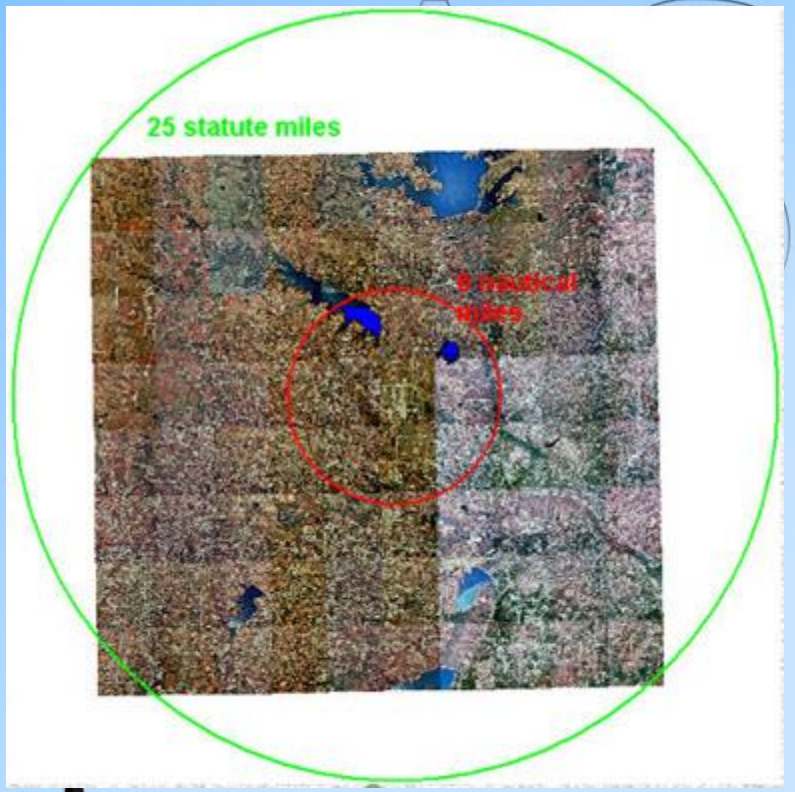


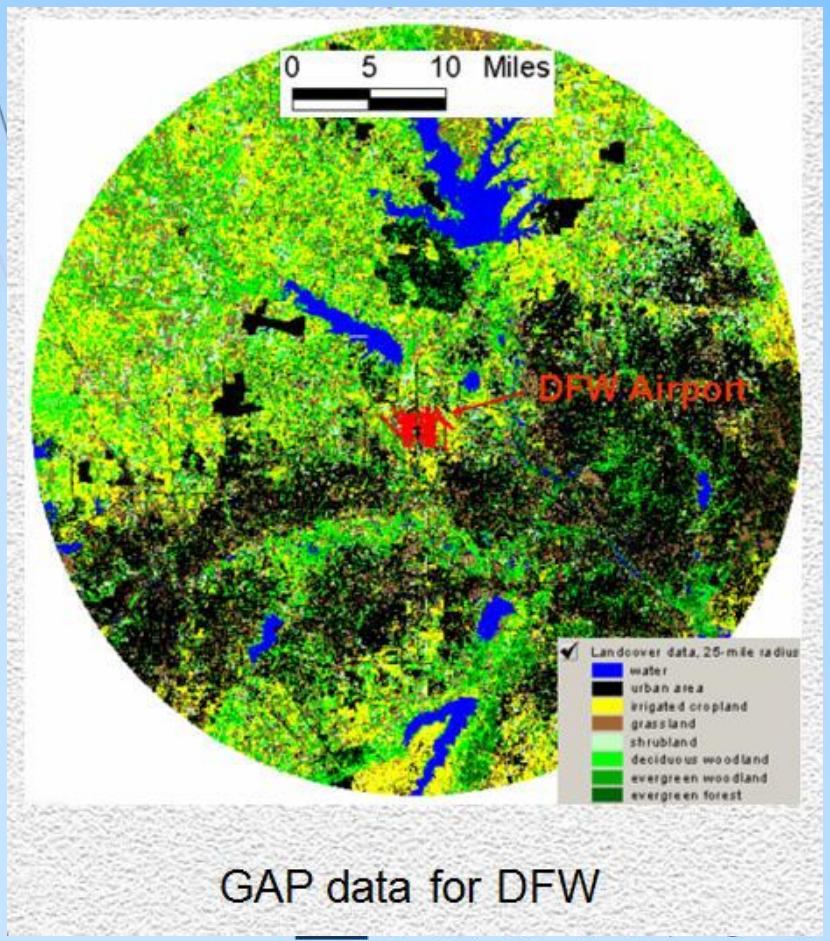


Lidar generated maps.

From reporting of the Sierra Nevada Adaptive Management Project, University of California, Berkeley

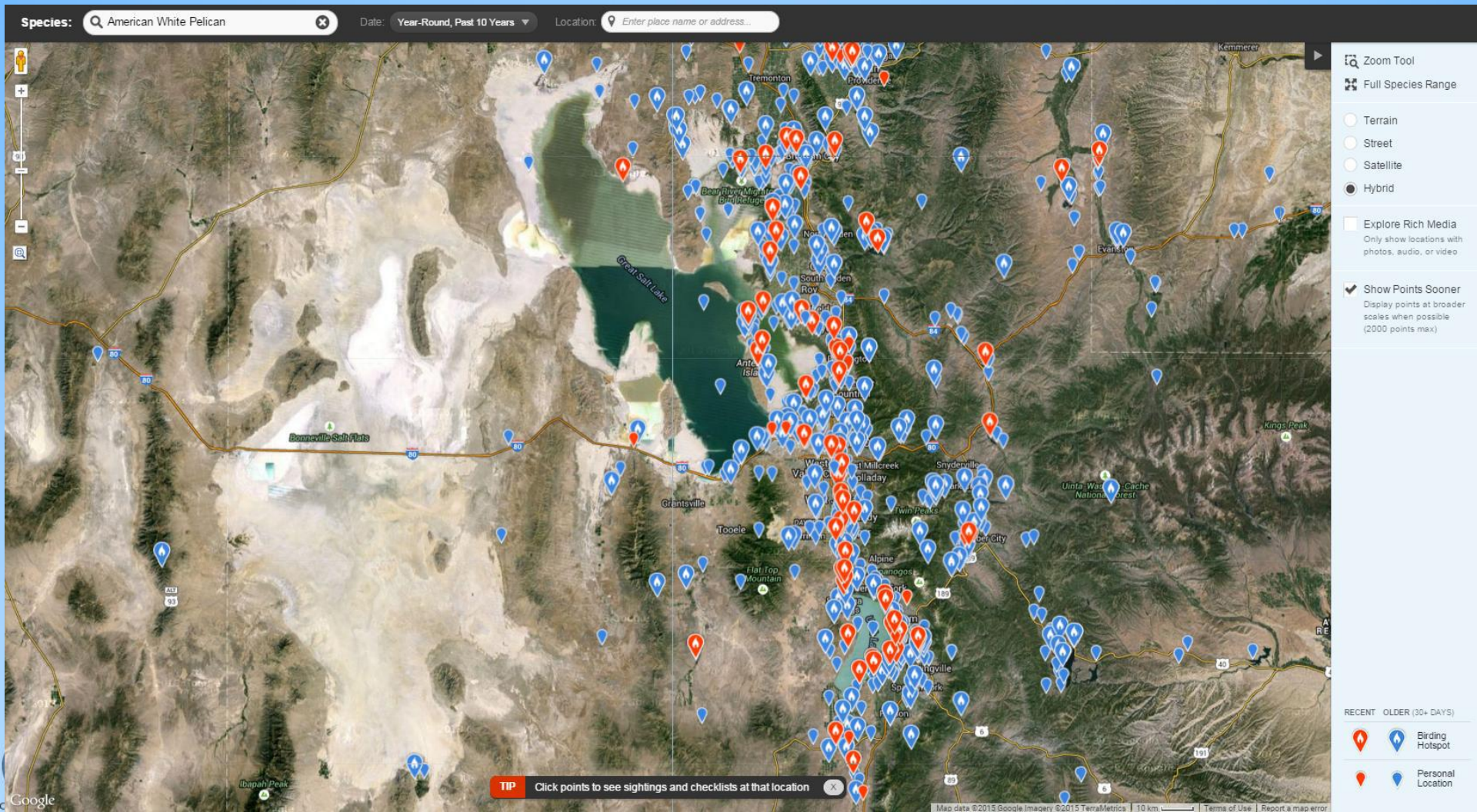
GIS technologies are now very advanced providing opportunities to layer data in spatial analyses for wildlife management.





GAP data for DFW

Net-based access is now available for an amazing array of habitat and wildlife data using GIS tools!



Birds and Wildlife

Two primary sensor types are used for wildlife (primarily bird) surveillance - radar and optical/thermal cameras. Systems using these sensors are the foundation for new technological applications in wildlife management.

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Operational requirements for wildlife management that technologies must meet include surveillance for birds of varying size and behavior over a range of scales from the airport to regions.

No single sensor type or design is available to meet local to regional scale requirements for wildlife management, but multiple sensors can be integrated, even fused, to provide a comprehensive picture of wildlife activity. Integration/fusion of multiple sensors is the future!

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Radar

Different radar types provide surveillance over multiple scales (airport, commuter, migration) supporting detection and tracking in 3-dimensions.

New radars include new hardware based on advanced solid state electronics coupled with sophisticated antenna configurations and innovative software providing data management and sophisticated user interfaces.

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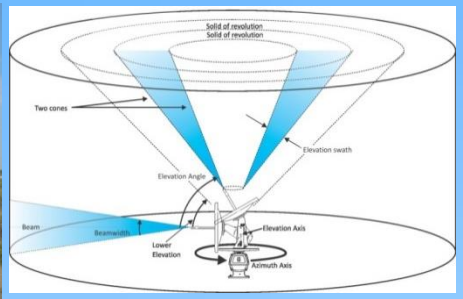
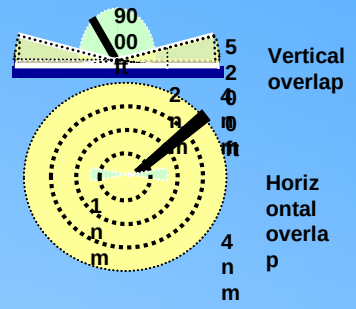
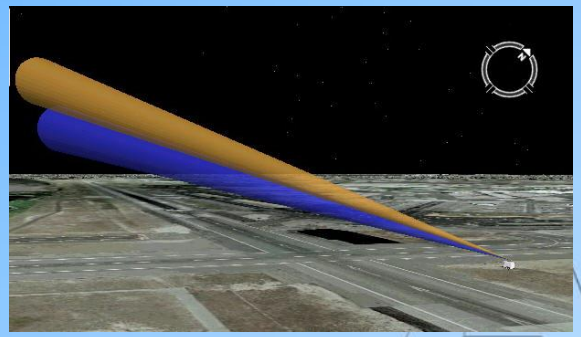
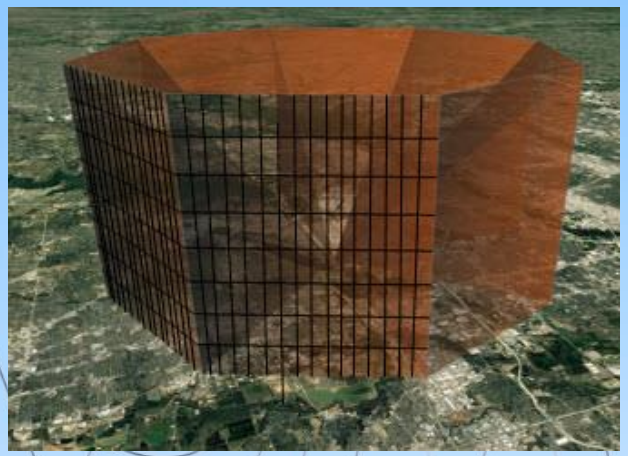


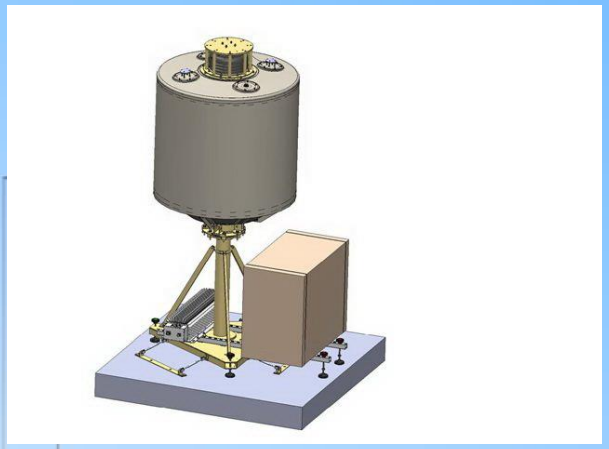


Vertical overlap

Horizontal overlap







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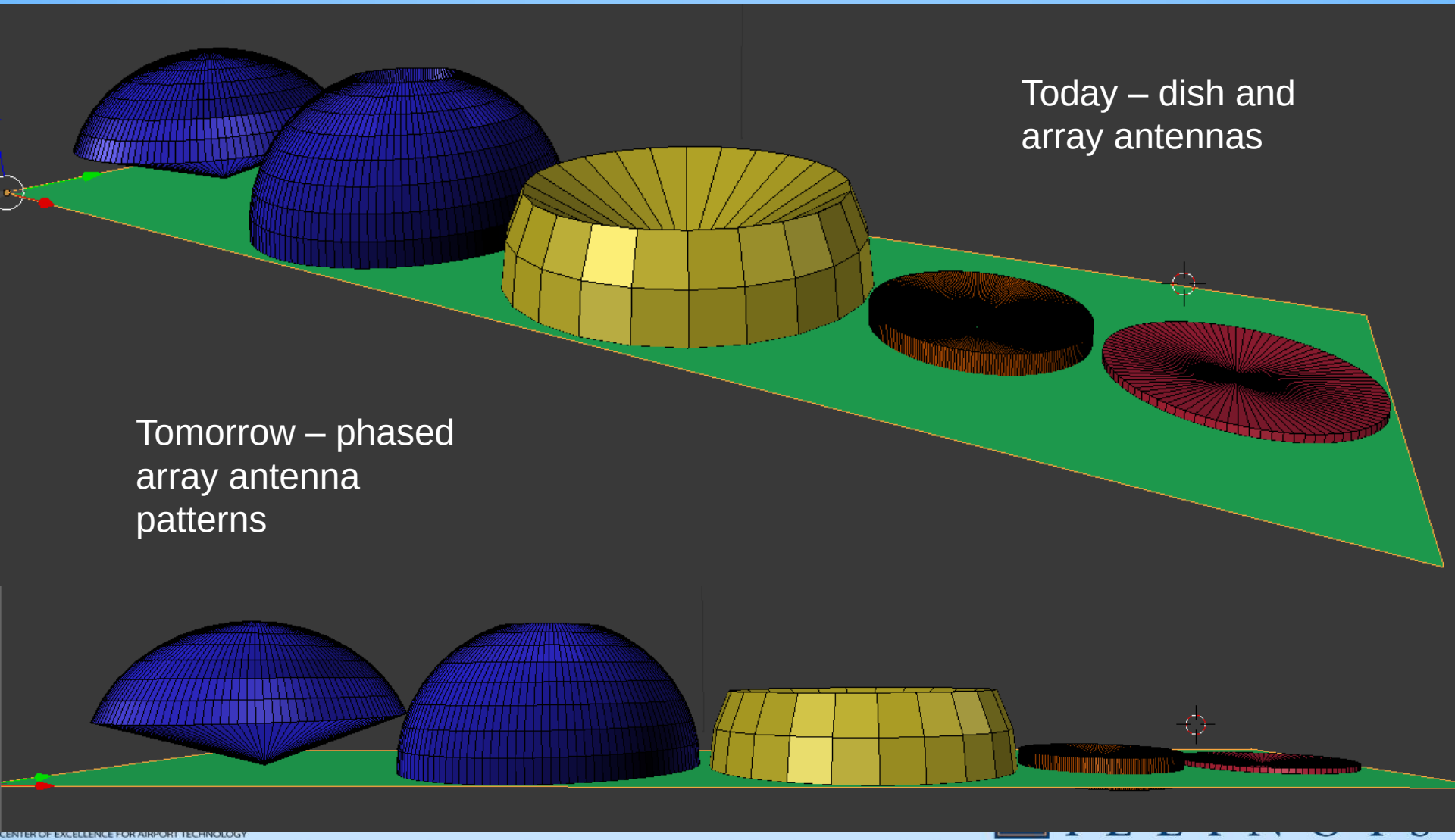
A critical characteristic of radar is coverage produced by antenna design.



There have been major advances in weather radars providing new tools for wildlife management at a regional scale.

Within the last decade the network of WSR-88D radars has received two major upgrades that greatly improve the monitoring of the movements of animals in the atmosphere:

Super-resolution
Dual-polarization

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Super-resolution

Resolution cells [pulse volumes] of all products are 0.5° in azimuth and 250 m in range.

Dual polarization

Simultaneous transmission of orthogonally oriented pulses added to the original radar products (base reflectivity, radial velocity, and spectrum width). Three new moments of return:

differential reflectivity,
correlation coefficient, and
differential phase.

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NOAA uses the three dual-polarization moments to discriminate different types of meteorological scatterers using hydrometeor classification algorithms (HCA), and discriminate between meteorological and biological scatterers.

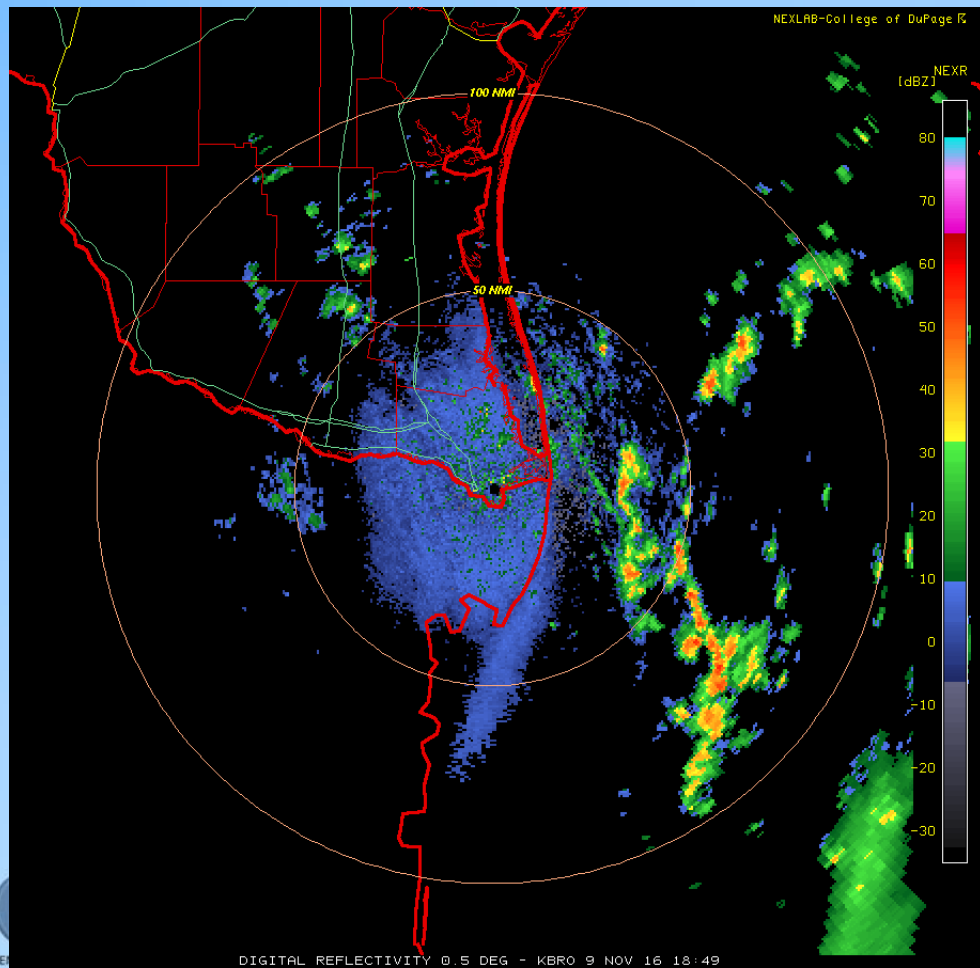
The pre-defined categories recognized under this classification are as follows:
BI- Biological (birds, insects)
GC – Ground clutter (buildings, trees)
IC – Ice crystals
DS – Dry snow
WS – Wet snow
RA – Light/moderate rain
HR – Heavy rain
BD – Big drops
GR – Graupel (soft ice, snow pellets)
HA – Hail-rain
UK – Unknown
RF – Range folded

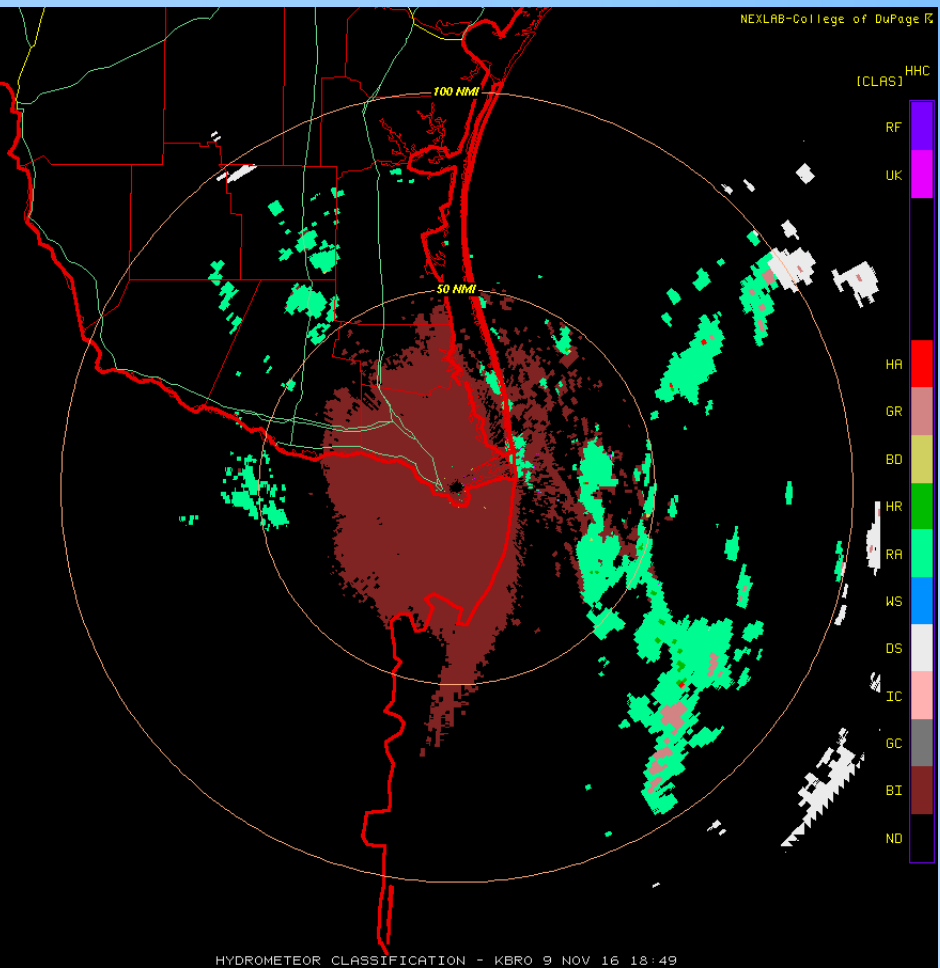
The algorithm determines only the most likely type of hydrometeor, omitting information pertaining to the likelihood of other categories.

These are examples of NEXRAD products commonly used today.

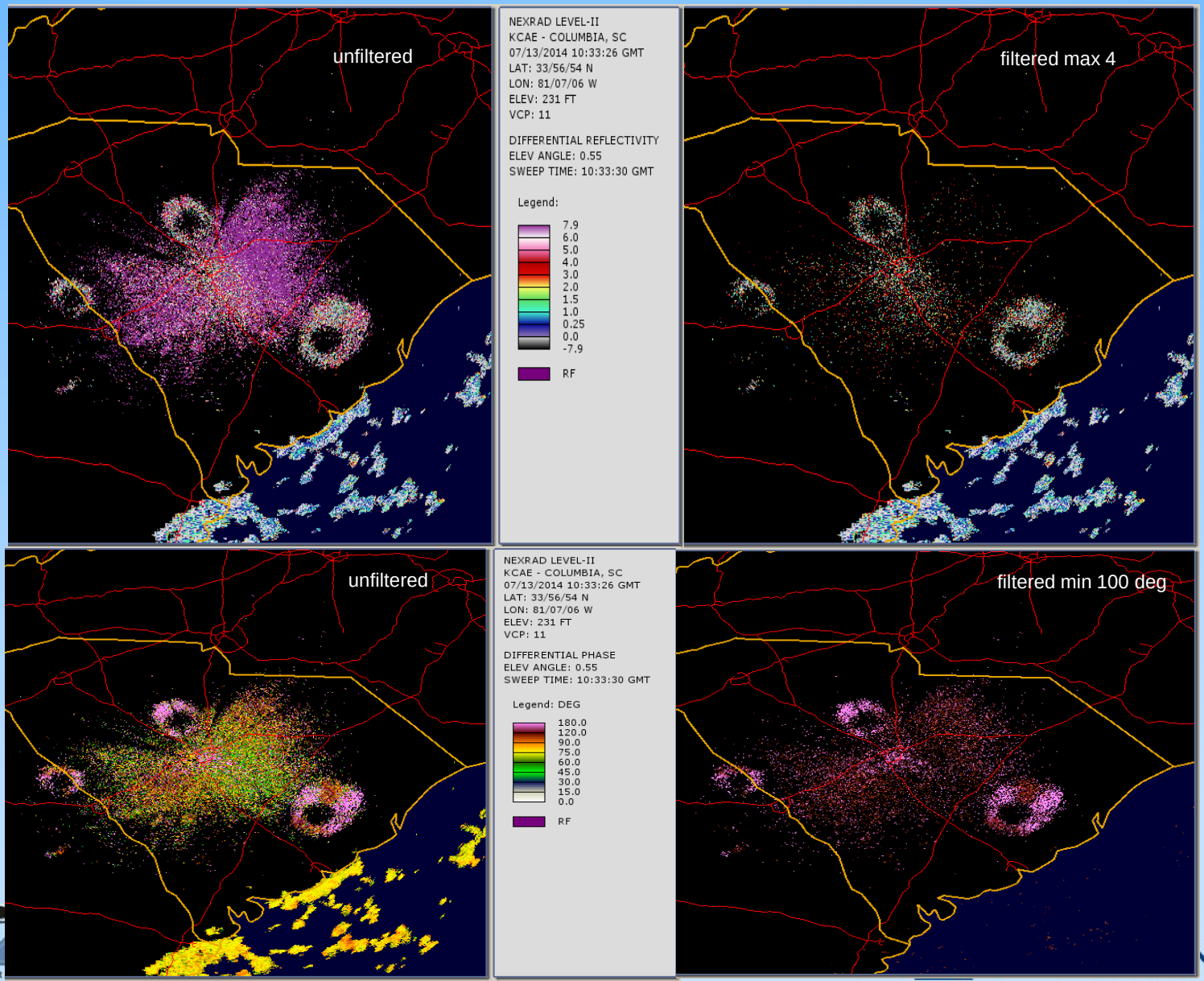
Reflectivity

Hydrometeor Classification

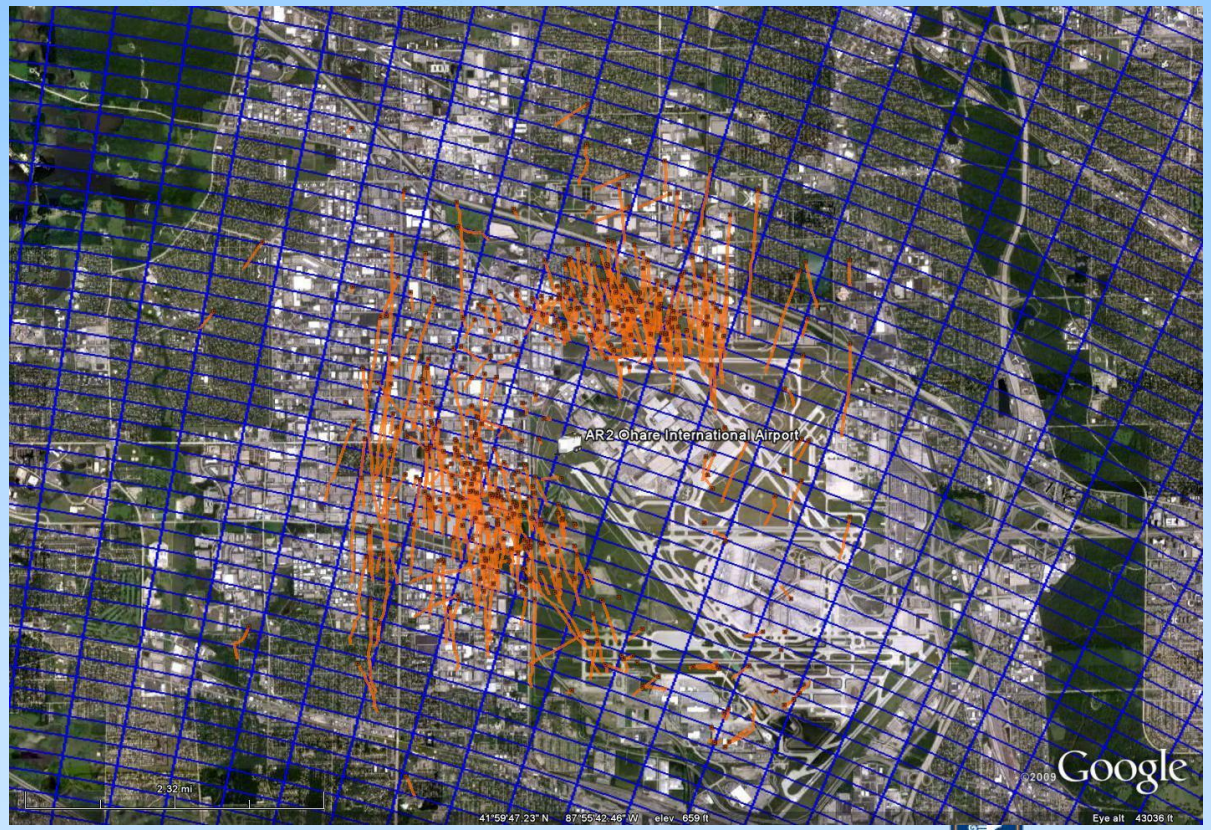




These are examples of NEXRAD data filtering using dual polarization to identify roost departures.



Weather radars operate over regional scales, but airport coverage may exist. This is an example of NEXRAD coverage for ORD.



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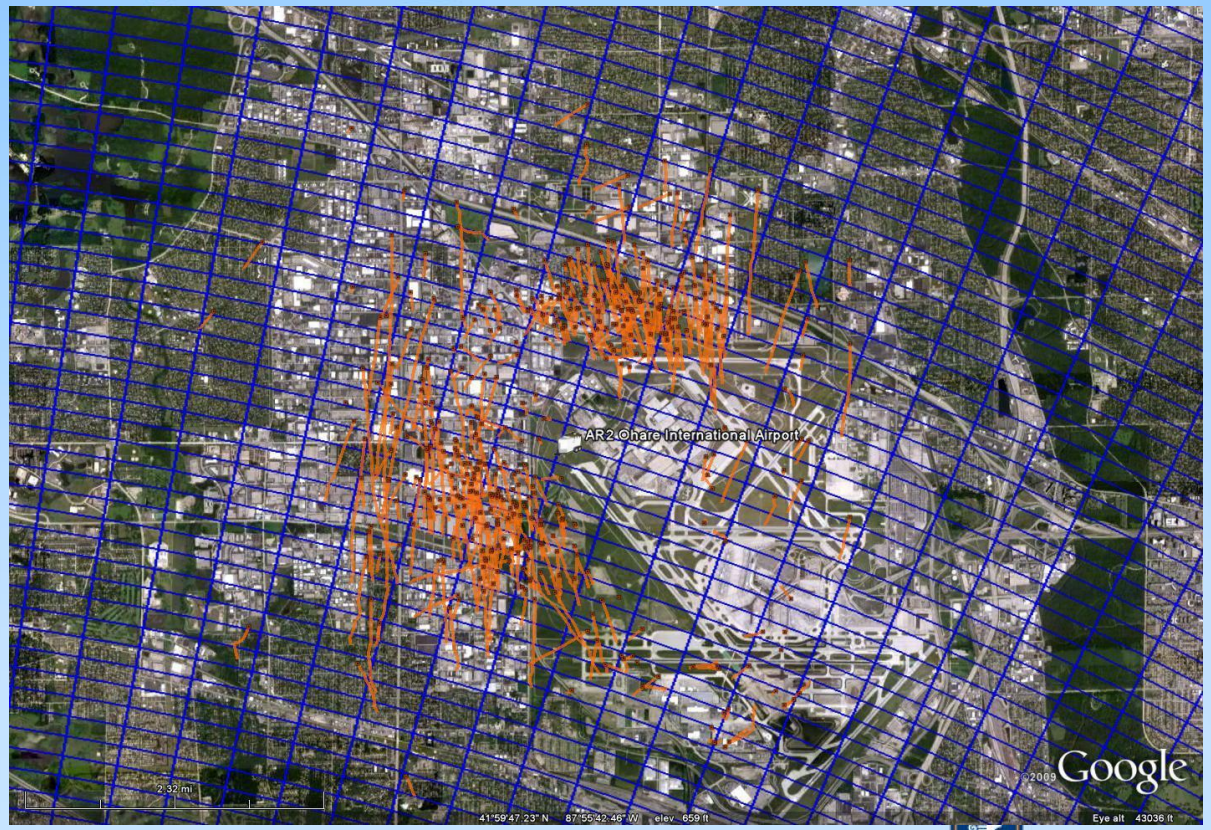

Radars of major local interest to wildlife managers are avian radar systems designed to cover 6 mile range and 3000 ft altitude.

Legacy systems use magnetron-based scanners with array or dish antennas.

Advanced solid state systems include Doppler resolution and offer advanced antenna designs, including phased array antennas.

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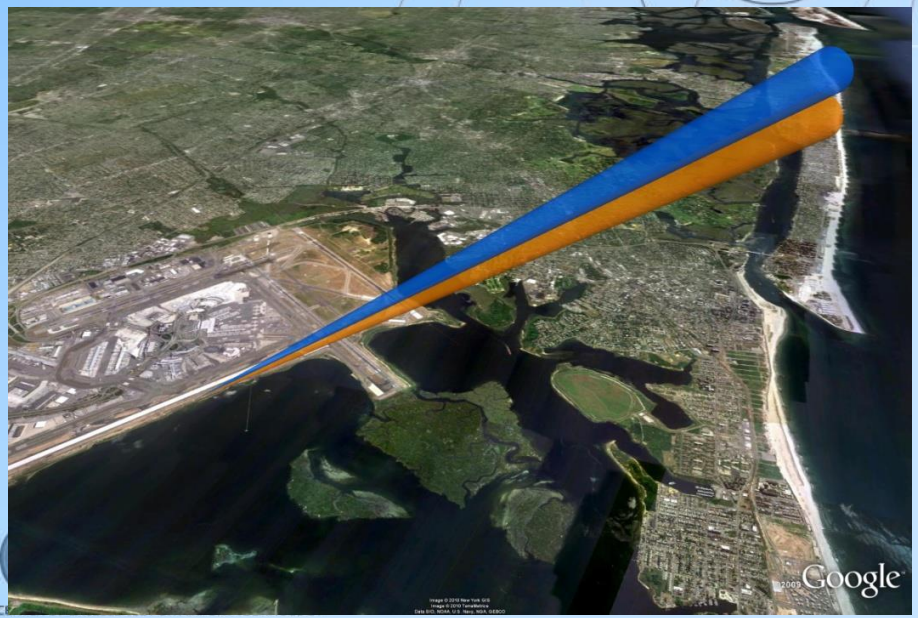
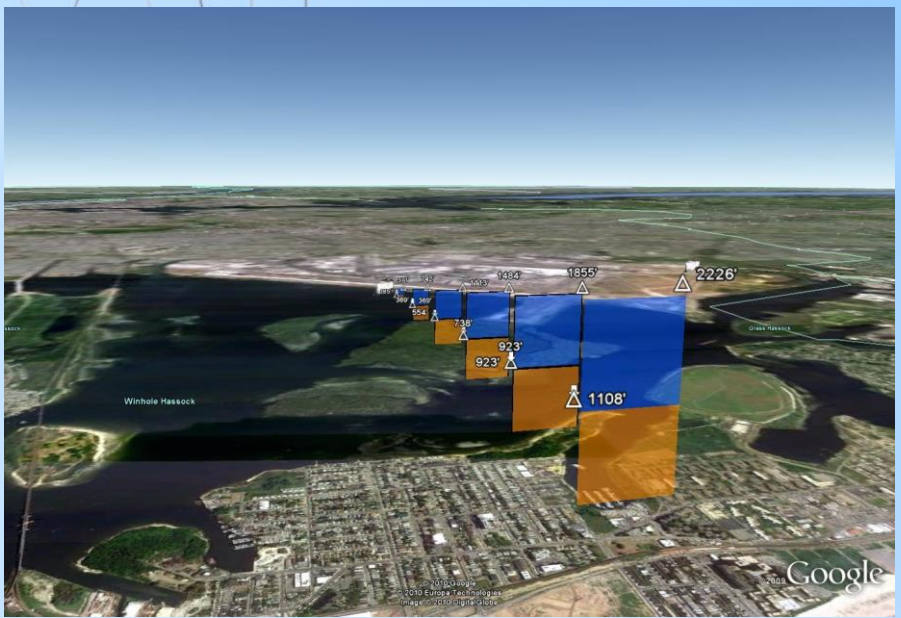
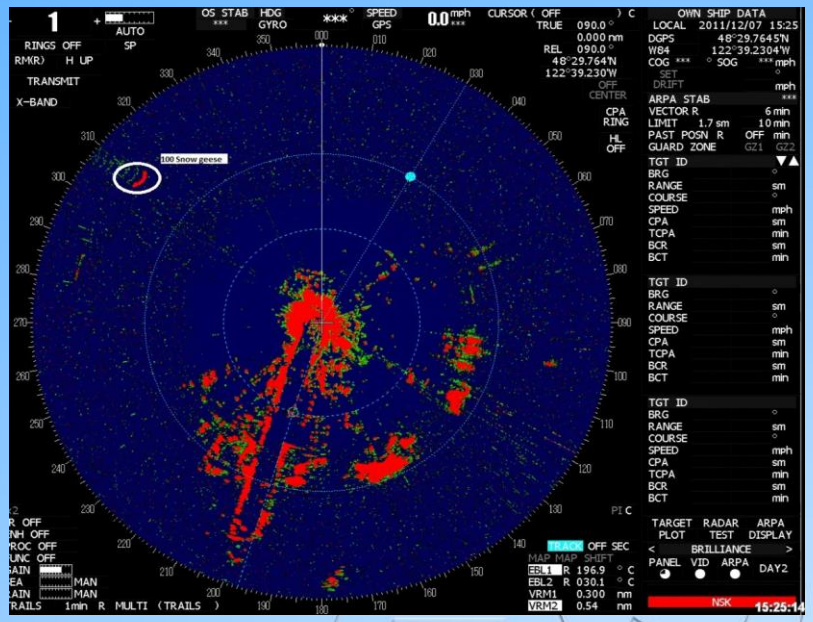
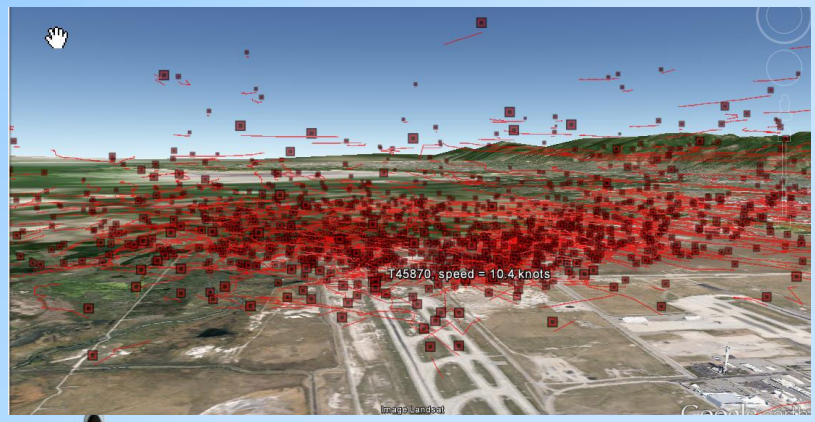
Legacy array and dish antenna coverage

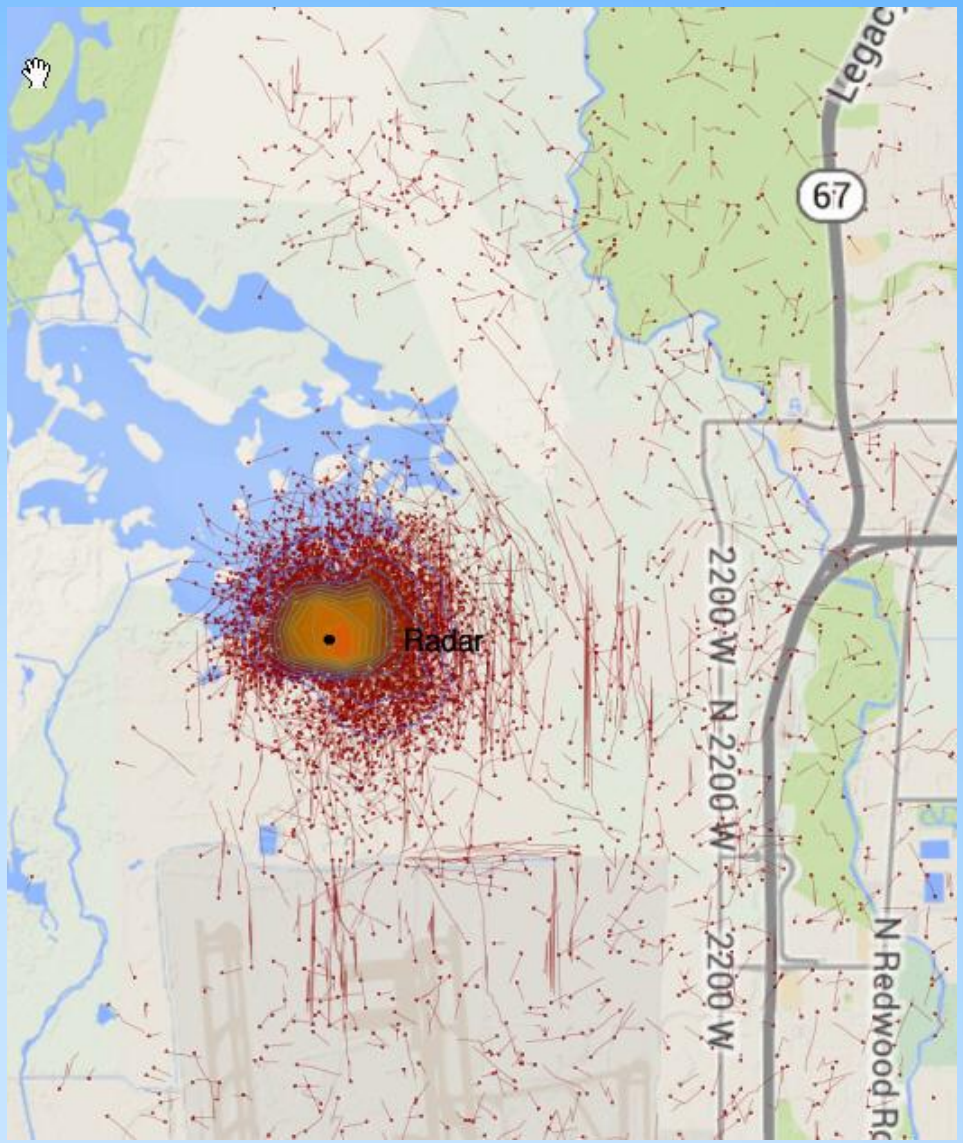




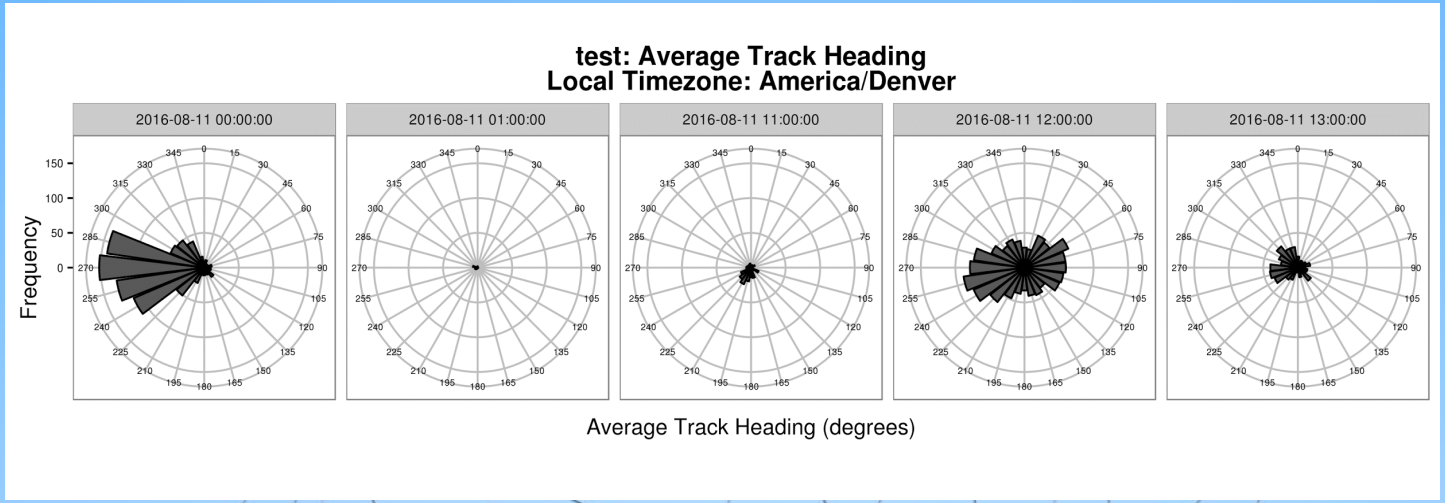
Typical displays of radar data

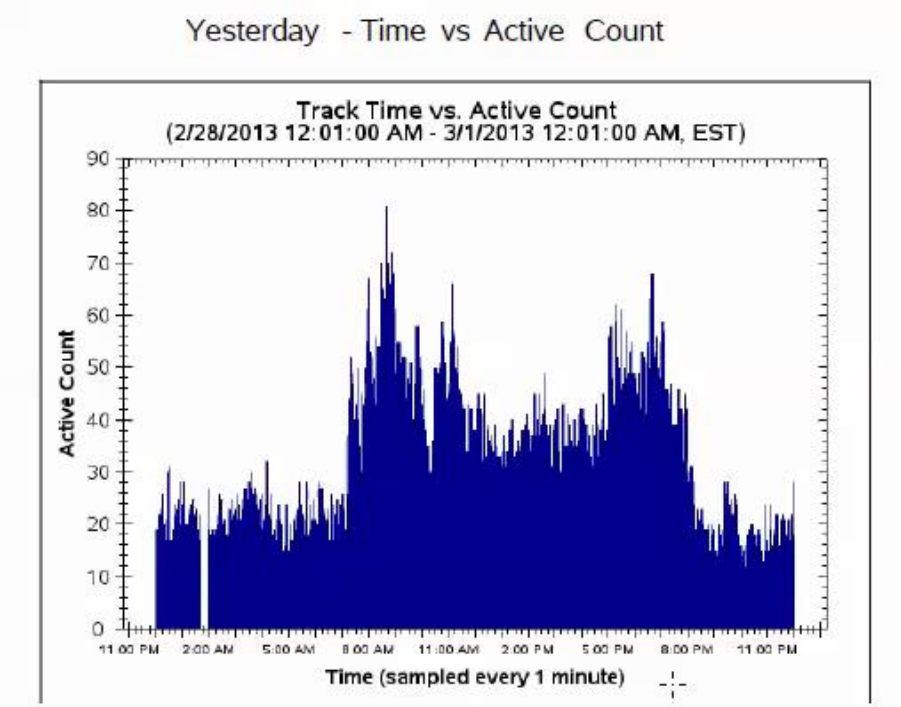


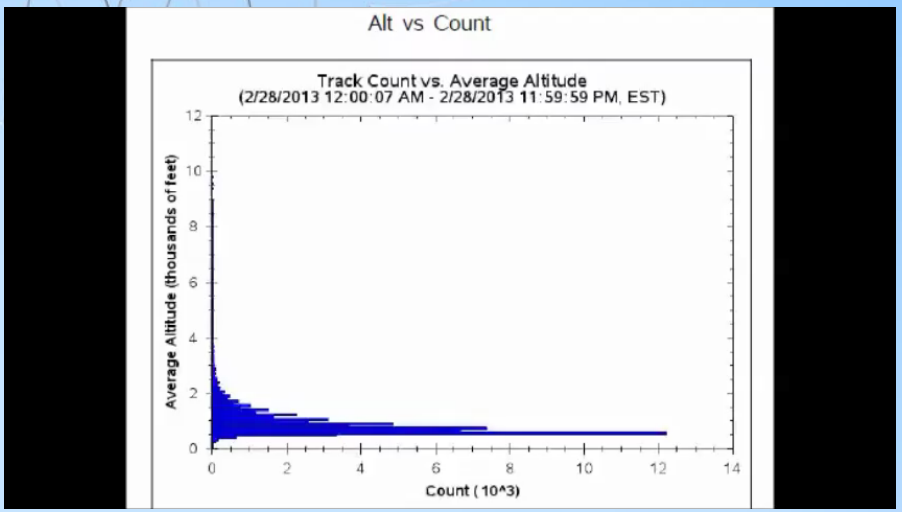




Radar data summaries







New antenna configurations provide information on location and altitude.

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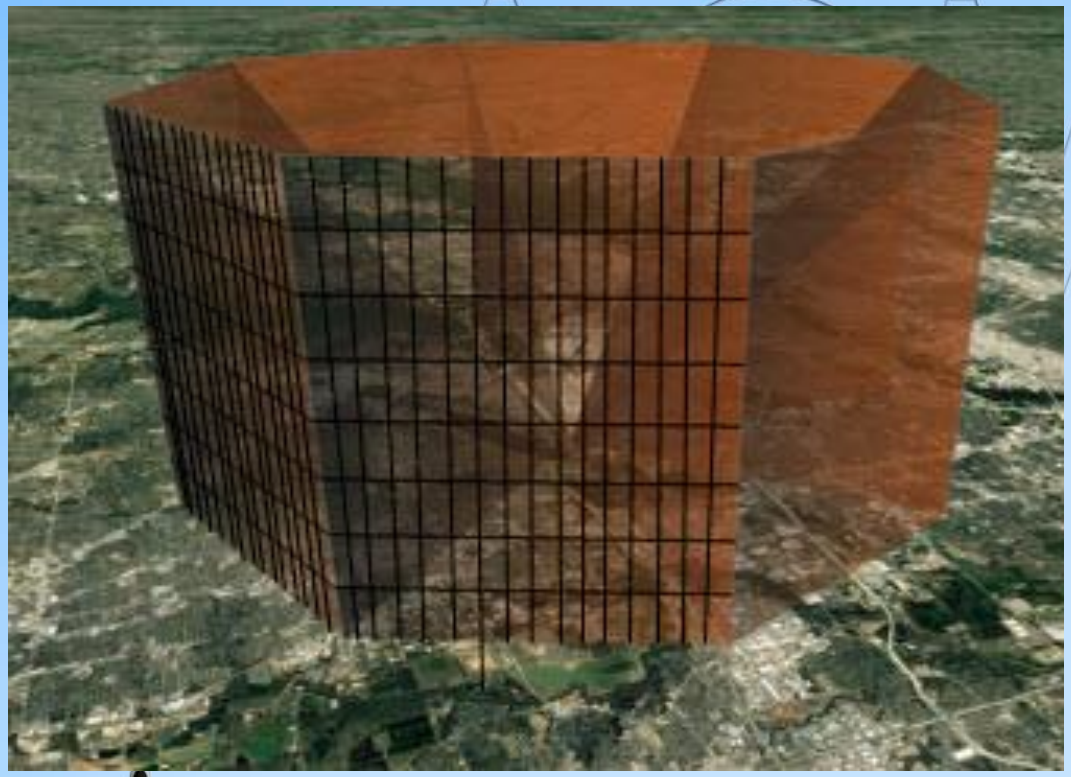
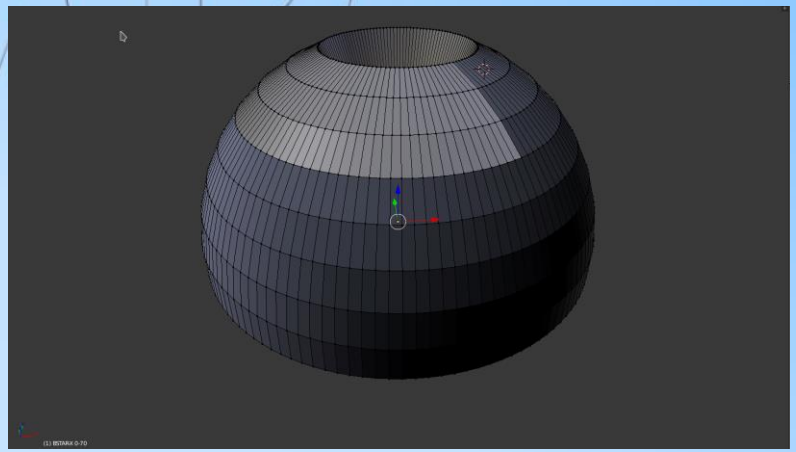
Phased array antennas on avian radar systems provide location and altitude information at high resolution. These antennas also address cone of silence issues.





A major disadvantage of radar is that limited information is available for target identification. Optical and thermal systems address this issue by providing an image that can be recognized by even untrained personnel as a bird.

Used with permission SRC

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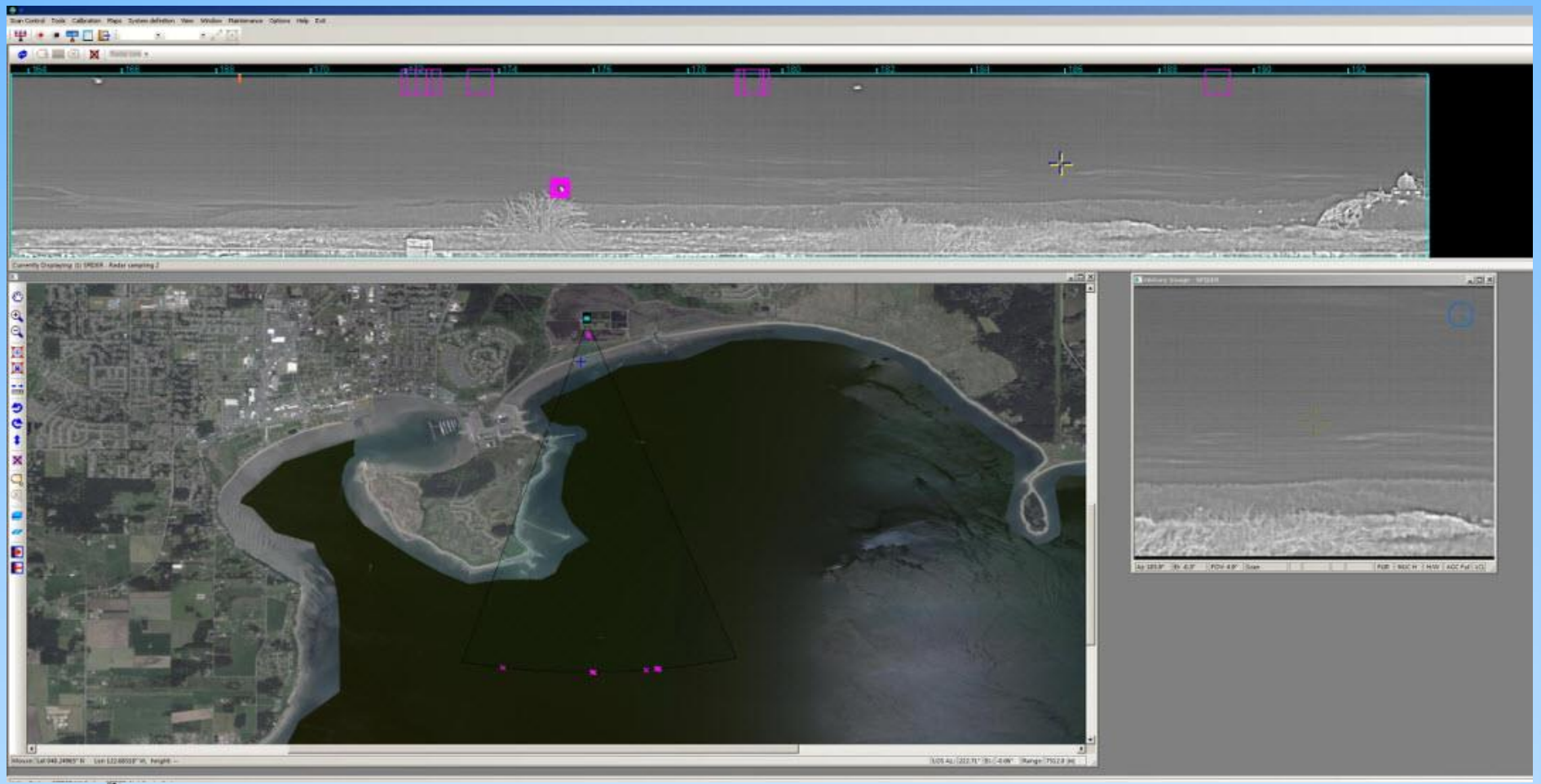
Used with permission of Robin Radar

There are new bird detection systems incorporating electro optical and thermal cameras.

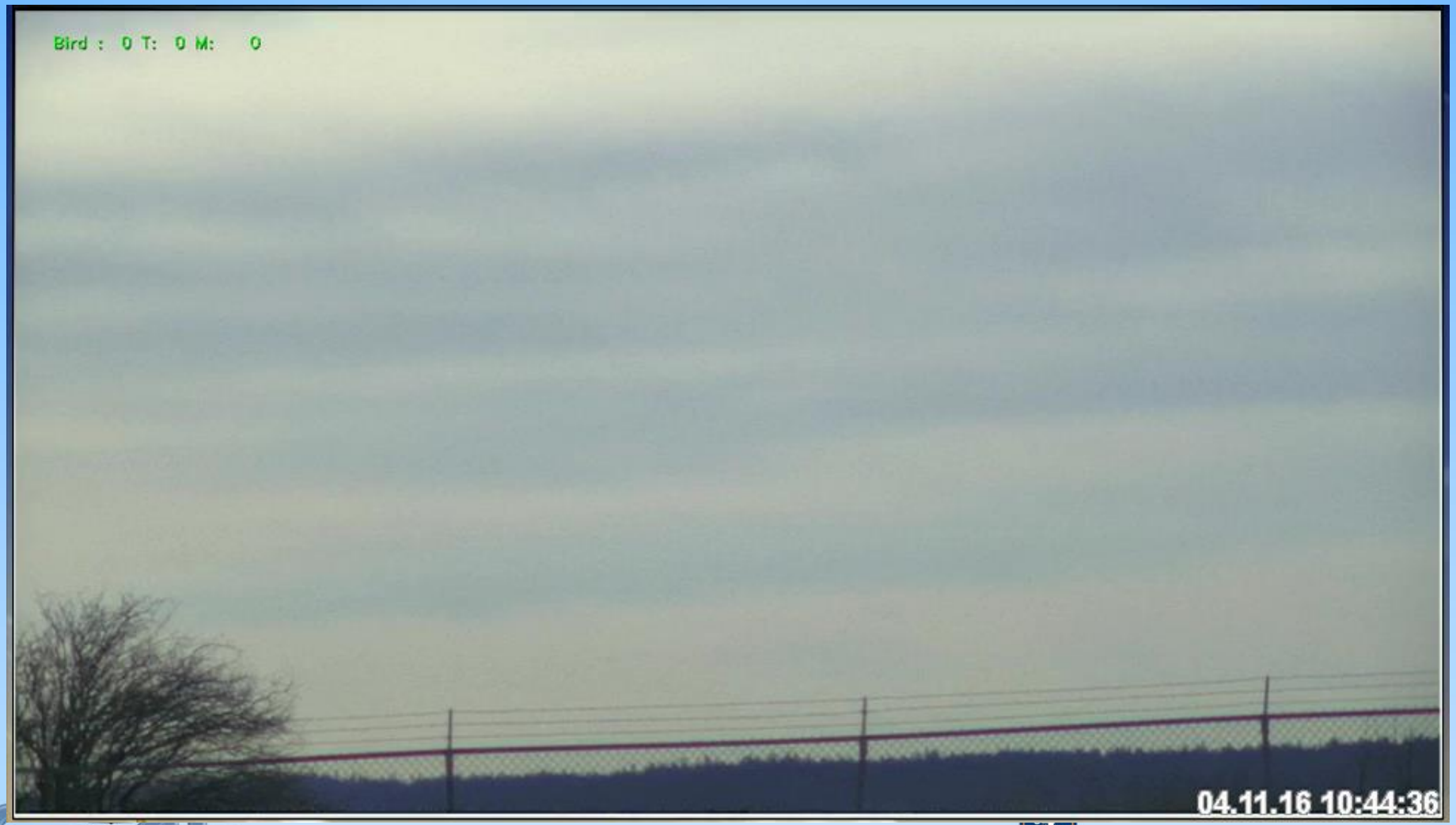
Interceptor from Pharovision

NEC Bird Detection Camera System

Example Interceptor display



Example NEC Bird Detection Camera System Display



Data/Information/User Interfaces

Technology develops data that is then processed into information. It is information that wildlife managers need!

There have been many innovations in information extraction from data and in the development of user interfaces. Vendors are meeting customer specific requirements.

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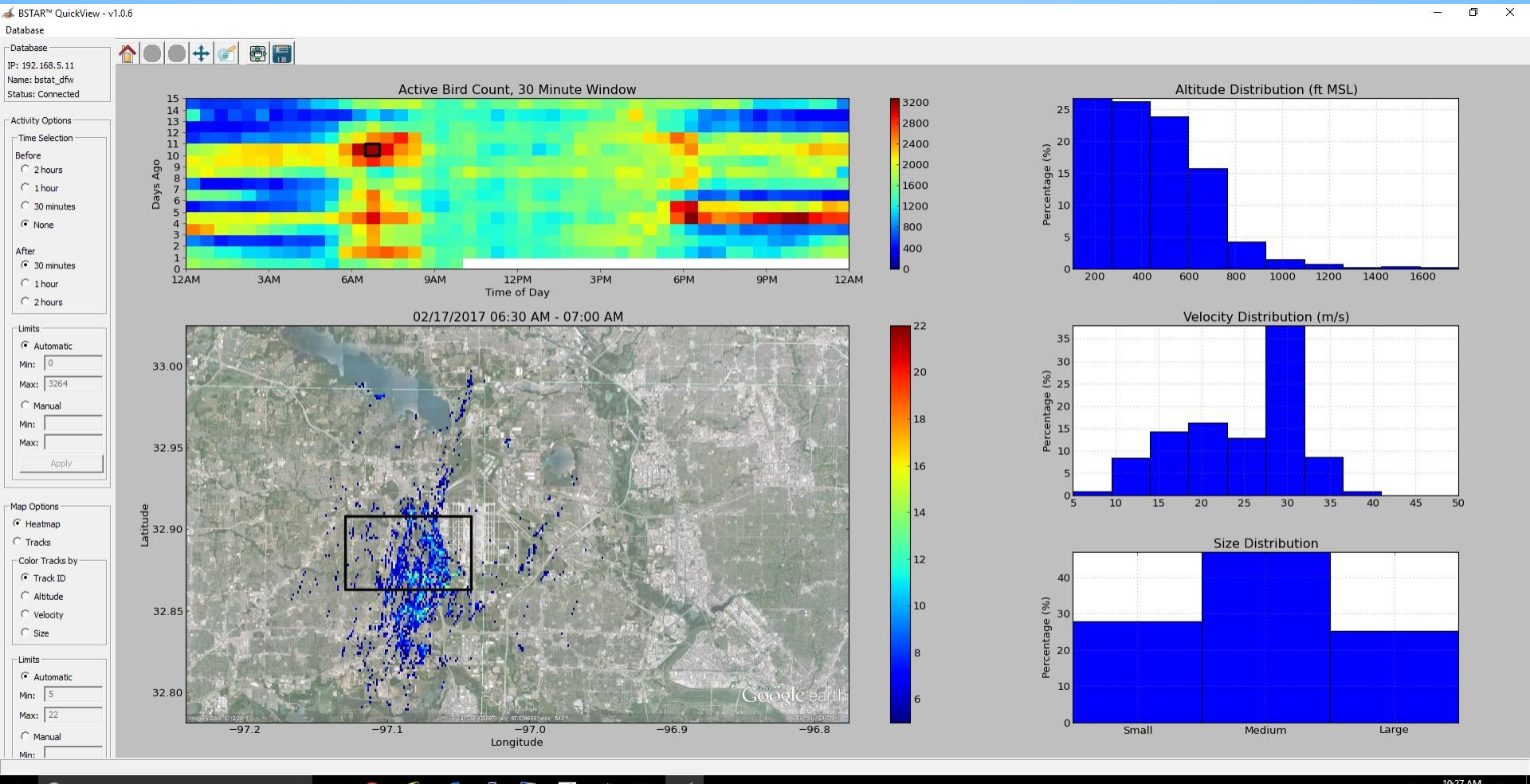
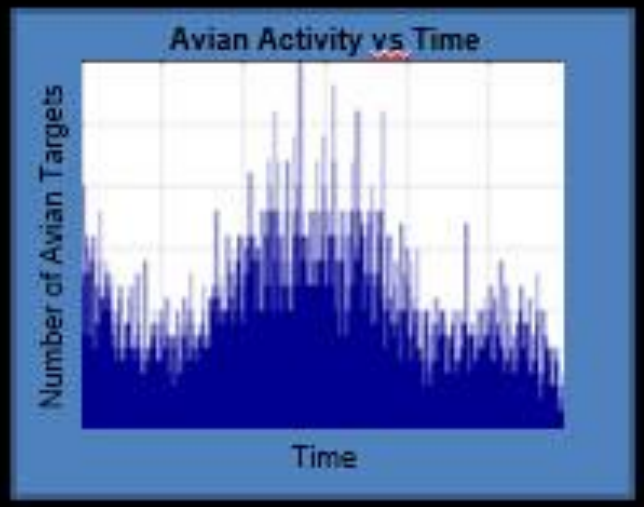
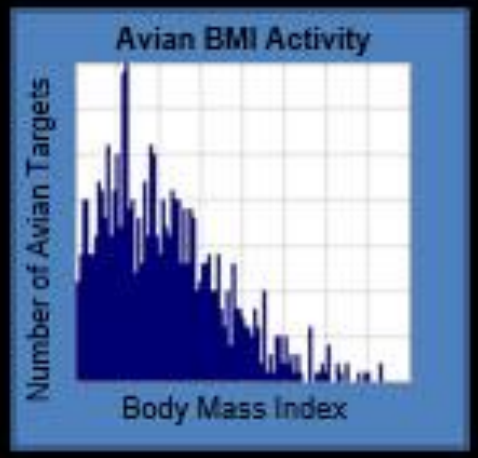
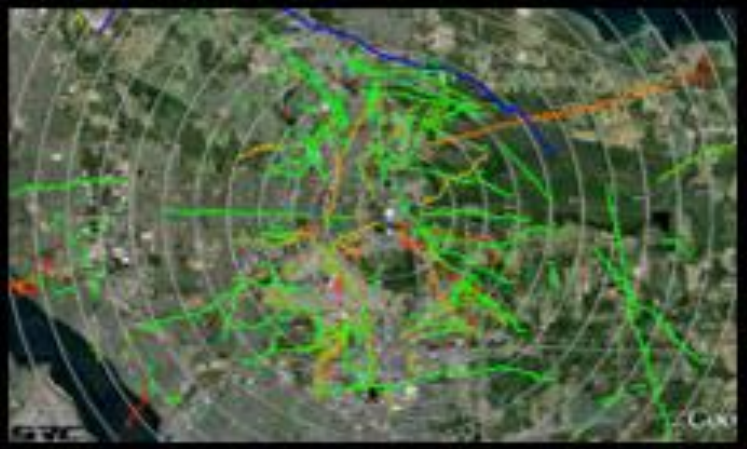
User displays summarize data and provide easy methods to access data archives.

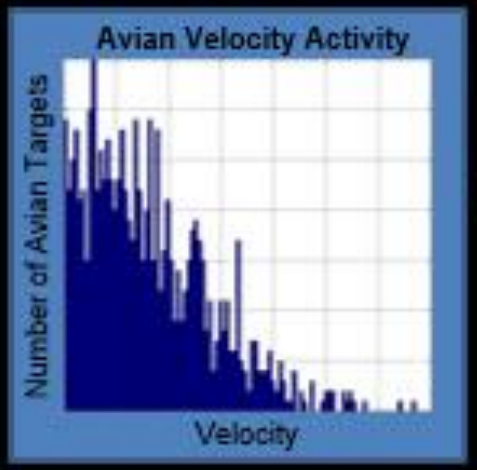


Avian Activity at a Glance

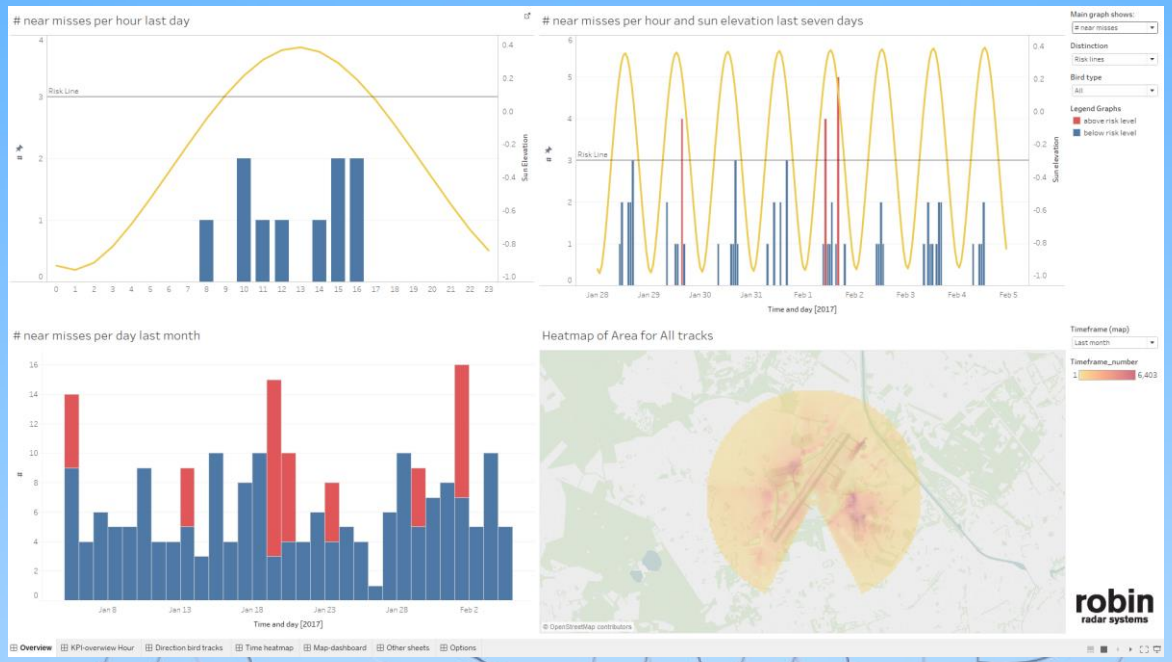




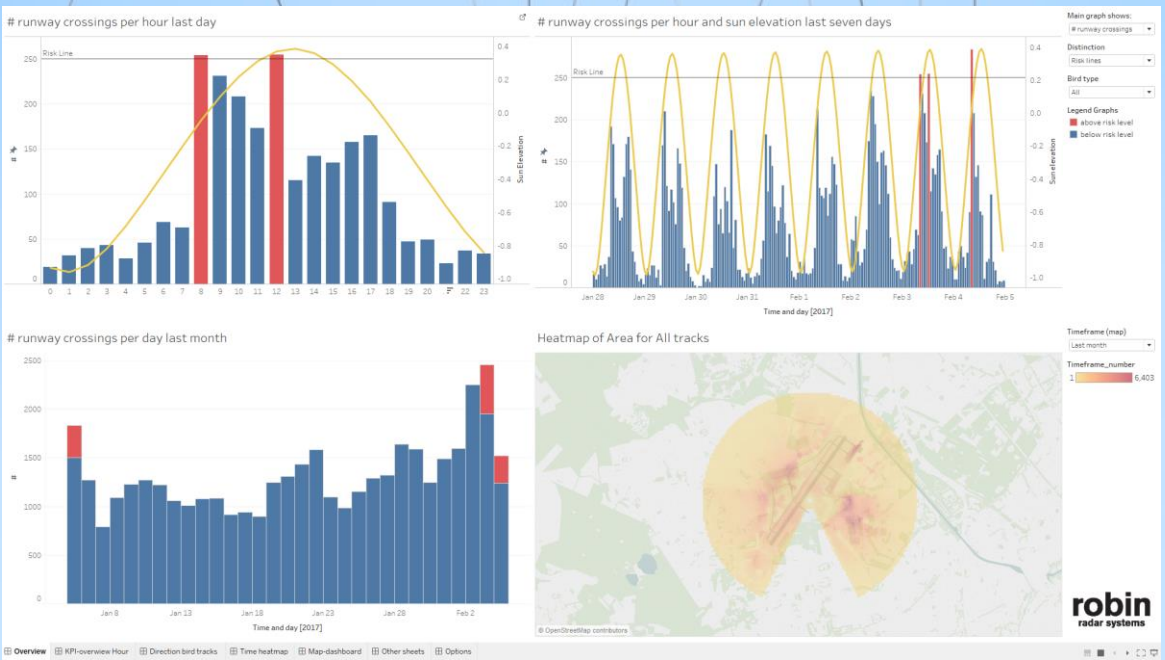




Near Misses
Last 7 days



Runway
Crossings
per hour
previous day



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Robin Radar

Information content of displays can be readily adapted to user needs or analysis requirements.

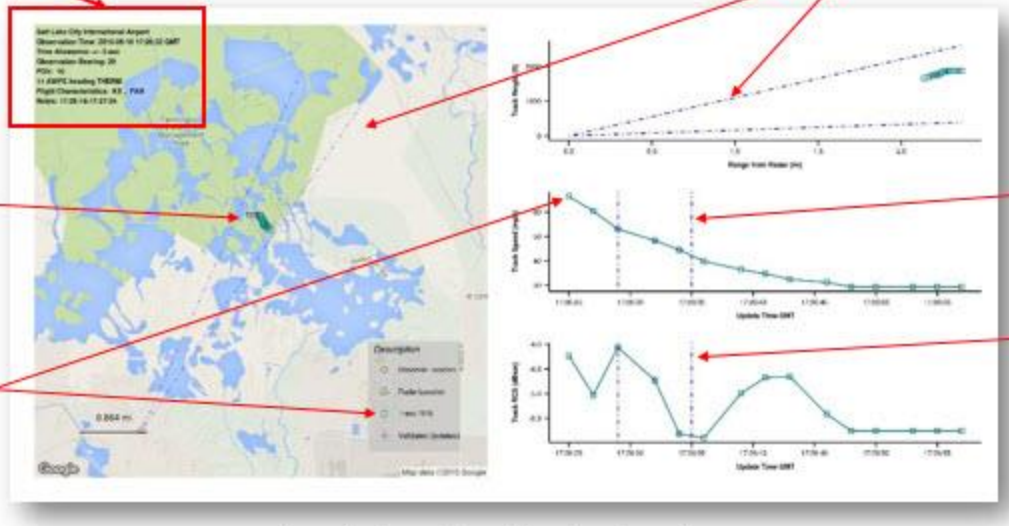
Example Result

Observation characteristics and track search allowances.

Dashed blue lines represent time and FOV allowances.

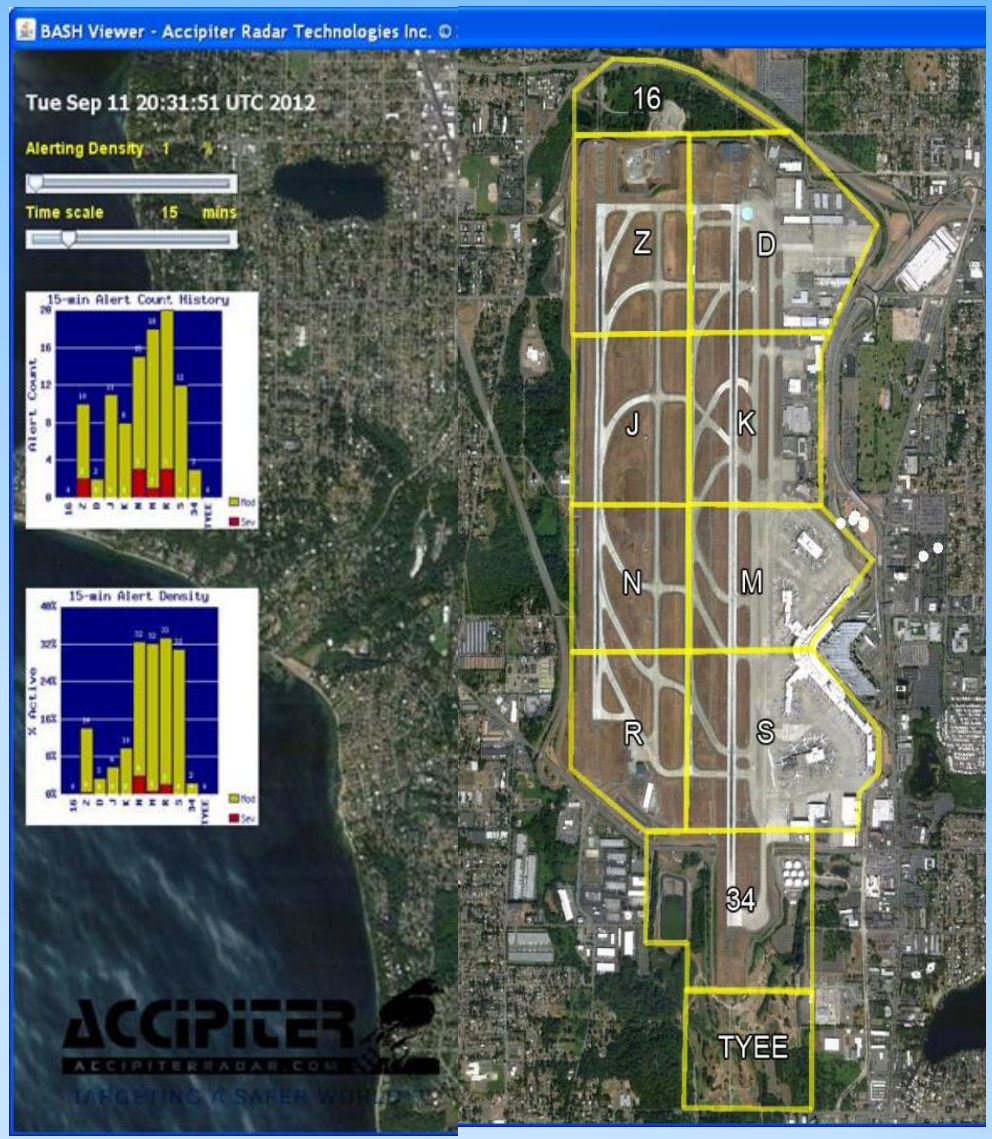
TrackID label represents direction of travel.

Legend symbols and colors are shared between left and right panels.



Map and graphs depict the validated track in it's entirety in addition to the specific track update that lead to the confirmation.

An operational system at SEA is the Threat Viewer. Using avian radar data this system alerts airport personnel to the persistence of bird activity on the airport. This is a model of future airport radar applications.



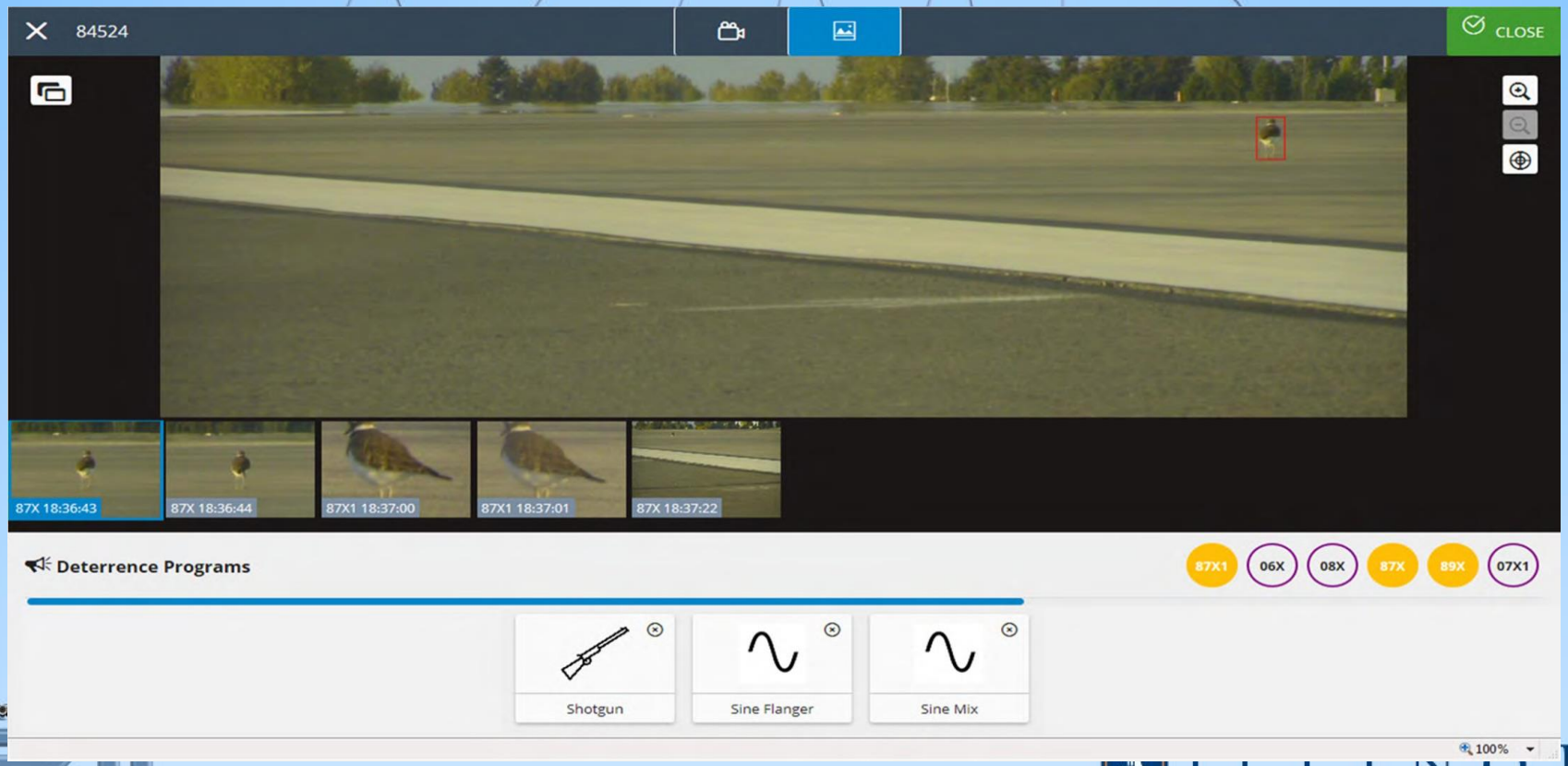
Reality Check II! – Technology is expensive and problem solutions complex. Technology is not easy and will require a personnel commitment!

Single use systems will lose favor to airport wildlife management technologies that integrate existing safety technologies where possible.

Example – FOD Detection

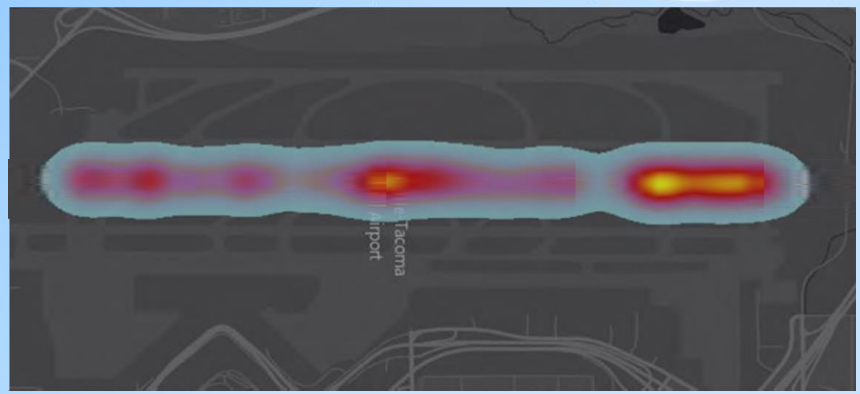
ASMP

In the first operational FOD detection systems wildlife was regularly detected on runways. I have found 60% of alerts at SIN due to wildlife. SEA has been integrating their FOD detection system in wildlife management.



SEA personnel have used FOD detection data in a number of ways.

Accounting for bird distribution and possibly food resources – worms.



Immediately detecting remains and assigning a strike to a specific aircraft.

ASAP

Don’t forget UAS!

Not only can UAS technologies benefit wildlife management by flying cameras or harassing wildlife, it is clear that the present emphasis on UAS detection is advancing detection technology that integrates radar and optical sensors.

We can expect significant improvement in bird radars because birds and drones present similar detection problems – in fact birds are clutter in UAS detection!

ASAP

In summary:

There is little new in basic technology but there are exciting new applications of technology systems. These systems are available now, or soon will be, in wildlife management.

We must not ignore existing surveillance technologies nor fail to take advantage of technologies deployed to address other safety problems.

ASAMP

In wildlife management, technology is a **tool**, not a **solution**. Considering technology-based tools in wildlife management we must consider:

- application needs,
- design,
- cost (acquisition and operation),
- user acceptance.

We need to know whether we have:

- A technology looking for a problem
- A problem defining the technology.

ASMP

Questions?