Spring 2013

Federal Aviation Administration Evaluation Requirements for Airport's Wildlife Hazard Management Plans

Enrique Guadamos
San Jose State University

Follow this and additional works at: https://scholarworks.sjsu.edu/etd_projects

Part of the [Emergency and Disaster Management Commons](#), [Public Administration Commons](#), and the [Transportation Commons](#)

Recommended Citation

Guadamos, Enrique, "Federal Aviation Administration Evaluation Requirements for Airport's Wildlife Hazard Management Plans" (2013). *Master's Projects*. 319.

DOI: <https://doi.org/10.31979/etd.qs4e-zwq7>

https://scholarworks.sjsu.edu/etd_projects/319

This Master's Project is brought to you for free and open access by the Master's Theses and Graduate Research at SJSU ScholarWorks. It has been accepted for inclusion in Master's Projects by an authorized administrator of SJSU ScholarWorks. For more information, please contact scholarworks@sjsu.edu.

Federal Aviation Administration Evaluation Requirements for Airport's
Wildlife Hazard Management Plans:

A Thesis Quality Research Project
Submitted in Fulfillment of the
Requirements
for the Masters of Public Administration
San Jose State University

Author: Enrique Guadamos

Adviser: Dr. Peter Haas

INTRODUCTION

On January 15, 2009, USAir flight 1549 carrying 155 passengers and crew, landed on the Hudson River after a bird strike disabled both engines. Fortunately, every one of the 155 people involved in this incident was accounted for and alive. According to a report from Alan Levin of *USA Today*, bird-aircraft collisions are not a rare incident. The Federal Aviation Administration (FAA) database that tracks bird strikes in the United States shows that collisions between aircraft and birds increased by 62% for the period of 2000-2009. “Birds damaged at least one engine on aircraft an average of 10 times a year in the 1990s, and between the years 2000-2009, that number climbed to more than 12 per year (Levin 2009).

FAA efforts at addressing wildlife strike problems have been regulatory-driven. If an airport has a Wildlife Hazard Management Plan (WHMP), and targeted projects are completed, the airport is in compliance. The FAA reviews airport’s WHMP annually, but has no objective procedures to evaluate the effectiveness of Airport’s WHMP at reducing bird strikes or guiding improvements. Each Airport with a WHMP decides how to best evaluate the effectiveness of its own WHMP (Begier & Dolbeer, 2011).

Should the FAA provide direction and objective procedures for evaluating the effectiveness of WHMP at U.S. airports? If airports cannot compare their programs’ effectiveness using the same methodology, how can they know if their priorities and efforts are correct? If airports are utilizing different procedures for evaluating the effectiveness of their WHMPs, which evaluating procedures and methods provide the best results?

There are approximately 570 airports certified by the Federal Aviation Administration under Title 14 CFR, Part 139, of the U.S. Code of Federal Regulations for passenger traffic. The FAA under Part 139.337 requires airports that experience wildlife hazards to develop and implement a Wildlife Hazard Management Plan (WHMP). The FAA has developed and published the manual “Wildlife Hazard Management at Airports” which provides guidance to airport operators on how to handle habitat and food attractive to wildlife, use of techniques to remove hazardous wildlife posing a risk to aircraft, training of personnel, and establishment of an airport wildlife hazard working group. What the FAA’s Wildlife Management Program does not provide are formalized procedures requiring airports to benchmark the effectiveness of their WHMP. (Dolbeer & Wright, 2009)

According to the FAA’s report “Wildlife Strikes to Civil Aircraft in the United States 1990-2009” published in May 2011, the number of strikes annually reported have increased five times from 1,793 in 1990 to 9,474 in 2009 (Begier, Dolbeer, Weller & Wright, 2011).

This research will compare and contrast the WHMP of three west coast airports, San Francisco International Airport (SFO), Seattle-Tacoma International Airport (SEA), and Portland International Airport (PDX), to determine whether or not the lack of objective and standard evaluation procedures affects their effectiveness at reducing bird strikes. Additionally, this research will identify best practices and make recommendations accordingly.

LITERATURE REVIEW

The challenge of bird strikes to aviation has been studied extensively, yet no uniform method of evaluation has been undertaken nationwide. Dolbeer and Wright (2009) concluded that the FAA's wildlife database is an objective source of information on bird-aircraft collisions. It provides a scientific foundation for various efforts that are underway to reduce the problem of bird strikes and other wildlife strikes with aircraft, and an objective benchmark of the effectiveness of Wildlife Hazard Management Plans (WHMP). However, Levin (2009) reports that the bird strike database is not mandatory, and reporting is inconsistent, and that it undercuts the ability of federal regulators, airports and airlines to assess the risk that birds create.

Airports require large amounts of open space necessary for the safe operation of aircraft. These vast amounts of open air and land also provide the ideal habitat for wildlife. Migratory and non-migratory birds find in airports' open spaces the ideal location for refuge, food and nesting. Airfields may be ideal for birds, but when aircraft and birds collide, the results can be catastrophic. The Federal Aviation Administration (FAA) has the authority to regulate airline, airport and aircraft operations in the United States. The FAA website (2011) provides information regarding Code of Federal Regulations (14 CFR) Part 139. 337 - Wildlife Hazard Management, which requires airport operators to take action to alleviate wildlife hazards.

The FAA's Safety and Operations Division is in charge of evaluating airports' Wildlife Hazard Assessments (WHA). On June 11, 2009, and following the events of the USAir 1549 bird strike, the Airport Safety and Operations Division issued a certification alert reminding airport operators of the need to conduct wildlife assessments when specific triggering events take

place. The FAA's website on Wildlife Hazard Mitigation Program (2011) provides background information, latest certification alerts to airports, and current and continuing FAA regulatory efforts geared toward mitigating wildlife hazards.

Following the USAir Flight 1549 bird strike emergency in January 2009, the FAA started several initiatives that included the following:

- The publication of the FAA National Wildlife Strike Database containing all bird-collision data collected since the 1990s.
- Issuance of a certification alert in June 11, 2009, reminding airport operators of their obligation to conduct Wildlife Hazard Assessments upon specific triggering events, such as the wildlife being ingested into an aircraft engine.
- Initiated rulemaking in late summer 2009 to make Wildlife Hazard Assessments mandatory, regardless of the presence of triggering events.
- Conducted educational outreach with the aviation community to emphasize and encourage the reporting of wildlife strikes; and made reporting bird strike to the FAA's database easier by creating a generic web service. (Federal Aviation Administration, 2011)

As a result of the FAA initiatives, several airports initiated Wildlife Hazard Assessments (WHA) and updates to their Wildlife Hazard Management Plans (WHMP). In June of 2011, ICF Jones & Stokes finalized the San Francisco International Airport's (SFO) WHMP. SFO WHMP's objective is to develop an integrated, adaptive program to effectively manage risk by reducing the probability of occurrence of wildlife-aircraft collision. SFO is located

approximately thirteen miles south of downtown San Francisco, near the cities of Millbrae and San Bruno, California to the west, and the San Francisco Bay to the east and south. SFO is a major international airport and the largest in the Bay Area. SFO is the second busiest airport in California; the tenth busiest in the United States; and the twentieth largest in world. SFO's August 2011 flight operations totaled 36,250 operations, with 3,905,087 passengers flying to and from the airport (San Francisco International Airport, 2011).

Portland International Airport (PDX) in Oregon also updated its Wildlife Hazard Management Plan in 2009. Portland prepared its first WHMP in 1998, and revised it in 2003 to address significant changes in program organization, administration and implementation. The 2009 update addresses revised FAA regulations and incorporates the findings of the airport's wildlife risk assessment process. PDX is owned and operated by the Port of Portland and is the 34th busiest airport in the country. It is located approximately six miles northeast of downtown Portland, and it is situated adjacent to the Columbia River. A large variety of wildlife live in the vicinity of PDX, and many birds pass through the area during their seasonal migrations along the Pacific Flyway (Portland International Airport, 2009).

Seattle-Tacoma International Airport (SEA)'s WHMP was last updated in 2004. SEA's Wildlife Hazard Working Group reviews periodically its WHMP, and updates it as needed, and when circumstances merit changes. SEA addresses potential wildlife hazards on and near the airport with a particular emphasis on wildlife attractants. SEA's WHMP focuses on habitat modifications, monitoring and responding on potential wildlife hazards associated with wetlands mitigation sites built in 2004. (Port of Seattle-Tacoma International Airport, 2004).

Begier et al.'s (2011) report to the FAA states that the number of strikes reported has increased by five times from 1,793 in 1990 to 9,474 in 2009 (99,411 for 1990-2009). Birds were the predominant wildlife involved in collisions with aircraft, averaging 97 percent of the strikes. Begier et al. attribute the increase in wildlife strikes to three main factors: (1) remarkable population increase of wildlife species commonly involved in strikes (i.e., Canada goose, pelicans); (2) increase in air traffic operations (310 million in 1980 to 690 million in 2009); and (3) use of more efficient and quieter, two-engine aircraft.

Collisions between birds and aircraft are not exclusively a problem of civil aviation. Military flight operations are also vulnerable to wildlife collisions. Bissonette and Zakrajsek's (2005) journal report indicates that, during the period of 1985-1998, bird strikes cost the United States Air Force (USAF) an average of \$35 million per year in damages. A review of the USAF Bird Strike Database and categorizing of the risk of wildlife species shows vultures being ranked as the most hazardous species group to USAF aircraft, followed by geese and pelican in the large bird categories. Among smaller birds, blackbirds, starlings and swallows were species ranked highest.

Allan and Orosz's (2001) report to the Bird Strike Committee USA/Canada provides estimates of the costs of birdstrikes to commercial aviation. This report states that reliable estimates of the cost to civil aviation are difficult to obtain, because some of the data are commercially confidential, and some of the sources cannot be accurately verified. Allan and Orosz utilize United Airlines' system of tracking repair and flight delay costs due to birdstrikes, and estimate the total cost of birdstrikes to commercial aviation to be in the range of \$1.21 - \$1.36 billion per year. According to the Federal Aviation Administration, the average cost to

planes involved in a bird strike is about \$120,000 (Thomas, 2009). Although the majority of collisions between aircraft and wildlife do not end in a fatal aircraft accident, since 1988 more than 200 people have died in crashes associated with bird-aircraft collisions (Lynch, 2009)

In order to assist airports with the management of birds and other wildlife hazards, the FAA utilizes the services of the United States Department of Agriculture. Begier and Dolbeer's (2008) report explains that the USDA-APHIS Wildlife Services has developed a national network of professional wildlife biologists who are trained and qualified to deal with the unique and complex conflicts between wildlife and aviation. The wildlife services provided by this team include effective science-based mitigation for a variety of wildlife. Barras and Seamans' (2002) report provides objective recommendations for habitat management on airports. Barras and Seamans state that habitat management is one component of an integrated approach for reducing wildlife use of airports. The report provides information on how to best modify different types of airfield vegetation and structures to deter wildlife. They conclude that despite the 30 years of discussion regarding the importance of habitat management techniques, few reliable studies of the effectiveness of these techniques have been conducted.

Cleary, Dolbeer and Wright (2000) state that in implementing programs aimed at reducing the risk of wildlife hazards at airports, airport management must first focus on understanding the relative risk posed by various species, so that management actions can be prioritized by the most hazardous species. Cleary et al. rank various wildlife species' hazard to aircraft based on the FAA Wildlife Strike Database for civil aircraft in the U.S. from 1991 -

1998. Twenty-one groups of species were ranked based on the percentage of strikes causing damage, major damage, and effect on flight.

Carter's (2001) report also agrees that effective control of wildlife requires the identification and prioritization of the hazards that each species poses to aircraft. Carter provides ten primary risk factors that can help airport operators determine the relative threat posed by individual species or groups of similar species. Carter's assessment provides a list of wildlife species that pose the greatest risk to aviation.

Examining and categorizing the risk of certain bird species is only one part of the equation leading to the understanding of birdstrikes. Sodhi's (2002) journal article, suggests that more rigorous ornithological investigation and sound ornithological understanding are still required to find long-term management solutions for bird-aircraft conflict. Sodhi's examination of birdstrike incidents considers additional factors, such as human safety and economics, as leading to the increase in bird and aircraft collisions. Shamoun-Baranes, et al.'s (2008) journal article proposes the use of real-time information on bird movements to make alterations in the flight trajectory of aircraft. Shamoun-Baranes, et al. determined that information regarding the distribution of birds in the air and on the ground can be used to reduce the risk of birdstrikes and their impact on operations. The practice of active-bird-scanning techniques is currently being used by the military both in the US and abroad, in Europe and Israel.

Allan's (2000) report presented to the International Bird Strike Committee suggests a risk assessment protocol that first identifies and describes the hazard, followed by risk estimation, risk evaluation and risk management. The identification part of the risk assessment

process should be conducted by ornithologists familiar with the bird strike problem and its alleviations. Once the hazard has been adequately described in terms of species, numbers, location and behavior, the risk assessment can proceed to estimate the probability that particular species' populations of birds frequenting a particular site will cause a bird strike which will result in a specified level of harm. Risk evaluation will determine if the risk is acceptable or if it requires management action to reduce it. Risk management will evaluate options for managing the hazard, or changing an operation to reduce the resulting risk.

The Bird Strike Committee USA (2011), a voluntary organization formed of members from the FAA, USDA, Department of Defense, aviation industry, airlines and airports, provides an overview of risk assessment as it relates to bird strikes. The Committee emphasizes the importance of distinguishing between hazard and risk in discussing wildlife and aviation. In developing management plans to mitigate wildlife at airports, operators should document the species found, rank them by hazard level, and determine the probability of each species being struck. The risk posed by each species can be determined by combining hazard level with probability of each event.

Begier and Dolbeer (2011) in their report, presented at the North America Bird Strike Conference in Canada, also suggest that airports and the FAA prioritize wildlife species based on their risk factors. Begier and Dolbeer go a step further and propose that airports benchmark the Adverse Effect (AE) strike rate of each species and compare it to that of other airports to measure the effectiveness of wildlife mitigation plans. Adverse Effect strikes are those strikes that cause damage or have a negative effect on flight movements. The AE strike rate

incorporates hazard level of species struck. They also propose annual reports for each Part 139 airport and the incorporation of the hazard level of wildlife species observed on airports as part of their Wildlife Hazard Assessment.

Dale (2009) in his journal article suggests that, given the devastating consequences of aircraft accidents resulting from bird strikes, airport operators and managers must address the issues of organizational and corporate liability. Dale discusses how airport managers and operators must strive to conduct accurate assessments, and develop and implement effective wildlife management plans. He explains the regulatory implications, and states that managers must have a clear understanding of the responsibilities placed on them. Dale cites examples of civil lawsuits filed citing negligence on the part of airport managers and operators as contributing factors to property loss, injuries and fatalities after a birds strike. Due diligence in establishing measures to alleviate bird hazards at airports is the best protection against corporate and personal liability, and failing to do so could bring civil and criminal charges upon airport managers and airport operators.

METHODOLOGY: PROCESS EVALUATION

To determine if the current FAA Wildlife Management regulation -which lacks standard procedures for evaluating the effectiveness of airports' WHMPs - is meeting its fundamental objective of reducing wildlife-aircraft conflicts at U.S. airports, it will be necessary to determine

if the evaluation processes currently used by airports were producing the expected results towards the reduction of bird strikes.

Using Sylvia and Sylvia's process evaluation research method, this study obtained and analyzed data that provided information on how three west coast airports (PDX, SEA and SFO) approach the evaluation of their wildlife management programs. This study followed phase IV "Feedback Evaluation" of the process evaluation method and performed a systematic assessment of WHMP evaluation methodologies. This phase of the process evaluation "involves collecting data to determine whether the solutions were implemented as intended and whether the solutions produced the desired effects" (Sylvia & Sylvia, 2004).

Quantitative data was obtained from the FAA bird strike database, and used to determine increases or decreases trends in the incidence of bird strikes. Qualitative data was obtained through one-on-one interviews of airport personnel directly involved with the implementation and evaluation of the airport WHMP. Interviewing questions focused on obtaining information on how the airport's WHMP evaluating procedures were set up, and how well they are working. A copy of the questions to be asked during the interviewing of airport staff is available as Attachment A.

Process Evaluation Elements

This study compared PDX, SEA and SFO's wildlife hazards, control techniques, wildlife management strategies, implementation strategies, and most importantly, their program evaluation and implementation methodologies. A description of each airport's operating environment was identified and compared. Significant differences were be highlighted to

determine if these are site specific and whether or not the evaluation process can be replicated at other airports.

Determining Program Components – Program components were identified by determining:

- (a) Who are the responsible parties in charge of assessing the effectiveness of WHMPs?
- (b) What activities, procedures and methods have been set in place to review and evaluate wildlife management plans?
- (c) When are evaluations taking place, and at what intervals?
- (d) How are evaluations conducted and analyzed?

Data Collection Process - Data obtained for this study was collected utilizing two main sources:

1. Quantitative: Data was collected and available through the FAA bird strike database. On April 24, 2009, under pressure by the public, the FAA Bird Strike Database was released to the public. The FAA began collecting data in the 1990s for use by the FAA's Office of Airports, academia, and researchers as a means to improve airport safety and reduce wildlife hazards (Federal Aviation Administration, 2011). This data contains specific information that includes the type of bird species involved in strikes, time of day, weather condition, extent and type of damage from the strike. It is important to state that this data is obtained from airports on a voluntary basis. This data contains over 121,000 civil and USAF wildlife strikes reported between 1990 and 2010. The FAA Bird

Strike Database will also be used to determine the AE strike rate ranked by bird species.

In addition, data related to aircraft operations at airports was collected from the FAA's Air Traffic Activity System (ATADS) database which tracks all airport operations activities. This data will be utilized to compare increasing and decreasing trends in aircraft operations and its potential effect on the number of bird strikes at airports.

2. Qualitative. Data was obtained by conducting interviews with key airport staff in charge of each airport's WHMP. These interviews were open-ended with the same questions being asked of airport staff to ensure consistency and validity. These interviews helped reveal the reactions of airport staff to the program's development and implementation, special notice was given to staff observations about difficulties encountered and explanations, as well as suggested solutions.

In addition, all three airport's wildlife hazard management plans describing procedures and techniques for managing wildlife hazards are available in electronic form on the World Wide Web, and considered public record. Questions used in the interview process did not seek to gather personal opinions, but rather professional observations of the effectiveness of their WHMP evaluation process.

Finally, the author of this study enlisted the assistance of the academic advisor overseeing this project whenever necessary to ensure complete adherence to the basic principles of policy analysis, and to aid in the delivery of a timely and administratively relevant study.

Data Findings and Analysis

The findings of the process evaluation will be shared with airport personnel directly involved in the evaluation of Wildlife Hazard Management Plan at each of the three airports evaluated in this project if requested. The evaluation process report might prove useful to airport management staff when interacting with FAA safety officials, and used as another tool to evaluate the effectiveness of their WHMP. If the evaluation methods used at PDX, SEA and SFO are meeting their desired objectives of managing wildlife hazards by improving the effectiveness of their WHMPs; then, a positive evaluation should reflect, at minimum, a decline in the number of bird strikes for the evaluation period.

QUANTITATIVE FINDINGS

This report examined wildlife-aircraft strikes obtained from the FAA website. Data collected and evaluated included a ten-year period starting from January 1, 2002 through December 31, 2011. Data on bird strike incidence as well as aircraft operation at airports across the U.S. was obtained and evaluated. A random sample of airports was also collected and evaluated for trends on bird strikes, and the results were compared with finding for PDX, SEA and SFO.

Operationally, the FAA divides all airports in the U.S. into nine regions. For purposes of this study, six of the nine FAA regions were randomly selected. Of a total of three hundred and

seventy-two (372), Part 139¹ airports, in these six regions, sixty were randomly selected. Ten airports of each of the six regions were selected for a total of sixty (60) airports that had wildlife strike(s) reported between January 1, 2002 and December 31, 2011. Exhibit A lists the regions and airports analyzed.

Bird strikes were analyzed throughout the above mentioned ten-year period to determine increases or decreases in the number of occurrences at each selected airport. The results were compared to the total U.S. bird strike incidence. In addition, the total number of aircraft operations for the same ten-year period at the same sixty randomly selected airports was analyzed to determine increases or decreased in the number of aircraft operations. The results were compared to the total U.S. aircraft operations.

U.S. Bird Strike Incidence

During the period of January 1, 2002 and December 31, 2011, there were a total of 76,006 bird strikes in the U.S. and reported in the FAA Bird Strike database. Since 2002, the number of bird strikes have steadily increased from 6,104 (8.0%) in 2002 to 9,730 (12.8%) in 2011. This increase of 4.8 percent represents 3,626 additional bird strikes at airports in the United States.

¹ There are a total of 549 Part 139 airports which comprise of Class I through IV airports. Federal regulations require 451 Class I through III airports to comply with Part 139.337 requirements, including wildlife mitigation requirements. Airports serving all types of scheduled operations of air carrier aircraft designed for at least 31 passenger seats (large air carrier aircraft) and any other type of air carrier operations are Class I airports. Class II airports are those airports that serve scheduled operations of small air carrier aircraft and unscheduled operations of large air carrier aircraft. Class III airports are those airports that serve only scheduled operations of small air carrier aircraft.

There are two noticeable increases, year to year, in this ten-year period. The first one occurs between 2003 and 2004. In 2003 there were a total of 5,886 (7.7%) strikes reported while in 2004 the number increases to 6,411 (8.4%), an increase of 525 strikes. The second noticeable increase occurs between 2008 and 2009. In 2008 there were a total of 7,417 (9.8%) reported bird strikes while in 2009 the number increases to 9,229 (12.1%), an increase of 1,812 strikes. This 2.3% increase represents the sharpest increase year-to-year in this ten-year period. Table #1 provides the total number of bird strikes for each year as well as year-to-year percentage distributions.

Table #1 Reported Bird Strikes, USA, 2002-2011		
Year	Bird Strikes	Percentage
2002	6,104	8.00%
2003	5,886	7.70%
2004	6,411	8.40%
2005	7,092	9.30%
2006	7,053	9.30%
2007	7,538	9.90%
2008	7,417	9.80%
2009	9,229	12.10%
2010	9,546	12.60%
2011	9,730	12.80%
Total (N)	76,006	100%

Source: Data obtained from FAA Bird Strike Database, 2012

U.S. Aircraft Operations (take offs and landings)

During the period of January 1, 2002 to December 31, 2011, the FAA reported a total of 146,471,633 aircraft operations. Aircraft operations include number of landings and takeoffs at each airport. For the period of 2002 to 2004, flight operations in the U. S. showed a small

increasing trend starting in 2002 with 15,280,928 (10.4%) operations, and climbing to 17,132,923 (11.7%) operations in 2004, an increase of 1,851,995 (1.3%) operations in a two-year period. This increasing trend was followed by seven years (2005 – 2011) of steady decreases in the number of aircraft operations. Starting in 2005 with a total of 16,485,718 (11.3%) operations declining to a total of 11,475,866 (7.8%) in 2011, a decrease of 5,009,852 (3.5%). The sharpest decrease in this seven year period can be observed between 2008 and 2009. In 2008, there were 14,379,097 (9.8%) operations compared with 12,426,312 (8.5%) in 2009, a decline of 1,952,785 (1.3%). Table #2 provides the total number of aircraft operations for each year as well as year-to-year percentage distributions.

Table #2 Aircraft Operations, USA, 2002-2011		
Year	Aircraft Operations	Percentage
2002	15,280,928	10.40%
2003	16,047,672	11.00%
2004	17,132,923	11.70%
2005	16,485,718	11.30%
2006	15,830,185	10.80%
2007	15,421,078	10.50%
2008	14,379,097	9.80%
2009	12,426,312	8.50%
2010	11,991,854	8.20%
2011	11,475,866	7.80%
Total (N)	146,471,633	100%

Source: Data obtained from FAA Air Traffic Activity System (ATADS), 2012

U.S. Bird Strikes and Aircraft Operations

During the ten-year period of January 1, 2002 to December 31, 2011 the percentage distribution of bird strikes in comparison to aircraft operations show two opposing trends with

aircraft operations decreasing in numbers while bird strike incidences show an increasing trend. In 2008, the percentage distribution of bird strikes and aircraft operations intersect at exactly 9.8 percent, or 7,417 bird strikes compared to 14,379,97 aircraft operations. Following 2008, the comparison of percentage distribution between bird strikes and aircraft operations continue to diverge from each other as well as increasing the gap between the two. In 2002, the gap between the percentages of bird strikes (8%) compared to the percentage of aircraft operations (10.4%) was 2.4%. By 2011, the percentage of bird strikes (12.8%) compared to the percentage of aircraft operations (7.8%) has more than double to 5% in the last ten-years.

Bird Strikes at PDX (2002-2011)

A total of 908 wildlife-aircraft strikes were recorded at Portland International (PDX) from 2002-2011. Bird strikes accounted for 906 of all of the wildlife strikes for the same ten-year period. Strikes reached peaks of over 100 strikes between the years 2006-2008 with 109 (12%) strikes in 2006; 112 (12%) strikes in 2007; and 114 (13%) strikes in 2008. After 2008, wildlife strikes declined reaching its lowest number in 2011 with 75 strikes (See Table #3).

Table #3: Percentage Bird Strikes, PDX and USA, 2002-2011		
	PDX	USA
Year	Bird Strikes	Bird Strikes
2002	11%	8%
2003	8%	8%
2004	9%	8%
2005	10%	9%
2006	12%	9%
2007	12%	10%
2008	13%	10%
2009	9%	12%
2010	7%	13%
2011	8%	13%
Total	100%	100%
(N)	906	76,006

Source: Data analyzed from FAA Bird Strike Database

A large percentage (27%) of strikes at PDX was not identified because of a lack of identifiable remains or the failure to collect and send remains for identification. The percentage of unidentified strikes was lowered by 6 percentage points in the last five-year period (21%) from 2006 to 2011 signaling an increased effort by PDX staff in ensuring bird strike

identification (Figure 2). Bird strikes that incurred the most identifiable strikes included raptors (24%), Swallows and Martins (11%), Owls (9%), and Gulls (8%).

Raptor strikes varies throughout this ten-year period (2002-2011) reaching the highest number of 37 strikes in 2008 followed by sharp declines between 2009 and 2010 with 19 strikes in 2009 and 10 strikes in 2011 (See Table #3a).

Table # 3a: PDX Bird Strike Trends by Bird Categories 2002-2011.

PDX 2002-2011 Bird Strike Trends												
Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Percentage of Bird Strikes
Cardinal	1									1	2	0%
Columbids	2	1			1	1		2	1	3	11	1%
Corvids		2	1	1	2	5	4		3		18	2%
Cowbird						1					1	0%
Finch		1							1		2	0%
Gull	1	1	5	9	12	13	11	7	7	7	73	8%
Hummingbirds									1		1	0%
Kinglets									1		1	0%
Larks			1	1					1	1	4	0%
Owls	13	6	4	6	17	10	12	6	2	9	85	9%
Passerine	2	1		1	1	1		1	1	1	9	1%
Pipits		1			1			1	2		5	1%
Raptor	31	18	21	17	23	28	37	19	10	11	215	24%
Robins								1			1	0%
Shorebirds				1	1	1			1	1	5	1%
Sparrows	2			1	1					2	6	1%
Starlings and Blackbirds	4	3	1	3	3		1	2	2	2	21	2%
Swallows and Martins	11	8	5	8	10	12	18	4	9	17	102	11%
Swift				1	2	5	2	1	3	1	15	2%
Tern							1				1	0%
Thrushes			2			1			2	1	6	1%
Tyrannidae										1	1	0%
Unknown	24	25	39	35	26	25	16	30	14	9	243	27%
Waders	1	1	3	4	5	4	5		3	1	27	3%
Warbler		1	1			1	1	2		2	8	1%
Waterfowl	5	3	1	6	4	4	6	6	2	5	42	5%
Waxwing								1			1	0%
Total	97	72	84	94	109	112	114	83	66	75	906	100%

Wildlife Strikes at SEA (2002-2011)

A total of 610 wildlife-aircraft strikes were recorded at Seattle-Tacoma International Airport (SEA) from 2002-2011. Bird strikes accounted for 599 of all of the wildlife strikes for the same ten-year period (See Table #4). With the exception of 2005, strikes have consistently increased for this ten-year period, reaching its highest bird strike in 2011 with a total of 120 (20%) strikes, an increase of 36 strikes in a one-year period.

Table #4: Percentage Bird Strikes, SEA and USA, 2002-2011		
	SEA	USA
Year	Bird Strikes	Bird Strikes
2002	8%	8%
2003	7%	8%
2004	7%	8%
2005	5%	9%
2006	9%	9%
2007	9%	10%
2008	10%	10%
2009	11%	12%
2010	14%	13%
2011	20%	13%
Total	100%	100%
(N)	599	76,006

Source: Data analyzed from FAA Bird Strike Database

Unidentified or unknown strikes account for the largest percentage (50%) of all wildlife strikes in SEA (See Figure #3). Unidentified strikes diminishes to (35%) during the last five-year period 2006-2011. Bird strikes that incurred the most identifiable strikes include Gulls (7%), sparrow and meadowlarks (7%), raptors (6%), and shorebirds (6%), swallows and martins (6%), and owls (6%).

SEA Percentage of Bird Strike by Category 2002-2011

Figure #3: SEA Percentage of Bird Strike by Category 2002-2011
Source: Data collected and analysed from FAA Bird Strike web site.

Gull strikes have remained constant throughout this ten-year period (44 strikes) reaching its highest numbers in 2006 with 8 strikes and its lowest in 2010 with 1 strike. With the exception of 2005, which recorded zero strikes, raptor strikes varies reaching its lowest strikes in 2002 with 2 strikes and highest in 2011 with 12 identifiable strikes. Shorebird is another category/group of birds that remain constant with 41 strikes in this ten-year period. Owls, raptors, and sparrows show a significant increase in 2011 with 11 strikes; 12 strikes; and 18 strikes respectively.

Table #4a: SEA Bird Strike Trends by Bird Categories 2002-2011.

SEA 2002-2011 Bird Strike Trends												
Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Percent of Strike
Cardinal								1			1	0%
Columbids	3			2				2	8		15	3%
Cowbird					1		1				2	0%
Finches							1				1	0%
Grebe					1				1		2	0%
Gulls	6	4	5	2	8	5	4	2	1	7	44	7%
Larks	2	1								1	4	1%
Owls		1		2	8		5	4	4	11	35	6%
Parakeet		1									1	0%
Passerine							2	1			3	1%
Pipits								1			1	0%
Raptors	2	3	3		7	5	4	2	2	12	40	7%
Robins	1	4	1	1	3	1	1	1	1	1	15	3%
Seabirds						1	2				3	1%
Shorebirds	5	4	3	2	2	3	3	5	5	9	41	7%
Sparrows and Meadowlarks	3	4	1	1	1		3	4	7	18	42	7%
Starlings and blackbirds	5	2	3		1	3	3	6	3	2	28	5%
Swallows and Martins		5	1		2	2		3	13	14	40	7%
Swift									1	1	2	0%
Thrushes					2	1		3	2	4	12	2%
Unknown	14	15	25	17	18	26	21	27	34	31	228	38%
Wader						1	2			1	4	1%
Warbler						2	1	1		4	8	1%
Waterfowl	5		2	3	2	3	4	2	2	4	27	5%
Total	46	44	44	30	56	53	57	65	84	120	599	100%

Wildlife Strikes at SFO (2002-2011)

A total of 748 wildlife-aircraft strikes were recorded at San Francisco International Airport (SFO) between 2002 and 2011. Strikes between birds and aircraft account for 675 of the 748 strikes (See Table #5). Bird strikes have been consistent in this ten-year period showing a pattern of small peaks and valleys reaching its lowest bird strikes in 2003 with 56 (8%) strikes and 2008 with 53 (8%) strikes while its highest bird strikes were recorded in 2006 with 82 (12%) strikes and again in 2011 with 79 (12%) strikes.

Table #5: Percentage Bird Strikes, SFO and USA, 2002-2011		
	SFO	USA
Year	Bird Strikes	Bird Strikes
2002	11%	8%
2003	8%	8%
2004	9%	8%
2005	11%	9%
2006	12%	9%
2007	9%	10%
2008	8%	10%
2009	10%	12%
2010	9%	13%
2011	12%	13%
Total	100%	100%
(N)	675	76,006

Source: Data analyzed from FAA Bird Strike Database

A large percentage (59%) of bird strikes were not identified due to the lack of identifiable remains or due to failure to collect and send remains for identification. It should be noted that the number of unidentifiable bird strikes has consistently declined between 2002-2011, with its

highest number recorded in 2002 with 64 unknown strikes, and lower numbers in 2010 and 2011, 23 and 24 unknown strikes respectively (See Figure #4).

Birds that incurred the most identifiable strikes include Gulls (54 strikes); Shorebirds (51 strikes); Raptors (39 strikes); and Owls (29 strikes). Gull strikes remain consistent with an increase from 2005 – 2011 with the lowest strikes recorded in 2005 and 2006 (2 strikes) and climbing to its highest in 2011 (10 strikes). Shorebird strikes also show an increase between 2002 and 2001 with a sharp increase from 5 to 15 strikes in 2010 and 2011 respectively. Raptor

strikes show its peak in 2006 with 10 strikes followed by a decline in 2007, 2008, 2009 and 2010 with 0, 1, 5 and 3 strikes respectively. Strikes involving owls show peaks and valleys with zero strikes in 2002 and 2007 climbing to 7 strikes and 9 strikes in 2006 and 2010 respectively (See Table #5).

Table #5: SFO Bird Strike Trends 2002-2011.

SFO 2002-2011 Bird Strike Trends												
Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Percentage of Bird Strike
Columbids	2	1	1			1	2	1	2	1	11	2%
Grebe						1					1	0%
Gulls	4	1	3	2	2	8	7	9	8	10	54	8%
Hawks					5	1		1	3	6	16	2%
Larks								1		1	2	0%
Owls		2	1	4	7	1		4	9	1	29	4%
Pipits								1		2	3	0%
Raptor	3	3	2	4	10		1	5	3	8	39	6%
Seabirds			1	1	2	2		5	1	3	15	2%
Shorebirds		3	3	3	7	4	5	6	5	15	51	8%
Sparrows and meadowlark	1	1	2	6		1	2	3	2	3	21	3%
Starlings and Black Birds	2	2	1		3		1	1		1	11	2%
Swallows and Martins				1				2	1		4	1%
Swift										1	1	0%
Unknown	64	42	50	50	44	39	31	28	23	24	395	59%
Waders		1		1	2		1	1	3	1	10	1%
Waterfowl				2			3	1	4	2	12	2%
Total	76	56	64	74	82	58	53	69	64	79	675	100%

Bird Strikes at Randomly Selected Airports

Sixty airports were randomly selected from a group of 544 FAA, Part 139 airports for this evaluation, and for the period of 2002 to 2011. The FAA divides Part 139 airports into four classes, Class I through IV. Class I through III airports are required to comply with Part 139.337 Wildlife Hazard Management and mitigation requirements. Class I airports are those serving all types of scheduled operations of air carrier aircraft designed for at least 31 passenger seat. Class II airports are those airports that serve scheduled operations of small air carrier aircraft and unscheduled operations of large air carrier aircraft. Class III airports are those airports that serve only scheduled of small air carrier aircraft. Class IV airports are those airports that serve unscheduled large (30+ seats) air carrier aircraft (Federal Aviation Administration, 2012).

Of the sixty airports randomly selected, there were a total of 45 (75%) airports with percentage of bird strikes with ascending trends in comparison with the U.S. percentage distribution (See Exhibit B). 3 of these 45 airports are classified by the FAA as Class IV airports which are not required to have WHMP in place. Conversely, of the sixty airports randomly selected, there were a total of 15 (25%) of airports with percentage of bird strikes with descending or neutral trends in comparison with the U.S. bird strike percentage distribution (See Table #6). All of the 15 airports with descending trends were Part 139, Class I airports. Exhibit B provides tables of percentage distributions and ascending and descending trending figures for each sampled airport.

Table #6: Sample Airports with Constant or Declining Bird Strikes, 2002-2011

Year	US Percentage	SFO	SBA	PDX	TUS	DCA	IAD	PSC	GRI	TUL	ABI	AMA	STS	PBI	MRY	FAY
2002	8%	11%	12%	11%	5%	13%	11%	13%	30%	6%	18%	11%	31%	9%	0%	20%
2003	8%	8%	14%	8%	11%	12%	10%	8%	0%	7%	22%	19%	0%	16%	21%	0%
2004	8%	9%	16%	9%	10%	11%	10%	21%	0%	17%	10%	6%	0%	5%	14%	0%
2005	9%	11%	12%	10%	18%	12%	10%	8%	40%	10%	0%	11%	15%	10%	14%	20%
2006	9%	12%	13%	12%	8%	10%	10%	0%	20%	13%	14%	6%	8%	11%	14%	40%
2007	10%	9%	8%	12%	9%	8%	10%	13%	0%	19%	8%	6%	23%	12%	7%	0%
2008	10%	8%	4%	13%	8%	6%	8%	13%	0%	7%	6%	21%	8%	3%	0%	0%
2009	12%	10%	6%	9%	13%	10%	8%	4%	10%	13%	10%	13%	8%	10%	7%	0%
2010	13%	9%	11%	7%	8%	6%	12%	8%	0%	4%	8%	5%	0%	14%	0%	20%
2011	13%	12%	5%	8%	11%	11%	11%	13%	0%	5%	4%	2%	8%	10%	21%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	675	281	906	272	454	844	24	10	225	50	84	13	92	14	5

Aircraft Operations at randomly selected airports

Of the sixty airports randomly selected for this evaluation, Durango La Plata (DRO) and Fort Collins/Loveland (FNL) airports in Colorado, do not have an operational Air Traffic Control Tower (ATCT), therefore, aircraft operations are not recorded by the FAA, and are not included in this report. For purposes of calculating percentage distribution of aircraft operations, the N number was adjusted to 58. During the ten-year period of 2002 -2011, there were at total of 14 (24%) of 58 airports with constant or increasing aircraft operations trends. During the same time period, there were 44 (76%) airports with decreasing airport operations. This declining trend is most noticeable between 2007 and 2011 (See Exhibit C).

QUALITATIVE FINDINGS

The results of interviews of key airport personnel with direct responsibilities over the implementation of wildlife programs at PDX, SEA and SFO indicate compliance with the requirements of FAR Part 139.337 to take immediate action to alleviate wildlife hazards whenever they are detected. In addition, a review of these airport's WHMPs indicate no variations in meeting the requirements to manage wildlife populations, modification of wildlife habitat and changes to land use, as well as procedures to be followed during air carrier operations, and wildlife hazard control measures. Exhibit C provides a summary of PDX, SEA, and SFO's wildlife hazard management plan's implementation.

Where differences exist is in the way PDX, SEA and SFO comply with Part 139.337(e)(6)² which require that a minimum the airport operator should hold annual meetings, or after a triggering event, with representatives from all airport departments involved in the airport's wildlife hazard management efforts and the wildlife damage management biologist who did the original ecological study. The following provides a summary of each airport's program evaluation methodologies:

PDX Evaluation Methodology

PDX's WHMP is reviewed jointly by the Airside Operations Manager and the Wildlife Manager on an annual basis. This review and results are documented and filed with an annual accomplishment report with the FAA. As a result of two significant bird strikes in 2000 and 2001, PDX hosted an international panel site visit in December of 2001 to review issues and wildlife program capabilities at the airport. The panel recommendations for improvements included the need to increase the level of dedicated resources and wildlife staff. Dedicated dawn to dusk hazing and harassment capabilities on the airfield to clear the airspace for a specific aircraft operation was identified as an essential need. (Portland International Airport, 2009).

The evaluation of the effectiveness of PDX WHMP is performed by the FAA Certified Airport Biologist, Nick Atwell, and by the Aviation Wildlife Advisory Committee (AWAC) consisting of several external agencies. Nick has a degree in Natural Resources and Organismal Biology. He is responsible for managing a full-time proactive aviation wildlife management

² FAR Part 139.337(e)(6) requires airports with Wildlife Hazard Management Plans to have procedures to review and evaluate the WHMP every 12 consecutive months or following a triggering event, including: (i) The plan's effectiveness in dealing with known wildlife hazards on and in the airport's vicinity and, (ii) Aspects of the wildlife hazards assessment that should be reevaluated.

program, conducting research into new non-lethal wildlife deterrents, and making wildlife modification recommendations while focusing on environmental policy and regulations (Port of Portland, 2012).

According to Nick Atwell, PDX's Aviation Biologist, AWAC was first established in 1996 and is chaired by PDX's Wildlife Manager. In addition to evaluating the effectiveness of PDX's WHMP, AWAC provides a forum to discuss the WHMP with regulatory agencies, interest groups, and the public. This committee meets at least twice a year, and provides ongoing feedback and expertise to the WHMP. The evaluation methodology includes the review of current internal strategies and holding an AWAC meeting to discuss specific events or topics.

Currently there are no pre-established evaluation forms or checklists used in the evaluation, rather, meetings are held and minutes are recorded; therefore, well recorded meetings and overall documentation regarding the evaluation of the WHMP is essential. One of the challenges encountered in evaluating the entire plan is that not all strategies and/or activities described in the WHMP have been fully implemented due to funding constraints. In addition, it has become increasingly difficult getting all AWA members to attend the meetings. Mr. Atwell indicates that although there is always room for improvement when it comes to gaging the effectiveness of its WHMP, PDX uses an adaptive management strategy and constantly looks for way to improvement. PDX is considering the use of the FAA Safety Management System (SMS) process for evaluating its WHMP (Atwell, 2012).

SEA Evaluation (Annual Review and Reporting)

SEA has a Wildlife Hazard Working Group (WHWG) that is responsible for reviewing the WHMP, which meets at least annually, and is composed of representatives from Port of Seattle (including Airport staff); Federal Aviation Administration; USDA, Wildlife Services; and the Falcon Research Group Inc. During the reevaluation, each member from each group or agency reviews their departmental duties, monitor their activities and make recommendations to the Port of Seattle Wildlife Biologist (Port of Seattle-Tacoma International Airport, 2004).

According to Steve Osmek, SEA's Airport Wildlife Biologist, the WHMP is evaluated each May by the participants of the Wildlife Hazard Working Group (WHWG). The process consists of review of the past five years of strike data and longer term trends in wildlife abundance by clade referencing the biweekly survey data. SEA utilizes a Safety Risk Assessment process (SRA) to benchmark and systematically evaluate its WHMP's performance. The SRA facilitation and documentation is based on a five-step processes which include the following: 1) Defining the System; 2) Identifying the Hazards; 3) Analyze the Risk (consequences); 4) Assessing the Risk (Through the use of Risk Matrix); and 5) Treat the Risk (mitigation). SEA will be implementing a sixth step, Monitoring, as part of their Risk Management Program and as part of the required annual WHMP review.

SFO Evaluation (Annual Review and Reporting)

SFO will review its WHMP at least annually or following an event that would normally trigger a wildlife hazard assessment as required by the FAA. According to Audrey Park, SFO's

Senior Environmental Planner, SFO is currently conducting wildlife Hazard Assessment (WHA) and only informal reviews of its 2011 WHMP have been possible. These informal reviews are conducted by the Wildlife Management Coordinator and Airfield Safety Officer (ASO) assigned to wildlife control duties. Once the WHA is reviewed and approved by the FAA, an update of the WHMP will be conducted if necessary and formal evaluations (as stated in the WHMP) will resume. SFO's WHMP specifies that the ASO assigned to wildlife control duties and SFO Bureau of Planning and Environmental Affairs staff responsible for implementing the plan and a subgroup from the SFO Wildlife Hazard Working Group will conduct the evaluation of the effectiveness of the plan.

The ASOs and ASO Wildlife Coordinator receive annual training in the following areas (some of this training is conducted by the contracted airport wildlife biologist): Wildlife hazards at airports; Laws associated with wildlife control; techniques used for prey-base reduction; firearm and pyrotechnic safety (including hands-on training); and wildlife identification and dispersal techniques (Park, 2012). One of the current challenges in evaluating the effectiveness of the plan is the absence of a wildlife activity baseline to compare results to. The WHA will be extremely helpful as it will provide a comprehensive and accurate depiction of wildlife activity in the airfield (Brotman, 2012).

SFO's formal method for WHMP assessment is a modified version of Seubert's methods. Five assessment categories each with a list of elements to be evaluated are used to indicate how well the airport's WHMP is being implemented. Five categories are evaluated, including

management functions, bird control, mammal control, habitat/food source management, and land use control off airport (Park, 2012).

Qualitative findings at Sample Airports with Decreasing Bird Strikes

The evaluation of bird strikes at the randomly selected airports shows fifteen (15) airports with decreasing bird strikes trends in a ten-year period. Assuming that the decrease in bird strikes is associated with an effective WHMP, the researcher interviewed personnel directly involved in the implementation of the WHMP to assess how these airports approach the evaluation of their wildlife management program and to determine commonality and possible trends.

Following the process evaluation established by Sylvia and Sylvia, the interviews were geared to determine what type of evaluation methodology is currently being use; the interval of the WHMP evaluation; who are the key evaluator(s) of the WHMP effectiveness; and what lessons can be learned from their evaluation process.

Of the fifteen (15) airports interviewed, nine (9) have a FAA approved WHMP in place. The remaining six (6) airports have been required by the FAA to perform a Wildlife Hazard Assessment (WHA), and of these six (6) airports, two (2) have draft WHMPs currently under FAA review.

Of the nine (9) airports with approved WHMPs, 6 (67%) include an FAA certified biologist or USDA biologist as one of the evaluators of the effectiveness of their WHMP(s). In addition, 5 (56%) of the 9 airports include a Wildlife Hazard Working Group (WHWG) in their

evaluation process. Three (3) of the nine (9) airports utilize a quantitative process as part of the evaluation to determine the effectiveness of their WHMP. This review is performed by a WHGW and includes a review and analysis of the number of bird strikes in the previous year, as well as review of developing trends. The remaining six (6) airports perform yearly meetings to review specific events and programs included in their plans, as well as other topic associated with their WHMP, but no formal evaluation of bird strike data is performed. Although not currently utilizing a formal process one airport is considering the use of a newly established FAA Safety Management System (SMS) to evaluate the effectiveness of its WHMP. The FAA has initiated pilot studies for the best use of SMS at airports. The use of SMS or other risk assessment tools as a standard and objective evaluation process will be further discussed as part of the findings section.

ANALYSIS

The Analysis portion of this report is performed with the primary goal of determining whether or not the lack of objective and standard evaluation procedures affect the effectiveness of airport's WHMP, and therefore, their goal of reducing the number of bird strikes. The researcher utilized a combination of quantitative and qualitative data as detailed in the methodology to acquire the findings, and then summarize the results within this analysis.

For this project the researcher selected three west-coast airports (SEA, PDX and SFO) and assessed their bird strike incidence over a period of ten years (2002 – 2011). The percentage

distribution of bird strikes was compared with the number of aircraft operations to determine trends over time. These results were compared with U.S. bird strikes and aircraft operations of airports throughout the U.S. over the same ten-year period. In addition, a random sample of sixty airports selected from six of the nine FAA's regions (ten airports per region) was evaluated. The results were used to determine how PDX, SEA and SFO aligned with the randomly selected sample of airports.

The analysis of bird strikes at PDX, SEA and SFO, show three very different results with only a common and slight increasing trend in 2011. Although SEA evaluates the effectiveness of its WHMP in the most objective and scientific manner by utilizing a Safety Risk Assessment process to benchmark and make changes to its wildlife control techniques, these changes do not reflect a decrease in the total number of bird strikes. SEA has seen an upward trend developed since 2006 with a sharp increase just in the last three years with 65(11%) strikes in 2009; 84 (14%) strikes in 2010; and 120 (20%) strikes in 2011 (See Figure #5).

Source: Data collected from FAA Bird Strike Database

Steve Osmek, SEA’s Wildlife Biologist, attributes these increases in bird strikes to the effectiveness of its monitoring program which includes biweekly airfield monitoring, as well as the effective collection of data by trained observers and the increased participation of aircraft operators at reporting bird strikes. “The value of aircraft-wildlife strike data is increasing rapidly as both the number and quality of strike reports filed by the airlines has improved after summer 2010 when SEA Airport Operations began distributing strike reporting kits to the air carriers every three months.” (Port of Seattle, Seattle-Tacoma International Airport, 2011)

SFO has seen an increase in the number of bird strikes in 2011 increasing from 64 (9%) bird strikes in 2010 to a total of 79 (12%) strikes in 2011, but the analysis of the last ten years shows a constant trend with peaks and valleys thorough the ten-year span. Starting with a low point in 2003 with 53 (8%); a peak in 2006 with 82 (12%) strikes; a low point again in 2008 with 53 (8%) strikes; and a peak again in 2011 with 79 (12%) strikes (See Figure #6). Most of the increases were observed in the number of strikes involving gulls, raptors, and shorebirds. Shorebirds having the sharpest increase from 5 strikes in 2010 to 15 strikes in 2011. These increases can be attributed to the fact that SFO borders the San Francisco Bay which is a major refuge for migratory and overwintering waterfowl and shorebirds. Shorebird observations accumulated by SFO suggest that shorebirds flying around the edge of the bay are most likely to be struck. The areas at the edge of the bay are difficult to access by airfield personnel, since hindering the effectiveness wildlife non-lethal control techniques. SFO has yet to perform a formal WHMP evaluation since it is currently performing a WHA which will help in building a baseline on its wildlife population.

Source: Data collected from FAA Bird Strike Database

PDX analysis of bird strike activity shows a decreasing trend from 2002 - 2011. Most noticeably is the period from 2008 to 2011 with 114 (13%) strikes to 75 (8%) strikes, respectively. This decline in the number of strikes can be attributed to the effectiveness of PDX's raptor program. The number of strikes involving birds of prey declined from 37 strikes in 2008; to 19 strikes in 2009; 10 strikes in 2010; to 11 strikes in 2011. Raptor translocation is considered an ongoing management practice at PDX because of the attractiveness of the area to hawks. Captured raptors are released to sites with suitable habitat usually located a distance of 40 miles from the airport. It is this type of effective program management and techniques that could be replicated at other airports with similar airport/airfield characteristics and bird populations.

Source: Data collected from FAA Bird Strike Database

The aviation industry is particularly susceptible to external economic factors, and the financial crisis that began in late 2007 may have contributed to the decline and continual downturn in aircraft operations at airports across the U.S. Although the U.S. recession officially ended in mid-2009 with the positive economic growth in the overall economy, unemployment remained high throughout 2010. In addition, economic recovery in the air transport industry depends heavily on the recovery of the rest of the economy and generally lags overall movements when compared with trends in the country's economy (U.S. Department of Transportation, 2011). In the ten-year period of 2002 – 2011, FAA database reports show a

decrease in the number of aircraft operations at Part 139 airports, most noticeably between 2005 to 2011 showing a decrease of 5,009,852 operations or 3.5% in a seven-year period.

The decrease in the number of aircraft operations, however, did not result in a direct decrease in the number of bird strikes at all U.S. airports. During the same ten-year period (2002 – 2011), the number of bird strikes at Part 139 airports have continued to grow moving from 6,104 (8.0%) bird strikes in 2002 to 9,730 bird strikes (12.9%) in 2011. According to a recent report by the Office of the Inspector General regarding the FAA's effective implementation of its wildlife hazard mitigation program, stated that wildlife strikes have steadily and dramatically increased in the last two decades growing from 1,770 reported in 1990 to 9,840 in 2011, a five-fold increase. According to the USDA, birds were involved in 97.1% of the strikes, terrestrial mammals in 2.3%; bats in 0.5%; and reptiles in 0.1%. The rise in strikes can be attributed, in part, to the increase in large bird populations. The USDA also states that, 13 of the 14 largest bird species have shown significant population increases. Increases in the number of bird strikes involving large birds at PDX, SEA and SFO have also been noticeable. Strikes involving large birds such as gulls, owls and raptors represent a large percentage of the reported strikes at these three airports. (See tables 1 – 3).

To account for the number of aircraft operations at PDX, SEA and SFO over the same ten-year period, and its possible influence on the effectiveness over WHMP evaluation methods, the researcher randomly selected a sample of sixty (60) airports from six of the nine FAA regions. Aircraft operations and bird strikes from these sample airports were analyzed for the

same ten-year period as PDX, SEA and SFO (See figure #8). The results of this evaluation are as follows:

- 35 (60%) of the 58 airports follow the U.S. trend of increased bird strikes and decreased aircraft operations. SEA falls under this group with bird strikes increasing from 46 (8%) in 2002 to 84 (20%) in 2011 while aircraft operations fell from 364,671 (11%) in 2002 to 314,944 (9%) in 2011.
- 8 (14%) of the 58 airports experienced trends of increased bird strikes and an increasing trend in the number of aircraft operations.
- 11 (19%) of the 58 airports experienced a trend of decreasing bird strikes and decreasing aircraft operations. PDX falls under this group with bird strike trends starting at 97 (11%) in 2002 and declining to 75 (8%) in 2011 while aircraft operations also experienced a decreased from 278,406 (11%) operations in 2002 down to 219,197 (9%) operations in 2011.
- 4 (7%) of the 58 airports experienced a decreasing or constant trend in the number of bird strikes and an increasing trend in the number of aircraft operations. SFO falls under this category with bird strikes remaining constant between 2002 – 2012 with numbers as high as 82 (12%) in 2006 and as low as 53 (8%) in 2008 while aircraft operations have

seen an increase in the same ten-year period from 334,515 (9%) operations in 2003 to 403,675 (11%) operations in 2011.

Figure #8: Bird Strike and Aircraft Operations of Sample Airports with decreasing trends, 2002-2011

Source: Data Collected from FAA Bird Strike Web Site and Air Traffic Activity System (ATADS)

The analysis of bird strikes to aircraft operations for the 60 randomly selected, Part 139 airports, indicate that 15 (26%) of the 58 airports have been able to maintain or decrease the number bird strikes. The researcher conducted interviews of airport staff responsible for implementing the WHMP at each of these 15 airports to determine what methodology each of these airports uses to evaluate the effectiveness of their WHMP. The results indicated that of these 15 airports, 9 have approved FAA WHMPs. Furthermore, only 3 of the 9 airports with approved WHMPs use some form of objective procedures for evaluating the effectiveness of

their WHMPs. These procedures include the evaluation of past bird strike data and trends.

Although SFO falls under the quadrant of low bird strikes and high aircraft operations, SFO's evaluation process does not include the analysis of bird strikes as part of its evaluation methodology.

The results indicate that the evaluation methodology used for assessing the effectiveness of WHMPs does not have a significant influence on Airport's ability to maintain an effective WHMP. PDX for example, utilizes an evaluation methodology based on meetings between airport operations and the airport biologist geared at the evaluation of internal wildlife strategies without a formal evaluation or analysis of the effects of its wildlife programs on bird strike incidence. SFO has yet to implement its evaluation process as it is currently performing a second wildlife hazard evaluation, and according to its WHMP, SFO's evaluation methodology will not review bird strike trends either. On the other hand, SEA the safety risks assessment to evaluate the effectiveness of its WHMP as well as reviewing past strike data, yet the percentage of bird strikes has increased dramatically in the last six years - from 5 percent in 2005 to 20 percent in 2011. What appears to be consistent among those airports, at least among those airports with declining bird strike trends, is the persistent monitoring and assertiveness at dealing with bird activity on the airfield. The following are some of the methods and techniques that have shown positive results in the management of wildlife:

1. Use of on-going Wildlife Hazard Assessment: Because one or more of the triggering events can occur at any time and at irregular intervals, airports like SEA have considered most prudent to conduct an On-going Wildlife Hazard Assessment consisting of daily

three-minute surveys each month throughout the year. These surveys are performed by Airport Operations Specialists (ASO) who actively patrol and inspect the airfield. This long-term monitoring provides an advantage for airports because it provides the most current wildlife trends. In determining when a hazardous situation is developing the availability of current data is essential because field staff and observers can rely on trend observation and adjust their response in the most appropriate and effective manner.

2. Dedicated resources: PDX, SEA and SFO agree in their WHMPs that even the most effective harassing and hazing technique becomes ineffective at some time due to wildlife becoming de-sensitive or accustomed to its effects. A robust WHMP includes dedicated resources and well trained wildlife staff that can apply a variety of control techniques necessary to decrease attractant at and near the airfield. SEA, for example, employs eight Airport Operations Specialist (AOS) who actively patrol and inspect the airfield; thirteen Airport Duty Managers (ADMs) who patrol and manage airfield inspections including wildlife; USDA who is contracted and provide one full-time and one half-time wildlife biologist; and a contractor who manages the SEA Raptor Strike Avoidance Program.

3. Bird Strike Kits distribution to airport and airline stakeholders. Voluntary wildlife strike reporting makes assessing strike rates difficult. In summer of 2010, SEA began issuing airport issued wildlife strike reporting kits to airline personnel. Since then, Strike Kits are being provided quarterly to all the airlines and have contributed to the increase in the number of reported strikes. The intent of these kits is to provide airline maintenance personnel a means to communicate any damages and down time related to a strike, the

date and time it was discovered, the aircraft involved, and a means of disposing of the animal remains. The Strike Kits are typically collected by airport personnel and an accurate strike report is then filed and properly identified. Unidentified strike remains are sent to Washington DC for identification by the Smithsonian Institution.

4. Use of Safety Risk Assessment (SRA) as an evaluation tool of the effectiveness of WHMPs. On October 14, 2011, SEA conducted an SRA of its WHMP. The results of this process yielded a total of thirteen risk mitigating recommendations to manage the top six species of concern that pose the greatest hazard at SEA. The panel performed the risk analysis and assessment considering the seasonal presence for each species as well as data and trends for the last five years which provided the basis for determining the likelihood of a strike event occurring again with the species. The proposed mitigation plan focused primarily on increasing resources, external communications and continuation of identifying wildlife attractants and hazardous trends in the abundance of previously identified species of greatest concern. Because WHMPs annual review has multiple inputs and operational variables, the SRA process provides the structure necessary to conduct the annual review in an organized manner. The SRA facilitation is based on industry standard 5-Step Risk Assessment process including the following: System Definition; Hazards Identification; Analysis of Risk (consequences); Assessment of Risk through the use of a Risk Matrix; and risk mitigation (Port of Seattle, Seattle-Tacoma International Airport, 2011).

CONCLUSION

The evaluation methodology used by airports in assessing the effectiveness of their Wildlife Hazard Management Plan has little or no significant effect on their ability to reduce the overall bird strike incidence. Consequently, the FAA's, lack of direct objective and standard evaluation procedures has no effect on its Wildlife Program goal of reducing the number of bird strike at U.S. airports. Much wildlife biologist state that there are too many factors affecting the effectiveness of airport's wildlife programs. Wildlife populations in and on the vicinity of airports are constantly changing in response to environmental factors, changes in land use, and state and federal management policies. A common objective to comparing strike rates among airports is that airports inherently vary in the number and species of birds and other wildlife present throughout the year and in the number of aircraft movements (Dolbeer & Wright, 2009).

The effectiveness of WHMP depends in great part on the active implementation of the programs developed specifically to control wildlife activity and to prevent collisions with aircraft operations. PDX, SEA and SFO utilize adaptive management where monitoring strategies and control techniques are adjusted in response to trends and outcomes observed when managing wildlife populations. In addition, dedicated resources as well as well-trained wildlife staff that can aggressively implement the various techniques necessary to discourage wildlife and decrease attractants is an essential element of a successful WHMP.

Finally, more accurate bird strike reporting on the part of all stakeholders is needed to effectively measure the effect of airport's WHMPs. As reported by SEA, one of the challenges in the evaluation of its WHMP is the voluntary nature of wildlife strike reporting. "You can't

manage what you can't accurately measure." Voluntary strike reporting makes assessing strike rates difficult. In an effort to obtain better reporting and to involve all stakeholders, SEA wildlife department began issuing in the summer of 2010 wildlife strike reporting kits to airline operators. Since then, the "number of recorded strikes at SEA has double, and we (SEA) are now getting closer to understanding our annual baseline strike rate." Reliable data is needed on strikes and trends in wildlife abundance. This information will make the WHMP evaluation process more effective at dealing with known wildlife hazards.

WORKS CITED

- Allan, J. R. (2000). A protocol for bird strike risk assessment at airports. *International Bird Strike Committee*, (pp. 25:29-46). Amsterdam.
- Allan, J. R., & Orosz, A. P. (2001). The costs of bird strikes to commercial aviation. *Bird Strike Committee-USA/Canada*, (pp. 218-226). Calgary.
- Atwell, N. (2012, August 28). Portland International Airport Wildlife Manager. (E. Guadamos, Interviewer)
- Barras, S., & Seanmans, T. (2002). Habitat management approaches for reducing wildlife use of airfields. *Vertebrate Pest Conference* (pp. 309-315). Davis, CA: USDA National Wildlife Research Center.
- Begier, M. J., & Dolbeer, R. A. (2008). *Protecting the flying public and minimizing economic losses within the aviation industry*. Washington, DC: USDA-APHIS Wildlife Services.
- Begier, M. J., & Dolbeer, R. A. (2011, September 12-16). Why we need to compare wildlife strike data among airports to improve aviation safety. *North American Bird Strike Conference*. Niagara Falls, Ontario, Canada: USDA-APHIS Wildlife Services.
- Begier, M. J.; Dolbeer, R. A.; Weller, J. R.; Wright, S. E. (2011). *Wildlife Strikes to Civil Aircraft in the United States 1990-2009*. Washington, DC: Federal Aviation

Administration and U.S. Department of Agriculture, Animal and Plant Health Service - Wildlife Services.

Bird Strike Committee USA. (2011, September 7). *Understanding and reducing bird hazards to aviation*. Retrieved October 10, 2011, from Bird Strike Committee USA Web site:
http://www.birdstrike.org/commlink/risk_faq.htm

Bissonette, J. A., & Zakrajsek, E. J. (2005). Ranking the risk of wildlife species hazardous to military aircraft. *The Wildlife Society*, 33 (1), 258-264.

Brotman, G. (2012, September 17). San Francisco International Airport Wildlife Hazard Coordinator. (E. Guadamos, Interviewer)

Bureau of Justice Assistance. (1997). Urban Street Gang Enforcement, Process evaluation. *Institute of Law and Justice, Inc.*, 97-98 and 102-103.

Carter, N. B. (2001). All birds are not created equal: Risk assessment and prioritization of wildlife at airfields. *Bird Strike Committee USA/Canada*, (pp. 22-30). Calgary.

Cleary, E. C., Dolbeer, R. A., & Wright, S. E. (2000). Ranking the hazard level of wildlife species to aviation. *Wildlife Society Bulletin*, 28(2): 372-378.

Cornell University Law School. (2012). *Legal Information Institute*. Retrieved September 15, 2012, from Cornell University Law School:
<http://www.law.cornell.edu/cfr/text/14/139.337>

- Dale, L. A. (2009). Personal and corporate liability in the aftermath of bird strikes: a costly consideration. *Human-Wildlife Conflicts*, 3(2): 216-225.
- Dolbeer, R. A., & Wright, S. E. (2009). Safety management systems: how useful will the FAA National Wildlife Strike Database be? *Human-Wildlife Conflicts*, 3(2):167-178.
- E-Code of Federal Regulations. (2011, September 28). *Electronic Code of Federal Regulations: Government Printing Office Access*. Retrieved October 1, 2011, from Government Printing Office Access: <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=4b377bb9d41d04afed5a8ed0bc983d50&rgn=div8&view=text&node=14:3.0.1.1.12.4.3.19&idno=14>
- Federal Aviation Administration. (2004, June 6). *Regulatory and Guidance Library: FAA*. Retrieved October 22, 2011, from FAA Web site: http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgFAR.nsf/0/d7aff358f3b62a9486256ebb005c3c40!OpenDocument
- Federal Aviation Administration. (2009, June 11). *Certaler: Airport Safety*. Retrieved September 15, 2011, from Federal Aviation Administration: http://www.faa.gov/airports/airport_safety/certalerts/media/cert0910.pdf
- Federal Aviation Administration. (2011, February 28). *Fact Sheets: Federal Aviation Administration Wildlife Hazard Mitigation Program*. Retrieved October 1, 2011, from FAA Web site: http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=12478

Federal Aviation Administration. (2012, July 6). *Airports*. Retrieved September 15, 2012, from Federal Aviation Administration:
http://www.faa.gov/airports/central/airport_safety/wildlife/media/Summary_Wildlife_Management.pdf

Federal Aviation Administration. (n.d). *Bird Strike Database: Federal Aviation Administration*. Retrieved October 5, 2011, from FAA Web site: <http://wildlife-mitigation.tc.faa.gov/wildlife/default.aspx>

Levin, A. (2009, April 26). *USA Travel: USA Today*. Retrieved September 26, 2011, from USA Today Web site: http://www.usatoday.com/travel/flights/2009-04-26-birdstrikes_N.htm

Lynch, J. (2009). Planes, birds, microscopes and DNA. *Birder's world*, (23) 30-33.

Osmek, S. (2012, August 24). Seattle-Tacoma International Airport - Port of Seattle. (E. Guadamos, Interviewer)

Park, A. (2012, September 19). San Francisco International Airport Senior Environmental Planner. (E. Guadamos, Interviewer)

Port of Portland. (2012, April 4). *Inside the Port: PDX Community Advisory Committee* . Retrieved September 16, 2012, from Port of Portland:
http://www.portofportland.com/PDX_Cmnty_Advsry_Cmt_Mbrs.aspx

Port of Seattle, Seattle-Tacoma International Airport. (2011). *Safety Risk Assessment #4*. Seattle: Port of Seattle.

Port of Seattle-Tacoma International Airport. (2004). *Wildlife Hazard management Plan*. Seattle:
Port of Seattle-Tacoma International Airport.

Portland International Airport. (2009). *Wildlife Hazard Management Plan 2009 Update*.
Portland: Port of Portland.

San Francisco International Airport. (2011, September 21). *Analysis of Scheduled Airline Traffic:
Comparative Traffic Report* . San Francisco: San Francisco International Airport.

San Francisco International Airport. (2011). *Wildlife Hazard Management Plan*. Oakland: ICF
Jones & Stokes.

Shamoun-Baranes, J., Bouten, W., Buurma, L., DeFusco, R., & Dekker, A. (2008). Avian
Information Systems: Developing web-based bird avoidance models. *Ecology & Society*,
13(2): 1-12: 38.

Sodhi, N. (2002). Competition in the Air: Birds versus Aircraft. *American Ornithologists' Union*,
119(3): 587-595.

Sylvia, K. M., & Sylvia, R. D. (2004). *Program Planning and Evaluation for the Public
Manager*. Long Grove: Waveland Press, Inc.

Thomas, F. (2009, January 17). *More birds, more strikes*. Retrieved October 1, 2011, from USA
Today:

[http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=JOE416079675209&1
oginpage=login.asp&site=ehost-live](http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=JOE416079675209&1oginpage=login.asp&site=ehost-live)

ATTACHMENT A

Please provide answers to the following questions to the best of your ability. Responses will be used to compare similar Wildlife Hazard Management Plan evaluation methodology at other west coast airports.

1. Who at your airport evaluates the effectiveness of the WHMP, and what are their qualifications?
2. What is the level of training given to the person(s) performing the WHMP evaluation?
3. How often is the evaluation of the WHMP performed at your airport?
4. Describe the methods used for evaluating your airport's WHMP.
5. During the last WHMP evaluation, was the process followed and completed as established? If not, what elements were not completed?
6. Were the objectives of the WHMP clear and understandable?
7. Were the goals/objectives of the evaluation process clear and understandable?
8. Describe any barriers or challenges encountered during the evaluation process.
9. Have all WHMP strategies/activities implemented? If not, what remains to be done?
10. Is the WHMP evaluation process effective at dealing with known wildlife hazards?
11. What lessons have been learned during the evaluation process that can be useful to other airports?

ATTACHMENT B

SUMMARY OF PDX, SEA, AND SFO'S WHMP

Airport Operating Environment

Portland International Airport is part of the Port of Portland which owns and operates the Sea Port and the Airport. The Airport operates in approximately 3,339 acres of Port-owned land situated on the south shore of the Columbia River (See Appendix A). The Airport airfield comprises of 1,735 acres and consists of two parallel runways and one cross wind runway, a system of taxiways, roadways and buildings including hangars, terminals, and an Air Traffic Control Tower. PDX is bordered on 3 sides by open water and is located on a major migratory flyway which makes the area rich in avian wildlife. The areas north and south of the Columbia River which are located near PDX have become largely urbanized pushing wildlife to available and undeveloped areas near the airfield (Portland International Airport, 2009).

Seattle-Tacoma International Airport is located approximately thirteen miles south of the city of Seattle. The Airport is owned and operated by the Port of Seattle which along with the Airport, owns and operates the Sea Port. There are 10 wetland sites to the north and south of the airfield and approximately two miles west of the airport is Puget Sound, an area with substantial wildlife abundance, especially during migration (See Appendix B). Other potential wildlife attractant locations include the industrial wastewater lagoons, golf course, Des Moines Creek Regional Detention Facility – also known as the North West Ponds, Lora Lake, and Lake Reba. These wildlife attractants are located inside the Port of Seattle property. Other wildlife attractants outside of Port-owned land includes Angel Lake and Bow lakes (Port of Seattle-

Tacoma International Airport, 2004). SEA opened a third runway in November 2008 which required the construction of a large retaining wall at the north end of the airfield. This additional runway created a substantial change to the habitat in the area, and was identified as the possible root cause for additional raptor activity (Port of Seattle, Seattle-Tacoma International Airport, 2011).

San Francisco International Airport is located on the eastern side of the San Francisco Bay peninsula and borders the Bay Estuary immediately to the north, south and east. To the west, SFO is bound by urban areas and U.S. Interstate 101 that runs north/south (See Appendix C). The Estuary is a major refuge for migratory and overwintering waterfowl and shorebirds. The San Francisco Bay Estuary is a Western Hemisphere Shorebird Reserve Network site used by more than one million shorebirds during migration. SFO occupies approximately 2,500 acres of land owned by the City and County of San Francisco. Approximately 180 of the total 2,500 acres are located west of U.S. 101 and provides habitat for two endangered and threatened species. The Airport operates five terminal buildings, two primary runways, and two crosswind runways. Other buildings that are associated with airport operations, include a water treatment plant, a supersize hangar, United Airlines SF Maintenance Center, Airport Commission buildings and various cargo facilities, U.S. Coast Guard facilities, parking garages, rental car facilities and the Bay Area Rapid Transit (BART) station (San Francisco International Airport, 2011).

Wildlife Hazard Management Plans and Wildlife Hazard Assessments.

The FAA under 14 Code of Federal Regulations (CFR) Part 139.337 (b) and (c) require certificate holders (i.e., airport sponsors) that service regularly scheduled commercial aircraft to

complete a Wildlife Hazard Assessment when one of the following events occurs on or near the airport: (a) an air carrier aircraft experiences multiple wildlife strikes or engine ingestion; (b) an air carrier aircraft experiences substantial damage from striking wildlife; (c) an air carrier aircraft experiences an engine ingestion or wildlife; or (d) wildlife of a size, or in numbers, capable of causing one of the above events is observed to have access to any airport flight pattern or aircraft movement area (Federal Aviation Administration, 2009).

In accordance with Part 139.337, PDX prepared its first WHMP in 1998 to address wildlife hazards identified on and around PDX. This first WHMP was revised in 2003 to address changes in program organization, administration, and implementation that had occurred over the prior 5 years. In 2003, PDX prepared a baseline Wildlife Hazard Assessment that included information on wildlife and wildlife habitats in relation to potential aviation safety concerns (Portland International Airport, 2009).

SEA had its first wildlife hazard assessment conducted in late 1970's and mainly due to concerns over an overwhelming number of European starlings that frequented the airfield and roosted in the trees inside the aircraft operating areas. Although FAR 139.337 (b) required an assessment be conducted after anyone of four triggering events occurs, SEA has taken the initiative to conduct an On-going Wildlife Hazard Assessment. This assessment is comprised of four sets of three-minute surveys each month, throughout the year. These surveys are conducted by either the Port of Seattle Wildlife Biologist or USDA Biologist. SEA's most recent WHMP was last amended in June, 2004, and it was developed in cooperation with the U.S. Department of Agriculture's Wildlife Services program. This plan places particular

emphasis on identification and abatement of wildlife hazards within two miles of the airfield environment. SEA's WHMP is flexible and provides the Airport with the discretion and capability to respond to many changing circumstances (Port of Seattle-Tacoma International Airport, 2004).

SFO's first WHMP was prepared in 1999 and last updated in June 2011 to address wildlife hazards identified on and around SFO. The latest revision of the WHMP addresses significant changes in program organization, implementation, and regulation and emphasizes the overall objective of developing an integrated, adaptive program to effectively manage risk by reducing the probability of occurrence of wildlife-aircraft collisions (See Appendix D). In a similar manner to PDX and SEA, SFO has developed a Wildlife Hazard Assessment that is based on bird strike data and wildlife activity reporting. Data is continually collected on an on-going basis as part of the FAA approved WHMP. The collected data is periodically reviewed and updated by SFO staff or SFO's biologist (San Francisco International Airport, 2011).

Wildlife Management Strategies, Implementation, And Control Techniques and Procedures

The Code of Federal Regulations (CFR) 14 CFR 139.337 requires each certificate holder – Airport Operator – to take immediate action to alleviate wildlife hazards whenever they are detected. The FAA is the agency in charge of determining whether or not a wildlife hazard management plan is needed. If required, the certificate holder must provide a wildlife hazard management plan that is based and implemented using a wildlife hazard assessment as its basis. The WHMP must provide measures to alleviate or eliminate wildlife hazards to air carrier

operations; be submitted and approved by the FAA; and become part of the Airport Certification Manual (Cornell University Law School, 2012).

PDX utilizes wildlife management techniques that are aimed at discouraging wildlife activity. PDX allows innovation on the part of the individuals implementing the management strategies especially since most common control techniques retain their effectiveness if they are used infrequently and in conjunction with other methods. The control method(s) used by PDX wildlife staff will depend on the nature of the wildlife threat and associated risk and with consideration of biological, sociologic, economic and political factors.

PDX's wildlife control measures and procedures fall under one of four distinct objectives:

- 1- Wildlife control procedures used to disperse wildlife includes discouraging, dispersing and removal species of concern from the airfield vicinity.
 - a. PDX utilizes wildlife personnel that are on duty seven days a week from dawn to dusk, and are responsible for inspection of the aircraft movement areas and other areas critical to wildlife hazard management. The number of staff assigned to wildlife duties may increase during periods of high wildlife activity. Wildlife staff is equipped with the necessary communication equipment and pyrotechnic scaring devices such as shell launching pistols and 12-gauge shotguns. Other hazing and harassment techniques include the use of remote controlled propane cannons, sirens, visual deterrents such as lasers, silt fencing, and paintball markers.

- b. Raptor trapping and relocation is a year-round program that monitors and manages raptors at PDX. Trapping of young and transitory migrating hawks increases during the spring and fall season. The program focuses on the monitoring and management of Red-tailed hawks. Other raptors are occasionally trapped and relocated as well.
 - c. Avian Nest Intervention techniques include the manipulation of red-tailed hawk nest with the intent of preventing nesting, disrupting eggs from hatching or removal and relocation of young chicks. Another avian nest intervention technique is Egg Addling which is performed on eggs that are less than fourteen days old and prevents the embryonic development and renders the egg unviable. Addling requires shaking each egg vigorously for several minutes to detach and mix the interior contents.
 - d. Lethal control is only used as a last resort. Port of Portland policy requires the use of lethal methods only after all other non-lethal options have been exhausted and when there is an ongoing threat to public safety. Lethal action on birds is allowed under local, state and federal permit guidelines (See Appendix E).
- 2- Research and development projects to gather data and field test new equipment and technique, and gain understanding of wildlife dynamics at PDX. Trained wildlife staff also performs wildlife data collection which allows management to review annual and monthly reports enabling well-informed management decisions.

- 3- Habitat Modification practices aim at reducing the attractiveness of the airfield to wildlife species by modifying habitats on PDX-owned lands that are known to be attractive to wildlife species of concern and by discouraging land use practices on non-Port lands adjacent to the airport that are also attractive to wildlife. Habitat modification includes the physical removal, exclusion, or manipulation of natural and constructed features that attract wildlife species of concern.
- 4- Information and education programs to articulate the hazards wildlife can pose to the safe operation of aircraft are continuously communicated to PDX internal department employees through departmental briefings. New employees are given an overview of the program by a wildlife staff member on their initial Port tour. Regarding outside regulatory agencies, PDX continuously interacts through the certification process, permit issuance, or through other forums that encourage the understanding of WHMP issues. PDX has an established Wildlife Advisory Committee since 1966 which is chaired by the Wildlife Manager and meet at least twice a year, and provides a forum to discuss the WHMP with regulatory agencies, interest groups and the public (Portland International Airport, 2009).

SEA's initial response to most wildlife species is commensurate with the perceived risk of the wildlife species. SEA evaluates the risk hazard as well as the wildlife abundance, body size, and behavioral attributes as part of its control measures. Birds observed in the airfield are hazed with frightening devices, and as last resort, direct control methods including lethal removal will be employed when necessary. SEA utilizes an integration of multiple methods to

obtain maximum effectiveness in its efforts to reduce most hazards involving species of concern as well as persistence and innovation.

Some of SEA's wildlife procedures include the following:

1. Wildlife Patrol- Consisting of the Port of Seattle (POS) Wildlife Biologist, Airport Duty Managers (ADM), Airfield Operations Specialists, USDA Wildlife Services, and other personnel certified to use firearms, pyrotechnics or trapping techniques to control hazardous wildlife. The patrol monitors and responds to wildlife hazards on the airfield, and coordinates their activities through the POS Wildlife Biologist to ensure a secure environment is maintained for safe airport operations. Observations of wildlife activity are reported in the Daily Wildlife Report. These forms are forwarded to POS Wildlife Biologist for review.
2. USDA-Wildlife Services Assistance - The Port of Seattle which owns and operates SEA has a Cooperative Service Agreement with USDA-APHIS Wildlife Services to assist SEA personnel in deterring or removing European starlings and rock pigeons from the airfield. Wildlife services also provide a USDA Biologist that assist SEA with conducting surveys and control techniques.
3. Raptor Strike Avoidance Program – This program has as its main objective the trapping and relocating of raptors to areas with richer prey base with the overall goal of reducing raptor densities at SEA, and specifically young and migrating birds.

SEA utilizes a flow chart that provides guidance and facilitates decisions when assessing and responding to hazard. This flow chart indicates the most appropriate control method in handling wildlife. If determined that an actual wildlife hazard exists, then the observer takes direct action with the response to the hazard becoming increasingly more aggressive and in combination with other methods until the wildlife responds favorably or the hazard is abated. In the event that birds are non-respondent or the hazard increases, lethal removal will be utilized. SEA's wildlife control techniques include a long-term management approach in resolving reoccurring problems that have a high frequency of occurrence. This long-term approach primarily focuses on the management of people through training, public education, review of proposed construction plans; and managing habitat and prey such modifying vegetation and removal of food sources. If frequency of incidents continues, then more aggressive actions must be proposed, planned, reviewed and implemented (See Appendix F) (Port of Seattle-Tacoma International Airport, 2004).

SFO analyses each wildlife hazard situation to determine the most practical solution. The methods used will depend mostly on the species involved, but the initial response for most species is dispersal by hazing and harassment followed by population control methods only when necessary and as the last resource. SFO's Wildlife Coordinator is charged with maintaining a database of all aircraft-wildlife strikes recorded at SFO. This database is continuously monitored and evaluated for trends. If unacceptable wildlife strike increases are detected, the cause will be determined and the WHMP modified to reflect new directions to resolve the problems. "If there are high numbers of incidents of wildlife strikes in a given period of time, SFO will develop, in conjunction with the contracted airport wildlife biologist, specie-specific plans that may include

bird habitat modifications. This approach enables SFO to focus its management and control efforts in areas that have the highest likelihood of reducing wildlife-aviation risk” (Park, 2012). Records of wildlife activity, wildlife strikes, and wildlife management actions taken at SFO are kept by the wildlife coordinator. These records include daily logs of wildlife activity; daily logs of wildlife strikes; management actions taken; monthly and annual wildlife management report; and records of all personnel training (San Francisco International Airport, 2011).

Direct control is classified into non-lethal and lethal techniques. The following include techniques available to SFO airfield staff to reduce potential wildlife hazards at SFO. These techniques are applied according to all local, state and federal laws.

1. Personnel and Communications: Airfield Operations staff responds to wildlife hazards on the airfield and are trained in wildlife identification, proper control techniques and safety. Airfield Operations staff patrols the airfield throughout the day and as often as necessary. Wildlife observation reports are submitted and recorded daily, and entered into a database. This information is compiled and submitted to the FAA during SFO’s annual 14 CFR Part 139 certification reviews.
2. Integrated Pest Management Program: Airport Maintenance coordinates relevant pest control programs with Airfield Operations Staff. This includes daily trapping of pigeons and flocking birds, as well as addressing problem birds in and around airport structures. Monthly Integrated Pest Management (IPM) reports provide information regarding current bird issues and provide improvement plans. These reports cover pest management options, risk, and implementation timetable. Reports are distributed to

custodial, landscape, property management, food court, airfield operations, IPM, paving and ground and Airfield Operations staff.

3. **Non-Lethal Control Techniques:** Consist of auditory or visual devices aimed at hazing birds in the vicinity of the airfield. Auditory frightening techniques available for SFO include pyrotechnic devices such as shell launching pistols, remote-controlled propane cannons, and other auditory frightening devices such as air horns and sirens. The use of effigies is a typical practice for small areas such as hangars and building ledges. Other non-lethal techniques include relocation, nest removal, non-lethal traps.
4. **Lethal Techniques:** As a policy, SFO uses lethal control when other methods have become ineffective, or when there is an ongoing threat to public safety. Lethal techniques are used on special circumstances to reduce the population abundance of prey species such as small mammals, insects that provide attractant food source to larger wildlife, or involve non-native wildlife species that can pose a hazard to aircraft. Egg addling, the vigorous shaking of egg, or other destruction techniques such manual removal and breaking, or oiling of the eggs are used for nests found on the airfield.
5. **Habitat Management:** The physical removal, exclusion, or manipulation of areas attractive to wildlife. This is the most effective long-term remedial measure for reducing wildlife hazards on or near airports. SFO's long-range goal is to minimize the risk of wildlife strikes by modifying habitat or land uses on SFO-owned lands, and discourage land use practices on non-SFO lands adjacent to the Airport.

- a. SFO-Owned Property - In addition to the land encompassing the airfield (terminals, taxiways and runways), SFO also owns and manage 180 acres outside the airfield borders. If a wildlife attractant determined to pose an unacceptable risk is identified on SFO-owned lands, the airport director and wildlife biologist will meet to discuss modification to habitat or land uses, or to consider wildlife control methods.
- b. Water Management –SFO property includes many wetlands consisting of seasonal wetlands, freshwater/brackish marsh, relic saltmarsh, drainage channels, detention ponds, and open water -San Francisco Bay. Drainage channels are inspected for debris and silt build-up to ensure drainage efficiency and vegetation growing alongside these ditches are maintained at the lowest possible height to prevent nesting, hiding, and foraging habitat to waterfowl.
- c. Exclusion methods – Birds are excluded from ponds using overhead wire grids. This technique discourages birds loafing and feeding activities. Exclusion devices for structures include spike strips, netting, doors, and other devices that deter or prohibit perching or entry.
- d. Vegetation Management –Management of vegetation in the airfield areas is complex and requires insecticide, herbicide, changes in vegetation cover and adjustments to mowing schedules. Grass is the primary cover inside the perimeter of the airport and is kept at a height between seven to twelve inches to deter small and large bird species. New landscaping projects within the airfield (Primary

Zone) will be reviewed by the wildlife coordinator before landscaping designs are finalized.

- e. Structure Management – Human-made structures can provide cover, nest sites and perches for potentially hazardous wildlife and their prey. SFO monitors all structures located in the airfield, if wildlife is documented, a risk evaluation is conducted to inform future decision regarding appropriate actions to eliminate or minimize the hazard.
- f. Food/Prey-Base Management – SFO Facilities ensures that trash - which attracts gulls and crows - is collected on a regular basis to ensure control of wildlife. To avoid the feeding of birds or mammals around the airport, SFO Airport staff continuously educates tenants and airport users about the aviation safety risks associated with wildlife and the need for reducing wildlife attractants. Pocket gophers, moles and other rodents found at SFO attract raptors such as hawks, heron, and owls. Earthworms which attract many species of birds, especially during heavy rains, are controlled through the use of pesticides.
- g. Non-Airport Land Use Projects – SFO coordinates with surrounding local jurisdictions and discourages land use practices that are known attractants of potentially hazardous wildlife. SFO discourages any proposed land use projects that has the likelihood of increasing populations of species of concern or wildlife activity within aircraft flight zones.

6. Research and Development: Cost-effective methods that achieve positive results without adverse effects will be considered and incorporated into future updates of the WHMP. SFO intends to develop a strong network of contacts with other airports and with aviation/bird strike community to share information about programs, equipment and techniques (San Francisco International Airport, 2011).

APPENDIX A TO ATTACHMENT B: Portland International Airport

Source: Port of Portland – Portland International Airport

APPENDIX B TO ATTACHMENT B: Seattle-Tacoma International Airport

Source: Port of Seattle, Seattle-Tacoma International Airport

APPENDIX C TO ATTACHMENT B

San Francisco International Airport

Source: San Francisco International Airport

APPENDIX D TO ATTACHMENT B

SFO Adaptive process

APPENDIX E TO ATTACHMENT B

Flow Chart for Resolving Wildlife Hazards Near Seattle-Tacoma International Airport

EXHIBIT A: RANDOMLY SELECTED FAA REGIONS AND AIRPORTS

FAA Randomly Selected Regions

Central Region: Serving - KS, IA, MO, NE

Western Pacific Region: Serving – AZ, CA, HA, NV

Southern Region: Serving – AL, FL, GA, KY, MS, NC, PR, SC, TN, VI

Eastern Region: Serving – DE, MD, NJ, NY, PA, VA, WV

Northwest Mountain Region: Serving – CO, ID, MT, OR, UT, WA, WY

Southwest Region: Serving – AR, LA, NM, OK, TX

Randomly Selected Airports

Los Angeles Int'l Airport, CA, LAX

San Francisco Int'l Airport, CA, SFO

Oakland Int'l Airport, CA, OAK

Sacramento Int'l Airport, CA, SMF

Tucson Int'l Airport, AZ, TUS

Monterey Regional Airport, CA, MRY

Redding Municipal Airport, CA, RDD

Flagstaff Pulliam Airport, AZ, FLG

Sonoma County Airport, CA, STS

Santa Barbara Municipal Airport, CA, SBA

John F. Kennedy Int'l Airport, NY, JFK

Reagan Washington National Airport, DC, DCA

Washington Dulles Int'l Airport, DC, IAD

Philadelphia Int'l Airport, PA, PHL

Baltimore Washington Int'l Airport, DC BWI

Dutchess County Airport, NY, POU

Norfolk Int'l Airport, VA, ORF

Stewart Int'l Airport, NY, SWF

Syracuse Hancock Int'l Airport, NY, SYR

Albany Int'l Airport, NY, ALB

Hartsfield-Jackson Atlanta Int'l Airport, GA, ATL

Palm Beach Int'l Airport, PBI

Tampa Int'l Airport, TPA

Southwest Int'l Florida Airport, FL, RSW

Memphis Int'l Airport, TN, MEM

Randomly Selected Airports (Continue)

Savannah/Hilton Head Int'l Airport, GA, SAV

Coastal Carolina Regional Airport, NC, EWN

Fayetteville Regional Airport, NC, FAY

McGhee Tyson Airport, TN, TYS

Wilmington Int'l Airport, NC, ILM

Portland Int'l Airport, OR, PDX

Seattle-Tacoma Int'l Airport, WA, SEA

Salt Lake City Int'l Airport, UT, SLC

Denver Int'l Airport, CO, DEN

Durango La Plata Airport, CO, DRO

Rogue Valley Int'l-Medford Airport, OR, MFR

Fort Collins Airport, CO, FNL

Aspen/Pitkin County Airport, CO, ASE

Missoula Int'l Airport, MT, MSO

Tri-Cities Airport (Washington), WA, PSC

Des Moines Int'l Airport, IA, DSM

Mason City Airport, IA, MCW

Cape Girardeau Municipal Airport, MO, CGI

Kirksville Regional Airport, MO, IRK

Joplin Regional Airport, MO, JLN

Kansas City Int'l, MO, MCI

St. Joseph/Rosecrans Memorial Airport, MO,
STJ

Chardon Municipal Airport, NE, CDR

Grand Island Airport, NE, GRI

Texarkana Regional Airport, AR, TXK

New Iberia / Acadiana Regional Airport, LA,
ARA

San Antonio Int'l Airport, TX, SAT

Lawton Municipal Airport, OK, LAW

Abilene Regional Airport, TX, ABI

Amarillo Int'l Airport, TX, AMA

Del Rio Int'l Airport, TX, DRT

Houston / George Bush Intercontinental Airport,
TX, IAH

McAllen / Miller Int'l Airport, TX, MFE

Dallas / Ft. Worth Int'l Airport, TX, DFW

EXHIBIT B: SAMPLE AIRPORT WITH INCREASING BIRD STRIKES 2002-2011

Sample Airports with increasing Bird Strikes, 2002 - 2011								Page 1
Year	US Percentage	LAX	SMF	JFK	PHL	POU	RDD	FLG
2002	8%	9%	6%	9%	5%	0%	0%	8%
2003	8%	8%	9%	7%	6%	11%	10%	0%
2004	8%	10%	10%	7%	5%	0%	5%	0%
2005	9%	10%	9%	8%	7%	11%	5%	8%
2006	9%	11%	9%	10%	8%	0%	15%	8%
2007	10%	6%	8%	10%	8%	0%	0%	8%
2008	10%	6%	11%	9%	9%	11%	5%	25%
2009	12%	11%	14%	10%	12%	33%	25%	33%
2010	13%	12%	14%	13%	11%	22%	20%	0%
2011	13%	16%	10%	16%	28%	11%	15%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	677	1,348	1,522	838	9	20	12
Airports without Air Traffic Control Tower. No Aircraft Operations reported.								
Year	US Percentage	RSW	SAV	DRO	SWF	SYR	ALB	ATL
2002	8%	10%	4%	0%	6%	4%	8%	9%
2003	8%	8%	7%	10%	9%	8%	5%	7%
2004	8%	9%	6%	0%	9%	20%	6%	8%
2005	9%	9%	11%	0%	0%	8%	10%	8%
2006	9%	8%	9%	10%	2%	0%	12%	11%
2007	10%	12%	11%	20%	9%	8%	9%	12%
2008	10%	7%	15%	30%	19%	16%	16%	10%
2009	12%	10%	16%	10%	8%	14%	13%	12%
2010	13%	14%	14%	0%	13%	10%	11%	14%
2011	13%	12%	10%	20%	25%	10%	11%	10%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	299	200	10	64	49	264	567

EXHIBIT B – Continues

Sample Airports with increasing Bird Strikes, 2002 - 2011							Page 2	
Year	US Percentage	MFR	EWN	TYS	ILM	SEA	DEN	FNL
2002	8%	1%	0%	4%	4%	8%	7%	0%
2003	8%	4%	0%	8%	8%	7%	7%	0%
2004	8%	3%	0%	1%	2%	7%	8%	0%
2005	9%	6%	0%	7%	3%	5%	8%	0%
2006	9%	12%	29%	7%	5%	9%	7%	0%
2007	10%	21%	14%	2%	3%	9%	8%	0%
2008	10%	14%	14%	4%	5%	10%	11%	56%
2009	12%	8%	29%	13%	16%	11%	15%	11%
2010	13%	18%	14%	33%	18%	14%	14%	11%
2011	13%	13%	0%	23%	34%	20%	14%	22%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	77	7	226	92	610	3,019	9
Airports without Air Traffic Control Tower. No Aircraft Operations reported.								
Year	US Percentage	ASE	MSO	DSM	CID	SUX	SGF	MKC
2002	8%	4%	0%	4%	6%	8%	6%	4%
2003	8%	0%	3%	6%	5%	0%	4%	2%
2004	8%	15%	6%	5%	5%	4%	4%	2%
2005	9%	8%	18%	7%	6%	0%	9%	3%
2006	9%	12%	21%	16%	10%	23%	8%	1%
2007	10%	4%	6%	17%	10%	13%	24%	18%
2008	10%	12%	12%	15%	16%	10%	5%	12%
2009	12%	31%	3%	10%	15%	25%	18%	14%
2010	13%	12%	15%	14%	15%	12%	14%	15%
2011	13%	4%	15%	5%	12%	6%	8%	28%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	26	33	336	136	52	157	163

EXHIBIT B – Continues

Sample Airports with increasing Bird Strikes, 2002 - 2011						Page 3	
Year	US Percentage	MCI	TXK	ARA	SAT	IAH	MFE
2002	8%	7%	17%	0%	8%	5%	2%
2003	8%	10%	0%	0%	8%	5%	0%
2004	8%	9%	0%	0%	7%	4%	0%
2005	9%	8%	0%	43%	6%	6%	4%
2006	9%	6%	33%	7%	9%	6%	2%
2007	10%	9%	0%	0%	9%	8%	4%
2008	10%	13%	17%	7%	12%	6%	4%
2009	12%	14%	0%	14%	14%	24%	20%
2010	13%	13%	17%	14%	14%	20%	20%
2011	13%	11%	17%	14%	14%	17%	43%
Total	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	1125	6	14	408	563	49
Airports without Air Traffic Control Tower. No Aircraft Operations reported.							
Year	US Percentage	DFW	JLN	ELP	BWI	OAK	ORF
2002	8%	8%	14%	8%	9%	6%	12%
2003	8%	5%	14%	7%	8%	10%	6%
2004	8%	6%	0%	7%	10%	8%	8%
2005	9%	5%	0%	7%	10%	13%	8%
2006	9%	8%	0%	4%	7%	12%	9%
2007	10%	12%	0%	21%	10%	13%	14%
2008	10%	11%	0%	9%	8%	8%	13%
2009	12%	15%	14%	23%	13%	8%	10%
2010	13%	14%	43%	9%	12%	10%	11%
2011	13%	16%	14%	4%	13%	11%	9%
Total	100%	100%	100%	100%	100%	100%	100%
(N)	76,006	2210	7	116	826	543	240

EXHIBIT B – Continues

Sample Airports with increasing Bird Strikes, 2002 - 2011						Page 4
Year	US Percentage	TPA	MEM	SLC	STJ	OMA
2002	8%	7%	7%	4%	4%	3%
2003	8%	9%	9%	9%	4%	11%
2004	8%	12%	10%	10%	4%	14%
2005	9%	9%	12%	9%	6%	12%
2006	9%	6%	9%	15%	7%	7%
2007	10%	11%	10%	9%	26%	7%
2008	10%	12%	11%	8%	20%	11%
2009	12%	7%	12%	11%	19%	13%
2010	13%	13%	10%	13%	3%	13%
2011	13%	13%	9%	11%	6%	9%
Total	100%	100%	100%	100%	100%	100%
(N)	76,006	267	1,681	1,087	69	723

EXHIBIT C: SAMPLE AIRPORTS AIRCRAFT OPERATIONS

Airport with Increasing Aircraft Operations Trend, 2002 - 2011								
Year	US Percentage	LAX	SFO	RDD	JFK	DCA	IAD	PHL
2002	10%	10%	10%	9%	8%	8%	8%	10%
2003	11%	10%	10%	10%	8%	9%	9%	9%
2004	12%	10%	10%	10%	9%	10%	10%	10%
2005	11%	10%	10%	9%	9%	10%	10%	11%
2006	11%	11%	11%	10%	10%	10%	10%	11%
2007	11%	11%	11%	10%	12%	10%	10%	10%
2008	10%	10%	10%	8%	12%	10%	10%	10%
2009	8%	9%	9%	10%	11%	10%	10%	10%
2010	8%	9%	9%	11%	11%	10%	10%	10%
2011	8%	10%	10%	13%	11%	11%	11%	9%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	6,258,432	6,258,432	771,138	3,828,511	2,688,744	2,688,744	4,813,633
Year	US Percentage	ATL	RSW	FAY	DEN	STJ	ARA	IAH
2002	10%	9%	9%	11%	9%	9%	8%	9%
2003	11%	10%	9%	9%	9%	9%	7%	9%
2004	12%	10%	10%	9%	10%	10%	6%	10%
2005	11%	10%	11%	10%	10%	10%	9%	10%
2006	11%	10%	11%	11%	10%	11%	11%	11%
2007	11%	10%	11%	10%	11%	10%	13%	11%
2008	10%	10%	11%	10%	11%	10%	14%	11%
2009	8%	10%	10%	9%	10%	11%	11%	10%
2010	8%	10%	10%	11%	11%	11%	11%	10%
2011	8%	10%	10%	9%	11%	9%	10%	10%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	9,538,416	858,584	505,173	5,891,267	313,569	1,118,027	5,410,977

EXHIBIT C: SAMPLE AIRPORTS AIRCRAFT OPERATIONS - Continues

Airport with Decreasing Aircraft Operations Trend, 2002 - 2011								
Year	US							
	Percentage	OAK	SMF	TUS	MRY	STS	SBA	POU
2002	10%	12%	10%	12%	11%	11%	12%	13%
2003	11%	11%	10%	11%	2%	11%	12%	13%
2004	12%	11%	11%	11%	11%	12%	12%	13%
2005	11%	11%	11%	12%	13%	11%	12%	12%
2006	11%	11%	11%	12%	13%	11%	10%	11%
2007	11%	11%	12%	11%	12%	12%	9%	10%
2008	10%	9%	10%	9%	11%	9%	9%	7%
2009	8%	8%	9%	8%	10%	8%	8%	5%
2010	8%	7%	8%	7%	8%	7%	8%	7%
2011	8%	7%	8%	7%	8%	7%	8%	7%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	3,030,358	1,531,739	2,295,402	689,007	1,077,182	1,312,184	1,009,078
Year	US							
	Percentage	ORF	SWF	SYR	ALB	PBI	TPA	MEM
2002	10%	11%	15%	12%	13%	11%	10%	11%
2003	11%	11%	13%	11%	12%	11%	10%	11%
2004	12%	11%	13%	12%	12%	11%	11%	10%
2005	11%	11%	13%	12%	10%	11%	12%	11%
2006	11%	11%	10%	11%	10%	11%	11%	11%
2007	11%	12%	11%	10%	9%	11%	11%	10%
2008	10%	10%	9%	10%	8%	10%	10%	10%
2009	8%	8%	5%	8%	9%	8%	9%	9%
2010	8%	8%	6%	7%	8%	8%	8%	9%
2011	8%	8%	6%	7%	7%	8%	8%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	1,146,423	824,425	1,062,613	1,112,915	1,763,608	2,334,295	3,690,705

EXHIBIT C: SAMPLE AIRPORTS AIRCRAFT OPERATIONS - Continues

Airport with Decreasing Aircraft Operations Trend, 2002 - 2011								
Year	US							
	Percentage	EWN	TYS	ILM	MFR	MSO	PSC	DSM
2002	10%	13%	12%	11%	11%	13%	15%	12%
2003	11%	11%	11%	11%	11%	11%	13%	11%
2004	12%	11%	11%	11%	11%	12%	12%	11%
2005	11%	11%	11%	10%	11%	11%	12%	10%
2006	11%	11%	10%	12%	11%	11%	9%	11%
2007	11%	10%	10%	11%	10%	10%	9%	10%
2008	10%	8%	9%	9%	9%	8%	8%	9%
2009	8%	9%	8%	8%	8%	8%	6%	9%
2010	8%	9%	9%	8%	9%	8%	7%	8%
2011	8%	8%	8%	8%	8%	7%	8%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	408,708	1,268,906	723,726	550,969	493,637	678,425	1,019,279
Year	US							
	Percentage	SUX	JLN	MCI	TXK	SAT	ABI	AMA
2002	10%	13%	13%	11%	11%	11%	11%	12%
2003	11%	11%	12%	10%	11%	12%	11%	14%
2004	12%	12%	12%	10%	12%	10%	10%	12%
2005	11%	12%	10%	10%	12%	10%	10%	11%
2006	11%	10%	12%	11%	10%	10%	11%	10%
2007	11%	9%	10%	12%	9%	10%	11%	9%
2008	10%	10%	7%	10%	8%	10%	11%	8%
2009	8%	8%	8%	9%	9%	9%	9%	9%
2010	8%	7%	7%	9%	9%	8%	8%	9%
2011	8%	7%	8%	8%	8%	8%	8%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	266,406	294,107	1,692,633	330,484	2,129,684	741,394	924,108

EXHIBIT C: SAMPLE AIRPORTS AIRCRAFT OPERATIONS - Continues

Airport with Decreasing Aircraft Operations Trend, 2002 - 2011								
Year	US Percentage	FLG	CID	DFW	GRI	ASE	SLC	
2002	10%	12%	12%	11%	11%	11%	10%	
2003	11%	12%	11%	11%	11%	10%	10%	
2004	12%	12%	11%	12%	10%	10%	10%	
2005	11%	10%	10%	10%	11%	10%	11%	
2006	11%	10%	10%	10%	11%	10%	10%	
2007	11%	9%	10%	10%	12%	10%	11%	
2008	10%	10%	10%	9%	9%	11%	10%	
2009	8%	8%	9%	9%	9%	9%	9%	
2010	8%	7%	8%	9%	9%	9%	9%	
2011	8%	9%	8%	9%	8%	9%	9%	
Total	100%	100%	100%	100%	100%	100%	100%	
(N)	146,471,633	430,652	628,635	7,068,569	196,966	426,736	4,003,528	
Year	US Percentage	SEA	PDX	BWI	SGF	MKC	OMA	TUL
2002	10%	11%	11%	10%	13%	14%	11%	13%
2003	11%	10%	11%	10%	12%	13%	11%	12%
2004	12%	11%	10%	11%	12%	12%	11%	12%
2005	11%	10%	10%	11%	12%	11%	11%	11%
2006	11%	10%	10%	11%	11%	9%	11%	10%
2007	11%	10%	11%	10%	10%	10%	10%	10%
2008	10%	10%	10%	9%	9%	8%	9%	9%
2009	8%	9%	9%	9%	8%	8%	9%	8%
2010	8%	9%	9%	9%	7%	8%	9%	8%
2011	8%	9%	9%	9%	6%	8%	8%	7%
Total	100%	100%	100%	100%	100%	100%	100%	100%
(N)	146,471,633	3,399,078	2,517,475	2,926,750	727,637	910,114	1,298,036	1,427,418

EXHIBIT C: SAMPLE AIRPORTS AIRCRAFT OPERATIONS - Continues

Airport with Decreasing Aircraft Operations Trend, 2002 - 2011						
Year	US					
	Percentage	ELP	SAV	MFE		
2002	10%	12%	11%	11%		
2003	11%	11%	11%	11%		
2004	12%	11%	10%	10%		
2005	11%	10%	10%	10%		
2006	11%	9%	10%	10%		
2007	11%	10%	10%	10%		
2008	10%	9%	9%	9%		
2009	8%	9%	9%	9%		
2010	8%	9%	10%	9%		
2011	8%	9%	10%	11%		
Total	100%	100%	100%	100%		
(N)	146,471,633	1,056,557	1,021,482	611,152		