Avian Mortality at Communications Towers

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Presentation Number 6

NEXRAD Doppler weather radar, other radar applications for bird monitoring

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Al Manville's introduction of the sixth conference speaker, Adam Kelly

Our next speaker is Adam Kelly who has been the manager of the U.S. Air Force 3rd Air Force Bird Control Unit from 1980-1992. He holds a Masters Degree in Conservation Biology from the University of Kent in England. Adam joined Geo-Marine, Inc. and has worked for them since 1994 to develop bird avoidance models for the U.S. Air Force. Currently he is upgrading an avian hazard advisory system for the Air Force; he has been doing that since 1995 and hopes to have it online nationwide by early 2001. Adam Kelly.

Adam Kelly

I wanted to start at the large scale with something that we call the Avian Hazard Advisory System, where we are using NEXRAD weather radar to look at bird migration across huge areas of ground. This is of interest to the Air Force because bird collisions with a military aircraft when it is training, doing 400-odd knots airspeed, usually leads to a lot of damage to the aircraft, particularly if the collisions is with a large bird. So the Air Force has a big interest about where and when those birds are moving. This work that we are doing builds upon some prior work by Ron Larkin who is here and who really is one of the first to look at automatically recognizing bird or biological targets in weather radar data. I need to mention Ron's work here because it really started this field off. But we took another approach to it. We wanted to eliminate the weather targets first, and then refine down to the biological targets – it's a little bit easier way to look for the needle in the haystack in some instances. And what we've done is use advances in computer technology since the mid-1980s, when Ron was doing a lot of his work, and use a satellite link to take all the data from the NEXRAD radar sites and bring it to one central location in Panama City, Florida, where we can analyze it.

These images are from the southeast United States – you don't see any map outline on there because it is just raw radar data [*reference to slide*]. But an image that will mean something to people who have looked at radar images before – these are sunspurs; this is taken at dawn as the sun comes up, this is the line where the electromagnetic radiation from the sun has been detected by each radar station, and the image on the other side has been automatically processed to remove that target type. By automatic target classification, we can now get to the point where we can turn weather on and off, turn off the sunspurs, etc., in the imagery and leave behind the biological targets. And all this is done in a GIS system.

When you have GIS-referenced datasets you have great capabilities for looking at and modeling the effects for the military – when they are likely to have a hazardous collision with a bird. But from this perspective, we can take weather data products, such as what is the visibility outside at any point and time, and overlay it with the radar imagery of where birds are migrating.

We use that to test our algorithms to see if we are successfully removing the weather from the data and leaving biological targets behind all the time. We are also using the weather data we receive through the satellite link to make predictions on when birds are going to migrate, and we actually match those up to the radar observations some 24 hours after we've made the predictions to see if they have held true. How could you use this? We could use this for monitoring and forecasting low visibility conditions -- something that's been suggested as a cause of high bird mortality at communications towers. If you can predict where the birds are, perhaps there are some mitigation measures that can be taken with changing lighting regimes especially in conditions where there may be high bird mortality (*e.g.*, low cloud ceilings). We can also use these datasets from a strategic standpoint of modeling to determine locations where we have lots of birds migrating. Southeastern United States is definitely an area where there are more days of bird migration and higher numbers coming through than say out west. Next, match these migration areas to low visibility conditions.

It's interesting that Todd Engstrom is here from the Tallahassee area. Tallahassee is well known in aviation circles for having the worst airport to fly into with respect to low visibility. There are regions of the country which historically have suffered from low visibility conditions. Being able to gather this weather data and match it to areas where we know there are concentrated migrations may highlight regions of the country where you should be more concerned about towerkill issues than others.

To measure this, simply look at the intensity of migration. You could probably pull up a good index of days such as an intensity of migration on specific days over a long period of time on a continental scale and do this across the entire United States. This could help us to answer the question of why the observed towerkills in the western U.S. are not as severe even when the towers are actually taller, which should theoretically be affecting more birds. My guess is that it has to do with the lower density of birds moving out west, but maybe the lack of low visibility weather conditions is also a factor. There are some techniques we can use within a GIS system. You saw where Bill Evans has shown with his acoustics research where you would likely have a species like Kirland's Warbler. You could then match that to radar imagery and start to interpret where sensitive species may be moving through the country.

In the big sense, these data may be used to cue research to hone in on where we have a prior history of towerkill characteristics. These characteristics include low visibility, tower location, and the use of more local studies to ground truth and get the detailed information on the ground. Ground truthing is one of the huge challenges in all remote sensing work on birds. You must have good quality ground truthing to make sense of these larger datasets. This, specifically, means measuring the numbers of birds that move. NEXRAD gives you 1 by 1 kilometer measurements of reflectivity which is proportional to the amount of moisture in the birds' bodies. But you actually have to physically be on the ground if you want to turn that into some measure of the individual number of birds.

Ron Larkin's work in the mid-1980s is a good example of how you go about calibrating that kind of imagery. With radar -- as Ron has outlined -- you can use it to assess the behavior of birds near the towers. I've put together a table of some of the commercial technologies. However, not all the ones that Ron has mentioned are included because some of them, like his tracking radar, are used military equipment which can be difficult to come by and can often be difficult to maintain over the long run because spare parts are a problem. Looking at my table, I've outlined technologies that are commercially available and likely reliable, including cost.

To review, let's run through some of the techniques that could be used for local ground truthing, starting with X-band vertical scanning radar. In the current issue of the *Wildlife Society Bulletin*, note the paper by Michael Morris which outlines this technique. It's relatively new in the last 3 years. Essentially you are taking a marine radar and flipping it on its side so it spins like a windmill, taking a nice vertical slice of the atmosphere. You can count bird targets crossing that line through the atmosphere. It also gives you altitude of the targets and the position that they are going across the ground. You could actually image adjacent to a tower, have the tower within the image, and be able to see where the birds come through relative to it, and ground track vertical distribution. This would give you some very good data of the vertical distribution of the birds.

The S-band radar we have found incredibly useful. Pretty much everywhere the Air Force has had us working has been wetland areas, and we've found that X-band 3cm radar does not work well in a wetland environment with a lot of wet vegetation. The dampness tends to just eat up what we are transmitting out, and we never see any birds even if we are looking at them with a pair of binoculars or a spotting scope. At 10 cm we have had much greater success in a terrestrial environment. Where Ron Larkin was showing with a tracking radar that you can watch the tracks of birds coming in, the S-band radar gives us the capability of looking for birds that are coming in toward a tower and image them actually circling it.

Image intensification through night vision goggles is a pretty cheap technology currently available. Sid Gauthreaux outlined how he used those for his study. The problem: you have to amplify the ambient light or you have to provide a light. If, however, we are really interested in looking at these birds under low visibility conditions, night vision techniques do not work very well.

The next category down, thermal imagery (TI) -- also called forward looking infrared -- actually picks up the heat that is transmitted from the bird's body in the far region of the infrared spectrum. We have a camera -- unfortunately it costs about $70,000 -- which will image a bird the size of a goose or a swan at about 2 miles in clouds and bad visibility. We have literally looked across a lake in fog and been able to tell that the bird was preening; the image is that detailed. You can also change the field of view of this system to actually look into a cloud. This could actually image birds flying in low visibility around a tower enabling assessments of bird behavioral responses. Care must be taken, however, in your scientific protocol to not over-interpret the imagery. Couple this work with the acoustics research Bill Evans has already outlined, combined that with some of the image processing techniques we are using on a larger scale where you automatically count and quantify bird targets going by, and you now have some really good techniques for actually measuring what's going on. You may also have some of the hypotheses as to the reasons for these towerkills.

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