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16. Abstract

The Federal Aviation Administration (FAA) Concept Development and Validation Branch held a Knowledge Elicitation Activity (KEA) for the Wildlife Surveillance Concept (WiSC) in February 2014. The purpose of this activity, which was funded by the FAA Airport Technology Research and Development Branch, was to elicit information from stakeholders. The researchers convened a panel of certified professional controllers, front line managers, and commercial airline pilots to learn how they currently handle bird threat information and their perspectives on the potential introduction of supplemental bird threat information into the air traffic control (ATC) environment via airport avian radar systems.

This KEA served as the first in a series of research activities aimed at maturing the WiSC and gathering information to prepare the Concept of Operations document. The purpose of this report is to provide an in-depth summary of the KEA and its findings.

Participants reviewed and validated five common operational situations depicting how bird threat information is managed and disseminated today and the changes that might be anticipated with the introduction of more precise and timely bird threat information. In addition, participants provided feedback on notional graphical and textual display options for providing this supplemental information on ATC displays.

All participants confirmed the value of integrating more timely and precise supplemental bird threat information into the ATC environment. In addition, they identified areas requiring further investigation. For example, they suggested research is needed to quantify the potential benefit of supplemental bird threat information on aviation safety, to ensure that controller and pilot workload levels and performance are not adversely impacted by the new information, and to ensure that the new information is optimally integrated into the ATC operational environment.

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The authors extend their appreciation to the FAA Airport Safety R&D Section support contractors who spent many hours working collaboratively with the authors, and who, through their technical expertise, contributed significantly to the success of this activity. Specifically, the authors thank Mr. Mike DiPilato (CSRA, Inc.) for his management as well as his expertise in bird radar systems and research methods; Mr. John Pallante (John Pallante and Associates) for his hours of expertise not only as a main Air Traffic Control Tower Subject Matter Expert but also for his leadership abilities; and Mr. John Kelley (John Pallante and Associates) whose subject matter expertise was invaluable throughout the process.

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LIST OF ACRONYMS

ACTA	Applied Cognitive Task Analysis
AFTIL	Airport Facilities and Tower Integration Laboratory
ASDE	Airport Surface Detection Equipment
ASDE-X	Airport Surface Detection Equipment (Model-X)
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATIS	Automatic Terminal Information Service
ConOps	Concept of Operations
CPC	Certified professional controller
CTA	Cognitive Task Analysis
ERP	Engineering research psychologist
FAA	Federal Aviation Administration
FLM	Front line manager
IDS	Integrated Display System
IEEE	Institute of Electrical and Electronics Engineers
KEA	Knowledge Elicitation Activity
LLWAS	Low Level Windshear Alert System
n=#	Number of participants (n=2)
NAS	National Airspace System
NextGen	Next Generation Air Transportation System
PIREP	Pilot Report
PSQ	Post-Scenario Questionnaire
RDHFL	Research Development Human Factors Laboratory
SME	Subject matter expert
STARS	Standard Terminal Automation Replacement System
TRACON	Terminal Radar Approach Control
WiSC	Wildlife Surveillance Concept

EXECUTIVE SUMMARY

The Federal Aviation Administration Concept Development and Validation Branch held a Knowledge Elicitation Activity (KEA) for the Wildlife Surveillance Concept (WiSC) on February 25-26, 2014. It was a six-member subject matter expert (SME) panel consisting of two current certified professional controllers from air traffic control tower (ATCT) facilities, two front line managers from ATCT facilities, and two pilots (one current and one retired) that flew commercially for major airlines.

The purpose of this activity was to elicit information from the air traffic stakeholders regarding their attitudes and opinions on the introduction and integration of supplemental bird threat information into the air traffic control (ATC) environment. One of the key activities was to refine and validate five typical operational scenarios depicting how bird threat information is managed and disseminated today by tower and Terminal Radar Approach Control ATC personnel. Following this, the panel identified how radar-based bird threat information could best be disseminated, how it would impact ATC operations, and what benefits may be associated with its use. Participants also provided their expertise on some notional display options for supplemental bird threat information, including graphical and textual depictions on representative ATC displays.

Participants responded favorably to the KEA and to the notion of supplemental bird threat information derived from airport avian radar. Throughout, the KEA participants identified numerous positive impacts that precise supplemental threat information could provide. While ratings and comments were generally skewed towards the positive, participants did identify some areas that require further investigation. Research is required to quantify the potential benefit of supplemental bird threat information on aviation safety, to ensure that controller and pilot workload levels and performance are not adversely impacted, and to ensure the optimal integration of this information into the ATC operational environment. Regardless of how effectively this type of information is integrated into the air traffic environment, any workload increase must be offset by improvements in safety, situation awareness, procedural improvements, and other factors.

1. INTRODUCTION.

1.1 SCOPE.

The Wildlife Surveillance Concept (WiSC) will improve aviation safety through the dissemination of improved bird threat information to air traffic controllers. Although alternative radar systems are currently being researched to track bird targets, this project focuses specifically on the application of radars identified in Advisory Circular 150/5220-25 to supplement airport wildlife management efforts and to reduce bird threats to aircraft [1]. It is based upon existing airport avian radar systems approved for use today by airport operations personnel, wildlife management personnel, and biologists at civil airports. The objective of the Knowledge Elicitation Activity (KEA) was to identify and begin to investigate the factors that are critical to the design and implementation of an effective air traffic control (ATC) avian threat information display based on this technology. It served to help define a set of functional requirements, capabilities, procedures, and practices to best detect, disseminate, and display supplemental bird threat information to controllers, supervisors, and pilots in the ATC environment.

1.2 BACKGROUND.

Wildlife hazards, including bird strikes, have been recognized as a reason for concern to pilots and aviation stakeholders since the earliest days of air travel. Recently, the Federal Aviation Administration (FAA) and researchers have noted that bird strike incidents have shown an alarming trend of significant growth [2]. In fact, from 1990 to 2012 there were 131,096 bird strikes reported to the FAA [3]. While birds are not the only type of wildlife that can be problematic to aircraft, they accounted for 97% of all recorded strikes from 2007 through 2012 [3 and 4] and are the focus of this KEA. Figure 1 illustrates this growing problem.

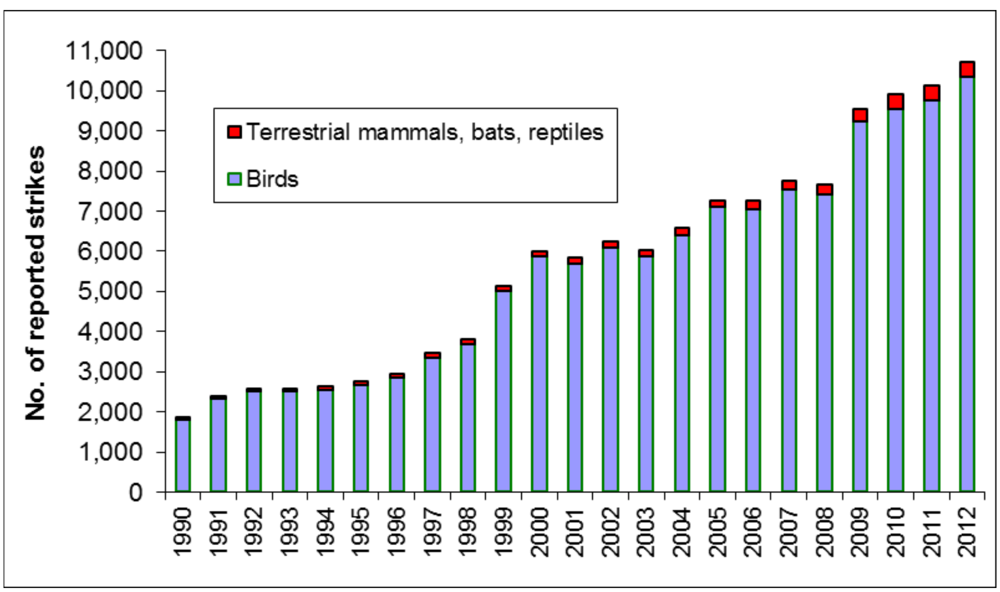

Figure 1. Annual Wildlife Strikes (1990-2012)

The increasing trend in incidents is particularly alarming when one considers the losses caused by wildlife strikes. Bird strikes have resulted in more than 250 fatalities and the destruction of 229 aircraft since 1988 [2 and 3]. In the United States, the economic cost associated with wildlife strikes to civil aviation is estimated to be more than $625 million per year [5]. Allan [6] estimated that bird strikes cost commercial air carriers worldwide more than $1.2 billion annually.

Several factors contribute to the substantial increase in bird strike reports. Passenger enplanement and subsequent aircraft operations have increased over the years adding more aircraft to the National Airspace System (NAS). Coincidentally, as demand has increased, aggressive environmental and natural resource protection efforts have indirectly resulted in an increase in bird populations that present a high risk to aircraft. These two factors coupled with faster aircraft and quieter aircraft engines increase the probability of an aircraft bird strike.

As bird strike incidents have increased, so has the awareness of the problem. The FAA strongly encourages bird strike reporting and maintains a bird strike database. However, perhaps recent incident events have done more than anything else to add visibility to the problem. For example, in 2009, Captain Chelsey B. Sullenberger lost thrust in both engines of US Airways Flight 1549 due to bird strikes and was forced to "ditch" the plane in the Hudson River. Remarkably, there was no loss of human life in this incident, which has been dubbed as the "Miracle on the Hudson." As awareness of the bird strike problem has increased so has the interest in methods, procedures, and systems used to report and mitigate these events.

One potential avenue that shows promise in mitigating bird strike problems is avian radar. In 2005, the FAA initiated the Bird Radar Performance Assessment Research Program within the Wildlife Hazard Mitigation Research Program. Among the key activities within this program is the collaboration with several organizations to determine the current state of available avian radar technology [7].

While assessments of commercial avian radar are ongoing, there have been significant findings from the FAA Wildlife Hazard Mitigation Research Program. First, it has been determined that existing commercial avian radars are suitable for detecting and tracking birds on and around the airport. Second, avian radars can provide nearly real-time alerts of bird activity in airport operational areas where they represent a high collision risk. Third, avian radar has demonstrated a utility in the development of a focused wildlife management plan at an airport [7]. The current direction in the field of avian radar mitigation includes understanding the impact that improved radar technology can have on mitigating this growing problem.

1.3 PURPOSE.

The purpose of this KEA is to examine how air traffic controllers, supervisors, and pilots interact with wildlife/bird information in the ATC environment. This KEA gathered information on how the participants receive wildlife/bird activity information today, what actions they take in response to this information, what procedures and processes they follow, and what may be changed in the future to improve Air Traffic Management response to bird strike threats. The research team also examined how future technologies may be implemented to deal with the substantial safety and economic costs that bird threats pose to the flying public, air carriers, and the NAS.

Specifically, the purpose of this activity was to

- elicit information from civil air traffic controllers, supervisors, and pilots regarding how wildlife/bird activity information is distributed and managed today and develop and validate operational scenarios.
- evaluate options for future Air Traffic Control Tower (ATCT) and/or Terminal Radar Approach Control (TRACON) automation prototype displays for subsequent evaluation by end users.
- gather information to help guide more efficient dissemination of actionable avian radar information (display and user requirements).
- explore preliminary interface development requirements for the display of information to appropriate ATC personnel (e.g., local position, ground position, clearance delivery, supervisor, and traffic flow manager).
- investigate job/task design considerations for ATC personnel.
- evaluate training impacts for ATC users of wildlife/bird information.
- support development of preliminary requirements (hardware and software) for ATCT and/or TRACON automation.
- develop opportunities to leverage Next Generation Air Transportation System (NextGen) capabilities to help mitigate the incidence of aircraft bird strikes (e.g., data communications and Automatic Dependent Surveillance-Broadcast).

The FAA Concept Development and Validation Branch used this KEA to leverage existing literature, identify preliminary ATC information requirements, validate how bird threat information flows in operations today, and gain early assessment of some notional ATC bird threat information display ideas. As such, it represented a first step in maturing the WiSC for inclusion in the preliminary Concept of Operations (ConOps) document.

2. METHOD.

2.1 PARTICIPANTS.

This section is a brief overview of the six research participants (two controllers, two supervisors, and two pilots) who attended the 2-day KEA at the Research Development Human Factors Laboratory (RDHFL) at the William J. Hughes Technical Center, Atlantic City International Airport, New Jersey. The participants' names are withheld in compliance with common research confidentiality practices. The participants represented three key air traffic-related stakeholders:

- Civilian certified professional controllers (CPC), referred to as controllers in this report

- ATC front line managers (FLM), referred to as supervisors in this report
- Commercial airline pilots

The participants' responses were analyzed in terms of two primary categories: ATC participants (consisting of controllers and supervisors) and pilot participants. In situations where noting the specific stakeholder was considered relevant, the research team differentiated between controllers and supervisors.

2.1.1 Air Traffic Control Participants.

The average amount of experience for ATC participants (controllers and supervisors) was 22.56 years. On average, the ATC participants had slightly more experience in the ATCT environment (21.33 years) than in the TRACON environment (18.12 years). The average amount of experience for the two supervisors was 5.33 years.

ATC participants reported working at a combined 15 facilities and locations (4 different facilities on average) as well as a variety of shifts during their careers. All ATC participants reported they had last controlled air traffic in February 2014. The data regarding ATC experience are shown in table 1.

Table 1. Air Traffic Control Participant Experience

Role	Facility	Controller Experience (years)	Supervisor Experience (years)	ATCT Tower Experience (years)	TRACON Experience (years)
Controller	Denver International Airport	21.25	--	21.25	18.83
Controller	Orlando International Airport	25.58	--	25.41	22
Supervisor	Denver International Airport	21	6	21	15
Supervisor	Kansas City International Airport	22.41	4.66	17.66	16.66
	Averages	22.56	5.33	21.33	18.12

2.1.2 Pilot Participants.

The pilot participants had an average of 45 years of flying experience. One pilot, a current airline transport pilot, had 40 years of combined commercial (18 years) and military (22 years active and reserve) flying experience and recorded over 11,000 flying hours. The other pilot, a retired airline transport pilot, had 50 years of flying experience and recorded over 22,000 flying hours. Both pilots were certified on and had flown a wide variety of aircraft. In addition, both pilots were certified flight instructors, and one was a certified flight engineer. The data regarding the pilots' experience is presented in table 2.

Table 2. Pilot Participant Experience

Role	Flying Type	Flying Experience (years)	Total Hours Flying Reported
Pilot	Commercial (active)	40	11,000
Pilot	Commercial (retired)	50	22,000
	Averages	45	16,500

2.2 RESEARCH PERSONNEL.

A human factors specialist supporting the Concept Development and Validation Branch served as the principal investigator and oversaw the panel activities along with an engineering research psychologist (ERP). This included briefing the participants, collecting the data, and leading group discussions with the panel members. A program analyst supporting the Concept Development and Validation Branch assisted the principal investigator in the data collection activities. The Airport Safety Technology Section members assisted with development efforts and provided valuable oversight. They also attended the KEA to provide their expertise.

The research team members were:

- Anton Koros (FAA/Concept Development and Validation Branch)
    - Mark Hale (CSSI, Inc.)
    - Danielle Pagan (CSSI, Inc.)
- Ryan King (FAA/Airport Safety Technology Section)
    - Mike DiPilato (CSRA, Inc.)
        - John Pallante (John Pallante and Associates)
        - John Kelley (John Pallante and Associates)

2.3 KNOWLEDGE ELICITATION ENVIRONMENT.

2.3.1 Research Facility.

All KEA activities, except the Airport Facilities and Tower Integration Laboratory (AFTIL) tour, were held at the RDHFL at the William J. Hughes Technical Center.

2.3.2 Audio Recording System.

The research team, with the participants' consent, audio recorded their inputs during the various activities. These audio recordings served as a record of the activity, and gave the researchers the capability to review the activities at a later time if needed.

2.4 MATERIALS.

2.4.1 Informed Consent Statement.

The Informed Consent Statement describes the purpose of the study, outlines the rights and responsibilities of the participants, and ensures the participants that their data will be confidential and anonymous. Each participant read and signed the Informed Consent Statement before beginning the activity (see appendix A).

2.4.2 Biographical Questionnaire.

Each participant completed the Biographical Questionnaire before beginning the KEA. The purpose of the questionnaire was to collect general descriptive information about the participants, including their ATC experience, work environment, and any other factors that may influence or affect their responses (see appendix B).

2.4.3 Pre-KEA Opinion Survey.

The participants completed a Pre-KEA Opinion Survey that was designed to elicit their opinions on the nature of bird threats in the ATC environment today, their experience dealing with bird threats, and their opinions on potential mitigation methods (see appendix C).

2.4.4 Post-Scenario Questionnaire.

The participants completed the Post-Scenario Questionnaire (PSQ) after each scenario. The purpose of the PSQ was to collect data regarding the participants' experience and thoughts about the scenario walkthrough that was just completed. The controllers provided ratings about the realism of the scenarios and gave feedback on different interface options (see appendix D).

2.4.5 Post-Interface Evaluation Questionnaire.

The participants completed the Post-Interface Evaluation Questionnaire following the presentation of notional bird threat interfaces. The research team designed this questionnaire to gauge the participants' opinion on information needs, interfaces, and other interaction-related information that was presented during the activity (see appendix E).

2.4.6 Exit Questionnaire.

The participants completed the Exit Questionnaire after the 2-day KEA. The purpose of the questionnaire was to collect data regarding their experience during the KEA. The questionnaire included ratings and open-ended questions. The controllers also were able to comment about anything they experienced during the entire activity that they considered relevant to the study of bird threat information (see appendix F).

2.5 RESEARCH METHODOLOGY.

The research team applied a wide range of Applied Cognitive Task Analysis (ACTA) techniques (see section 2.5.1) and cognitive engineering research methods (see section 2.5.2) to develop the methodology. As a result, the team developed and used several operational scenarios during the KEA, which are described in section 2.5.3.

2.5.1 Applied Cognitive Task Analysis Tools.

Task analytic techniques play a crucial role in many system design exercises. These activities focused on describing and representing the cognitive elements that underlie goal generation, decision making, and judgments within existing and proposed systems [8]. Cognitive Task Analysis (CTA) can be a laborious endeavor that requires significant effort and substantial cost. Therefore, a modified version of the ACTA was used to gather the necessary information within the time and resource constraints of the KEA. ACTA is a streamlined CTA aimed at reducing time and costs while maximizing access for practitioners and engineers. This technique allows researchers to elicit and represent cognitive components of skilled task performance and to transform the data into meaningful design recommendations and requirements. The research team adapted these elements to fit the exercise, time, and domain requirements of the KEA. The ACTA consisted of four main components: Task Decomposition, Development of Task Diagrams, Knowledge Audit, and Simulation Interview. The Simulation Interview is described in a standalone section (2.5.3) because of the central role it represented in the current KEA.

2.5.1.1 Task Decomposition.

The research team solicited feedback from available subject matter experts (SMEs) to develop high-level descriptions of the tasks being examined, specifically, investigating the distribution, processing, and dissemination of bird strike threat information. The team generated a graphical information flow diagram to represent the process by which tower controllers typically receive this information today (see figure 2).

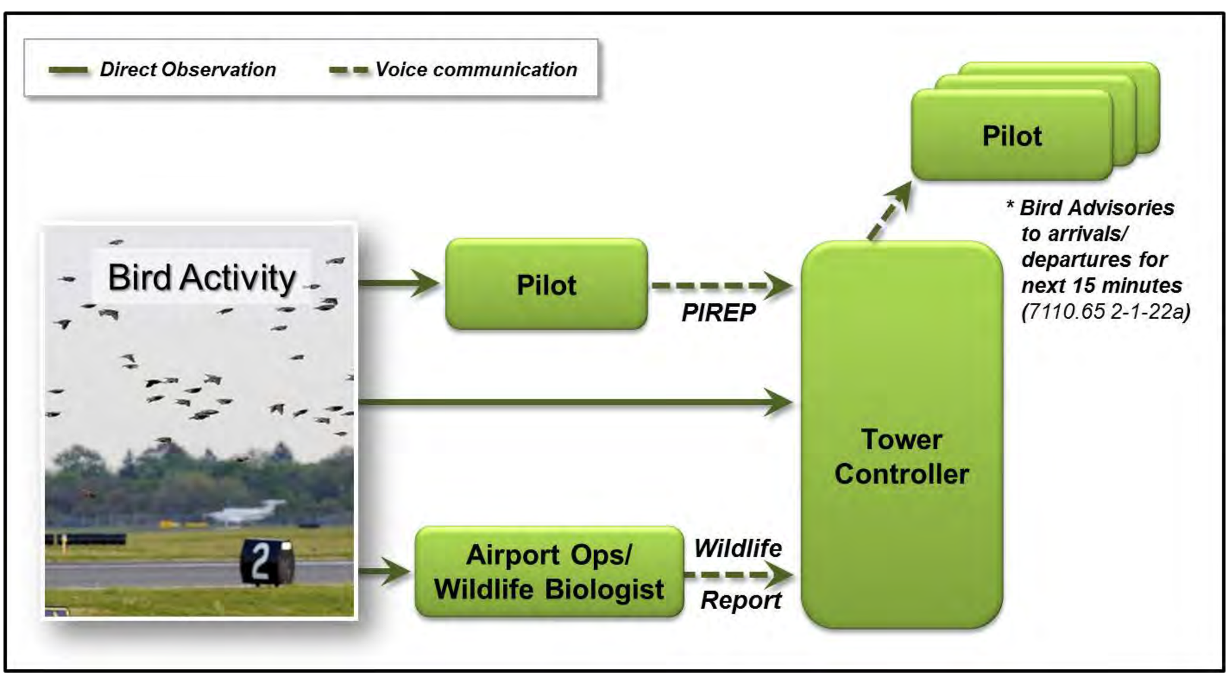

Figure 2. Typical Bird Threat Information Flow Diagram

During this activity, the research team also explored critical physical and mental aspects of the users' task required during each stage of execution. This included the perception of an event; cognitive decision-making strategies, including situation assessment strategies; and identification and interpretation of critical cues, as well as actions taken based upon the assessment of the situation [8]. The research team performed this process with assistance from SMEs via in-depth interviews prior to the KEA.

2.5.1.2 Development of Task Diagrams.

The purpose of the task diagram was to elicit a broad overview of the task through questions to identify difficult cognitive demands placed upon the user. Although this offers only a surface-level view, it does provide a basis for deeper exploration.

The research team asked the SMEs to decompose the task in question into steps and/or subtasks. To do this, the research team asked questions such as: "Think about what you need to do when you (task of interest)." The SMEs were tasked with breaking down these high-level tasks into less than six, but more than three, steps when possible*. The SMEs then walked through the tasks in their mind while verbalizing major steps. Researchers then asked the SMEs to identify which steps required further analysis due to particular cognitive and/or workload factors. Figure 3 shows the output of this process.

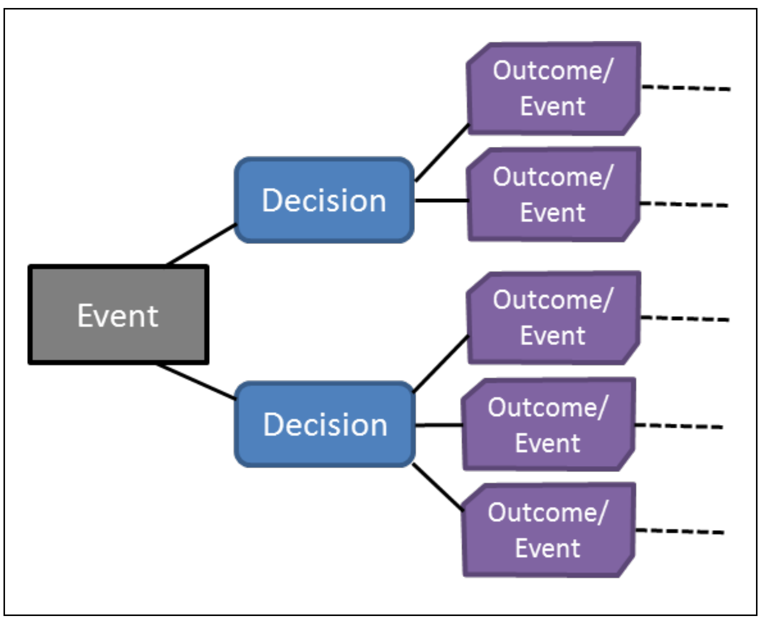

Figure 3. Typical Task Diagram

* Limiting the number of steps to between three and six provides enough insight into the task without becoming overly cluttered with minor details.

2.5.1.3 Knowledge Audit.

The knowledge audit identifies how the users employ their expertise and helps to elicit examples of the subject matter that are based on real-world experience. It also serves to capture the most important aspects of the task and required expertise while streamlining the intensive data collection typically found in research. Finally, the knowledge audit helps to identify gaps in functionality or task resources that may result in poor task performance.

2.5.1.4 Simulation Interview.

The main purpose of the simulation interview was to better understand the SMEs' cognitive processes within the context of an incident or scenario. Generally, this procedure requires an up-front analysis with the SMEs, prior to administration, to ensure that the developed scenarios are internally and externally valid. Similar to storyboarding, the simulation interviews allowed the SMEs to walkthrough a realistic event and provide feedback regarding their decision-making processes. After exposure to the simulated event or scenario, the SME was asked to identify major events, including judgments and decisions. For example, an SME was asked: "If you just received a Pilot Report (PIREP) about bird activity on a runway, what tasks do you perform cognitively and what action would you take?" Researchers explored each important event for situation assessment, actions, critical cues, and potential errors surrounding the event, following the established methodology [8].

The scenario walkthrough is described in more detail in section 2.5.3. This was the final stage of the ACTA process, and it also served a vital role in developing the concept and production of the ConOps document. As a result, the scenario walkthrough represented a major portion of the KEA.

2.5.2 Cognitive Engineering Research Methods.

In addition to the ACTA techniques, the research team employed several common usability analysis and job design methodologies to develop elicitation materials and methodology for the KEA. This series of methodologies included interviews and discussions, storyboarding sessions and verbal protocol analysis, questionnaires, and interface design and evaluation exercises, as described in the following sections.

2.5.2.1 Group Discussions.

The most efficient method in terms of time is the traditional group discussion. This format simultaneously captures multiple stakeholder viewpoints and enables discussions in a collaborative environment. One key challenge in interactions of this type is that multiple stakeholders must be effectively managed so the focus of the discussion is kept on the area of interest. While differing points of view can lead to a better understanding of the problem as whole, researchers must ensure that the most important aspects of the problems are emphasized. Often, discussions of large interdependent systems like the ATC can become overly distracted by minor details. The research team facilitated both one-on-one discussions and stratified group discussions. Stratified group discussions proved to be particularly important because the KEA included multiple stakeholders representing different roles. For example, it was beneficial to elicit input from representatives from the flight deck perspective on some issues independently from those captured from the ATC participants.

2.5.2.2 Storyboarding Sessions and Verbal Protocol Analysis.

The research team conducted storyboarding sessions to present mockups of notional system interfaces to the ATC participants to capture SMEs judgments on the operational utility of the design and likely controller actions. The team's main goal was to engage the SMEs by providing them with visual cues designed to simulate their real-world mental models without enlisting observational field research. The team also used verbal protocol analysis and storyboarding to elicit verbal descriptions from the participants to document any required domain expertise.

2.5.2.3 Questionnaires.

The research team used questionnaires designed to elicit the SMEs mental processes in managing bird activity information as well as determining informational gaps in current bird activity information handling.

2.5.2.4 Interface Design and Evaluation Exercises.

For the interface design and evaluation exercises, the research team used common office software tools to develop static notional ATC displays with integrated bird threat information. First, screen captures were taken of the Standard Terminal Automation Replacement System (STARS) and the Integrated Display System (IDS). Next, the team imported images into Microsoft® PowerPoint® and, based on SME input, developed a range of display options that included graphical and textual formats.

2.5.3 Scenario Walkthrough.

Scenario walkthroughs, derived from the simulation interviews, were one of the core activities conducted at the KEA. The research team used scenarios to capture the cognitive and physical demands imposed on controllers to process and disseminate bird threat information. The team selected this technique because scenarios are an efficient way to communicate the characteristics of a new system to a user and to illustrate its functionality so that users can easily identify impacts. Scenarios immerse the user in the context of a common operational environment, with or without its current limitations and constraints. By capturing this information, researchers can identify changes in system interactions, processes, critical decision points, system requirements, and other important elements. Consequently, the Institute of Electrical and Electronics Engineers (IEEE) Standard 1362-1998 [9] requires that scenarios be included as part of a ConOps document.

ATC is predominantly a cognitive task; however, it does include physical aspects, such as the need to move from one location in the tower to another to view or gain access to a system or to coordinate with another individual (e.g., a supervisor). The researchers considered it important to capture these aspects of the controller's task because, in some circumstances, these may represent significant workload implications for the controller's task, and the frequency of these events may be very different under a new concept.

The researchers developed five unique operational scenarios with input from ATC SMEs. The researchers designed the scenarios to represent common ATC bird threat situations. These dimensions included:

- Time of day (day/night)
- Type of operation (arrival/departure)
- Type of ATC facility (ATCT/TRACON)
- Controller workload (low/moderate)
- Mechanism by which controllers learn of bird strike threats today (airport operations crew report, pilot report, radar observation, or visual observation out the tower cab).

2.6 PROCEDURE.

2.6.1 Schedule.

Table 3 shows the daily WiSC KEA schedule. The participants arrived at the RDHFL and participated in the WiSC KEA for 2 days.

Table 3. Daily WiSC KEA Schedule

February 25, 2014		February 26, 2014	
8:30-10:00	Introduction Briefing	8:30-10:00	Interface Discussion
10:00-10:15	Break	10:00-10:15	Break
10:15-11:45	Scenario Walkthrough	10:15-11:45	Research Questions
11:45-1:00	Lunch	11:45-l:00	Lunch
1:00-2:30	Scenario Walkthrough, continued	1:00-2:30	Final Discussions
2:30-2:45	Break	2:30-2:45	Break
2:45-3:30	Scenario Walkthrough, continued	2:45-4:00	AFTIL Tour
3:30-4:30	Interface Briefing		

Upon arrival, the participants received an introductory briefing on bird strikes, avian radar research, and the purpose of the KEA. The next activity was a walkthrough of the operational scenarios. The first day was largely dedicated to analyzing scenarios that the research team prepared.

On the last day, the research team presented some notional ATC interfaces containing supplemental bird threat information, held a discussion on the general research questions, and conducted an exit briefing. After the exit briefing, the participants toured the AFTIL.

2.6.2 Introductory Briefing.

The participants met in the RDHFL briefing room where an ERP and a human factors specialist presented an introductory briefing. This briefing included a description of the KEA's purpose, methods used, background research on bird threats, and potential detection and mitigation methods, including radar technologies. Following the introductory briefing, the participants signed the Informed Consent Form (appendix A) and completed both a Background Questionnaire (appendix B) and the Pre-KEA Opinion Survey (appendix C). The research team designed these materials to understand and quantify the type and amount of experience that participants had and to gauge their opinions and attitudes regarding the threat that birds pose to aviation and their work duties in general.

2.6.3 Scenario Walkthrough.

The human factors specialist guided the participants through each scenario based on current operations. For each step, the research team captured what equipment would be used, cognitive elements, workload drivers, and controller actions. The research team integrated all recommendations that the participants made to improve the scenario. Upon finalizing the scenario, the participants rated the scenario's realism and representativeness and provided additional comments. The research team guided the participants through the scenario's final version one more time and asked the participants to identify any changes or differences that might be anticipated if a bird threat advisory system was available.

2.6.4 Notional Interfaces Briefing and Review.

At the end of the first day, the ERP gave the participants a briefing regarding pertinent aspects of avian radar research and examples of displays showing how this information is currently displayed to biologists, international ATC, and other users. This activity not only was to inform the participants of the current state of technology and its application but also to give them an opportunity to process that information before convening to review some notional ATC displays. The next day, the research team presented notional displays with examples of textual and graphical alternatives for displaying supplemental bird threat information to an ATC user. The examples were intended to initiate conversations on useful or detrimental elements and not a depiction of a potential display. At the conclusion of the presentation, the participants completed the Post-Interface Evaluation Questionnaire and then engaged in a group discussion.

2.6.5 Research Questions and Final Discussion.

The research team dedicated the last half of the second day to Research Questions and a Final Discussion. Both of these activities were a group discussion style format. A human factors specialist led the participants through a discussion of research questions related to bird threats. Table 4 presents a preliminary list of WiSC-related research questions. The research team explicitly addressed many of these questions during KEA discussions.

Table 4. Preliminary Research Questions

Topic	Research Question
General Bird Hazards	What birds represent the most risk?
	What phase(s) of flight could benefit most from avian radar?
Current Procedures	How do controllers learn of bird activity today?
	How often does a controller see a flock of birds and issue an advisory to an aircrew?
	In what situations does a pilot need/want to know about a bird threat?
	What phase(s) of flight could benefit most from avian radar?
	In what situations does a controller need/want to know about a bird threat?
	Are there different types/levels of wildlife threat information for different users (e.g., tower, TRACON, biologist)?
Information Needs	What information does the controller need? • A general alert; alert and section of the airport? • Target with latitude/longitude, altitude, bearing, speed, number of targets, species? • Other?
	How long should alerts remain (persistence)?
	Does/should the system need to distinguish between species? Does species identification impact decision making?
	What should the system display (biomass, number of targets, bird size, location/proximity to traffic/flight path, likelihood/density of targets)? • Is biomass important to display? What biomass/density is important to pilots?
	What ATC users, if any, need a capability to access historical data?
	In what situations does a pilot need to know about a bird alert/advisory (departure, landing, real time, strategic)?
	In what situations does a controller need to know about a bird alert/advisory (biomass, number of targets, bird size, location/proximity to traffic/flight path, likelihood/density of targets)?
Radar Capabilities/ Requirements	Is there too much “noise” in radar to be useful? • How much noise can be tolerated?
	What radar sensitivity/accuracy is required (altitude, bearing, speed, number of targets, wing-beat frequency (presented as likely species to controller))?
	If species identification is important, is this technically achievable at acceptable identification levels?
	Would a TCAS-type alert for birds be desirable or effective?

Table 4. Preliminary Research Questions (Continued)

Topic	Research Question
Display and Integration	What system (if any) should be used to present bird activity to controllers (STARS, IDS, ASDE-X, etc.)?
	If an alert is required, should it be graphic or text?
	Who in ATC should receive avian alerts (supervisor, ground, local, radar, etc.)?
	Should alert types be dependent on the ATC position (e.g., supervisor, ground, local)?
	How often should the display update (dependent on display)?
Future Recommended Procedures/ Processes	How should bird activity information be disseminated in the mid-term?
	What new procedural changes would be advocated
	What new ATCs responsibilities/procedures/phraseology would be required under subsequent revisions of the concept? • What advisories are required? What is the phraseology? Is the phraseology different for different threat levels?
	Where do bird threat alerts fall in terms of their priority? (Different from current practice?)
	How might avian radar information be integrated with NextGen technologies?

The Final Discussion section served as a capstone activity. Participants were able to share additional comments or experiences that they had not provided previously. This section also gave the research team an opportunity to close any open discussion topics.

3. RESULTS.

The results are organized by activity: pre-KEA survey, scenario walkthroughs, information needs and interface discussion, and exit questionnaire. Where possible, the research team categorized responses into common themes to help consolidate and organize the findings. The controllers and supervisors are referred to collectively as ATC Participants unless researchers noted an important difference in responses or the nature of the task that required a differentiation between these two user groups.

All questions used a 10-point rating scale with the lower values representing low/less/disagree and the higher values meaning high/more/agree. The anchors and questions provided the context for the item. Figure 4 provides examples of the types of scale anchors used in the WiSC KEA questionnaires. All questionnaires used in this KEA are contained in the appendices.

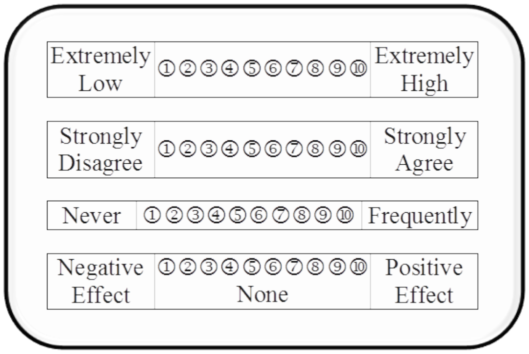

Figure 4. Ten-Point Rating Scales and Anchors Used in KEA Questionnaires

<u>3.1 PRE-KEA SURVEY</u>.

The Pre-KEA Opinion Survey's primary objective was to assess the participants' experience levels with bird threats and gauge their opinions on mitigation efforts. The intent was to gather the participants' opinions prior to exposure to any KEA activities so the researchers could identify any resulting changes in their opinions.

<u>3.1.1 Awareness of the Bird Strike Threat and Mitigation Efforts</u>.

ATC participants rated their awareness of the bird strike threat issue as high (8.5) and their awareness of current mitigation efforts as high also (7.75). The pilots' ratings were similar, rating their awareness of the problem and knowledge of mitigation efforts as high (7.5 and 7.0, respectively). Two ATC participants had worked directly with United States Department of Agriculture Wildlife Services biologists on bird strikes and potential ways to mitigate them. This experience included reading and reviewing current literature and research reports on the issue. One pilot also was fairly familiar with the literature on the current state of the problem, including mitigation efforts.

<u>3.1.2 Experience With Bird Strikes</u>.

ATC participants confirmed that bird hazards play a significant role in their daily activities, with three of the four participants rating it a 10 on the 10-point scale. These ratings are along the levels anticipated because the participants were recruited from among the top ten facilities with reported aircraft bird strikes. The two pilots provided disparate ratings; one rated it high (8) and the other low (3).

All participants in the KEA reported firsthand experience dealing with and reporting bird strike events. This included receiving bird advisories, reporting information on the Automatic Terminal Information Service (ATIS), and completing bird strike reports. In fact, three of the four ATC participants had experience managing an aircraft after it encountered a bird strike. Each pilot had issued or received countless bird advisories throughout their career and had encountered several bird strikes or close calls.

3.1.3 Severity of the Bird Strike Issue.

The ATC participants indicated that bird activity frequently impacts operations at their facility. They reported incidences ranging from multiple times per week to as many as 30 times a day. This activity results in 1-10 advisories on a typical day to what was referred to as "non-stop" during peak migratory season. As a result, the ATC participants reported that bird hazards contributed significantly to their duties/workload (averaging 7.5 on the 10-point scale). There was some variability in the response to this question with one controller providing a much lower rating of 4.

According to the ATC participants, one of the most significant workload drivers is the dynamic nature of bird threat information. Maintaining vigilance of a threat that is somewhat ambiguous or ill-defined in terms of location increased their workload. This includes the constant need to query pilots for updated information and attempts to track down more information from other sources. With respect to workload, one controller commented, "There are numerous primary radar targets. We are never sure if they are birds or something else. We are constantly passing traffic advisories for these primary targets to pilots not knowing (what the targets are)."

The consequences of bird threats on controller workload are evident even when birds are not directly affecting their operations at the time. In fact, ATC participants reported that even when birds were present, but not a hazard to their operations, they still required extra effort to remain vigilant of their potential impact (8.25). The most frequently occurring operational impacts of bird activity were reported to be a pilot request to delay departure and emergency landings.

The pilots were split on the issue of how much impact bird threats had on their daily activities. One pilot rated the impact as high while the other rated the impact as low to moderate. These responses are not surprising when one further examines the data. The pilot who rated the impact as high estimated having about 250 close calls/bird strikes over a 30-year career. The other pilot recalled only three occurrences in 50 years.

When asked to identify how they currently receive bird threat information, the ATC participants listed direct observation from the tower cab and verbal communications from a supervisor, another controller, pilot, or airport operations personnel. They ranked the sources according to frequency. PIREPs were identified as the most common, followed by all other sources.

3.1.4 Value of Supplemental Bird Threat Information.

The ATC and pilot participants reported that additional bird threat information would be valuable in the ATC environment (8.0) and in the cockpit (8.5). One key reason was that bird location and level of activity is constantly changing, which requires controllers to continually seek updated information by contacting pilots or by other methods. The controllers indicated that if bird threat information could be updated with accurate and reliable information, it would be helpful in alleviating some of the interrogation that occurs today. Pilots also reported that additional information would aid their scan out the window. One pilot added, "I'm looking outside 99% of the time inside 10 miles from the airport. It would be helpful to have more (precise position) information from ATC to put my eyes on to avoid the bird threat."

Controllers were generally in favor of having supplemental bird information available to them (9.5) with three out of four participants providing the highest possible rating (10). According to one participant, "The more information that controllers have, the more information they can pass to pilots as long as that information is accurate and beneficial."

Although the pilots were in favor of having additional bird information available to them, they indicated that they did not want this information to be sent directly to the cockpit. They reported potential challenges such as additional heads down time, increased workload, and increased reaction time. Instead, they considered it preferable to receive the information from the controller as they do today. As one pilot stated, "I'm already busy enough. I don't want eyeballs inside during a critical phase of flight."

3.2 SCENARIO WALKTHROUGHS.

The KEA moderator led the participants through each scenario as described in the procedures. Researchers updated the scenarios as needed until they were "approved" by the participants. The research team captured all comments regarding each step of the procedure.

At the conclusion of each scenario, the participants rated three key attributes of the scenario: realism, representativeness, and frequency of this type of event at their current facility. Table 5 summarizes the four ATC participants' ratings, sorted by realism. These items were important because they are an initial assessment of the frequency of specific types of operational events and how common they are within the NAS and across facilities. This information is crucial for the shortfall analysis (e.g., to gauge how often a particular shortfall might occur), the ConOps document (e.g., selecting a realistic situation to demonstrate benefits), and other follow-on documentation.

Table 5. Average ATC Ratings for Each Scenario (Range in Parentheses)

Scenario	Realism	Representativeness	Frequency of Event at Current Facility
Scenario B: PIREP to TRACON Controller	9.75 (9-10)	9.25 (8-10)	8.50 (5-10)
Scenario E: Tower Controller Visual Observation	9.00 (9-9)	9.00 (9-9)	6.75 (3-9)
Scenario D: PIREP to Tower Controller	8.50 (7-9)	9.00 (9-9)	8.75 (7-10)
Scenario A: Airport Operations Report to Tower (night)	7.25 (3-9)	5.75 (2-9)	5.25 (1-9)
Scenario C: TRACON Controller Radar Observation	6.75 (1-10)	5.50 (1-10)	4.75 (1-9)

Scale: 1 = Very low, 10 = Very high

The ratings suggest that PIREPs and controller visual observation are among the most common means by which bird threat information reaches the controller today. PIREPs are applicable and important in both the ATCT and TRACON environments. Clearly, visual observation (Scenario E) is only an option from the tower cab.

Radar observation of bird targets (Scenario C) was reported to be an uncommon occurrence. This is not surprising because ATC radar and software is designed to locate relatively large targets (aircraft), typically equipped with a transponder, moving at a relatively high rate of speed, and at altitude. Birds violate all of these parameters. As a result, birds rarely appear as a target on a STARS display, and when they do, their target signature is typically intermittent, sporadic, and unreliable. The avian radar systems available at some airports may represent a revolutionary change in the ability to provide controllers more precise information on the location of bird threats.

The participants also rated three human factors-related aspects of the WiSC system. The results are presented in table 6. The ATC participants demonstrated strong agreement that a well-designed bird advisory would be helpful in all situations described with ratings of helpfulness averaging 8.75 across all scenarios. It was recognized that there is a potential risk of unfavorably impacting controller workload with the introduction of a bird threat advisory. Therefore, specific questions designed to capture how much supplemental bird threat information might impact the user, potentially introducing new cognitive or temporal demands, were included.

Table 6. Average ATC Ratings of Impact of WiSC Advisories (Range in Parentheses)

Scenario	WiSC Advisory Would be Helpful[1]	WiSC Advisory Would Improve Situation Awareness[1]	Workload Impact of WiSC Advisory[2]
Scenario B: PIREP to TRACON Controller	10.00 (10)	7.75 (2-10)	8.00 (7-10)
Scenario C: TRACON Controller Radar Observation	9.00 (8-10)	6.75 (5-10)	5.75 (1-9)
Scenario E: ATCT Controller Visual Observation	8.25 (5-10)	7.25 (5-10)	6.75 (5-10)
Scenario D: PIREP to ATCT Controller	8.25 (6-10)	7.25 (5-10)	7.25 (6-10)
Scenario A: Airport Operations Report to ATCT (night)	8.25 (6-10)	6.25 (1-10)	6.75 (5-8)

[1] Scale: 1 = Strongly disagree, 10 = Strongly agree
[2] Scale: 1 = Negative effect, 5 = No effect, 10 = Positive effect

Several recurrent themes were identified during the scenario walkthroughs. The participants indicated that an effective WiSC-type bird threat advisory might eliminate steps in several scenarios they reviewed. They attributed this to the ability of this type of system to proactively provide updated and precise bird threat information rather than requiring controllers to actively seek additional information as they often do today. However, there were conflicting opinions regarding WiSC's impact on communications between controllers, supervisors, and pilots. During the scenario walkthroughs, participants reported that the number of communications was greatly reduced as a result of having accurate bird threat information. However, during the post-scenario group discussions, participants noted that this reduction may not completely offset the potential need to issue many more bird strike advisories if they are given more current and precise bird threat information. Participants considered it important to share updated bird activity information, but noted that the information could be very dynamic because of the erratic and pervasive nature of this activity. The range in responses most likely resulted from the methods used. The scenarios encouraged the participants to focus on specific details and actions in a pre-prescribed situation; whereas, the group discussions allowed them to adopt a more global view and identify systematic considerations.

Similar comments were provided regarding workload and supplemental bird threat information. During the scenarios, approximately half the participants believed there would be either a reduction in workload or a neutral effect. The other half focused on the importance of procedural issues that must accompany WiSC. Another common theme was related to the ATIS and its update procedures. In many scenarios, communication and coordination was necessary to update the ATIS information. This process adds to the workload and can be cumbersome when bird threats are persistent. The controllers and supervisors reported that ATIS currently includes general bird threat information 24 hours a day at their facility. These ATIS messages may simply be general year-round messages advising of bird activity. While this advisory may help offset some of the controller's burden to report the information, it does not support the broadcast of current and precise information that may be very valuable for pilots. WiSC may allow for the dissemination of more specific, reliable, accurate, and meaningful information to pilots via ATIS. If this information could be inserted in the ATIS in an automated fashion, it may reduce the controller and supervisor workload.

Another common theme centered on procedural requirements. The Air Traffic Control Manual, 7110.65 [10], requires controllers to provide threat advisory information to pilots for 15 minutes after a bird threat is reported or observed, unless they can confirm that there is no longer a threat. This represents several controller workload implications. First, controllers recognize that they must rely on direct observation (which may be compromised by fog, obstructions, night, etc.) or actively seek pilot reports to confirm the ongoing nature of the hazard. Second, they may issue several unnecessary advisories in circumstances when they were not aware or are not notified that the birds have left the area and no longer represent a threat. In addition, the value of these required advisories may be reduced as time passes from the last report. The participants suggested that, with timely and accurate information, a WiSC-type system likely would help offset these sources of workload.

The following sections present the results from the walkthrough of the five scenarios (A-E). Each section provides background on the objectives of the scenario, participant ratings or realism and representativeness, the final approved version of the scenario, scenario assumptions, information captured by the team during the walkthrough, and general comments provided by the participants. Scenario realism is indicative of how closely the scenario reflects actual ATC operations, procedures, and outcomes. Representativeness, in contrast, is an indication of how common this specific situation is at a given facility. Both are valuable when selecting conditions for the shortfall analysis and consideration for inclusion in the ConOps document. Participants also identified common themes in their responses during the discussions and in the questionnaire data.

3.2.1 Scenario A.

In this scenario, an airport operations crew observes and reports bird activity to the ATCT controller. This scenario represented the only night condition scenario in the KEA and was developed for a variety of reasons. Although there is some discrepancy in the reported level of bird activity at night, with estimates varying widely from low to relatively high levels, the incidence is certainly site and species dependent. Also, the actual number of aircraft bird strikes is lower during night conditions; however, the strike incidence rate at night may be underestimated. The night strike incidence deserves attention because raw counts do not take into consideration the number of active flights (flight density) and night strikes may be less likely to be observed. Another important aspect of night operations is that introducing new information into the tower to supplement what is currently a situation without visible bird threat information could potentially result in a fundamental change in ATC practices with associated costs and benefits.

Table 7 summarizes controller (number of participants (n=2)) and supervisor (n=2) ratings of realism and representativeness for Scenario A. The ratings confirm that ATC participants found this scenario to be very realistic but not all that common (i.e., 5 out of 10 for representativeness). This scenario was rated as more indicative of operations at some facilities and not at others. However, the current sample size does not offer sufficient weight to confirm this interpretation.

The participants emphasized that, even with the very specific and accurate bird threat information provided by WiSC, the responsibility for a go/no go departure decision should remain with the pilot, as is the case today. Controllers would issue a departure clearance with the improved advisory information, but it would still be at the pilot's discretion on whether or not to request a delay. The participants indicated that, today, when pilots are advised of a bird threat prior to departure, they rarely request a delay and that strikes, even during these circumstances, remain extremely infrequent. The pilots commented that if they were made aware of a bird threat in the immediate departure path at the end of the runway and they had confidence in the accuracy of the information, they would be more likely to request a delay.

Table 7. Scenario A—Airport Operations Report to ATCT Controller at Night

Realism: 7.25 out of 10 (Range: 3-8) Representativeness: 5.75 out of 10 (Range: 2-9)

Scenario A		Scenario Assumptions: Type: Tower, Departure, Ops Report Time: Night	Sky: Clear Visibility: >10 miles	Workload: Moderate
Step	Actor	Event	Current Operations	WiSC Operations
1	Airport Ops Crew	An airport Ops crew working near 27L hears a large flock of Canada Geese passing north to south at low altitude.		Local controller receives WiSC alert that birds are crossing midfield runway 27L at 200 ft. If WiSC incorporated a camera system (potentially with night vision) it may automatically slew to an identified target.
2	Airport Ops Crew	Crew member picks up radio and contacts ATCT and notifies them of bird activity crossing midfield runway 27L at about 100-300 ft.	Ops crew uses radio to call tower on local frequency or phone to call tower supervisor/ controller. If no supervisor on the shift, answering an outside call is a relatively low-priority task for controllers.	This communication is unnecessary; however, it may corroborate the WiSC alert.
3	Pilot	AWE253, having just departed, stabilizes on climb out.		
4	Local Controller	The local controller contacts AWE253 and asks if they observed bird activity on departure.	This request may have been included in the departure clearance if the local controller was aware of bird activity in the area.	This communication is unnecessary. The local controller has more precise information from the WiSC alert.
5	Pilot	AWE253 reports that they did not.		This communication is unnecessary. Local controllers have more precise information from the WiSC alert.
6	Local Controller	The local controller clears the next departure (DAL456) and notifies them bird activity was reported midfield on 27L at 100-300 ft.		Local controller clears DAL456 for departure and provides updated and accurate WiSC bird advisory information. Pilot can more effectively determine if birds are a threat when making the go/no go decision.
7	Pilot	DAL456 pilot advises that they would like to delay departure for activity to clear.	Pilot has the option to request a delay (it is very rare that pilots see the need to request a delay for bird activity).	This step may be unnecessary. With more timely and accurate information, the pilot can make a more informed decision on whether a delay in departure is advisable. May elect to depart, which would eliminate this and steps 8-9.
8	Local Controller	Approves DAL456's request.	The local controller may approve the delay request or re-sequence that aircraft, depending on departure demand and current workload.	Potentially unnecessary—dependent on pilot's decision in step 7.

Table 7. Scenario A—Airport Operations Report to ATCT Controller at Night (Continued)

Realism: 7.25 out of 10 (Range: 3-8) Representativeness: 5.75 out of 10 (Range: 2-9)

Scenario A		Scenario Assumptions: Type: Tower, Departure, Ops Report Sky: Clear Workload: Moderate Time: Night Visibility: >10 miles		
Step	Actor	Event	Current Operations	WiSC Operations
9	Pilot	(After some time) DAL456 requests departure clearance.		Potentially unnecessary—dependent on pilot's decision in step 7. WiSC also could provide updated information that would cut this delay short.
10	Local Controller	The local controller clears DAL456 for departure and asks DAL456 to advise if they observe bird activity.		Reduced Workload. The request to report bird activity may be unnecessary.
11	Pilot	DAL456 departs.		
12	Birds	Birds depart vicinity of runway.	Per 7110.65 [10], tower controller continues to issue last reported bird activity to aircraft for the next 15 minutes.	Reduced workload. Termination of the WiSC alert indicates the birds are no longer a threat. This information would not otherwise be available at night. The controllers do not need to issue advisories for the next 15 minutes.
13	Local Controller	Local controller clears the next departure (GJS102) and notifies them bird activity was reported mid-field on 27L at 100-300 ft.		Reduced workload. Local controller issues the departure clearance without bird threat advisory.

Note: The shaded boxes indicate that this step is no longer necessary with WiSC.

3.2.2 Scenario B.

Scenario B represents a PIREP, which participants indicated is the most common source of bird information today (see table 8). In this scenario, a pilot issues a PIREP to a TRACON controller shortly after departure when they observe a large flock of birds. The second departure in this scenario was included to investigate how WiSC information might affect the controller and a pilot's decision on whether or not to request a delay.

The scenario emphasizes the importance of visual search in corroborating a pilot report. In this scenario, the location information provided by WiSC could aid the controller's visual scan by reducing the area of interest and it may also help overcome the potential issue of parallax (e.g., the inability to identify the birds' location in relation to a crossing). The participants suggested that communication and coordination may also be reduced with WiSC. This was attributed to a potential reduction in the need for controller-supervisor coordination and controller-pilot communications.

Table 8. Scenario B—PIREP to TRACON Controller

Realism: 9.75 out of 10 (Range: 9-10) Representativeness: 9.25 out of 10 (Range: 8-10)

Scenario B		Scenario Assumptions: Type: TRACON, Departure, Pilot Report Time: Day	Sky: Clear Visibility: >10 miles	Workload: Moderate
Step	Actor	Event	Current Operations	WiSC Operations
1	UAL246	UAL246 is at 3000 ft and climbing off runway 9L.		WiSC alert may have identified threat earlier and the local controller could have issued an advisory to UAL246.
2	Pilot	Observes flock of Canada Geese at 3000 ft moving left to right and contacts TRACON departure controller to report information.	Pilots often have only one piece of data to report (e.g., altitude, miles out). Pilot may delay the report due to higher priority tasks.	This communication is unnecessary. The departure controller receives more complete and precise information from the WiSC alert.
3	TRACON Departure Controller	Uses radar to observe UAL246's location and correlates this with the bird report.	Birds are occasionally displayed on Airport Surveillance Radar as primary targets. These instances are infrequent and intermittent.	This step may be unnecessary. If WiSC alert includes position information on the radar display, the departure controller can easily correlate the aircraft and bird targets.
4	TRACON Departure Controller	Acknowledges the call.	Departure controllers typically capture just what was provided and do not follow up with the pilot for more information.	This communication is unnecessary. Controllers and supervisors at both facilities have the same information from the WiSC alert.
5	TRACON Departure Controller	Contacts local controller (tower) and reports flock of geese 2 miles east of the airfield at 3000 ft southbound.	Supervisor monitoring the area will often hear the call and be aware of the bird PIREP.	This communication is unnecessary. Controllers and supervisors at both facilities have the same information from the WiSC alert.
6	Local Controller	Looks out the tower cab with binoculars attempting to locate the geese—does not see them.		The local controller looks in the area identified by WiSC (more efficient visual search due to more precise location information). If WiSC incorporated a camera system (potentially with night vision), it may automatically slew to an identified target.
7	Local Controller	Local controller issues departure clearance to DAL165 and provides bird activity advisory to subsequent aircraft on the affected departure route.		Local controller includes updated WiSC location information if available. With more precise information, the pilot can more effectively determine if birds are a threat when making the go/no go decision.

Table 8. Scenario B—PIREP to TRACON Controller (Continued)

Realism: 9.75 out of 10 (Range: 9-10) Representativeness: 9.25 out of 10 (Range: 8-10)

Scenario B		Scenario Assumptions: Type: TRACON, Departure, Pilot Report Sky: Clear Workload: Moderate Time: Day Visibility: >10 miles		
Step	Actor	Event	Current Operations	WiSC Operations
8	Pilot	DAL165 pilot accepts the clearance and departs.		Pilot is aware of ongoing threat. Pilot can focus attention on active area.
9	Local Controller	Local controller issues "last reported" bird advisories to relevant traffic for the next 15 minutes.	Advisories are issued for 15 minutes unless the local controller can confirm birds are no longer a threat. Value of advisory is reduced as time passes from last report. If a controller actively tries to determine if the threat persists, either by PIREP or visual observation, there is some workload associated with that activity.	WiSC supports improved advisories. Advisories are timely and provide more accurate location information. Advisories are only issued during threat periods.

Note: The shaded boxes indicate that this step is no longer necessary with WiSC.

Table 8 presents average controller (n=2) and supervisor (n=2) ratings of realism and representativeness for Scenario B. The ratings indicate that ATC participants found this scenario to be both very realistic and representative of typical situations at their facility. Given the consistency of responses, it was concluded that this scenario is indicative of common operations at ATC facilities.

The participants noted that having a bird target presented on a display along with aircraft might aid them in quickly discerning proximity/relationships between the birds and aircraft. This scenario was also unanimously rated the situation that WiSC would be the most helpful to them, with all participants rating helpfulness at 10. However, this was a preliminary observation provided within the operational context of the scenario and requires validation and research before it can be considered a viable option.

3.2.3 Scenario C.

In this scenario, bird targets are presented on the radar at a TRACON controller's display. The participants indicated that this is very uncommon and among the least frequent methods to learn of bird activity. The objective was to examine the situations when the current primary radar systems occasionally depict unknown targets that "pop up" and "disappear" in a very inconsistent fashion. Because the terminal radar system is not designed or configured to detect bird targets, they are filtered out. Controllers are still required to report these targets for 15 minutes or until they are determined to no longer be a factor despite their unreliable and unpredictable nature. During scenario development meetings, anecdotal situations demonstrated that at least some controllers interacted with an unknown target by "tagging" it with some sort of reminder. This was considered an area of interest because these controllers demonstrated that labelling this type of activity, though temporary, was important enough to dedicate their time and cognitive resources to perform. The research team considered that providing precise and robust bird information through WiSC may help alleviate the ambiguity and uncertainty caused by the ambiguous, unreliable, and transient nature of these targets.

A number of valuable insights were captured from this scenario. First, not all controllers used this method of "tagging" an unknown primary target. In fact, a few participants in the KEA said that the likelihood of being able to put a radar tag on a flock of geese is extremely low under normal conditions at their facility. Other participants took a more moderate approach to this question, stating that the mechanism being used here (tagging) was something they were aware of but had used only on occasion. However, all agreed that the unpredictable and unreliable nature of bird targets on their primary radar discouraged the use of tagging. As a result, the practice of labeling birds is highly site and controller dependent.

Table 9 averages across controller (n=2) and supervisor (n=2) ratings of realism and representativeness for Scenario C. The average ratings indicate that ATC participants found this scenario to be both moderately realistic and moderately representative of typical situations at their facility. However, given the range of responses (1-10) on both questions and the small sample size, it is more accurate to conclude that opinions on representativeness and realism were either very high or very low across individual participants. Given the variability of responses, it was concluded that this scenario may not be indicative of common operations at all ATC facilities.

Table 9. Scenario C—TRACON Controller Radar Observation

Realism: 6.75 out of 10 (Range: 1-10) Representativeness: 5.5 out of 10 (Range: 1-10)

Scenario C		Scenario Assumptions: Type: TRACON, Arrival, CPC radar Sky: Clear Workload: Moderate Time: Day Visibility: >10 miles		
Step	Actor	Event	Current Operations	WiSC Operations
1	TRACON Controller	Observes unidentified target on display, slews to target, and makes a keyboard entry "watch."	Using this labeling is not common or required, and so it is highly site and controller dependent. If non-aircraft targets are commonly captured by radar at a facility and the targets remain relatively persistent, then it is more likely this step will be performed.	This step is unnecessary. WiSC identifies bird threats and displays them to the controller. There is less ambiguity regarding the nature of the target.
2	TRACON Controller	Monitors the target and issues traffic to SWA585, "unknown slow moving target, 12-1 o'clock 3 miles, altitude unknown."		Controller issues bird advisory based on WiSC with specific location and altitude information. Improved confidence in value of information being relayed to pilot (e.g., looking for birds, not another aircraft).
3	Pilot	SWA585 answers call "looking."		Pilot can narrow search area to specific location. Altitude information is very helpful in locating target(s).
4	Pilot	After 15 seconds, the pilot responds, "flock of birds beneath me."		This report could verify WiSC information.

Table 9. Scenario C—TRACON Controller Radar Observation (Continued)

Realism: 6.75 out of 10 (Range: 1-10) Representativeness: 5.5 out of 10 (Range: 1-10)

Scenario C		Scenario Assumptions: Type: TRACON, Arrival, CPC radar Time: Day	Sky: Clear Visibility: >10 miles	Workload: Moderate
Step	Actor	Event	Current Operations	WiSC Operations
5	TRACON Controller	Asks pilots to estimate altitude.		This step may be unnecessary. WiSC provides altitude information; however, controller may ask pilot to confirm this information.
6	Pilot	"Birds 200 ft below me."	Controller computes the birds' altitude using SWA585's altitude from the radar display.	This step is unnecessary. WiSC provides more timely and accurate altitude information.
7	TRACON Controller	Replaces "watch" radar tag with "birds" on STARS.		This step is unnecessary. WiSC identifies bird threats and displays them to the controller.
8	TRACON Controller	Issues traffic to AAL222 (the next aircraft on the route) "last reported birds at 1500 ft."		WiSC enables controller to provide advisories that are up to date and provide more accurate location information.
9	Pilot	Acknowledges call and looks for birds.		Pilot can narrow search area to specific location. Altitude information is very helpful in locating target(s).
10	Radar display	Two minutes later, the target drops from the display.	Controller is unsure whether the birds have left or if the radar is no longer capturing the targets.	WiSC provides accurate location information. Controller is aware of whether or not the threat persists.
11	TRACON Controller	Issues traffic alert to subsequent aircraft for the next 15 minutes.	Advisories are issued for 15 minutes unless controller confirms birds are no longer a threat. Value of advisory diminishes as time passes. Workload is increased if controller actively attempts to confirm if the threat persists through PIREPs or visual observation.	WiSC supports improved advisories. Advisories are timely and provide more accurate location information. Advisories are only issued during threat periods.

Note: The shaded boxes indicate that this step is no longer necessary with WiSC.

3.2.4 Scenario D.

Scenario D examined a pilot report of bird activity to the tower during final approach. This scenario describes a controller using binoculars to observe the bird target, which is very common in this and other PIREP situations. The benefit of having WiSC information for these situations is that the controller may already be aware of the birds' location and potentially have other information, such as altitude and speed, which could have been provided to the pilot before final approach. This would have negated the need for the PIREP and provided valuable information to the pilot before descent. In addition, the detailed bird threat data enables the controller to more efficiently monitor and scan the airport surface.

The participants indicated that pilots often can only provide a few of the possible information elements regarding the bird threat (e.g., altitude, distance from the runway, heading, and speed). In addition, pilots may be required to defer communicating the advisory in favor of more pressing flight deck responsibilities. As a result, the information provided may be incomplete and not timely. WiSC could, potentially, alleviate some of these concerns.

During this and several other scenarios, the participants indicated that communications could, potentially, be decreased with WiSC due to the distributed/shared nature of the information. They stated that the shared nature of the information could, potentially, eliminate several communication steps in this scenario.

Table 10 shows the averages across controller (n=2) and supervisor (n=2) ratings of realism and representativeness. The ratings indicate that ATC participants found this scenario very realistic and representative of typical situations at their facility. Given the consistency of responses, it was concluded that this scenario is indicative of common operations at ATC facilities.

Table 10. Scenario D—PIREP to ATCT Controller

Realism: 8.5 out of 10 (Range: 7-9) Representativeness: 9.0 out of 10 (Range: 9-9)

Secnario D		Scenario Assumptions: Type: Tower, Arrival, Pilot Report Time: Day	Sky: Clear Visibility: >10 miles	Workload: Moderate
Step	Actor	Event	Current Operations	WiSC Operations
1	AWE607	AWE607 is at 300ft on 1 mile final to runway 27R.		WiSC alerts controller to location and altitude of birds.
2	Pilot	Observes birds and reports to Local Controller, “Flock of birds under me, crossing left to right.”	Pilots often have only one piece of data to report (e.g., altitude, miles out). Pilot may delay the report due to higher-priority tasks.	This communication may be unnecessary. Local controller may have already issued an advisory to AWE607. Local controller would not have to mentally translate direction of flight into relevant compass position (“left to right” to “northbound”).
3	Local Controller	Acknowledges call and informs supervisor of PIREP.	Supervisor monitoring the area will often hear the call and be aware of the PIREP.	The communication with the pilot may be unnecessary if an advisory was issued. Local controller may not need to inform supervisor, because they have access to the WiSC system.
4	Local Controller	Looks out the tower cab with binoculars attempting to locate the birds—does not see them.		Local controller looks in the area identified by WiSC (more efficient visual search due to more precise location information). If WiSC incorporated a camera system (potentially with night vision), it may automatically slew to an identified target.

Table 10. Scenario D—PIREP to ATCT Controller (Continued)

Realism: 8.5 out of 10 (Range: 7-9) Representativeness: 9.0 out of 10 (Range: 9-9)

Secnario D		Scenario Assumptions: Type: Tower, Arrival, Pilot Report Time: Day	Sky: Clear Visibility: >10 miles	Workload: Moderate
Step	Actor	Event	Current Operations	WiSC Operations
5	Local Controller	Informs supervisor so that it can be put on ATIS.	Bird activity is most likely already noted on ATIS. The ATIS at almost every facility includes a general comment to be alert for flocks of birds.	This communication is unnecessary. Supervisor has access to the WiSC system. Quantitative metrics may be used to selectively determine when bird activity alerts are placed on ATIS (e.g., if bird counts or number of events per day exceeds an established threshold). WiSC may allow bird threat information on ATIS to be more specific.
6	Local Controller	Issues alert to subsequent arrivals for the next 15 minutes.	Advisories are issued for 15 minutes unless local controller can confirm birds are no longer a threat. Value of advisory is reduced as time passes from last report. If a local controller actively tries to determine if the threat persists, either by PIREP or visual observation, there is some workload associated with that activity.	WiSC supports improved advisories. Advisories are timely and provide more accurate location information. Advisories are only issued during threat periods.

Note: The shaded boxes indicate that this step is no longer necessary with WiSC.

3.2.5 Scenario E.

The objective of this scenario was to elicit feedback on the effects of persistent low-altitude bird threats on the tower controller. Understanding how controllers and supervisors manage unpredictable and ongoing bird threats is important because it is a relatively common situation at several facilities. Depending upon the birds' location, airport/runway configurations, distance from the tower, and other factors, the controller may have difficulty determining the exact location of the threat in relation to the runway and taxiways. For example, they may not be able to ascertain if the birds are "just this side of 09L or far enough away to not be an issue." This exercise is cognitively demanding and requires both visual and spatial processing to maintain focused attention that greatly diminishes the ability to multitask.

Controllers perform frequent, routine visual scans of the airport surface to identify potential hazards, such as foreign objects on the runway, occupied runways, airport vehicular traffic, as well as wildlife threats and other hazards. The participants indicated that although WiSC would not change this procedure, it may provide an efficient means for controllers to remain aware of bird activity without the need for additional dedicated scans. In addition, the system may provide information that is difficult to determine today, such as direction of movement or velocity.

Due to the shared situation display available through a WiSC system, controllers may no longer need to inform supervisors of bird activity. A well-designed system could simultaneously provide all users with user-centric, updated information. Users could include air traffic stakeholders, such as controllers and supervisors, as well as airport operations personnel and biologists. This would offset the need for communication between these users and support collaboration if needed through shared situation awareness. The system could also incorporate automated or semi-automated processes to efficiently update the ATIS, perhaps by pre-composing detailed messages that can be reviewed and approved by the supervisor for broadcast. Table 11 summarizes the controller (n=2) and supervisor (n=2) ratings of realism and representativeness for Scenario E. The ATC participants rated this scenario as very realistic and representative of typical situations at their facility. It was considered to be indicative of common operations across ATC facilities.

Table 11. Scenario E—ATCT Controller Visual Observation

Realism: 9.0 out of 10 (Range: 9-9) Representativeness: 9.0 out of 10 (Range: 9-9)

Scenario E		Scenario Assumptions: Type: Tower, Arrival, CPC Visual Time: Day	Sky: Clear Visibility: >10 miles	Workload: Low
Step	Actor	Event	Current Operations	WiSC Operations
1	Local Controller	Observes persistent bird activity near the intersection of active runways 27 and 35 crossing north to south during their normal scan.	Local controller would most likely notify supervisor when they first observe the activity.	WiSC alerts controllers and continuously updates location and altitude information.
2	Birds	The flock repeatedly circles between 100 and 300 ft and lands again in the same vicinity of the runway.	Controllers may have difficulty determining the affected runway or runway crossing (e.g., "are the birds flying just this side of 27R or far enough away not to be an issue").	WiSC alerts controller and continuously updates the birds' location and altitude. Accurate position information helps controller determine when the runways/operations are impacted.
3	Local Controller	Informs supervisor of the bird activity.		This communication may be unnecessary. Supervisor has access to the WiSC system.
4	Supervisor	Notifies airport operations management and puts an advisory on the ATIS.	If birds are on the runway itself, the controller may discontinue its use and call airport operations to clear them.	Notifying airport operations is most likely unnecessary since they have also received WiSC alerts. If they do not respond, then the call is still needed. However, this is unlikely in this specific scenario due to the persistent nature of the threat. WiSC may have an option to provide predefined alerts based on current data for supervisor to upload to ATIS.
5	Local Controller	Advises AWE607 of the bird activity and clears it to land.		Pilot has current information on the specific location of the bird activity.

Table 11. Scenario E—ATCT Controller Visual Observation (Continued)

Realism: 9.0 out of 10 (Range: 9-9) Representativeness: 9.0 out of 10 (Range: 9-9)

Scenario E		Scenario Assumptions: Type: Tower, Arrival, CPC Visual Time: Day	Sky: Clear Visibility: >10 miles	Workload: Low
Step	**Actor**	**Event**	**Current Operations**	**WiSC Operations**
6	Pilot	AWE607 acknowledges bird activity and the landing clearance.		Pilot has more precise information on where the bird activity is in relation to their flight path and can narrow their focus.
7	Local Controller	Waits for AWE607 to exit the runway and then asks pilot if the birds "were a problem for them."	Workload dependent. Controller is unlikely to request this information unless their workload is relatively low or there is a significant concern/reason.	This communication may be unnecessary. WiSC identifies the specific bird location and the controller would not need to contact pilot if, for instance, WiSC indicated the bird activity was not in proximity of the runway.
8	Pilot	AWE607 responds that the birds were not a factor.		This communication may not be necessary. WiSC identifies the specific threat location. The local controller would not need to contact the pilot if the bird activity was not in proximity of the runway.
9	Local Controller	Clears ENY3143 for takeoff and advises them of the bird activity.		WiSC enables local controller to provide more precise and up-to-date information on current bird activity.
10	Pilot	ENY3143 acknowledges bird activity and the departure clearance and departs.		Pilot can more effectively determine if birds are a threat when making the go/no go decision. Pilots are aware of the location of the threat, can preplan for acceptable adjustments to their flight path, and can narrow their search scan.
11	Local Controller	Issues alert to subsequent traffic for the next 15 minutes.	Advisories are issued for 15 minutes unless the local controller can confirm the birds are no longer a threat. Value of advisory is reduced as time passes from last report. If a controller actively tries to determine if the threat persists, either by PIREP or visual observation, there is some workload associated with that activity.	WiSC supports improved advisories. Advisories are timely and provide more accurate location information. Advisories are only issued during threat periods.

Note: The shaded boxes indicate that this step is no longer necessary with WiSC.

3.3 NOTIONAL INTERFACES BRIEFING AND REVIEW.

The scenario walkthroughs resulted in validated descriptions of current operational sequences and procedures. It also identified potential changes that might occur if a WiSC provided enhanced bird advisory information to a controller. The research team presented examples of current biologist and airport operations bird advisory displays. Although not ATC-based, the displays illustrated the types of available information and various methods for presenting it.

During the next activity, the research team presented several notional ATC displays depicting integrated bird advisory information. The team's intent was to illustrate textual and graphical alternatives for presenting this new information on an existing air traffic system. During this session, the participants were encouraged to share their insights based on what they learned from the briefings and scenario reviews. Figure 5 shows a notional example of the graphical representation and summary alert status of bird threat information on the STARS display.

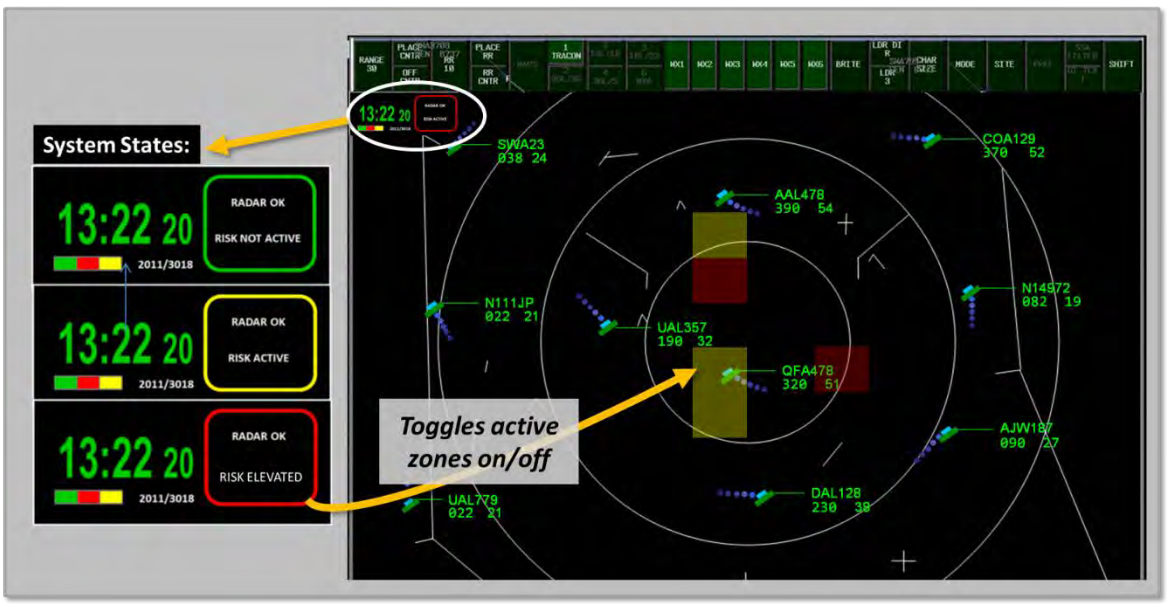

Figure 5. Alerted Zone With Summary Depiction of Bird Threat Information on STARS

Figure 6 shows an alternative notional method of displaying bird threat information on a prototype IDS-R display. The information in the figure represents both graphical and textual display methods of bird threat information.

The participants were asked to identify what information they considered to be most important and how to effectively present that information. It was apparent that some participants' opinions and recommendations had evolved as they became more informed about the system and its potential implications on the ATC operational environment. When possible, this evolution and motive for the shift in participant attitudes is described in the following sections. The recommendations below represent preliminary guidance for the WiSC research team to develop more mature, alternative interface options. However, additional validation and research must be performed before any of the interfaces can be considered viable design alternatives.

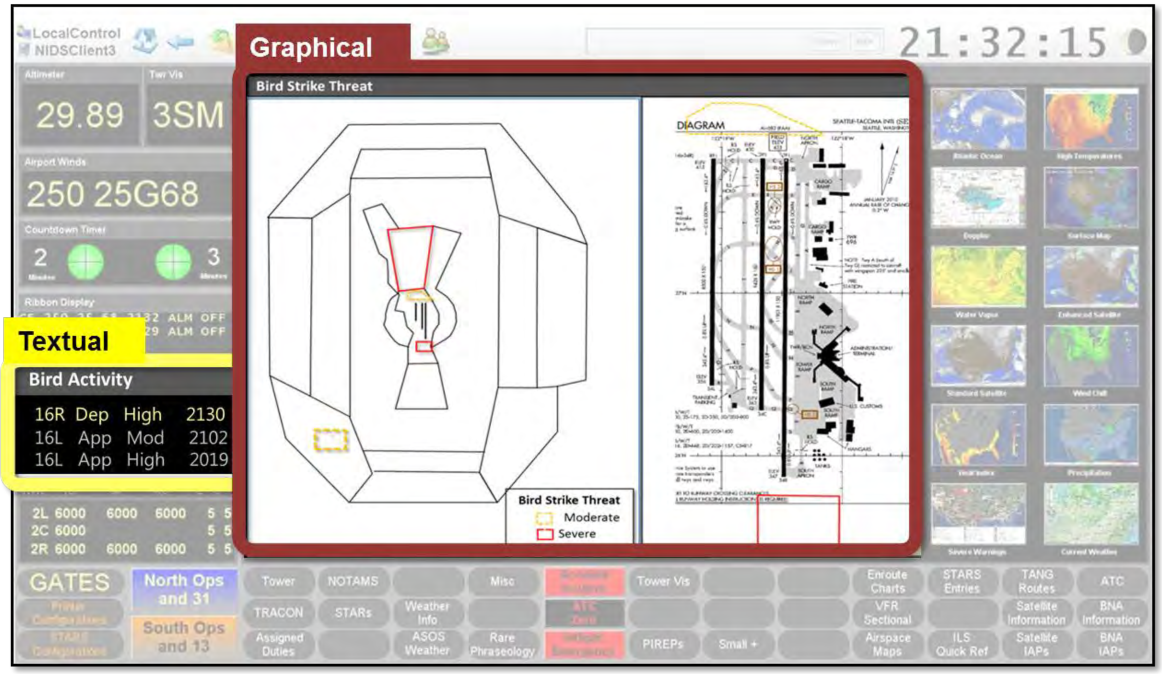

Figure 6. Textual and Graphical Depiction of Bird Threat Information on IDS-R

In the Pre-KEA Survey, the participants identified the information they considered important for bird threats. The participants' most frequent responses were heading, altitude, number of birds (flock), and biomass. The participants expressed an interest in having additional information if it was available (e.g., species). On the Exit Questionnaire, participants shifted their ratings on the importance of specific information elements. Participants rated biomass as the most important element followed by altitude and location. Some participants indicated that history trails would also be valuable. During the Interface Discussion, the participants added that it was essential for information to be selectively displayed or filtered, especially when having access to "all available information." The pilots reported being most concerned with the location, heading, and altitude of the bird threats. This concern remained consistent throughout the KEA. One pilot added a note that threat location in terms of "clock position" in relation to their aircraft might be useful.

Another key KEA focus was capturing ATC guidance on where supplemental bird threat information should be displayed if it is presented to a controller. Most ATC participants suggested existing systems were good options. They identified the most appropriate choices as STARS/CARTS, Airport Surface Detection Equipment (ASDE)/ASDE-X, and IDS, respectively. Although providing this information on an existing system overrides the challenge of introducing yet another display or system into the tower environment, it raises another significant issue—screen clutter. To address this challenge, one participant suggested activating the information with an on/off toggle button on a side bar. Users could either selectively filter predefined levels of bird activity or select all activity. Some parameters the participants suggested as filters included altitude, biomass, speed, projected headings, history, and number of birds. One participant suggested further refining some filters to notify controllers only in situations of a significant bird threat, perhaps based on the size of the bird target (e.g., large flock) or if the flock is on a conflicting course with an aircraft. Participants offered ASDE as one option for presenting this information. However, ASDE focuses primarily on ground-based operations and would need to be supplemented via another display option to address airborne bird threats. The participants recognized several potential WiSC benefits. Also, the participants indicated that if not effectively designed, the interface could lead to an increase in their workload. Some ATC participants shared experiences of occasionally failing to disseminate Low Level Windshear Alert System (LLWAS) alerts due to the LLWAS ribbon alerts' design.

The participants offered guidance on effective ways to present bird threat information. All agreed that it is essential that supplemental bird threat information represent a minimal footprint on the display. Participants also were in agreement that the information might best be presented graphically and not textually. One participant offered several reasons for not using textual advisories. First, due to the dynamic nature of the threat, text advisories might update frequently, and changes might be difficult to discern without monitoring and careful examination (e.g., "Bird activity Runway 28L near TXWY OD" versus "Bird activity Runway 28C near TXWY QD"). If the change is not apparent, controllers might issue expired information or spend more heads down time and cognitive resources reviewing the advisory and checking for updates rather than scanning the airport surface. One ATC participant noted that incorporating redundant coding, such as an aural alarm, might be valuable.

Going back to the previous comments about clutter, the controllers indicated that individual bird tracks most likely should not be presented as the system default. They suggested that site-specific alert zones might be a viable means to identify bird threats and emphasized that it is essential that the interface be well-designed and tailored to be meaningful for the ATC user and specific operation. One practical recommendation offered was to implement zones of a consistent length, perhaps in mile increments off the departure end of a runway. This would enable a controller to quickly identify a very precise and operationally relevant threat location that could readily be broadcast (i.e., the affected distance in miles off a specific runway).

With respect to whether the bird threat should be disseminated directly to the flight deck, the pilot participants' decisions were split. One pilot, who provided a rating of 8, was in favor of receiving this information directly into the cockpit and suggested it might be valuable if the threat area could be presented on an airport diagram or approach plate. The other pilot, who provided a rating of 2, was not in favor of it because they are "already busy enough and shouldn't be spending heads down time on a display particularly during a critical phase of flight."

The research team demonstrated the slew-to-target camera functionality to the participants. This functionality enables a remote camera to identify and track a target that is selected on the display. This capability is useful for some stakeholders, such as biologists. However, this functionality was not popular amongst the group (averaging 3.5) because they did not see any additional value beyond what is provided by the radar display.

3.4 EXIT QUESTIONNAIRE.

This questionnaire was administered to determine if the participant's knowledge or opinions about bird threats changed as a result of participating in the KEA. All reported that their knowledge of bird strike threats and/or mitigation efforts had increased. Overall ratings on these two items averaged 8 and 8.5, respectively. One individual noted the change was predominantly due to learning about mitigation strategies.

ATC and pilot participants remained confident in the value of supplemental WiSC information in the ATC environment in general, providing an average rating of 8.25 and 7, respectively. When asked about the value in the tower/TRACON specifically, controllers again responded favorably with an average rating of 7.75. Pilot ratings regarding the importance of enhanced bird threat information in the cockpit were positive and remained unchanged at 7. Average ATC and pilot participants ratings indicated that having supplemental bird threat information was considered useful (7.75 and 7, respectively). The research team compared these responses to identical items included in the Pre-KEA Opinion Survey and the differences between the ratings were calculated (see table 12).

Table 12. Pre- and Post-KEA Ratings on the Value of Supplemental WiSC Information

Questionnaire Item	ATC			Pilot		
	Pre-KEA	Post-KEA	Difference	Pre-KEA	Post-KEA	Difference
Supplemental bird threat information is valuable in my environment (i.e., tower, TRACON, flight deck).	8.0	8.25	+0.25	8.5	7.0	-1.5
I am in favor of having supplemental bird threat information available to me.	9.5	7.75	-1.75	8.5	7.0	-1.5

Scale: 1 = Strongly Disagree, 10 = Strongly Agree

As noted above, all ratings were favorable and remained relatively unchanged. There was almost no observable change in ATC participant ratings (+0.25) and a moderate decrease in pilot participant ratings (-1.5) regarding the value of the supplemental information (item 1, table 12). The moderate decrease in the pilots' responses is likely an artifact of the small sample size (2). One pilot's opinion shifted from a strongly favorable stance to one that was more neutral. During the group discussions, it became apparent that one pilot believed that more precise bird threat information would be actionable, while the other pilot was not certain.

Controllers were very much in agreement on the value of supplemental bird threat information at their workstations (item 2, table 12). This remained true even with the average decrease in ratings of 1.75 points by the conclusion of the KEA. Part of this shift was due to one participant reducing his rating of 10 (very favorable) to 5 (neutral) on the Exit Questionnaire. The research team gained insights into some potential reasons for the shift during the open group discussions. The participants explained that controller displays are already saturated with information, and any new data must be well-integrated, have a small footprint, and provide quick access to more detailed information when needed. The controllers were aware of the challenge of making an alert salient without cluttering their display or requiring increased heads down time. In addition, bird activity is pervasive and unpredictable, which leads to the potential for incessant alerting. The ATC participants emphasized the need to use advanced filtering techniques and to develop procedural guidance prior to full integration into the NAS (i.e., 7110.65) [10]. These solutions appeared to help offset some of the challenges because the participants remained in favor of having this information at their workstation. The decrease in pilot ratings appeared to be more related to the perceived need to keep their eyes focused inside the flight deck and, as noted above, one of them was not certain more precise bird threat information would be actionable.

This questionnaire also asked participants to provide their overall assessment of the KEA. All responses were highly favorable. Participants reported having a better understanding of the nature of bird threats and how avian radar information might be used in their work environment. In addition, participants found the group discussions to be insightful and thought-provoking and appreciated the opportunity to help shape the concept. As one participant stated, it is a "good first step" in the process of determining how this capability might be integrated into ATC.

4. DISCUSSION.

The KEA participants acknowledged the operational value of WiSC in providing supplemental bird threat information to controllers. The questionnaires, scenario walkthroughs, and notional interface review provided significant insights from an ATC perspective regarding the effective integration and dissemination of WiSC information within the ATC operational context. The group discussions in particular gave the participants and researchers an opportunity to explore the concept in detail and gain a deeper understanding of the conceptual space. The KEA identified several key factors in the design and dissemination of this information that require further research to ensure the development of an effective system. The panel also noted important procedural considerations that must also be addressed. Based on feedback from the KEA activities, the research team identified six main themes: System Accuracy, ATC System, Graphic versus Textual Display Options, Information Display and Interface Design, ATC Procedural and Workload Considerations, and Pilots' Procedural and Workload Considerations. These themes are discussed in sections 4.1 through 4.6.

4.1 SYSTEM ACCURACY.

Regardless of the method for displaying WiSC information, the participants indicated that bird threat accuracy and reliability were the most important factors. The participants indicated that if accuracy and reliability are not assured, then the information would be of little to no value, and it would substantially increase their workload and the complexity of their task.

ATC participants reported that for information to have any practical value it needs to be accurate within approximately ±50 ft or as accurate as their current radar system. Pilot participants responded that at least a ±200-ft accuracy is needed to give meaning to the information. ATC participants also noted that they would like to have some real-time gauge of how accurate the system predictions are at the time of display.

4.2 THE ATC SYSTEM.

Most ATC participants recommended presenting WiSC supplemental bird threat information on an existing display. The most common display identified was the primary radar display STARS/CARTS. Several participants also rated an IDS-like display as a good option. The ASDE-X display was also suggested as a possible option.

One participant indicated their preference for the information to be located on a new and separate display. This is interesting to note because prior research [10] also found a similar trend with some ATC participants. While these opinions generally represent the minority, they require consideration and may advocate for alternative solutions that are tailored to accommodate the preferences of a wide range of users. Further research is necessary to determine whether a new display might be preferred or beneficial at certain facilities and what impacts it might have on the layout of the tower cab, controller's scan patterns, and general job duties.

Integration of avian information into an existing system or display is desirable because it eliminates the need for a new, separate display in an already system-saturated environment. However, a key challenge in using an existing display is introducing new information and capabilities without resultant clutter or distractions for the end user. Therefore, the decision on whether to employ a new or existing display cannot be answered without further research.

4.3 GRAPHIC VERSUS TEXTUAL DISPLAY OPTIONS.

The ATC participants expressed a strong preference for a graphical presentation for supplemental bird threat information because of the relative ease of representing system/alert state/status during their normal visual scan. The ATC participants concluded that a textual information presentation could be unwieldy, inefficient, and error prone. For example, a textual information presentation can be problematic at times because it may lead to difficulties in discerning between characters (e.g., O and Q). In addition, when spatial information (as with bird threat information) is represented in textual form, it almost always requires users to perform additional cognitive steps to mentally represent and localize the information. The ATC participants agreed that they wanted multiple types of information available to them regarding the detected birds. The participants all agreed that biomass, altitude, and location were amongst the most important elements to know followed by speed, heading, number of birds (flock), and histories of individual tracks or groupings of birds.

4.4 INFORMATION DISPLAY AND INTERFACE DESIGN.

The ATC participants stressed that the effective integration of WiSC information is critical. The interface must be well-designed, represent a minimal footprint on their display, and avoid computer-human interface issues. They agreed that one solution might be a zone-based interface on their current radar display. If these zones were developed to be meaningful and consistent (e.g., with standardized sizes or shapes with associated altitudes and ranges), they could minimize clutter and cognitive processing demands. The zones could remain invisible to the user until an alert was activated when certain biomass or threat level parameters were exceeded. Appropriately selecting and setting these thresholds will be critical to producing an effective WiSC avian alert system. If set too low, controllers will not be aware of a threat. If set too high, the controller's workload levels will rise, alerts will compete for operationally significant information, and users will lose trust in the system. The participants also acknowledged the importance of having the option to gain additional information on the nature of the threat. To accomplish this, they suggested having the capability to efficiently retrieve more detailed data upon request. This information might include factors such as individual tracks, biomass, location, altitude, and heading. As with the zones, this information would have to be designed to avoid occluding radar, airspace, and other critical screen elements. Figure 7 shows an example of how alerted zones and supplemental information might be presented on a primary radar display.

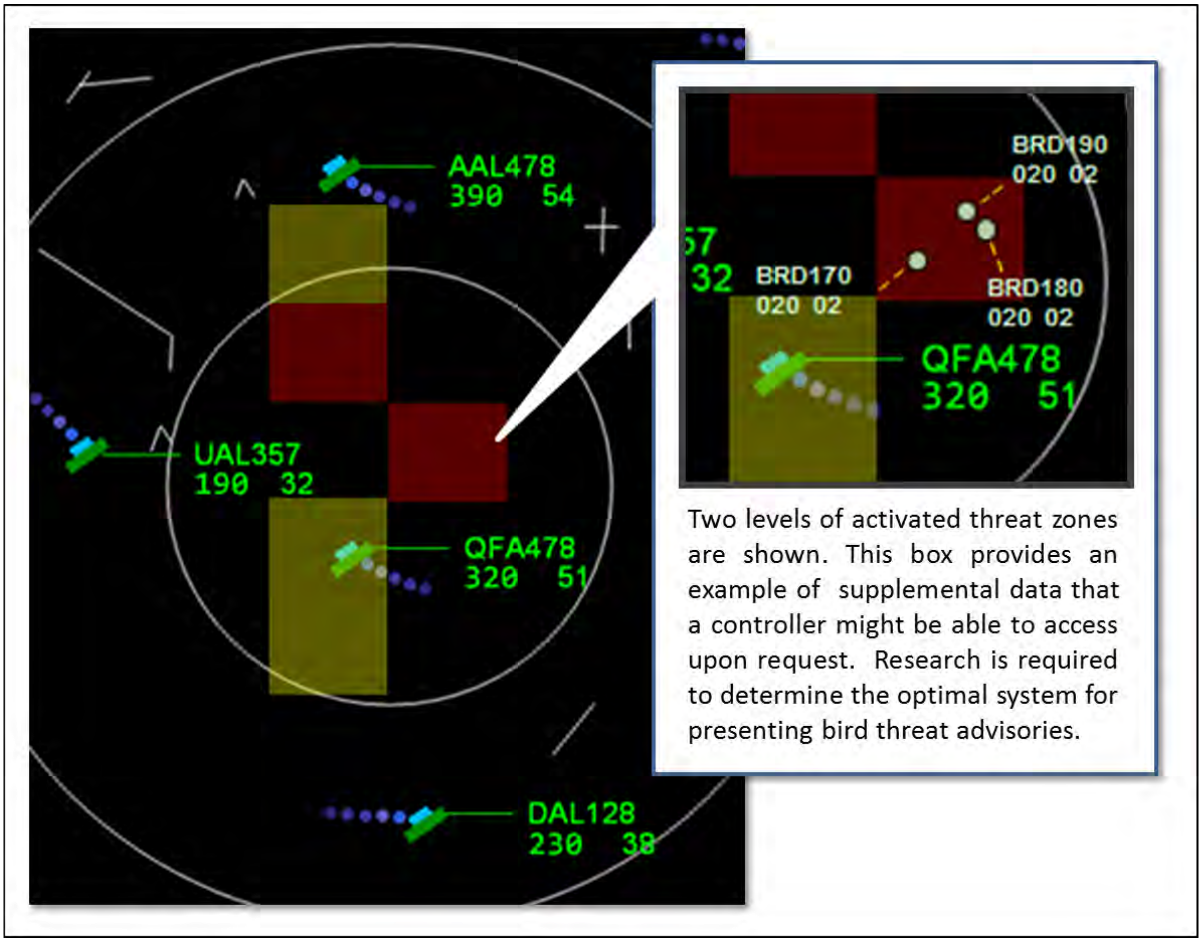

Figure 7. Notional Representation of Alerted Areas on a Primary Radar Display

<u>4.5 THE ATC PROCEDURAL AND WORKLOAD CONSIDERATIONS</u>.

Perhaps the biggest overarching themes were related to controller workload and ATC procedures. The group's consensus was that the introduction of supplemental bird threat information will likely increase communications and necessitate a change in the procedures used to deal with bird threats.

The participants noted that more precise bird threat information would require them to issue many more advisories. Current practices dictate a standardized, "blanket" transmission regarding known or suspected bird activity. However, with frequent bird threat advisory updates, controllers would be compelled to disseminate any relevant new information to pilots. Besides the increase in radio transmissions, these advisories could impose additional cognitive burdens associated with the need to constantly reprioritize this activity with respect to other duties. Procedural requirements, formalized in 7110.65 [10], could help limit unnecessary transmissions and cognitive demand by providing clear guidance on the advisory priority and the operational factors that influence that decision.

The participants considered it essential that controller-issued bird threat transmissions remain advisory in nature. Otherwise, the participants believed, the result would be temporary runway closures, missed approaches, and delayed departures. They believed these operational costs were not justified, given the low incidence of bird strikes. All participants agreed that, ultimately, the decision to land or depart should always be the pilot's.

The KEA participants identified another mechanism by which new bird threat information might impact controller workload. Today, controllers are essentially unaware of bird activity at night. Primarily, pilots acquire bird threats through direct visual observation and observation—both of which are severely hampered at night and during reduced visibility conditions. Bird activity does not necessarily terminate at night, which was demonstrated by sharing a recording made by the DFW airport biologist of bird activity at night. In fact, one participant was surprised at the amount of night activity indicated in the video that the research team shared. The participants agreed that the potential increase in their workload, which might result from this new information, would be more than offset by the increase in safety.

The participants proposed a zone-based format to address the procedural and workload considerations. These zones would only be alerted when a certain threat parameter was exceeded (e.g., biomass). This approach was described in detail in section 4.4.

The participants identified another procedural solution that could, potentially, reduce the workload and improve the saliency of bird threat advisories. Currently, ATIS messages do not have a lot of meaning at high bird activity airports because they are too general and are almost always included in the broadcast. Multiple participants confirmed that, at their facility, the ATIS message warns of "bird activity" 24 hours a day. A message or "alert" like this is, although it may satisfy a legal requirement, does little to inform pilots of the true nature of the threat and may even desensitize them to it. WiSC may help alleviate these concerns through three mechanisms. (1) More precise information is available that, conceivably, could lead to more meaningful ATIS entries. (2) WiSC may offer a means to streamline the inclusion of this more tactical information into ATIS by automating the process. The spectrum of automation options range from semi-automated, in which a user reviews and approves a predefined message; to fully automated, in which ATIS may automatically update on a real-time basis as needed without any human intervention. (3) Quantitative metrics could be used to selectively determine when bird activity alerts are placed on ATIS (e.g., counts, number of events per day, or historical data). However, there are research challenges to implementing these ideas. Operational considerations impact the optimal or acceptable update rate of ATIS. As a result, although it is possible to make ATIS messages more precise than the current standards, they most likely cannot ever be truly tactical. A compromise may be possible by applying creative quantitative methods (e.g., determination of whether the current level of activity is above a median day for that site).

Additionally, WiSC could be designed to automatically capture, store, and centrally log quantified historical data without requiring controller tasking. This information could be used to support wildlife biologists and others in characterizing the level of bird activity at a facility, improve seasonal and daily predictions, and assess the performance of mitigation efforts. In addition, PIREPs and other observation-based sources may not include all associated information, such as specific location, time, or heading.

4.6 PILOTS' PROCEDURAL AND WORKLOAD CONSIDERATIONS.

Although pilots are key stakeholders in WiSC, this activity focused on the ATC perspective. Based on this KEA, it is unclear whether supplemental bird threat information would necessitate procedural changes from a pilot's perspective. The pilots in this panel represented two different perspectives. One believed that improved bird threat information relayed by a controller would have very little impact to their existing task or procedures. However, the other pilot already mitigates exposure to known bird threats by performing "avoidance maneuvers" and "little S turns" when practical. Real-time information in these circumstances may help supplement these types of evasive actions. Although a direct-to-cockpit display is not planned under WiSC, the pilots were asked whether this type of information would be useful or change the way they perform their duties. A direct-to-cockpit display would certainly impact pilot duties, if for no other reason than requiring more heads down time. One pilot participant was open to the idea and suggested putting a graphical representation of bird threats on an airport diagram or approach plate. However, the other pilot indicated that direct information would add too much workload when they are already in a critical phase of flight. This underscores the importance of carefully investigating how direct-to-cockpit bird threat information might impact the flight deck.

5. SUMMARY.

The KEA panel of ATC and pilot stakeholders confirmed the operational value of WiSC and provided preliminary guidance on how this information might be effectively integrated into the ATC environment. This activity also provided an opportunity to conduct a detailed and comprehensive investigation of how bird threats are managed and disseminated within the ATC tower and TRACON today. The group leveraged their technical knowledge and expertise to identify and expound on factors that are critical to the implementation of an effective ATC bird threat information display based on this technology.

As bird threat information becomes more precise and dynamic, clear guidance will be necessary to determine how to best disseminate the advisory information without negatively impacting workloads. These procedures require further research and, once refined, must be formalized into the Air Traffic Control Manual [10]. The KEA participants believed the best opportunity to improve safety, when using this technology, was in the takeoff phase of flight. Overall, the panel recommended the WiSC information be presented graphically and integrated into an existing ATC system, possibly the primary radar display. To prevent cluttering an already data-saturated display, the participants suggested using zones. The zones remain invisible to the user until an alert is activated when certain biomass or threat level parameters are exceeded. Controllers could access additional detailed information, such as individual tracks, biomass, location, altitude, or heading, if needed.

Future research will focus on refining the functional requirements, capabilities, procedures, and practices to best detect, disseminate, and display supplemental bird threat information to controllers, supervisors, and pilots in the ATC environment. One key activity will be to conduct a part-task, human-in-the-loop simulation using more refined and interactive displays to objectively investigate alternative display options.

6. REFERENCES.

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APPENDIX A—INFORMED CONSENT STATEMENT

I, ______________________________, understand that this assessment, entitled "Wildlife Surveillance Concept Knowledge Elicitation Activity 1" is sponsored by the Federal Aviation Administration (FAA).

Nature and Purpose:
I have been recruited to volunteer as a participant in this evaluation. The purpose of the evaluation is to elicit information from current Certified Professional Controllers (CPC), ATC supervisors, and pilots regarding their experience related to wildlife threats in the ATC environment, as well as determine future direction in mitigation efforts. The results of this exercise will contribute to the knowledge base used by the research team to further examine the methods and products available to mitigate bird strikes. In addition, the data collected will help to identify and shape future concept development and validation activities.

Experimental Procedures:
Two current CPCs, two current supervisors, and two pilots will spend February 25th 2014 through February 26th 2014 serving as participants on a panel evaluating wildlife threats in the ATC environment and future directions in wildlife mitigation. The demonstration will take place at the Research Development Human Factors Laboratory (RDHFL) which is located at the FAA William J. Hughes Technical Center in Atlantic City, NJ.

On the first day, participants will arrive at the demonstration location and be briefed by the research team on the nature and purpose of the activities, as well as participant roles, responsibilities, and expectations. Following this introduction, participants will be guided through several operational scenarios and asked to provide feedback. On the second day, the participants will be exposed to several different interface options for bird radar information and a panel activity will be held to examine research questions. Following each of these session participants will be asked to complete questionnaires and participate in group discussions.

Audio Recording of Group Discussions:
I understand that, with my consent, the research team will make audio recordings of group discussions for the sole purposes of data analysis. I understand that this data will remain strictly confidential and I will not be identified in any way on the recording. In addition, I am assured that the recordings will never be used for any other purposes than originally intended and that the recordings will be appropriately archived or destroyed following the activity.

Discomfort and Risks:
I understand that I will not be exposed to any foreseeable risks. The work that I will perform in the study is safe and consists of listening to presentations, completing questionnaires, and providing feedback to the researchers about my experience during the sessions.

Confidentiality:
My participation is strictly confidential, and no individual names or identities will be recorded or released in any reports.

Benefits:
I understand that the only benefit to me is that I will be able to provide the researchers with valuable feedback and insight regarding my experiences during the research activity. My data will help the FAA to understand the nature of wildlife threats to ATC operations as well as how the aviation community can benefit from avian radar products.

Participant Responsibilities:
I am aware that to participate in this study I must be identified as a current Certified Professional Controller who is qualified at an air traffic control facility, a supervisor who currently works at an air traffic control facility, or a pilot. I will answer any questions asked during the assessment to the best of my abilities. I will not discuss the content of the experiment with anyone until the study is completed.

Participant's Assurances:
I understand that my participation in this study is completely voluntary, and I have the freedom to withdraw at any time without penalty. I also understand that the researchers in this study may terminate my participation if they feel this to be in my best interest. I have not given up any of my legal rights or released any individual or institution from liability for negligence.

The Wildlife Surveillance Concept Knowledge Elicitation Team has adequately answered all the questions I have asked about this study. I understand that individuals from the assessment team will be available to answer any other questions that I may have as the study proceeds.
If I have questions about this study or need to report any adverse effects from the research procedures, I will contact a member of the team.

Compensation and Injury:
I agree to immediately report any injury or suspected adverse effect to the assessment team conducting this research. Local clinics and hospitals will provide any treatment, if necessary. I agree to provide, if requested, copies of all insurance and medical records arising from any such care for injuries/medical problems.

Signature Lines:
I have read this informed consent statement. I understand its contents, and I freely consent to participate in this study under the conditions described. I understand that, if I want to, I may have a copy of this statement.

Research Participant:____ Date:__________
Witness:____ Date:__________

APPENDIX B—PARTICIPANT BACKGROUND QUESTIONNAIRE

Background Information – CPC/Supervisor

Instructions:
This questionnaire is designed to obtain information about your background and experience as a Certified Professional Controller (CPC) in the civil air traffic control environment. Researchers will only use this information to describe the participants in this study as a group. Your identity will remain anonymous.

1. How long have you been an Air Traffic Controller?	_____ years _____ months
2. How long have you actively controlled traffic in the tower cab environment?	_____ years _____ months
3. How long have you actively controlled traffic in the terminal radar environment?	_____ years _____ months
4. How long have you been a Supervisor?	_____ years _____ months _____N/A
5. When did you last control traffic?	(mm/yyyy) ____________
6. Please identify the shift(s) that you work a majority of time.	___Day ___ Night ___ Both

7. Please list the facilities that you have controlled traffic at.

____
____
____
____

8. Please list any other things that you would like us to know about your background.

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Background Information – Pilot

Instructions:
This questionnaire is designed to obtain information about your background and experience as a Pilot. Researchers will only use this information to describe the participants in this study as a group. Your identity will remain anonymous.

Background Information - Pilot

1. Are you currently active as a pilot?	______Yes _____No

2. How many years of experience do have flying?	_____ years

3. Approximately how many total hours do you have flying?	_________ Hours

4. Do you fly commercially or for pleasure?	____ Commercially ____ For Pleasure

5. Please list the aircraft types that you have flown.

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6. Please list your certifications.

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7. Please list any additional things you would like to share with the research team regarding your experience as a pilot.

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APPENDIX C—PRE-KEA OPINION QUESTIONNAIRE

Pre-KEA Opinion Survey – CPC/Supervisor

Instructions:
This questionnaire is designed to obtain information about your opinions regarding bird threats in your current operational environment. These are your opinions. Researchers will only use this information to describe the participants in this study as a group. Your identity will remain anonymous.

1. Please rate your awareness of the extent of bird strikes in the ATC environment.	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

Comments:

____

____

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2. Please rate your awareness of bird mitigation efforts in ATC.	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

Comments:

____

____

____

3a. Where do you get information about bird threats from today? (check all that apply)	___Observation from the tower cab ___ Supervisor ___ Another controller ___ Pilot report ___ Wildlife management ___ Airport Ops ___ Other: __________
3b. Which is the most common source of this information?	________________________

4. Additional bird threat information would be valuable/helpful for a controller in the ATC environment.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain:

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5. I am in favor of having additional bird information available to me.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain:

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6. Do you have first-hand experience reporting bird strike hazards?	______Yes _____No

Please explain:

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7. Bird hazards play a significant role in my daily activities at my facility.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain:

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8. On average, bird hazards impact my facility ______ times per ______
(circle one) Day Week Month Year

9. How often do you issue bird threat advisories?	Typical Day: ____ times per day/week/month Peak Season: ____ times per day/week/month

10. Reporting bird hazards at my facility contributes significantly to my duties/workload.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

___

11. The inaccurate/imprecise nature of current bird information increases my workload.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

12. Even when birds are not a hazard to traffic they require extra effort to remain vigilant of their potential impact.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

13. Do you have first-hand experience managing an aircraft that encountered a bird strike?	_____Yes _____No If yes, how many? _______

14a. Which of the following operational impacts of bird threats have you experienced as a controller (check all that apply)	___ Pilot request to delay departure ___ Aborted landing ___ Precautionary landing ___ Emergency landing ___ Other __________________
14b. Please list the most frequently occurring (in order) from the list above.	

15. Additional information regarding your opinion of bird hazards in the ATC environment:

16. Do you have any suggestions or recommendations to help mitigate bird strike threats?

Additional Bird Threat Information – CPC/Supervisor	
17. What type of information regarding bird activity would be useful to you? (check all that apply)	____ Location only ____ Heading ____ Altitude ____ Species ____ Biomass ____ All available ____ Other: ____________

Pre-KEA Opinion Survey - Pilot

Instructions:
This questionnaire is designed to obtain information about your opinions regarding bird threats and the introduction of bird radar to your current operational environment. These are your opinions. Researchers will only use this information to describe the participants in this study as a group. Your identity will remain anonymous.

1. Please rate your awareness of the extent of wildlife strikes in the ATC environment.	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

Comments:

____

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____

2. Please rate your awareness of wildlife mitigation efforts in aviation (ATC/Airlines).	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

Comments:

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3. Additional bird threat advisory information transmitted from ATC would be valuable/helpful for pilots.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain:

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4. I am in favor of ATC providing me with additional bird threat information.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain:

____

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____

5. I am in favor of having bird threat information provided directly to me in the cockpit.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain:

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____

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6. Bird hazards play a significant role in my daily activities.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

____

____

____

7. Please rate your experience level in dealing with bird hazards during your pilot duties.	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

8. On average, I experience a close encounter with, or hit a bird ______ times per ________
(circle one) Day Week Month Year

Comments:

____

____

____

9. Do you have experience communicating with ATC regarding bird strikes and/or bird strike activity?	______Yes _____No

10a. Have you experienced a bird strike while piloting an aircraft?	_____Yes _____No
10b. If Yes, In what phase of flight (departure, climb, approach etc): ____	
10c. Would bird advisory information have been of value to you? _______ Yes _______No	

11a. Which of the following operational impacts of bird threats have you experienced as a pilot (check all that apply)	___ Request to delay departure ___ Aborted landing ___ Precautionary landing ___ Emergency landing ___ Other

11b. Please list the most frequently occurring (in order) from the list above.

____

12. Please describe the worst threat or outcome you have experienced as a pilot in a bird strike situation. How was it resolved?

____

13. Do you have any suggestions/recommendations to help mitigate bird strike threats or any comments in general regarding bird threats?

____

Additional Bird Threat Information – Pilot	
14. What type of information regarding bird activity would be useful to you? (check all that apply)	____ Location only ____ Heading ____ Altitude ____ Species ____ Biomass ____ Other: ________________ ____ All available

APPENDIX D—POST-SCENARIO QUESTIONNAIRE

Post Scenario Questionnaire – CPC/Supervisor

Instructions:
Please answer the following questions based upon your experience in the scenario just completed. Your identity will remain anonymous.

Scenario Letter ____

Current Procedures and Operations – CPC/Supervisor

1. Please rate the realism of this scenario?	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High
2. How representative was this scenario of your experience with wildlife threats?	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

3. Please list any important elements/considerations missing from this scenario.

______
______
______
______
______

4. How frequently do you experience a situation like this at your facility?	Never	①②③④⑤⑥⑦⑧⑨⑩	Frequently

WiSC Operations – CPC/Supervisor

6. Precise bird advisory information would be helpful in this situation.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree
7. Precise bird advisory information would have improved my situational awareness of bird activity.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree
8a. Please rate your perceived level of impact that the addition of bird advisory information would have on your workload.	Negative Effect	①②③④⑤⑥⑦⑧⑨⑩ None	Positive Effect

8b. Please discuss the impact of having bird advisory information on your overall workload? Would it increase workload or decrease workload?

WiSC Operations - CPC

9. Please describe other beneficial impacts that the addition of supplemental bird threat information may have on your performance (e.g. improved safety, response time to an incident, increased situational awareness).

10. Please describe what negative impacts the addition of supplemental bird threat information may have on your performance (e.g. increased workload, increased communications).

Post Scenario Questionnaire - Pilot

Instructions:
Please answer the following questions based upon your experience in the scenario just completed. Your identity will remain anonymous.

Scenario Letter: ____

Current Procedures and Operations - Pilot

1. How realistic was the scenario?	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High
2. How representative was this scenario of your experience with wildlife threats?	Extremely Low	①②③④⑤⑥⑦⑧⑨⑩	Extremely High

3. Please list any important elements/considerations missing from this scenario.

____
____
____
____
____

4. How frequently do you experience a situation like this?	Never	①②③④⑤⑥⑦⑧⑨⑩	Frequently

WiSC Operations - Pilot

6. Precise bird threat information would be helpful in this situation.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree
7. Precise bird threat information would have improved my situational awareness of bird activity.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree
8a. Please rate your perceived level of impact that the addition of bird threat advisories would have on your workload.	Negative Effect	①②③④⑤⑥⑦⑧⑨⑩ None	Positive Effect

8b. Please discuss the impact of having precise bird threat advisories on your overall workload?

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WiSC Operations - Pilot

9. Please describe other beneficial impacts that the addition of supplemental bird threat information may have on your performance (e.g. improved safety, response time to an incident, increased situational awareness).

10. Please describe what negative impacts the addition of supplemental bird threat information may have on your performance (e.g. increased workload, increased communications).

APPENDIX E—INTERFACE EVALUATION QUESTIONNAIRE

WiSC Interface Evaluation – CPC/Supervisor

Instructions:
Please answer the following questions based upon your opinion on the interface. Your identity will remain anonymous.

1. Please describe the system that would be best for displaying supplemental bird threat information (current display, new display….etc).

2. What types of information would you like presented on the above system (altitude, heading, speed, biomass, other…etc.)

3. Please specify the type of data presentation you would prefer (individual tracks, flocks, zones - and when you would like to see this information (all info available vs. only alerts).

4. Please describe the minimum accuracy that this supplemental bird threat information needs to have to be useful to you. For example, “as accurate as *system*” or “at *altitude* and *distance* within *feet.”*

5. Are there any additional comments that you have regarding your ideal interface (what, where, and when)?

WiSC Interface Evaluation – Pilot

Instructions:
Please answer the following questions based upon your opinion on the interface. Your identity will remain anonymous.

1. Please describe your overall thoughts on the potential capabilities just demonstrated and the impact that they might have on your job as a pilot.

2. Please convey your opinion on the possibility of having bird threat information direct-to-the cockpit. Would this information be useful to you? Would there be any downside to this?

3. Are there any additional comments that you have regarding your ideal interface in the cockpit (what, where, and when)?

4. Please describe the minimum accuracy that this supplemental bird threat information needs to have to be useful to you. For example, "as accurate as *system*" or "at *altitude* and *distance* within *feet.*"

APPENDIX F—EXIT QUESTIONNAIRE

Exit Questionnaire – CPC/Supervisor

Instructions:
Please answer the following questions based upon your experience in the during this activity and your opinions on the material covered. Your identity will remain anonymous.

1. My knowledge of avian threats to aviation and the current efforts to mitigate those threats has increased following this activity.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

____

____

____

2. Additional bird threat information would be valuable/helpful for a controller in the ATC environment.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain how your opinion may have changed from before this KEA:

____

____

____

3. I am in favor of having additional bird information available to me.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain how your opinion may have changed from before this KEA:

____

____

____

Additional Bird Threat Information – CPC/Supervisor	
4. What type of information regarding bird activity would be useful to you? (check all that apply)	_____ Location only _____ Heading _____ Altitude _____ Species _____ Biomass _____ Other: ________________ _____ All available

5. Please indicate how you would like to be notified of a bird threat alert (check all that apply)	___ Textual ___ Graphical ___ Aural ___ All of the above

6. What system makes the most sense for bird threat alarms/alerts?	___ IDS ___ STARS/CARTS ___ DBRITE ___ Other ___________

Comments:

____

____

____

7. Please indicate the frequency of bird threat information that would be useful to you.	___ All information, all the time ___ Only when alert is needed ___ Other ___________

Comments:

____

____

____

8. If this information is on your primary display, which would you prefer?	___ Individual bird tracks ___ Flocks/Groupings ___ Zones that are affected ___ Other ___________

Comments:

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____

____

9. Having a "slew to target" camera functionality would be useful in dealing with bird threats.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

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____

____

8. Please list the things that we touched on in the KEA that you thought would <u>most improve</u> dealing with bird threats (e.g. precise radar, procedures, interfaces, roles and responsibilities… etc.).

9. Please list any of your <u>major concerns</u> with some of the material discussed in this KEA. (e.g. workload, responsibilities, radar capabilities)

10. Are there any concerns/considerations that we missed during this KEA that you would like to tell us about?

11. Please list any additional comments related to bird threats, mitigation efforts, or your overall experience in the KEA.

Exit Questionnaire - Pilot

Instructions:
Please answer the following questions based upon your experience during this activity and your opinions on the material covered. Your identity will remain anonymous.

1. My knowledge of avian threats to aviation and the current efforts to mitigate those threats has increased following this activity.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Comments:

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2. Additional bird threat information would be valuable/helpful for a pilot.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain how your opinion may have changed from before this KEA:

____

____

____

3. I am in favor of having additional bird information available to me.	Strongly Disagree	①②③④⑤⑥⑦⑧⑨⑩	Strongly Agree

Please explain how your opinion may have changed from before this KEA:

____

____

____

Additional Bird Threat Information – Pilot	
4. What type of information regarding bird activity would be useful to you? (check all that apply)	_____ Location only _____ Heading _____ Altitude _____ Species _____ Biomass _____ Other: ____________________ _____ All available
5. Please indicate how you would like to be notified of a bird threat alert (check all that apply)	____ Textual ____ Graphical ____ Aural ____ All of the above

6. Please list of the things that we touched on in the KEA that you thought would <u>most improve</u> dealing with bird threats (e.g. precise radar, procedures, interfaces, roles and responsibilities… etc.).

7. Please list any of your major concerns with some of the material discussed in this KEA. (e.g. workload, responsibilities, radar capabilities)

8. Are there any concerns/considerations that we missed during this KEA that you would like to tell us about?

9. Please list any additional comments related to bird threats, mitigation efforts, or your overall experience in the KEA.