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ALTAMONT PASS WIND RESOURCE AREA 48-HOUR SEARCH INTERVAL BIRD FATALITY STUDY

(KESTREL/BURROWING OWL REPORT)

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Contents

Tables

Figures

Follows Page

Acronyms and Abbreviations

APWRA	Altamont Pass Wind Resource Area
Monitoring Team	Altamont Pass Avian Monitoring Team
SRC	Scientific Review Committee

DRAFT Altamont Pass Wind Resource Area 48-Hour Search Interval Bird Fatality Study

Introduction

The Altamont Pass Wind Resource Area (APWRA) is located in central California approximately 90 kilometers (56 miles) east of San Francisco (Figure 1). Permits have been granted for 5,400 wind turbines distributed over 165 square kilometers (40,772 acres) of rolling grassland hills and valleys in the APWRA. The APWRA supports a broad diversity of resident and migratory bird species that regularly move through the wind turbine area (Orloff and Flannery 1996). Birds passing through the rotor plane of operating wind turbines are at risk of being injured or killed. Multiple studies of avian fatality at the APWRA have documented golden eagles, red-tailed hawks, American kestrels, burrowing owls, barn owls, and a diverse mix of non-raptor species that are killed each year in turbine-related incidents (Howell and DiDonato 1991, Orloff and Flannery 1996, Howell 1997, Smallwood and Thelander 2008, Altamont Pass Avian Monitoring Team. 2008a).

The Altamont Pass Avian Monitoring Team (Monitoring Team) is responsible for implementing an ongoing, multiyear program to monitor avian fatalities at the APWRA (Altamont Pass Avian Monitoring Team 2008a). Avian fatality monitoring currently involves field searches of 2,500 turbines at approximately one-month intervals (average = 34–37 days). This fairly long search interval could result in an underestimate of avian mortality if scavengers remove bird carcasses from the search area between search events. This potential sampling error is likely to be greater for small birds that can be quickly and completely removed by scavengers from turbine survey areas without leaving residual evidence (i.e., feathers, body parts) for surveyors to detect (Smallwood 2007).

To evaluate this potential sampling bias, the APWRA Scientific Review Committee (SRC) directed the Monitoring Team to conduct a special short-search interval (48 hours) monitoring study of avian fatalities at a selected subset of turbines to investigate the effects of a short search interval on the detection of bird fatalities. Of special concern were small birds, particularly small raptors such as the burrowing owl and American kestrel. The objective of the study was to record fatalities over 48-hour search intervals and compare these results to the ongoing monthly avian fatality monitoring conducted at those same turbines to assess differences. A second component of the 48-hour search interval study was the monitoring of selected avian fatalities every 48 hours to gain a better understanding of the fate of bird carcasses (i.e., their alteration and/or removal by scavengers) over time. Removal of bird carcasses by scavengers between surveys is a widely recognized source of error that must be accounted for when estimating wind turbine-related mortality of birds (Smallwood 2007). The information gained from this study will contribute to the development of more accurate scavenger removal and searcher efficiency metrics at the APWRA, and ultimately more accurate estimates of annual avian fatalities.

Methods

Fatality Survey Protocol

A total of 244 turbines were selected for intensive bird fatality surveys at 2-day (48-hour) search intervals. The turbines were chosen based on a review of the historical locations where burrowing owls and American kestrels (small raptors of key interest) have frequently been killed by turbines in the APWRA. The locations of the turbines selected for this study are shown in Figure 2. Fatality surveys of each turbine were conducted according to the standard monthly survey protocol currently used for the 2,500 turbines monitored at APWRA (Altamont Pass Avian Monitoring Team 2008a), except that each turbine was surveyed every other day (as opposed to approximately every 30 days) and the area searched was slightly smaller (40-meter search radius versus 50-meter search radius). The 48-hour search interval study spanned two separate 2-month periods (September/October 2007 and March/April 2008) that were pooled for analysis.

Concurrent with the 48-hour search interval study, each of the 244 turbines was also surveyed at approximately monthly intervals by a separate and independent survey team as part of the ongoing avian fatality monitoring program at the APWRA (Altamont Pass Avian Monitoring Team 2008a). The timing of the monthly fatality monitoring conducted at each turbine was dependent upon the preexisting monitoring schedule in place for that turbine. Therefore, the comparison examined all fatalities detected by the monthly fatality survey team that were backdated into one of the two 2-month windows for the 48-hour search interval study.

Whenever a bird carcass or remains was detected during monitoring, its location was documented and specific data on the condition of the fatality were recorded. A detailed description of these methods, including the survey protocol, the specific information recorded for each find, and the criteria for determining the cause of death are provided by the Altamont Pass Avian Monitoring Team (2008a). Under the monthly survey sampling protocol, carcasses are typically removed after detection. However, bird carcasses or remains detected during monthly monitoring of the 244 turbine sites during the 4 months of the 48-hour search interval study were generally not removed from the site. This was to insure that all bird fatalities were available for detection by both the survey teams concurrently conducting fatality monitoring under both sampling protocols. In cases where both teams had detected a fatality and the carcass was not subject to further monitoring as part of carcass removal/scavenger studies being conducted, remains were removed from the study site.

Carcass Removal/Scavenger Study Protocol

A subset of fatalities detected during the 48-hour search interval was intensively monitored to estimate carcass removal/scavenging rates. Data were collected on the location (compass bearing and distance from nearest intact turbine; GPS coordinates) and the condition of each carcass/set of remains (hereafter referred to as carcasses). To allow the accurate tracking of scavenging activity and carcass movement, carcasses were uniquely marked by applying green tape to the bird's legs and wings, and/or by cutting the primary feathers in an identifiable manner. Each carcass was then returned to the exact location where it was originally found, and its position was marked using a labeled golf tee. Extreme caution was taken to minimize any observer bias that could attract scavengers to the carcasses, such as time spent handling bird remains.

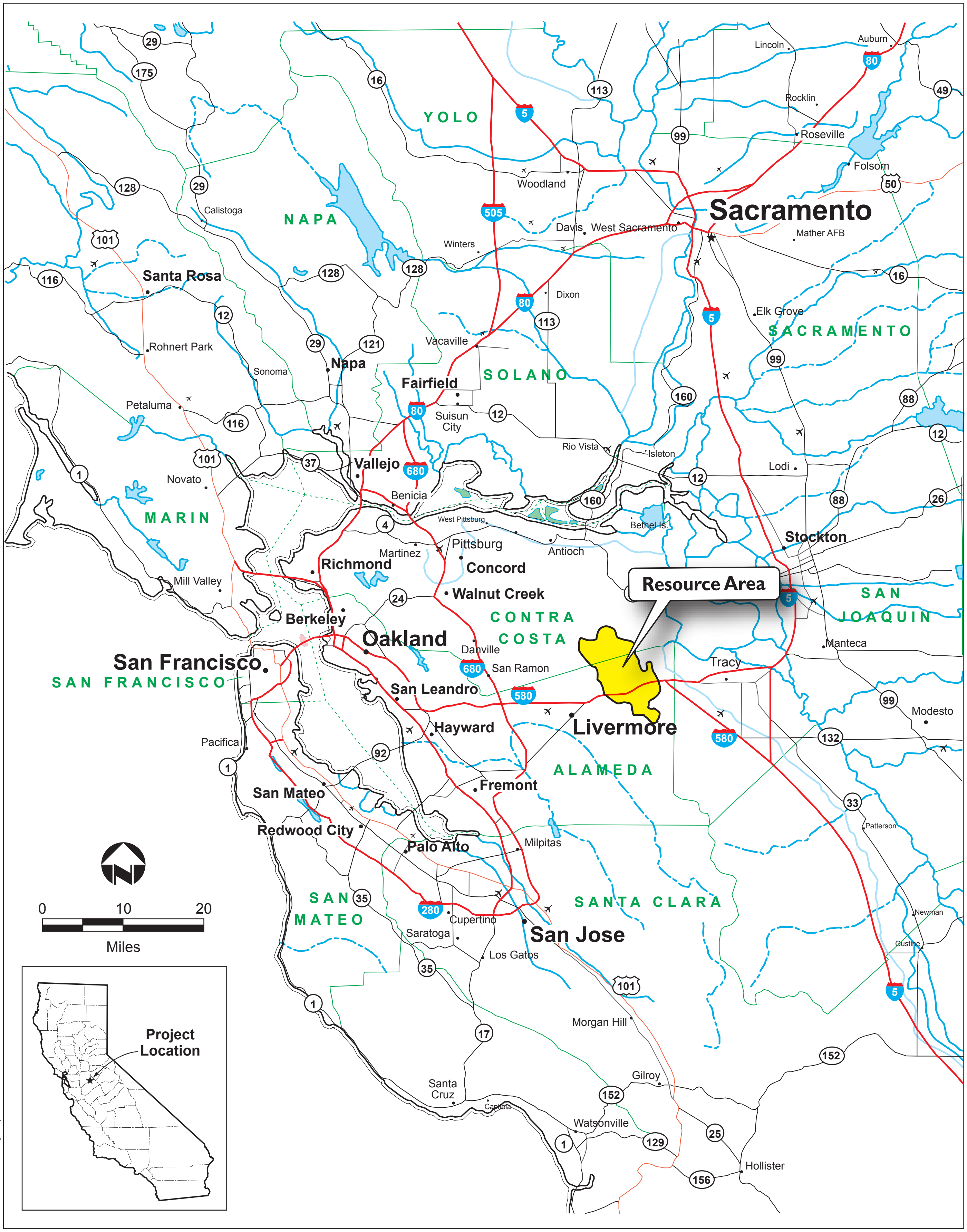

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Figure 1
Location of the Altamont Pass Wind Resource Area (APWRA)

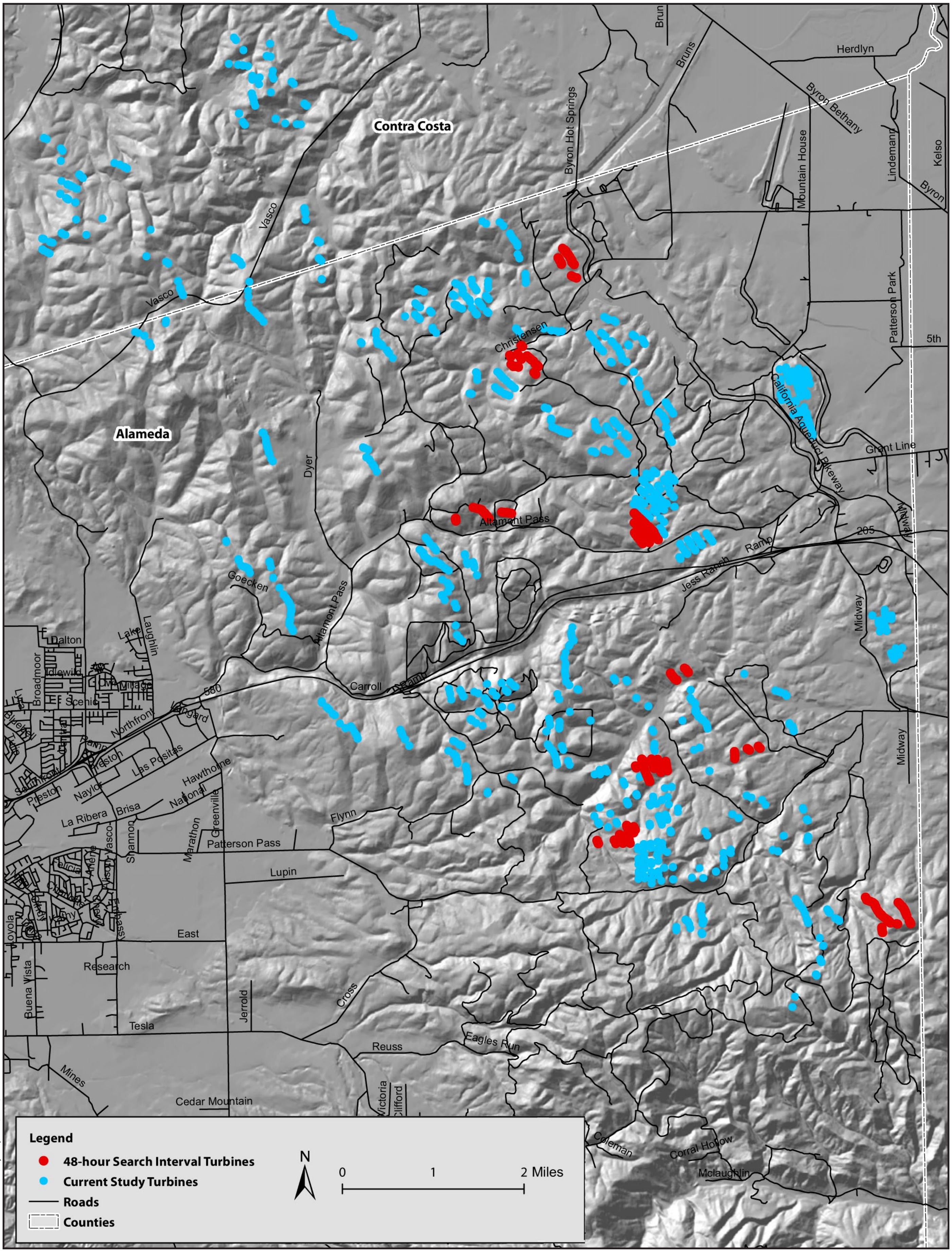

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Figure 2
Turbines Studied at 1-Month and 48-Hour Intervals

Carcasses selected for inclusion in the study were checked at approximately 48-hour intervals until the remains were either no longer detectable or the study ended. Monitoring for the September/October 2007 study period ceased at the end of October, resulting in the truncation of the time period for which some carcasses were monitored. However, monitoring of study carcasses from the March/April 2008 study period was extended beyond the end of April to increase the sample size of study carcasses tracked for a full month, the approximate length of the one-month monitoring search interval. At each visit, the location of the study carcass and associated remains was recorded, the type and degree of scavenging was noted, and pertinent notes were taken on the physical condition of the carcass. Whenever the position of a carcass and/or body parts changed from the last visit, the new location was field marked with a labeled golf tee. Surveyors searched for carcasses and carcass parts that had been scattered, and tracked these parts for the remainder of the study. Whenever a carcass or body parts moved from its prior location, a determination was made as to whether vertebrate scavenging was the likely cause of the movement. Photographs were taken to document the positions and movements of carcass and body parts.

Fatality Data Analysis

Not all of the bird fatality records documented during this study were appropriate for inclusion in the mortality analysis. An a priori set of criteria was established to determine which records would be included in the initial analysis; the process for selection is diagrammed in Figure 3. Bird fatality records were excluded from the initial analysis if they:

- contained insufficient information to fully describe the fatality, such as
    - the carcass or remains could not be classified into a defined avian group, or
    - the location of the carcass was not provided;
- represented an injured bird that was removed from the site;
- indicated that a bird death was not turbine-related (e.g. electrocution; nestling);
- were located outside the designated survey area (i.e., more than 40 meters from a study turbine);
- occurred outside of the survey period (backdated to September through October 2007 or to March through April 2008);
- consisted only of old bones or other evidence indicating probable time of death was more than 90 days prior to discovery.

The process for assigning cause of death is outlined in Figure 4. Backdating was used to estimate the time of death for each bird carcass detected. Backdating was either performed in the field or was based on photos taken of each specimen. Figure 5 illustrates the general process for determining and assigning a back date to carcasses, feather piles, and bones. Old feather piles consisting of brittle feathers and bones were excluded from the analysis because no back date could be associated with those finds.

Fatality records that met the filtering criteria were compiled by the sampling protocol (48 hours or 1 month) under which they were detected. These fatalities represent the unadjusted (raw) mortalities that were detected by the independent survey teams searching the 244 study turbines over the two 2-month periods. The total fatalities recorded for the 48-hour search interval study were compared to the total fatalities detected during the ongoing monthly avian fatality monitoring conducted at those same turbines to assess the effects of a shorter search interval on the detection of bird fatalities.

Carcass Removal / Scavenger Data Analysis

All fatality records of fresh, intact or almost intact carcasses were included in the initial analysis. This criterion was then relaxed to include fatality records with some fresh body parts indicating that the carcass was less than 1 week old, and then relaxed further to include fatalities of unknown age. The resulting groups of fatalities were then analyzed using simple logarithmic regression to estimate the proportion of carcasses that would remain detectable in the search area over the interval of 1–30 days. Comparable results from Smallwood (2007) were included for reference.

Results and Discussion

Fatalities

A total of 91 bird fatalities were recorded during the 48-hour search interval study, more than three times the 29 fatalities detected during the ongoing monthly avian fatality monitoring conducted at those same turbines. Table 1 summarizes the number of filtered fatality records detected by species at the 244 turbine sites during the two 2-month study periods. The size class, species group, and species code is also provided for each fatality. Western meadowlark (15 fatalities), European starling (13), burrowing owl (12) and rock pigeon (10) were the most frequent avian species recorded over the course of the 48-hour search interval study. The most common species detected during monthly avian fatality monitoring at those same turbines were rock pigeon (6), burrowing owl (4) and European starling (4). A total of 9 fatalities common to both studies (i.e., mutual detections) were documented during the monitoring efforts: 3 European starlings, 2 burrowing owls, a red-tailed hawk, a rock pigeon, an unidentified gull, and an unidentified blackbird. Mutual detections constituted 30.0% (9 of 30) of the bird fatalities recorded for the monthly avian monitoring.

Many more non-raptor fatalities than raptor fatalities were documented for both sampling protocols (Table 1). Raptors constituted 22.8% (21 of 92) of the fatalities recorded during the 48-hour search interval study, and 27.6% (8 of 29) of the fatalities detected during monthly avian monitoring at those same turbines. The burrowing owl represented the most abundant small raptor fatality detected under both studies, while the red-tailed hawk was the most frequently encountered medium/large raptor. Other raptor fatalities were American kestrel (4 fatalities), which was detected only under the 48-hour search interval sampling protocol, and one peregrine falcon fatality documented under both sampling protocols.

Most fatality detections consisted of partial bird remains, regardless of whether surveys were conducted every 48 hours or once a month. Partial remains were generally represented by some combination of feathers with attached bone or flesh. It was not uncommon, however, for a fatality detection to consist only of feathers. Approximately 35.5% of all fatality detections (43 of 121) recorded during the two 2-month survey periods under both sampling protocols involved just feathers. Few bird carcasses were intact or almost intact at initial discovery. Four relatively intact carcasses were documented during the monthly surveys (13.3% of the monthly fatality detections) and 13 relatively intact carcasses were documented during the 48-hour search interval study

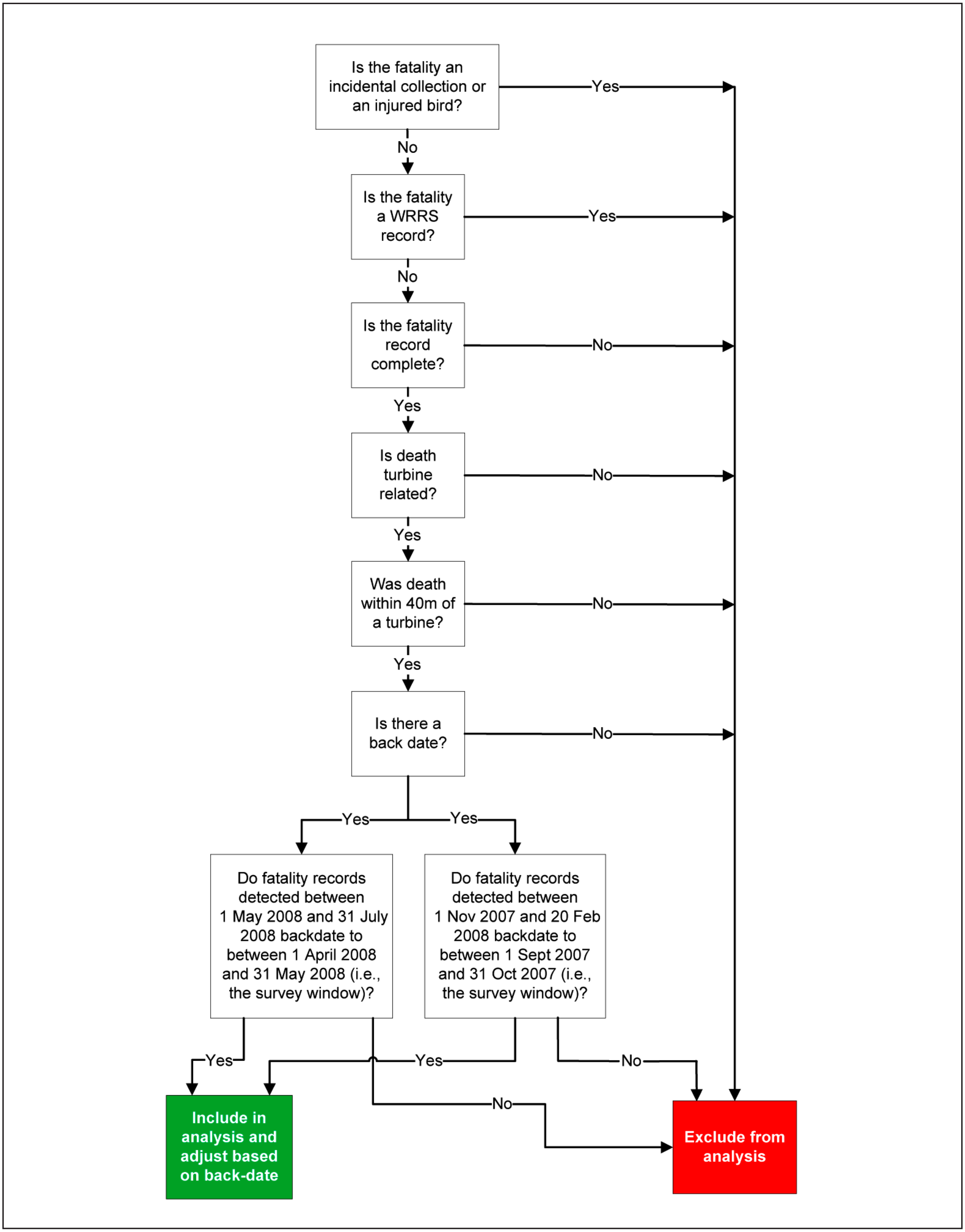

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Figure 3
Process for Filtering Data in the APWRA Fatalities Database

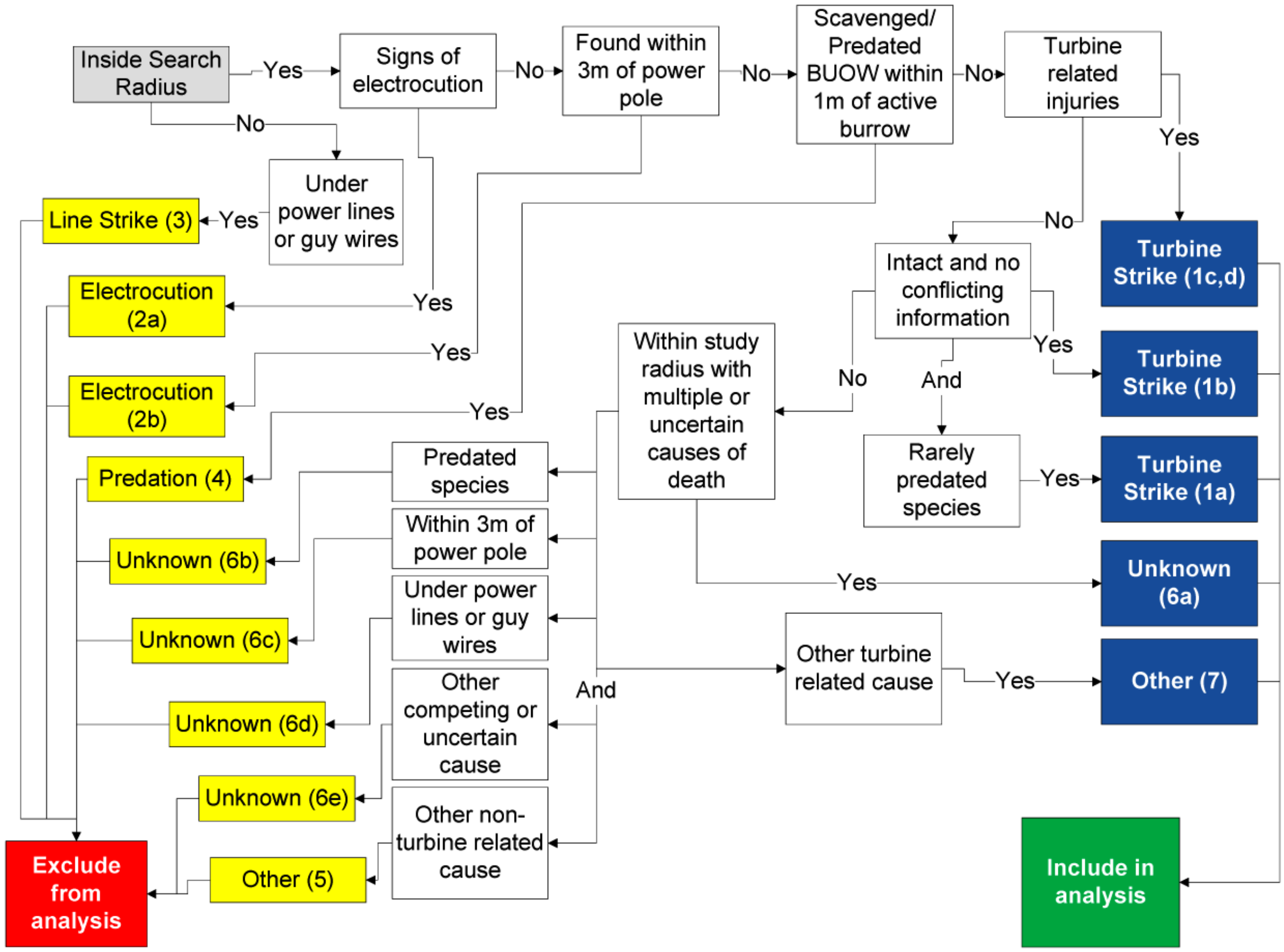

Figure 4
Process for Assigning Cause of Fatality to Records in the APWRA Fatalities Database

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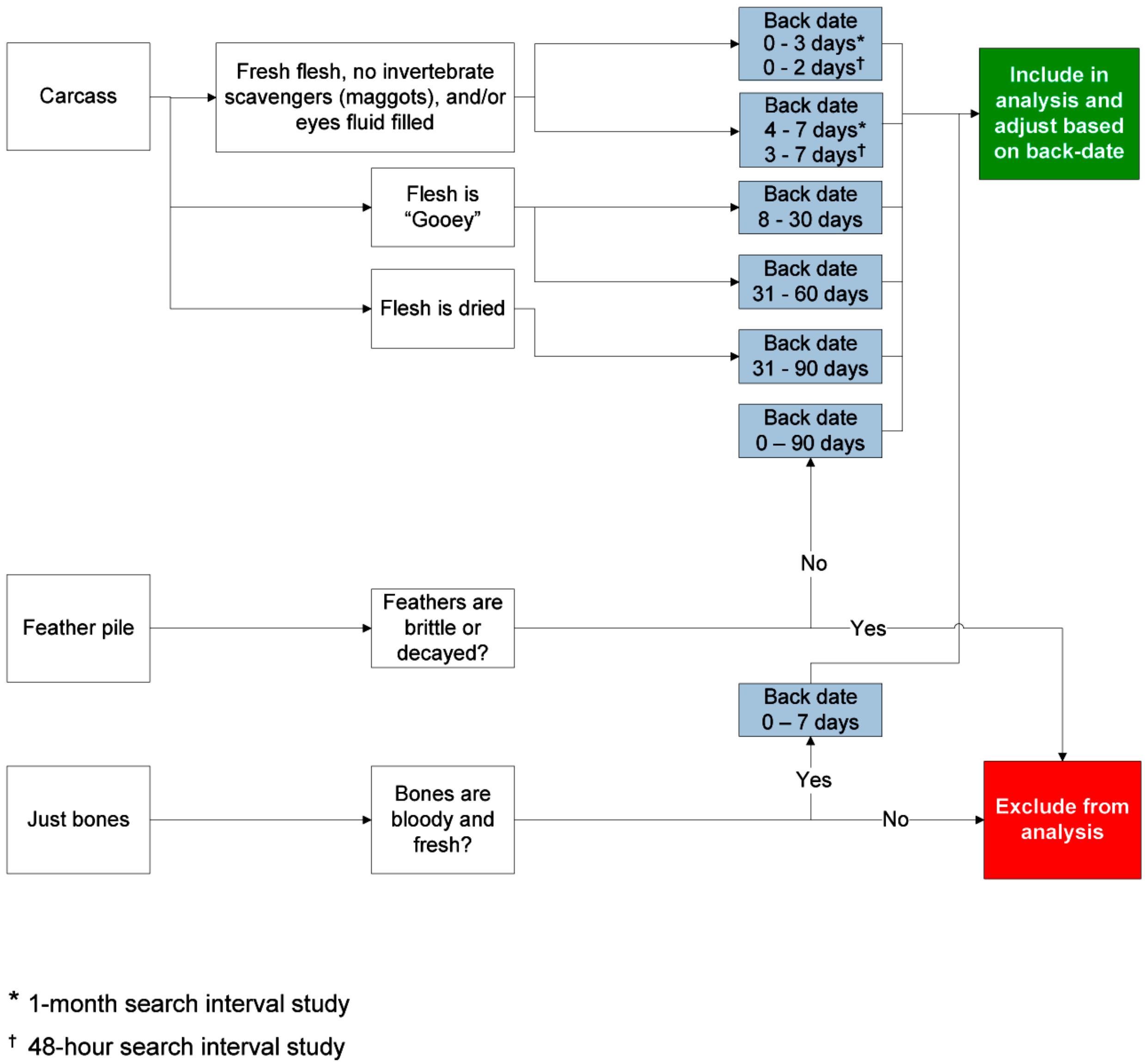

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Figure 5
Process for Back-Dating Records in the APWRA Fatalities Database

(14.3% of the 48-hour fatality detections). Most of these partial remains and incomplete carcasses can be attributed to a high incidence of vertebrate scavenging, which occurs soon after death.

Table 1. Number of Fatalities detected under the 48-Hour and 1-Month Search Interval Sampling Protocols

Common Name	Species Code	Size	Group	48-Hour Search Interval	1-Month Search Interval
Small Birds					
American kestrel	AMKE	s	Raptor	4	
Burrowing owl	BUOW	s	Raptor	12	4
Brewer's blackbird	BRBL	s	Non-raptor	1	
European starling	EUST	s	Non-raptor	13	4
Horned lark	HOLA	s	Non-raptor	2	
Loggerhead shrike	LOSH	s	Non-raptor		1
Orange-crowned warbler	OCWA	s	Non-raptor	1	
Red-winged blackbird	RWBL	s	Non-raptor	1	
Small bird	SMBI	s	Non-raptor	16	1
Townsend's warbler	TOWA	s	Non-raptor	1	
Unidentified blackbird	UNBB	s	Non-raptor	1	2
Unidentified warbler	UNWA	s	Non-raptor	1	
Unidentified wren	UNWR	s	Non-raptor	1	
Violet-green swallow	VGSW	s	Non-raptor	1	
Western meadowlark	WEME	s	Non-raptor	15	2
			Total Small Birds	*70*	*14*
Medium/Large Birds					
Peregrine falcon	PEFA	m	Raptor	1	1
Red-tailed hawk	RTHA	l	Raptor	4	3
California gull	CAGU	l	Non-raptor	1	1
Common raven	CORA	l	Non-raptor		1
Medium bird	MEBI	m	Non-raptor	1	1
Mourning dove	MODO	m	Non-raptor	1	
Rock pigeon	ROPI	m	Non-raptor	10	6
Unidentified corvid	UNCO	m/l	Non-raptor	1	
Unidentified gull	UNGU	l	Non-raptor	3	2
			Total Medium/Large Birds	*22*	*15*
			Total Birds	**92**	**29**
Mammals/Bats					
Unidentified bat	UNBA	s	Mammal	3	
			Total Mammals/Bats	**3**	

Small birds accounted for most of the difference in fatality detections between the 48-hour search interval study and the monthly fatality monitoring. Five times as many small bird fatalities were detected by searching turbines every 48 hours as compared to searching the same turbines monthly (70 fatalities vs. 14 fatalities, see Table 1). Detections of medium/large bird fatalities were similar between the two monitoring studies (22 vs. 15, see Table 1). These results suggest that substantial numbers of small bird fatalities may go undetected under the monthly fatality monitoring protocol conducted at the APWRA. The low probability of detection for small birds can be attributed to the interaction between searcher efficiency (the proportion of carcasses found by searchers during a survey), and the scavenger removal rate for small bird carcasses. The relatively frequent 48-hour search interval increases the opportunity for small bird fatalities to be detected. In concert, a high incidence of carcass removal/scavenging of small bird carcasses was documented in this study, with the carcass removal/scavenging taking place very soon after death occurred (see Carcass Removal/Scavenger Study below). This reduces the likelihood that small bird fatalities would remain available for detection during surveys conducted at monthly intervals. Taken together, the interaction of these factors offers a plausible explanation for the larger number of small bird fatalities detected under the 48-hour search interval study.

In addition to avian fatalities, 3 bat fatalities were also detected during the 48-hour search interval study (Table 1). No bat fatalities were detected during concurrent monthly surveys at those same turbines. Bat fatalities are rarely documented during avian monitoring at the APWRA. A search of the APWRA fatalities database revealed only 8 bat fatalities were recorded over the last 3.5 years of monthly fatality monitoring. The detection of 3 bat fatalities during the 4 months of the study suggests that the frequency of these fatalities is higher than that indicated by results of the monthly monitoring program.

Carcass Removal / Scavenger Study

As noted above, three groups of fatalities were then analyzed using simple logarithmic regression to estimate the proportion of carcasses that would remain detectable in the search area over the interval of 1–30 days. The first group consisted of 12 fresh small bird carcasses that were intact or almost intact (i.e., included the torso with most body parts present) and showed little to no evidence of scavenging at first discovery (Table 2). The species of intact small bird carcasses monitored were European starling (3 carcasses), burrowing owl (2), American kestrel (1), western meadowlark (1), Townsend's warbler (1), orange-crowned warbler (1), horned lark (1), Brewer's blackbird (1) and cliff swallow (1).

Table 2. Details of Small Bird Carcasses Monitored for Scavenger/Removal under the APWRA 48-Hour Search Interval Study

Fatality Number	Species[a]	Body Size	Date First Found	Carcass Condition	Carcass Age	Date First Scavenged	Last Date Detectible	Total Days Remains were Detectible	Last Date Monitored	Notes
Intact and Almost Intact Carcasses										
KB 20070912-02	OCWA	S	12-Sep-07	Intact	0-2 days (fresh)	22-Sep-07	20-Sep-07	9	22-Sep-07	Carcass gone on 9-22-07 without residual evidence.
KB 20070917-03	BUOW	S	17-Sep-07	Almost Intact	0-2 days (fresh)	21-Sep-08	5-Oct-07	19	31-Oct-07	Carcass gone on 9-21-07; residual evidence (feathers) remaining until no longer meets fatality definition.
KB 20070920-02	TOWA	S	20-Sep-07	Intact	0-2 days (fresh)	22-Sep-08	20-Sep-07	1	22-Sep-07	Carcass gone on 9-22-07 without residual evidence.
KB 20070929-01	AMKE	S	29-Sep-07	Intact	0-2 days (fresh)	1-Oct-07	31-Oct-07[b]	33	31-Oct-07	Carcass gone on 10-1-07; residual evidence (feathers) remaining.
KB 20071005-02	BRBL	S	5-Oct-07	Intact	0-2 days (fresh)	Not scavenged	31-Oct-07[b]	27	31-Oct-07	
M 20080325-02	EUST	S	26-Mar-08	Intact	0-2 days (fresh)	28-Mar-08	28-Mar-08	3	30-Mar-08	Carcass gone on 3-30-08 without residual evidence.
M 20080403-04	HOLA	S	3-Apr-08	Intact	0-2 days (fresh)	5-Apr-08	5-Apr-08	3	7-Apr-08	Carcass gone on 4-5-08; residual evidence gone next visit.
M 20080403-05	BUOW	S	3-Apr-08	Intact	0-2 days (fresh)	5-Apr-08	14-May-08	42	14-May-08	Carcass gone on 4-5-08; residual evidence (feathers) remaining, but becomes hard to distinguish.
KB 20080406-01	EUST	S	6-Apr-08	Almost Intact	0-2 days (fresh)	< 2 days	6-Apr-08	1	8-Apr-08	Carcass gone on 4-8-08 without residual evidence.
KB 20080418-01	WEME	S	18-Apr-08	Almost Intact	0-2 days (fresh)	< 2 days	2-May-08	15	7-May-08	Carcass gone 5-5-08 without residual evidence.
M 20080430-02	EUST	S	2-May-08	Almost Intact	0-2 days (fresh)	16-May-08	2-Jun-08[b]	32	2-Jun-08	Body gone 5-16-08, but detached leg remains.
M 20080506-01	CLSW	S	7-May-08	Intact	0-2 days (fresh)	12-May-08	9-May-08	3	12-May-08	Carcass gone on 5-12-08 without residual evidence.
Fresh Body Parts & Fresh Feather Piles										
KB 20080322-02	WEME	S	22-Mar-08	Body Parts	0-2 days (fresh)	< 2 days	14-May-08	54	14-May-08	
KB 20080324-03	WEME	S	24-Mar-08	Body Parts	0-2 days (fresh)	< 2 days	14-May-08	52	14-May-08	
KB 20070923-03	WEME	S	23-Sep-07	Body Parts	3-7 days	<1 week	31-Oct-07	39	31-Oct-07	
KB 20080327-01	BUOW	S	27-Mar-08	Feathers	0-2 days (fresh)	< 2 days	2-May-08	37	5-May-08	Residual feathers become hard to distinguish
KB 20080319-03	WEME	S	19-Mar-08	Feathers	0-2 days (fresh)	< 2 days	31-Mar-08	13	4-Apr-08	Residual feathers do not meet fatality definition
KB 20080316-02	WEME	S	16-Mar-08	Feathers	4-7 days	<1 week	14-May-08	60	14-May-08	Residual feathers become hard to distinguish

Fatality Number	Species[a]	Body Size	Date First Found	Carcass Condition	Carcass Age	Date First Scavenged	Last Date Detectible	Total Days Remains were Detectible	Last Date Monitored	Notes
Fatalities of Unknown Age										
KB 20070906-01	BUOW	S	6-Sep-07	Body Parts	Unknown	Unknown	30-Oct-07	55	30-Oct-07	Residual feathers become hard to distinguish; may not be fresh
KB 20070918-02	BUOW	S	18-Sep-07	Body Parts	Unknown	Unknown	30-Oct-07	43	30-Oct-07	
KB 20071016-03	BUOW	S	16-Oct-07	Body Parts	Unknown	Unknown	30-Oct-07	15	30-Oct-07	
KB 20071020-02	BUOW	S	20-Oct-07	Body Parts	Unknown	Unknown	30-Oct-07	11	30-Oct-07	
M 20070808-01	WEME	S	5-Sep-07	Body Parts	Unknown	Unknown	31-Oct-07	57	31-Oct-07	Located & tracked by KB Team beginning 9-5-07; additional parts located; residual feathers become very weathered; may not be fresh
KB 20070923-01	WEME	S	23-Sep-07	Body Parts	Unknown	Unknown	31-Oct-07	39	31-Oct-07	
KB 20071014-02	AMKE	S	14-Oct-07	Feathers	< month	< month	22-Oct-07	9	30-Oct-07	Residual feathers do not meet fatality definition
KB 20080303-02	BUOW	S	3-Mar-08	Feathers	< month	< month	9-Mar-08	7	11-Mar-08	Residual feathers do not meet fatality definition; may not be fresh
KB 20070909-01	AMKE	S	9-Sep-07	Feathers	Unknown	Unknown	31-Oct-07	53	31-Oct-07	May not be fresh
KB 20070917-01	AMKE	S	17-Sep-07	Feathers	Unknown	Unknown	31-Oct-07	45	31-Oct-07	Residual feathers become hard to distinguish
KB 20070906-02	BUOW	S	6-Sep-07	Feathers	Unknown	Unknown	30-Oct-07	55	30-Oct-07	May not be fresh
KB 20070911-02	BUOW	S	11-Sep-07	Feathers	Unknown	Unknown	23-Sep-07	13	27-Sep-07	Residual feathers do not meet fatality definition
KB 20070924-01	BUOW	S	24-Sep-07	Feathers	Unknown	Unknown	24-Sep-07	1	30-Sep-07	Residual feathers do not meet fatality definition
KB 20080421-01	BUOW	S	23-Apr-08	Feathers	Unknown	Unknown	25-Apr-08	3	29-Apr-08	Residual feathers do not meet fatality definition
KB 20080425-01	BUOW	S	25-Apr-08	Feathers	Unknown	Unknown	1-May-08	7	3-May-08	Residual feathers do not meet fatality definition
KB 20071007-01	WEME	S	7-Oct-07	Feathers	Unknown	Unknown	31-Oct-07	25	31-Oct-07	
KB 20080425-03	WEME	S	25-Apr-08	Feathers	Unknown	Unknown	27-May-08	33	27-May-08	Residual feathers become hard to distinguish
KB 20080501-02	WEME	S	1-May-08	Feathers	Unknown	Unknown	3-May-08	3	5-May-08	Residual feathers do not meet fatality definition

The second group included an additional 6 fatalities with fresh body parts indicating that they were less than 1 week old. This added 5 Western meadowlark and 1 burrowing owl fatality to the data set. In this group, scavenging on 5 of the 6 additional records did not remove evidence of the fatality such that they were likely to be detected by future surveys.

The third group included an additional 18 fatalities of unknown age that were likely to be fresh because they were discovered *after* more than two searches at a turbine had been conducted. This added 10 burrowing owl, 5 Western meadowlark, and 5 American kestrel fatalities to the data set. In these additional fatalities, it was unclear when scavenging may have occurred relative to the age of the carcass because its age was not determinable. Although 7 of the 18 additional fatalities were scavenged such that no residual evidence remained, in 11 cases enough evidence remained that they were likely to be detectable by subsequent monitoring.

A high incidence of carcass removal/scavenging of small bird carcasses was documented at the APWRA, with the carcass removal/scavenging taking place very soon after death occurred for intact carcasses (Table 2). Carcass removal/scavenging was documented for all but one (11 of 12, or 91.7%) of the intact small bird carcasses tracked for up to a month. The only carcass not scavenged was a Brewer's blackbird. Removal/scavenging of small bird carcasses was documented to have first occurred between 1 and 14 days after initial carcass discovery, with 9 of 11 intact carcasses (81.8%) scavenged within 5 days. About two-thirds (63.6%) of the scavenged small bird carcasses (7 of 11) were entirely removed from the search area without any residual evidence of the fatality remaining. Of the 11 scavenged intact carcasses, 5 (45.4%) were missing without residual evidence by the second search interval (fourth day) following initial carcass detection, with 2 of these 5 missing within 2 days of initial detection. When scavenging occurred without the complete removal of the carcass (4 of 11 detections in our study), the remains tended to persist for surveyors to detect during subsequent monitoring. The 4 intact scavenged carcasses that remained detectible in this study were the 2 burrowing owls, the American kestrel and one of the European starlings.

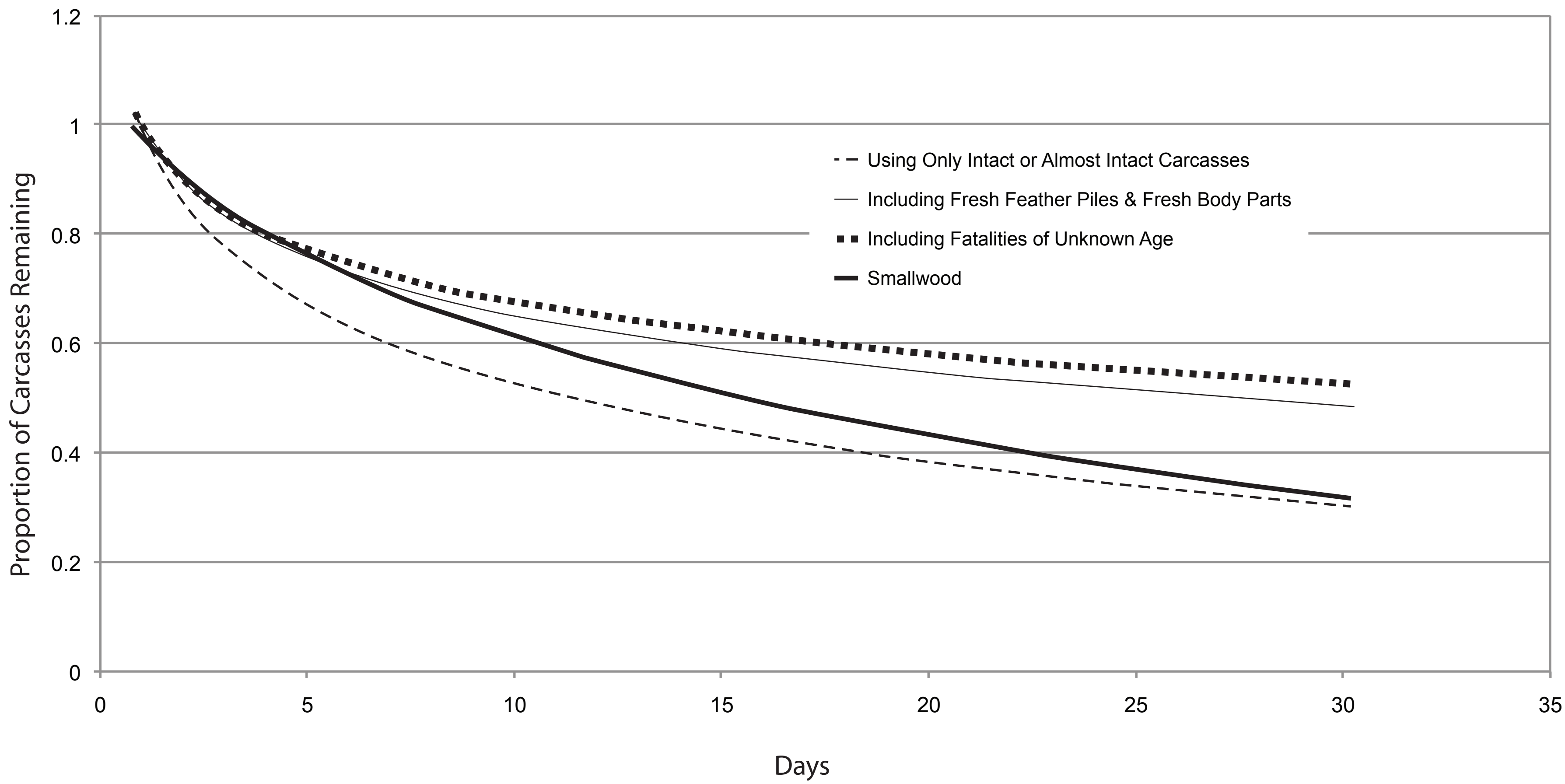
Based upon the carcass removal/scavenging rates observed in the 48-hour search interval study of intact carcasses, the predicted proportion of small bird carcasses remaining each day over a 1-month period was calculated by fitting a logarithmic curve to the fatalities data (Table 3). The best fit based on simple logarithmic regression was $Presence = 1 - 0.2062888*Log(Day), p<0.01$. The probability of removal of intact small bird carcasses by scavengers during the first few days after death occurred was high at the APWRA. By 19 days following death, only one-third of small bird carcasses at the APWRA would remain available for detection by surveyors. We compared this result to the metadata on small bird removal modeled by Smallwood (2007) to correct for the effect of carcass removal/scavenging on mortality estimates of small birds at wind farms. The results suggest that the predicted number of intact small bird carcasses remaining at the APWRA is lower than that predicted by Smallwood for the first few days after carcass deposition, but converges towards the end of the 30-day period (Table 3, Figure 6). This implies that scavengers remove small bird fatalities at the APWRA more quickly than predicted by Smallwood's model, especially during the first week following death.

When fatalities that were not fresh and intact but were less than 1 week old are included in the analysis, the best fit based on simple logarithmic regression was $Presence = 1 - 0.1515259 *Log(Day), p<0.01$. The proportion of fatalities detectable at 30 days was considerably higher for this sample than for the intact carcass group, and also markedly different than the results from Smallwood (2007) (Table 3, Figure 6).

When fatalities of unknown age are included in the analysis, the best fit based on simple logarithmic regression was *Presence = 1 - 0.1384496*Log(Day), p<0.01*. The proportion of fatalities detectable at 30 days was substantially higher than for either of the other groups of records and higher than results from Smallwood (2007) (Table 3, Figure 6).

Table 3. Comparison of the Proportion of Carcasses Remaining Calculated from the 48 hour Search Interval Study and from Smallwood (2007)

Days Dead	Using Only Intact or Almost Intact Carcasses (N=12)	Including Fresh Body Parts and Fresh Feather Clumps (N=18)	Including Fatalities of Unknown Age (N=36)	Small Birds (Smallwood 2007)
1	1.000	1.000	1.000	0.979
2	0.857	0.895	0.904	0.909
3	0.773	0.834	0.848	0.852
4	0.714	0.790	0.808	0.805
5	0.668	0.756	0.777	0.764
6	0.630	0.729	0.752	0.727
7	0.599	0.705	0.731	0.695
8	0.571	0.685	0.712	0.665
9	0.547	0.667	0.696	0.638
10	0.525	0.651	0.681	0.613
11	0.505	0.637	0.668	0.590
12	0.487	0.623	0.656	0.569
13	0.471	0.611	0.645	0.549
14	0.456	0.600	0.635	0.530
15	0.441	0.590	0.625	0.512
16	0.428	0.580	0.616	0.495
17	0.416	0.571	0.608	0.479
18	0.404	0.562	0.600	0.463
19	0.393	0.554	0.592	0.448
20	0.382	0.546	0.585	0.434
21	0.372	0.539	0.578	0.421
22	0.362	0.532	0.572	0.408
23	0.353	0.525	0.566	0.395
24	0.344	0.518	0.560	0.383
25	0.336	0.512	0.554	0.372
26	0.328	0.506	0.549	0.360
27	0.320	0.501	0.544	0.350
28	0.313	0.495	0.539	0.339
29	0.305	0.490	0.534	0.329
30	0.298	0.485	0.529	0.319



00904.08 Bird Fatalities Report (6-09)

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Figure 6
Predicted Proportion of Carcasses Remaining Using 3 Data Filters and Smallwood (2007)

Conclusions

1. More than five times the number of small bird fatalities were detected under the 48-hour search interval sampling protocol than under the monthly search interval sampling protocol conducted at those same turbines.
2. Most fatality detections consisted of partial bird remains, regardless of whether surveys were conducted every 48 hours or once a month. Few bird carcasses were intact or almost intact at initial discovery. Potential explanations for the lack of detections of intact carcasses include (a) an increased detectability of scavenged carcasses (i.e. intact carcasses are not found often because they are small and compact, and thus more difficult to detect than scattered, scavenged carcasses); (b) some of the carcasses detected were due to predation rather than turbine collision and therefore intact carcasses never were available for detection; and (c) that scavenging occurs almost immediately after carcass deposition.
3. Small birds accounted for most of the difference in fatality detections noted between the 48-hour search interval study and the monthly fatality monitoring. Detections of medium/large bird fatalities were similar between the two monitoring studies.
4. These results suggest that substantial numbers of small bird fatalities can go undetected under the monthly fatality sampling protocol conducted at the APWRA. These undocumented fatalities can be attributed to the interaction between increased searcher efficiency (resulting from multiple opportunities to detect a carcass), and scavenger removal of bird carcasses.
5. A high incidence of vertebrate scavenging and/or removal of small bird carcasses was documented during the 48-hour search interval study, with the removal/scavenging taking place very soon after death occurred for intact carcasses.
6. Vertebrate scavenging has the potential to have a substantial effect on the detectability of small bird carcasses because approximately two-thirds of the scavenged small bird carcasses were entirely removed from the study plots without any residual evidence of the fatality remaining for surveyors to locate.
7. When scavenging occurred without the complete removal of a small bird carcass, the remains tended to persist for surveyors to detect during subsequent monitoring visits.
8. Scavengers removed intact small bird carcasses from the APWRA more quickly than predicted by Smallwood's (2007) metadata analysis for small birds, especially for the first few days after carcass deposition, but converges towards the end of the 30-day period. Inclusion of fresh but scavenged carcasses and carcasses of unknown age that are likely to be fresh increases the predicted proportion of carcasses that would remain for surveyors to detect during subsequent visits.
9. The detection of 3 bat fatalities over the 4 months of the study suggests that the frequency of bat kills is higher than indicated under the monthly monitoring program.

References

Altamont Pass Avian Monitoring Team. 2008a. Altamont Pass Wind Resource Area Bird Fatality Study. July. (ICF J&S 61119.06.) Portland, OR. Prepared for Altamont County Community Development Agency.

Altamont Pass Avian Monitoring Team. 2008b. Altamont Pass Carcass Removal/Scavenging Trial Technical Memorandum. October. (ICF J&S 61119.06.) Portland, OR. Prepared for Altamont County Community Development Agency.

Howell, J. A. 1997. Avian mortality at rotor swept area equivalents, Altamont Pass and Montezuma Hills, California. *Transactions of the Western Section of the Wildlife Society* 33: 24-29.

Howell, J. A. and J. E. DiDonato. 1991. Assessment of avian use and mortality related to wind turbine operations, Altamont Pass, Alameda and Contra Costa Counties, California, September 1998 through August 1989. Final Report submitted to U.S. Windpower, Inc. Livermore, California.

Orloff, S. and A. Flannery. 1996. A continued examination of avian mortality in the Altamont Pass Wind Resource Area. Report to California Energy Commission, Sacramento, California. Biosystems Analysis, Inc., Santa Cruz, California.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. *Journal of Wildlife Management* 71(8): 2781-1701.

Smallwood, K. S. and C. G. Thelander. 2004. Developing methods to reduce bird fatalities in the Altamont Wind Resource Area. Final Report by BioResource Consultants to the California Energy Commission, Public Interest Energy Research-Environmental Area. Contract No. 500-01-019 (L. Spiegel, Project Manager).