Wildlife Exclusion and Management Assessment: A Coyote Case Study

Wayne County Airport Authority
Airfield Operations, Wildlife Division
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Purpose:
This project evaluated coyote-related risks at DTW, identified confirmed and potential perimeter access points, and developed recommendations aimed to enhance wildlife management, public safety, security, and airfield operations.

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Preface

Detroit Metropolitan Wayne County Airport (DTW) is committed to maintaining the highest standards of aviation safety, security, and operational efficiency. In alignment with 14 CFR § 139.337 and DTW's Wildlife Hazard Management Plan, proactive identification and mitigation of wildlife hazards are essential to reducing strike risks and protecting both airfield operations and the traveling public. Coyotes (*Canis latrans*) have emerged as a persistent and adaptable hazard at DTW, capable of breaching perimeter defenses and posing threats to safety, security, and airfield operations. Recognizing the importance of this issue, the Airfield Operations – Wildlife Division spearheaded a systematic evaluation of coyote activity and perimeter vulnerabilities, providing actionable exclusion strategies informed by field assessments and best management practices. The findings and recommendations presented in this report support DTW's ongoing commitment to collaborative, science-based, adaptive wildlife hazard management. They also reinforce the coordinated efforts among departments in protecting the airport's integrity while meeting regulatory obligations.

While this report is primarily framed from a wildlife management perspective, it integrates perspectives from Public Safety/Security and Field Maintenance, offering a full-scope assessment of perimeter security and exclusion challenges at DTW—supporting the recently developed Perimeter Integrity Initiative. Further, this report builds on and supplements the 2024 recommendations from Wayne County Airport Authority (WCAA) biologists and USDA – Wildlife Services contractors for enhanced coyote exclusion (Appendix A). Lastly, this report serves as the inaugural entry in the WCAA Airfield Operations – Wildlife Division's Special Publication Series, established to support institutional memory and provide clear, evidence-based justification for management recommendations—offering value not only to DTW but potentially to other airports facing similar challenges.

Executive Summary

Perimeter Integrity Initiative
Airfield Operations/Wildlife, Public Safety/Security, and Field Maintenance have jointly identified critical deficiencies along DTW's perimeter, including fencing, gates, culvert exclusion, and associated maintenance. This executive summary outlines shared and department-specific concerns, highlighting the urgent need for funding to protect public safety, strengthen security, and ensure efficient airfield operations.

Regulatory compliance
- The TSA-approved Airport Security Program (49 CFR Part 1542 § 1542.203) mandates adherence to FAR 139 safety standards; DTW is noncompliant in several areas.
- Perimeter exclusion is critical to meeting 14 CFR § 139.337 obligations. High rates of coyote conflicts through compromised fencing underscore deficiencies in both fence integrity and WCAA responses, potentially raising FAA scrutiny, including conditions that do not fully align with FAA guidance in AC 150/5200-33 and CertAlert 16-03.
- The Wildlife Hazard Management Plan designates specific departments, including Airfield Operations/Wildlife, Public Safety/Security, and Field Maintenance—as responsible for execution of the plan, emphasized through this collaborative initiative.

Problems
- *Airfield Operations/Wildlife*: A 2025 assessment of coyote activity revealed historically high conflict rates, at least one strike or near-strike annually, and up to 55 dig-holes beneath the perimeter fence each year. Noncompliance with SP20 gap standards was observed at 72% of surveyed sites (e.g., gates, culverts), allowing coyote entry. Exclusion remains the most effective management strategy.
- *Public Safety/Security*: Fence integrity issues—including erosion, leaning posts, gaps, and insufficient height—persist, particularly along a 1.6-mile stretch near Eureka Road. Wet conditions and lack of vehicle barriers exacerbate deficiencies, compromising both wildlife exclusion and TSA regulatory compliance.
- *Field Maintenance*: From 2020–2024, DTW had up to 473 perimeter-fence-related work orders annually, requiring up to 3,702 labor hours. Poor fence placement in ditch lines and narrow areas complicates access. Comprehensive repairs or upgrades could reduce maintenance burden, save costs, and improve operational efficiency.

Proposed solution
- Implement a phased, multi-year approach prioritizing areas of shared departmental concern.
- Multiple targeted efforts like installation of approximately 0.3 miles of fence skirting (to provide dig protection; $76,000) and the full replacement of up to 1.6 miles of compromised fencing ($1,000,000).
- Coordinate with Field Maintenance to resolve culvert and gate gaps.
- Apply WCAA Airfield Operations/Wildlife gap-limit recommendations (Figure 1).

Anticipated outcomes

- Enhanced compliance with FAA regulations and improved operational safety.
- Long-term resource savings through reduced maintenance and conflict-management costs.
- Reduced presence of other mammals, including important prey species.
- More effective and socially acceptable coyote hazard mitigation strategies.
- More proactive and wildlife hazard management rather than reactive responses, reducing the need for lethal management.

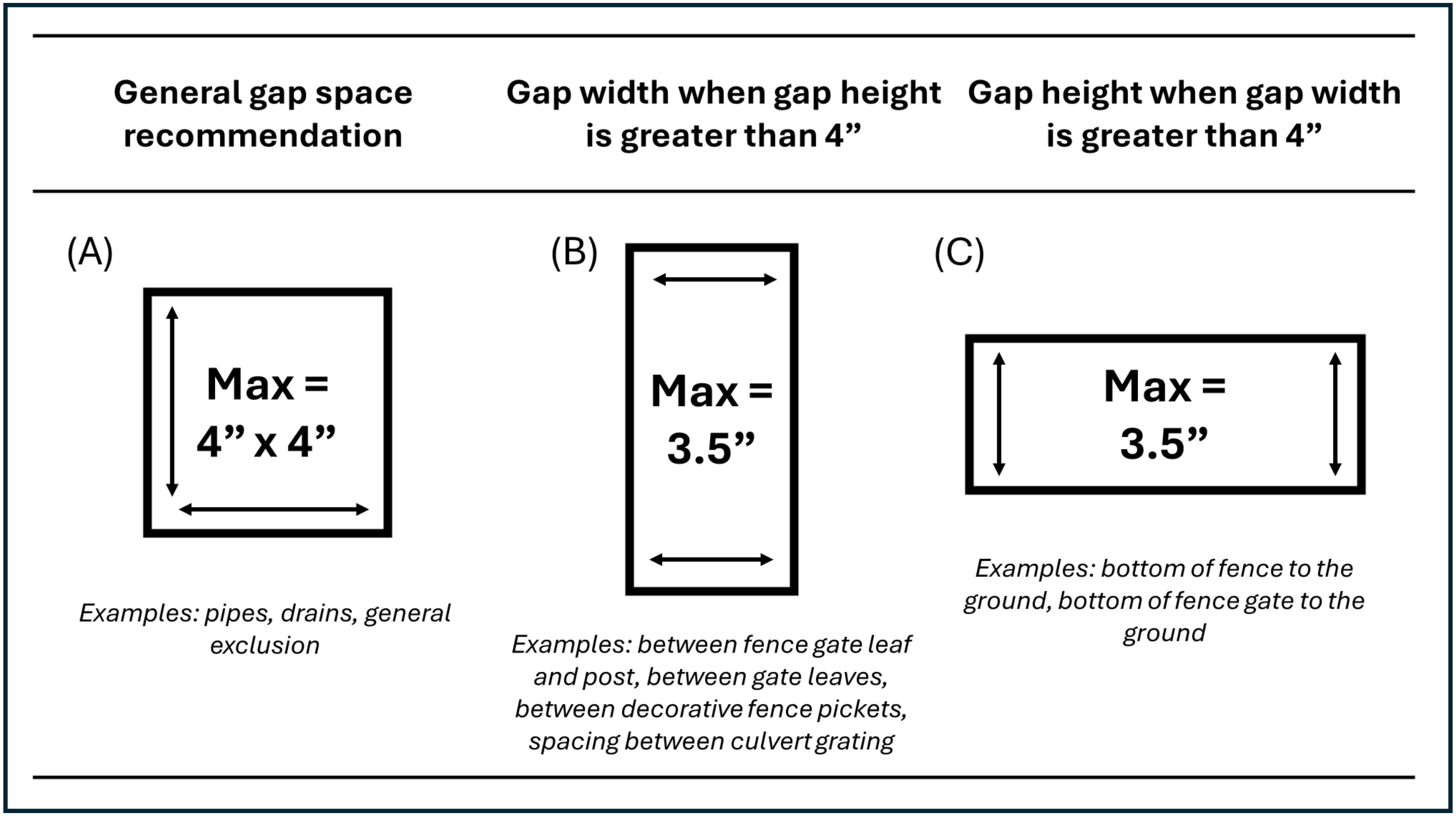


Figure 1. Evidence-based recommendations for standardizing and reducing gap-space limits at DTW’s airfield perimeter, including (A) general gaps, (B) select gap widths, and (C) select gap heights.

Regulatory compliance:

14 CFR Part 139

14 CFR Part 139, also known as the Airport Certification regulation, outlines the requirements for airports to obtain and maintain an operating certificate from the Federal Aviation Administration (FAA). This certification ensures that airports meet certain safety and emergency response standards. Airports like DTW that serve scheduled air carrier operations with aircraft seating more than 9 passengers—or at least 31 passengers for unscheduled operations—are required to be certified under 14 CFR Part 139.

49 CFR Part 1542 § 1542.203

49 CFR Part 1542 § 1542.203 is a TSA regulation that requires airport operators to secure the Air Operations Area (AOA) by preventing unauthorized access through physical barriers, surveillance, and access control systems. This regulation mandates that all access points to the AOA be monitored and that any deficiencies be promptly corrected. While primarily focused on human security, this regulation also supports perimeter integrity, which is relevant to wildlife exclusion efforts that help ensure overall airport safety and security. DTW is subject to 49 CFR Part 1542 § 1542.203, which mandates that DTW complies with FAA Part 139 standards as part of their TSA-approved Airport Security Program (ASP).

Airport Certification Manual

To comply with 14 CFR Part 139, airports must develop and maintain an Airport Certification Manual (ACM), which details procedures for meeting all 14 CFR Part 139 regulatory requirements. If wildlife hazards are identified (like they are at DTW), the ACM must include a Wildlife Hazard Management Plan (WHMP). The ACM is a central component of the airport-certification process.

14 CFR § 139.337

This section of Part 139 mandates wildlife hazard management to mitigate the risk of aircraft collisions with wildlife. Under this section, certificated airports are required to identify and mitigate wildlife hazards that pose a risk to air carrier operations. This approach includes monitoring wildlife activity, reducing attractants (e.g., standing water, cover, food sources), taking immediate action to disperse or remove hazardous wildlife when necessary, and adapting management strategies as needed. Airports certificated under Part 139 must have a Wildlife Hazard Management Plan as part of their Airport Certification Manual.

Wildlife Hazard Management Plan

The Wildlife Hazard Management Plan (WHMP) addresses the responsibilities, policies, and procedures necessary to reduce wildlife hazards. Specifically, airports must develop and implement a plan to manage wildlife hazards, including measures to reduce attractants (like standing water or food sources) and methods for actively dispersing or removing wildlife. Relevant to this report and recommendations therein, the WHMP also designates WCAA departments responsible for implementing the plan, including Airfield Operations, Airfield Maintenance, Trades, Engineering and Construction, Environmental/Sustainability, Public Safety, and Airport Tenants. More specifically, Airfield Operations staff are responsible for monitoring fence lines for potential access points for mammals like coyotes, Public Security monitors security and gate access points to ensure no wildlife gain access to the AOA, and Maintenance provides technical support to carry out objectives in the WHMP. The WHMP is a dynamic document that must be updated based on monitoring results and hazard assessments. It also assigns the WCAA Wildlife Biologists to evaluate wildlife trends and, in coordination with USDA Wildlife Services, develop more detailed recommendations as problems are identified.

FAA Advisory Circular 150/5200-33

In compliance with 14 CFR § 139.337, the DTW WHMP was developed following FAA issued AC 150/5200-33 guidance (*Wildlife Hazard Management at Airports*). This federal guidance document supports development and implementation of WHMPs and provides a framework for reducing wildlife hazards through active monitoring, habitat modification, exclusion, and interagency coordination.

FAA CertAlert 16-03

This federal guidance document, titled *Recommended Wildlife Exclusion Fencing*, provides best practices for excluding larger mammals such as deer and coyotes from airport environments. It emphasizes the importance of proper fencing, gate design, and ongoing maintenance. DTW's WHMP reflects the recommendations of CertAlert 16-03, particularly in its strategies for excluding larger mammals from airfield areas. Further, this report is intended to enhance the gap-limit recommendations provided in FAA CertAlert 16-03.

Relevant compliance issues at DTW

This report supports compliance with 14 CFR § 139.337 (Figure 2) and reflects joint observations from three WCAA departments—Airfield Operations/Wildlife, Public Safety/Security, and Field Maintenance. These departments have jointly identified critical deficiencies in DTW's perimeter infrastructure, including damaged fencing, unsecured gates, inadequate culvert exclusion, and lapses in maintenance. Perimeter exclusion is important to fulfilling DTW's obligations under 14 CFR § 139.337. However, a record-high rate of coyote conflicts through compromised fencing highlight deficiencies in both fence integrity and WCAA's response to this known hazard. This problem may invite compliance scrutiny related to the Wildlife Hazard Management Plan in DTW's Airport Certification Manual, including conditions that do not fully align with FAA guidance in AC 150/5200-33 and CertAlert 16-03. Further, the TSA-approved Airport Security Program (ASP), under 49 CFR Part 1542 § 1542.203, mandates that the airport adhere to, at a minimum, FAR 139 safety standards. Currently, DTW is not in full compliance with these requirements in several areas. The WHMP assigns execution responsibilities to specific departments—including Airfield Operations/Wildlife, Public Safety/Security, and Field Maintenance—and this report highlights the collaborative efforts of these groups in addressing wildlife risks and maintaining regulatory compliance (Appendix B and C, respectively).

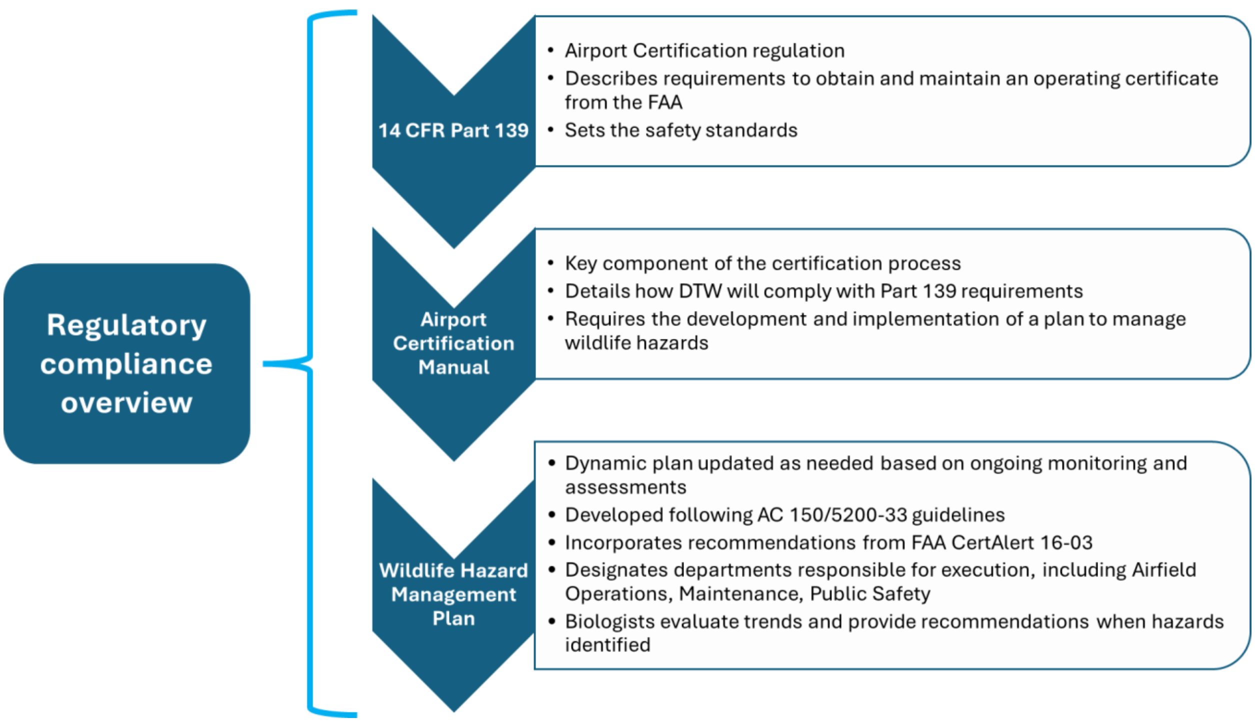


Figure 2. Regulatory compliance overview regarding wildlife management at Detroit Metropolitan Wayne Conty Airport (DTW). To maintain an operating certificate from the Federal Aviation Administration (FAA), DTW must implement a Wildlife Hazard Management Plan and appropriately respond to relevant, emerging wildlife issues.

Introduction

Mammals present a significant safety concern within airport environments, posing threats not only to aircraft integrity and operational costs but also to public safety, airfield personnel, and the overall efficiency of airport operations. Among all mammal-aircraft collisions in the United States, coyotes (*Canis latrans*) are the second most frequently struck species and the most commonly struck carnivore (FAA & USDA, 2024; Crain et al. 2015). Each coyote-aircraft collision results in an average of $72,000 in direct damage and approximately 217 hours of aircraft downtime (FAA & USDA, 2024). These figures highlight the ongoing risk that coyotes pose at airports, especially in the absence of comprehensive and proactive wildlife management strategies.

In response to these risks—ranging from aircraft damage to broader threats to public and operational safety—many airports adopt zero-tolerance policies toward coyotes (Biondi et al., 2014; Schwartz et al., 2014). These zero-tolerance approaches often include lethal removal efforts using coil-spring traps (alternatively referred as foothold traps) or firearms; however, both methods have important limitations. Coil-spring traps are labor-intensive, requiring daily checks, and their effectiveness varies with weather, season, and operator experience. Firearms have limited range, and some require close proximity to the animal (e.g., shotguns), whereas others demand a proper backstop (e.g., rifles)—something not consistently available across the airfield. An often-overlooked aspect of coyote management is the safety risk to personnel responding to active coyotes on the airfield. This issue includes the dangers associated with distracted driving—such as tracking animal movement while operating a vehicle—as well as the use of firearms or pyrotechnics in proximity to aircraft and other airfield staff. Distracted driving has been identified as a contributing factor to vehicle-aircraft incursions (Young & Vlek, 2009). When such high-risk response behaviors become routine—such as repeatedly engaging coyotes on the airfield—the likelihood of human error increases, potentially elevating the overall risk to aircraft operations.

Lethal management is often the initial response to coyote conflicts, intended to reduce immediate threats or local abundance. However, lethal control is often viewed unfavorably by some stakeholders (Martínez-Espiñeira 2006; Buteau et al. 2022). Further, populations frequently rebound once lethal removal efforts cease, or the removals may have limited effect altogether (Berger 2006; Margenau et al. 2023). In some cases, lethal control can lead to unintended consequences, including an overall increase in coyote numbers (Moll et al. 2024). This counterproductive outcome is likely driven by density-dependent responses such as immigration and reproductive compensation (Kayes et al. 2017; Kilgo et al. 2017;

Margenau et al. 2023). Lethal control may also destabilize the social structure of packs in the area, which can increase the number of female coyotes breeding. Further, exploited populations may shift toward a younger age structure and exhibit higher rates of yearling reproduction (Kilgo et al. 2017; Margenau et al. 2023). These dynamics are particularly concerning in airport environments, where coyote presence poses direct safety risks—especially when young, inexperienced individuals venture onto active airfields. While non-lethal methods such as hazing are often used as alternatives to lethal control, their long-term effectiveness is generally limited (Cleary and Dolbeer 2005; Darrow and Shivik 2009). Compounding these challenges, concerns about coyotes in airport settings are amplified by the species' continued population growth, expanding geographic range, and increasing ability to adapt and thrive in developed landscapes (Gompper 2002; Kilgo et al. 2010).

Exclusion is widely recognized as the most effective and often the only reliable method for limiting coyote access to large, open areas like airfields (Conover 2001). However, the long-term success of exclusion depends heavily on regular maintenance, as most exclusion structures degrade over time or are subject to damage (DeVault et al. 2008; Crain et al. 2015). Without proper exclusion and sustained maintenance, managers risk falling into a reactive cycle in which coyote removals are offset by density-dependent responses like increased immigration or reproduction, ultimately leading to continued conflicts. Additionally, roads are frequently used by mammals—including coyotes, particularly transient individuals—as movement corridors (Hill et al. 2021; Hinton et al. 2015). Culverts may also serve as critical passageways for coyotes in fragmented or developed landscapes (Tigas et al. 2002). As a result, roads and culverts within or adjacent to airfields may unintentionally serve as movement corridors, funneling coyotes toward poorly excluded or vulnerable access points such as inadequately secured gates or fence gaps.

There remains limited understanding of the gap sizes through which coyotes can pass—an important concern for airports that lack the resources for complete perimeter protection using high fencing, skirting, or concrete barricades. To the best of our knowledge, there are only two sources in the literature that provide guidance on gap dimensions for excluding coyotes. The first is the Federal Aviation Administration (FAA) CertAlert 16-03, which offers general recommendations for mammal exclusion, including deer and coyotes, primarily through the use of high fencing and fence skirting. However, the guidance is vague and occasionally inconsistent, which may lead to misinterpretation and reduce the overall effectiveness of exclusion efforts. For example, the document states that coyotes can fit through a 6-inch by 4-inch gap but does not specify whether these dimensions refer to height, width, or orientation, nor whether this recommendation applies solely to gaps beneath fences or to all potential entry points. Further, the guidance does not indicate whether these thresholds account for variation across coyote age or sex classes. The only other known reference to coyote-specific gap spacing appears in a USDA document, which recommends horizontal mesh spacing of less than 6 inches and vertical spacing of less than 4 inches (Tischaefer, 2020). However, these recommendations are also not supported by empirical data. Given the inconsistencies across sources and the overall lack of robust, data-driven guidance, there is a clear need for more explicit and evidence-based standards for coyote exclusion.

Coyote activity has become an increasing concern at Detroit Metropolitan Airport (DTW), despite existing perimeter controls such as tall fencing, limited skirted sections, concrete barricades, and grated hydrologic features (e.g., culverts). Coyotes are currently considered the most hazardous mammal at DTW, as they are the only species known to have caused disruptive events, including strikes with aircraft and negative impacts to flight operations. However, the relative risk coyotes pose compared to other wildlife species, as well as their primary modes of entry into the Airfield Operations Area (AOA), remain unclear. The goal of this study was to assess the current state of coyote management at DTW to inform strategies that strengthen wildlife exclusion, airport security, and operational safety. Specifically, our objectives were to: (1) summarize and evaluate historical data on coyote activity and conflicts, and (2) identify and describe confirmed or potential access points along the airfield perimeter. Herre, we present the first comprehensive review of DTW's coyote management efforts under the Wildlife Hazard Management Plan (WHMP), evaluating effectiveness, identifying areas for improvement, and supporting future risk-reduction strategies. This report also builds upon a 2024 recommendation from Wayne County Airport Authority (WCAA) Wildlife Biologists and USDA Wildlife Services to enhance coyote exclusion measures (Appendix A). We hypothesized that: (1) coyote observations and conflicts were elevated in 2024 relative to previous years; (2) coyotes gain access to the airfield through mechanisms other than digging; and (3) perimeter structure types (e.g., fencing, gates, hydrologic features) differ in their coyote permeability potential.

Methods

Relative hazard ranking

To inform broader management priorities and better assess the relative hazard posed by coyotes at DTW, we applied an established methodology for ranking wildlife species based on strike-related metrics—such as aircraft damage and operational impacts—commonly used in evaluations of civil and military aviation by the FAA, the United States Department of Agriculture, and the United States Geological Survey (Dolbeer et al. 2000; Zakrajsek and Bissonette 2006; Dolbeer and Wright 2009; DeVault et al. 2011, 2018; Schwarz et al. 2014; Altringer et al. 2024). For the 9-year period at DTW (2016–2024), 2,278 strikes were reported to the FAA. We used FAA National Wildlife Strike Database records for DTW from 2016 through 2024 that included identified species and were ≤500 ft AGL ([152 m]; thus, in the airport environment; Dolbeer 2006, DeVault et al. 2011, Schwarz et al. 2014), which represented 2,212 reports (retrieved 01 January 2025; NWSD 2025). We combined some similar species into groups because similarities in form and behavior facilitated pooling data (e.g., ring-billed gull [*Larus delawarensis*] and herring gull [*Larus argentatus*] were combined into a "Gulls" group). Only species-groups with ≥2 total incidents were used in our analysis, which resulted in 54 species–groups.

We calculated rankings for birds and mammals combined to demonstrate the relative hazards of all species at DTW. We used FAA records and definitions to calculate the percentage of total strikes for each species or group that 1) resulted in any level of damage to the aircraft; 2) resulted in substantial damage to the aircraft; and 3) caused an effect on flight. Effect on flight was characterized by any deviation from a normal flight routine (see Table 1 for definitions of damage and effect on flight categories). We ranked our 54 species–groups for each of the 3 hazard criteria (i.e., percentage of strikes with damage, percentage of strikes with substantial damage, and percentage of strikes with an effect on flight). Of our 54 species-groups identified, only 12 included sufficient information for meaningful ranking (i.e., sum of damages and effect >1). We focused our ranking on the top 10 species-groups with the intention of concise and effective communication, and we ranked species from most hazardous (1) to least hazardous (10). We created a composite rank by summing category ranks and then ordered species-groups from most to least hazardous, including tied ranks. We examined results, cross referenced FAA records with in-house DTW data, and cleaned and reanalyzed data as needed (e.g., strike record not directly linked to species listed).

Table 1. Categories of damage and effect-on-flight assigned to wildlife strike reports in the National Wildlife Strike Database 2016–2024, adapted from the Federal Aviation Administration (FAA 2025) and Dolbeer et al. (2000).

Criteria and categories	Definition
Damage	
None	No damage was reported.
Minor	When the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary.
Undetermined level	The aircraft was damaged, but details as to the extent of the damage are unknown.
Substantial	When the aircraft incurs damage or structural failure, which adversely affects the structure strength, performance or flight characteristics of the aircraft and which would normally require major repair or replacement of the affected component. Bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips, antennae, tires or brakes; and engine blade damage not requiring blade replacement are specifically excluded.
Destroyed	When the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.
Effect-on-flight	
Aborted take-off	Pilot aborted take-off.
Engine shutdown	The engine was shut down by pilot or stopped running because of strike.
Precautionary landing	The pilot landed at other-than-destination airport after strike.
Other	Miscellaneous effect or deviation from a normal flight routine, like a go around, in bound alert 2, overweight landing, or fuel burn.
None	The flight continued as scheduled although delays and other costs caused by inspections or repairs may have been incurred after landing.

Coyote-aircraft strikes

To assess the risk and spatial distribution of coyote-aircraft interactions, we summarized strike data obtained from the FAA's National Wildlife Strike Database (retrieved 01 January 2025; NWSD 2025) and the WCAA Maximo database (a computerized maintenance management system), which included both confirmed strikes (i.e., aircraft collision with coyote) and related incident reports. The Maximo database also provided records of near-strike events (i.e., pilot-reported suspected strikes lacking physical evidence). To identify potenital spatial clustering of strikes, we visualized spatial patterns in coyote-aircraft strikes and near-strike events by mapping associated locations in ArcGIS Online.

Integrated data analysis

To assess spatial and temporal trends in coyote conflict and activity on the airfield, we analyzed historical WCAA data spanning multiple databases. We implemented a novel, integrated approach to consolidate these data sources, enhancing the robustness of our assessments. Coyote reports were primarily obtained from WCAA using Maximo. Maximo contained coyote data from a variety of sources, including incident reports, service logs, wildlife reports, and work orders. Using all data up to 13 Nov 2024, we identified relevant records using keyword searches in Maximo. Data were retrieved using Maximo's query functions, specifically targeting the "Description" and "Summary" fields. For general coyote data, we searched using the term "coyote." For reports related to digging activity along DTW's perimeter (hereafter, "dig unders"), we used data from 01 Jan 2023 to 15 Nov 2024 and conducted a secondary search using the keyword "dig." Irrelevant entries were filtered out prior to analyses.

When possible, we manually approximated location and estimated the number of coyotes based on the notes section and any attached files (e.g., maps). Most reports included at least two spatial reference points (e.g., an intersection), allowing us to approximate coordinates by dropping a pin in Google Maps at the described location. If only a single point of reference was provided (e.g., a runway or taxiway), we placed the pin at the centermost point of that feature. To estimate the number of coyotes reported, we used a conservative approach. Reports using plural language without explicit counts were assumed to represent two coyotes. Reports with explicit numeric counts were recorded as stated. Reports using singular language were assumed to indicate one coyote. For the purposes of this study, we defined a conflict as any coyote-related complaint or observation relayed via radio communication, including pilot reports (PIREPs) and notifications from Air Traffic Control (ATC). Our integrated data analysis also included WCAA coyote activity data (01 Jan 2022 – 15 Nov 2024) from a designated wildlife survey application in ArcGIS Survey123, which included explicit location data (i.e., coordinates). Note that we did not incorporate coyote activity data that included scat observations (i.e., indirect observations), which were limited to 2024.

To assess temporal patterns in coyote activity and conflict, we plotted annual percentages of coyote-related records from Maximo and Survey123 and summarized lethal removals recorded therein. We used control charts—with control limits set at ±2 standard deviations to increase sensitivity—to detect significant deviations in conflict trends over time. Monthly patterns were visualized separately for conflicts (i.e., reports), activity, and dig unders. To account for variation in survey effort, we standardized these data as a percentage of total records. Lastly, we visualized spatial patterns in coyote activity and conflict by generating a density hotspot map using ArcGIS Online tools.

Dig surveys

From 2016 to 2022, we opportunistically documented dig holes beneath the perimeter fence. Beginning in 2023, we initiated standardized monthly surveys of the perimeter fence line. Surveys were conducted by driving a utility terrain vehicle (UTV) along the fence at approximately 10–15 mph while visually inspecting for dig unders from roughly 10 feet or less (Figure 3). In 2025, we collected additional data on the depth and width of dig unders to better understand the minimum gap size required for coyote passage and to compare with body size measurements. Further, we assessed the direction of digging to determine whether sites were used primarily for entering or exiting the airfield. We also queried historical WCAA work order reports using the keywords “coyote” and “dig,” extracting records from 2016 through 15 November 2024. These data were used to examine potential spatial clustering by mapping the relative density of dig-under locations with ArcGIS Online.

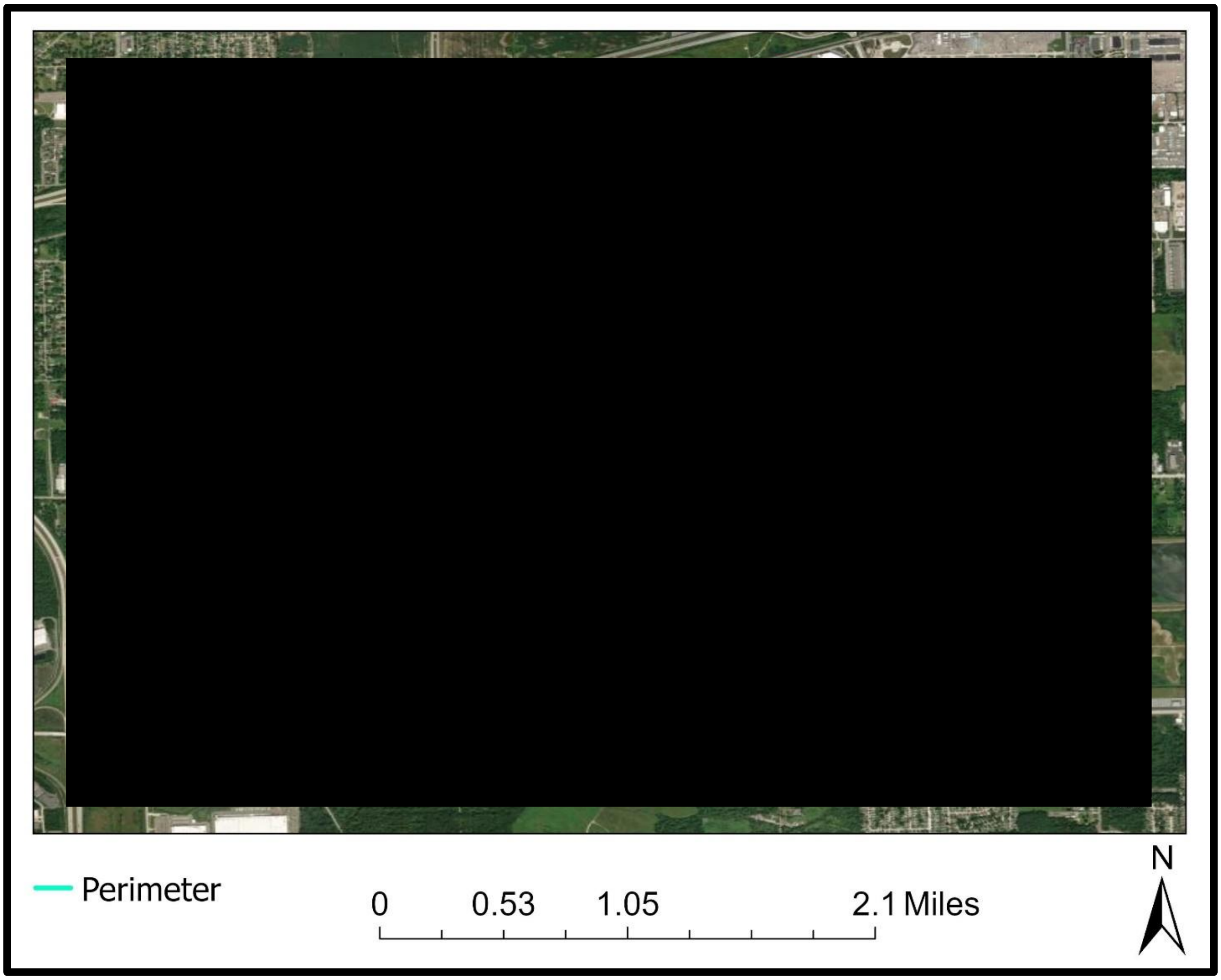


Figure 3. Approximate extent of Detroit Wayne County Metropolitan Airport (DTW) perimeter inspected during routine fence line surveys.

Postmortem surveys

We collected postmortem body measurements from coyotes lethally removed between January and June 2025. To ensure precision, we used calipers to measure maximum head width (zygomatic width), shoulder width, chest height, and hip width (Figure 4). These measurements were used to assess how coyote body dimensions may influence their ability to pass through various-sized perimeter gaps. Note that we did not collect all body measurements for each individual surveyed due to methodology development or poor sample quality. We also recorded the sex and estimated age of each individual. Age was categorized as either juvenile or adult using a multi-criteria approach, with primary emphasis on tooth replacement and wear patterns (Gipson et al. 2000; Maher 2002; McKenzie et al. 2020). Teeth on both sides of the mouth were examined to account for asymmetrical wear or replacement. Additional indicators—including body size and signs of reproductive activity (e.g., enlarged teats or evidence of lactation in females, testicular development in males)—were considered to support age classification but were not used independently of dental evidence. To maintain consistency across individuals, we classified coyotes as adults starting in January of the calendar year in which they reached approximately 8 to 9 months of age (assuming pups were born in April or May). For reference, we included supplemental materials on age classification criteria and guidance for aging coyotes in Appendix D.

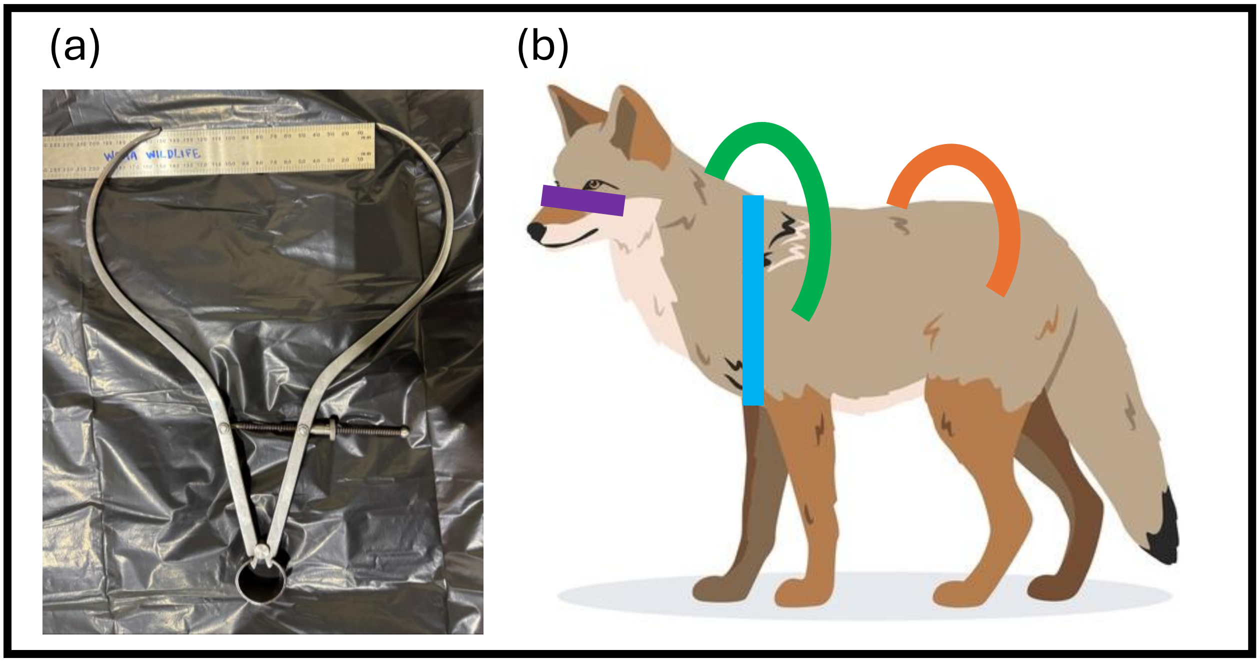


Figure 4. Caliper method (a) used to collect coyote body measurements (b), including head width (purple), chest height (blue), shoulder width (green), and hip width (orange).

Site inspections

We assessed the airfield perimeter at DTW to identify potential wildlife access points from adjacent public areas. Our approach followed guidelines outlined by DeVault et al. (2008), with adaptations tailored to our study system (Table 1). We conducted systematic surveys using a combination of vehicle-based perimeter patrols, targeted site inspections, and detailed measurements of gaps at fences, gates, and hydrologic sites. Fencing was surveyed during regular, vehicle-based dig surveys (see dig-survey methods above). We cross-referenced field observations with a WCAA map and performed a comprehensive assessment of all relevant gates, including those intended for vehicles and pedestrian entry. We referenced topographic maps and aerial imagery to identify potential hydrologic sites. We inspected both designated and undesignated hydrologic sites in the field (e.g., culverts, seasonally inundated areas).

At each potential access point, we measured any observed gaps using a tape measure or ruler, recording both maximum width and height. [redacted]

Table 2. Types of perimeter openings that may provide mammals, including coyotes, public-side access to the airfield (content adapted from DeVault et al. [2008]).

Opening type	Description
Break	Opening between 2 segments of fence line (e.g., where a driveway or pedestrian corridor occurred)
Culvert	Open culvert underneath fence (with or without exclusion devices attached)
Dig-hole	Hole excavated underneath fence (e.g., a coyote dig-under site)
General gap	Open space or discontinuity that occurs between an exclusion device and the area it is designed to protect, between the bottom of a fence and the ground, or between adjoining doors or panels of a gate within a fence line
Damage	Open space caused by warping or other physical damage to the exclusion device or fence
Erosion or land change	Ground beneath fence has been gradually worn away by natural agents (e.g., water), or landscape was modified by human, reducing the effectiveness of wildlife exclusion

Camera trapping

We deployed a variety of remote cameras (i.e., camera traps) to monitor a subset of hydrologic sites identified as potential coyote access points—specifically, locations where coyote tracks had previously been observed. Cameras were configured to record video with minimal delay between triggers (~1 second) and set to the highest available motion sensitivity. Each camera was mounted on a steel T-post or secured to nearby woody vegetation, positioned approximately 4 feet above ground level and angled downward toward the site's focal area to maximize detection probability (Figure 5). Cameras were deployed at each site for a minimum of two weeks and checked weekly for maintenance needs such as memory card replacement. All footage was reviewed by Airfield Operations/Wildlife staff to verify coyote presence and confirm access points.

Figure 5. Example of a camera trap set to monitor potential coyote activity at a culvert gate.

Spatial analysis and site prioritization

We implemented a weighted, multi-criteria approach to prioritize problem sites for coyote exclusion, incorporating two primary variables: (1) the average maximum gap size (based on recorded gap height and width at the site), and (2) the extent of surrounding natural land cover. Sites included in the final prioritization process were also selected based on meeting our updated exclusion criteria—i.e. recommendations developed in this study—derived from postmortem morphometric measurements and camera trap data (Figure 1). This approach ensured that rankings reflected both structural access potential and empirical evidence of coyote body size and behavior.

We obtained land cover data from the 2024 National Land Cover Database (USGS 2024) and clipped to the Wayne County extent to improve processing efficiency. We reclassified NLCD raster values into four land cover categories: Water, Open, Developed, and Forest (Table 3), based on relevance to coyote space use (Gehrt et al. 2009). Because Detroit Metropolitan Airport (DTW) contains many natural areas near runways and taxiways—often classified by NLCD as "open development" (<20% impervious surface) or "low-intensity development" (20–49%)—we reclassified both into the Open category. We then further simplified the four-class system into two categories: Natural (Water, Open, and Forest) and Developed. This simplification aligns with evidence that urban coyotes tend to select for natural habitat patches while avoiding highly developed areas (Grinder and Krausman 2002; Gehrt et al. 2009; Mueller et al. 2018; Franckowiak 2019).

To characterize the landscape context surrounding each problem site, we applied circular buffers with a 1.26 km (0.78 mi) radius. This distance corresponds to an area of 4.95 km^2 (1.91 mi^2), which approximates home range estimates for urban coyotes in a comparable landscape in the Chicago metropolitan region (Gehrt et al. 2009). For visualization and analysis purposes, we clipped the spatial extent by 500 meters (0.31 mi) beyond the outermost buffers to capture broader landscape patterns (i.e., the Greater DTW Area; ~28 mi^2[~73 km^2]). Using this raster, we quantified the total land area and calculated percent cover for each land cover category under both classification schemes (four-class system and binary). Additionally, we calculated the percentage of Natural land cover within each individual site buffer to support site-level prioritization.

We normalized both the percent Natural cover and average maximum gap size to a 0–1 scale, then assigned equal weights (0.5) to each variable. We calculated a composite score by summing these weighted values, yielding a maximum baseline score of 1.0. To elevate the priority of sites with confirmed coyote access, we added a bonus weight of 0.25. This ensured that confirmed-access sites were ranked higher without overwhelming the influence of gap size and surrounding land cover, as some sites may have suitable conditions but lack documented use. Sites with higher composite scores were considered a higher priority for mitigation (i.e., exclusion). To help facilitate communication and decision-making, we applied the Jenks natural breaks algorithm to assign scores into 5 priority levels: Very Low, Low, Medium, High, and Very High. This data-driven classification ensured that breakpoints reflected meaningful structure in the distribution of scores rather than forcing uniform group sizes.

Table 3. Land cover reclassifications and original National Land Cover Database (NLCD) classifications.

Reclassification	NLCD classification
Water	11 – Open Water
	12 – Perennial Ice/Snow
	90 – Woody Wetlands
	95 – Emergent Herbaceous Wetlands
Open	21 – Developed, Open Space
	22 – Developed, Low Intensity
	31 – Barren Land (Rock/Sand/Clay)
	51 – Dwarf Scrub
	52 – Shrub/Scrub
	71 – Grassland/Herbaceous
	72 – Sedge/Herbaceous
	73 – Lichens
	74 – Moss
	81 – Pasture/Hay
	82 – Cultivated Crops
Developed	23 – Developed, Medium Intensity
	24 – Developed, High Intensity
Forest	41 – Deciduous Forest
	42 – Evergreen Forest
	43 – Mixed Forest

Results

Relative hazard ranking

We found that coyotes were the most hazardous and only ranked mammalian species at DTW. Specifically, the coyote hazard ranking included a 3-way tie with red-tailed hawks (*Buteo jamaicensis*) and rough-legged hawks (*Buteo lagopus*) as the sixth most hazardous species (Table 4).

Table 4. Ranking of 10 bird and mammal species or species groups by relative hazard to aircraft in airport environments at Detroit Metropolitan Wayne County Airport, specifically for strikes occurring below 500 ft (152 m) above ground level. Rankings are based on a composite score (1 = most hazardous) derived from three variables: (1) the percentage of strikes that caused any aircraft damage, (2) the percentage that caused substantial damage, and (3) the percentage that resulted in an effect on flight. Wildlife strike data used were from the FAA's National Wildlife Strike Database (NWSD 2025), including reports from 2016 to 2025.

Species	% of strikes with damage	% of strikes with substantial damage	% of strikes with effect on flight	Composite rank
Snowy owl (*Bubo scandiacus*)	18	9	14	1
Turkey vulture (*Cathartes aura*)	50	50	0	2
Double-crested cormorant (*Phalacrocorax auritis*)	50	0	0	3
Gulls (*Larus sp.*)	7	2	8	4
Canada goose (*Branta canadensis*)	17	0	0	5
Red-tailed hawk (*Buteo jamaicensis*)	7	0	4	6
Rough-legged hawk (*Buteo lagopus*)	12	0	0	6
Coyote (*Canis latrans*)	0	0	33	6
Mallard (*Anas platyrhynchos*)	10	0	0	9
European starling (*Sturnus vulgaris*)	3	0	3	10

Coyote-aircraft strikes

We retrieved 9 coyote-aircraft strike records and 7 near-strike records from the FAA National Wildlife Strike Database and the WCAA Maximo database. To identify potential spatial clustering, we mapped these events and found the highest concentration along the 4L–22R runway, which accounted for 5 strike and 4 near-strike events (Figure 6). The second highest concentration occurred along the 3R–27L runway, where 3 strike events were documented.

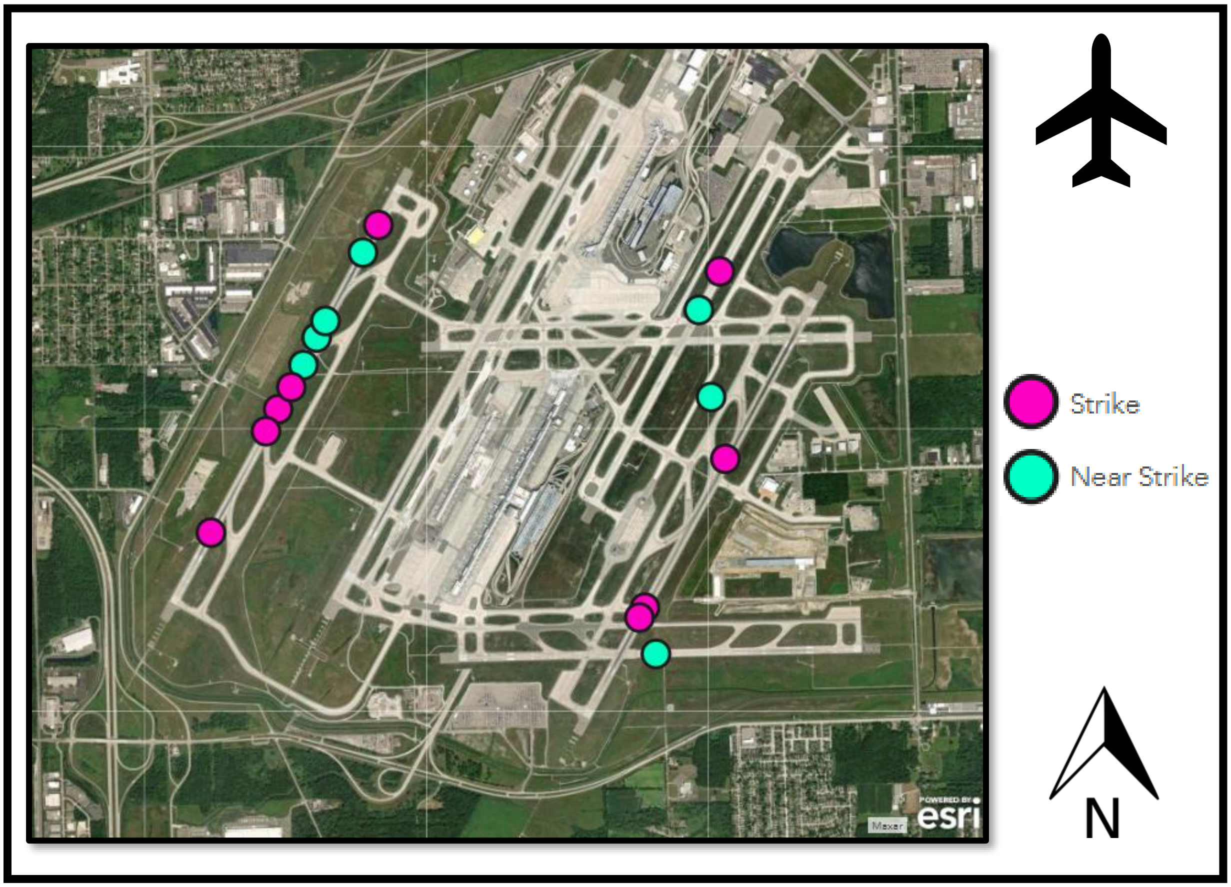


Figure 6. Location of coyote–aircraft strike and near-strike events (i.e., reports classified as strikes but lacking physical evidence) at Detroit Metropolitan Wayne County Airport. Strikes and near-strike events were concentrated in the western portion of the airfield along the 4L–22R runway, aligning with spatial patterns observed in other coyote-related data such as activity and conflict reports.

Integrated data analysis

After removing irrelevant data, we retained 480 records for analysis, including 6 of 9 incident reports (limited to 2016–2018), 169 of 175 service log entries, 64 of 69 wildlife reports, 87 of 88 work order records, and 154 activity reports. Coyote activity (i.e., visual observations) reached a record high in 2024, comprising 1.37% of all activity records—more than the two previous years combined (2023: 0.91%; 2022: 0.94%; Figure 7). Across all years, lethal removal efforts documented an average of 11 coyotes removed annually (range: 2–24). To assess trends in conflict over time, we applied a control chart approach. In 2024, coyote conflict reports peaked at 51 incidents—70% higher than the 2016–2024 average ($\bar{x}$ = 30; Figure 8). This annual report rate exceeded the upper control limit, representing a statistically significant increase in conflict activity. Monthly patterns in coyote conflict reports, activity observations, and dig-under incidents suggested activity generally increased from January to October and then decreased through December (Figure 9). Spatial mapping of activity and conflict records revealed coyote presence across the entire airfield, but was most limited in highly developed areas (Figure 10). Consistent hotspots were detected on the west side of DTW, along the 4L–22R runway, and in the southeast corner near the 27L runway approach.

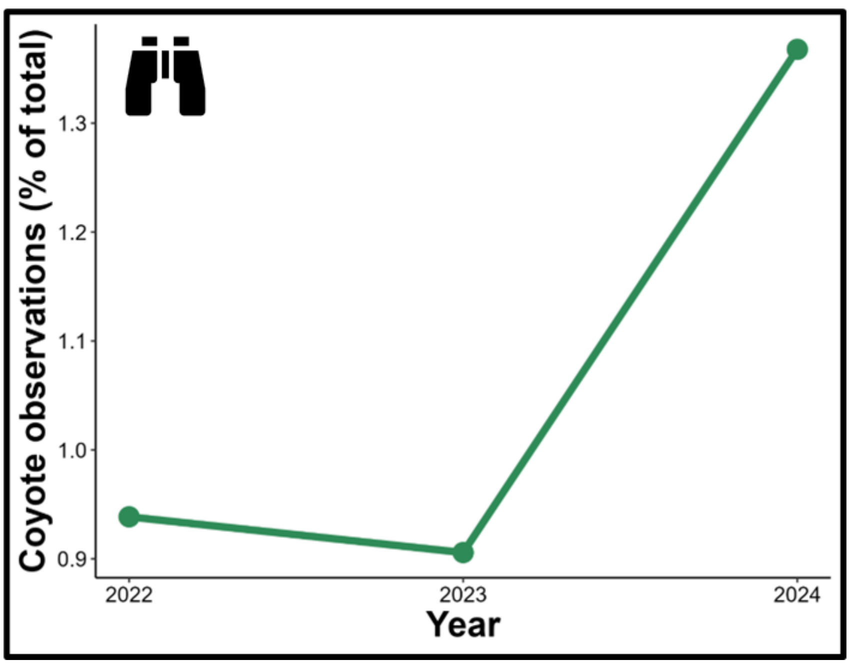


Figure 7. The annual percentage of coyote records in the activity-observation database. These trend data suggest that coyote observations were at an all-time high at Detroit Metropolitan Wayne County Airport in 2024.

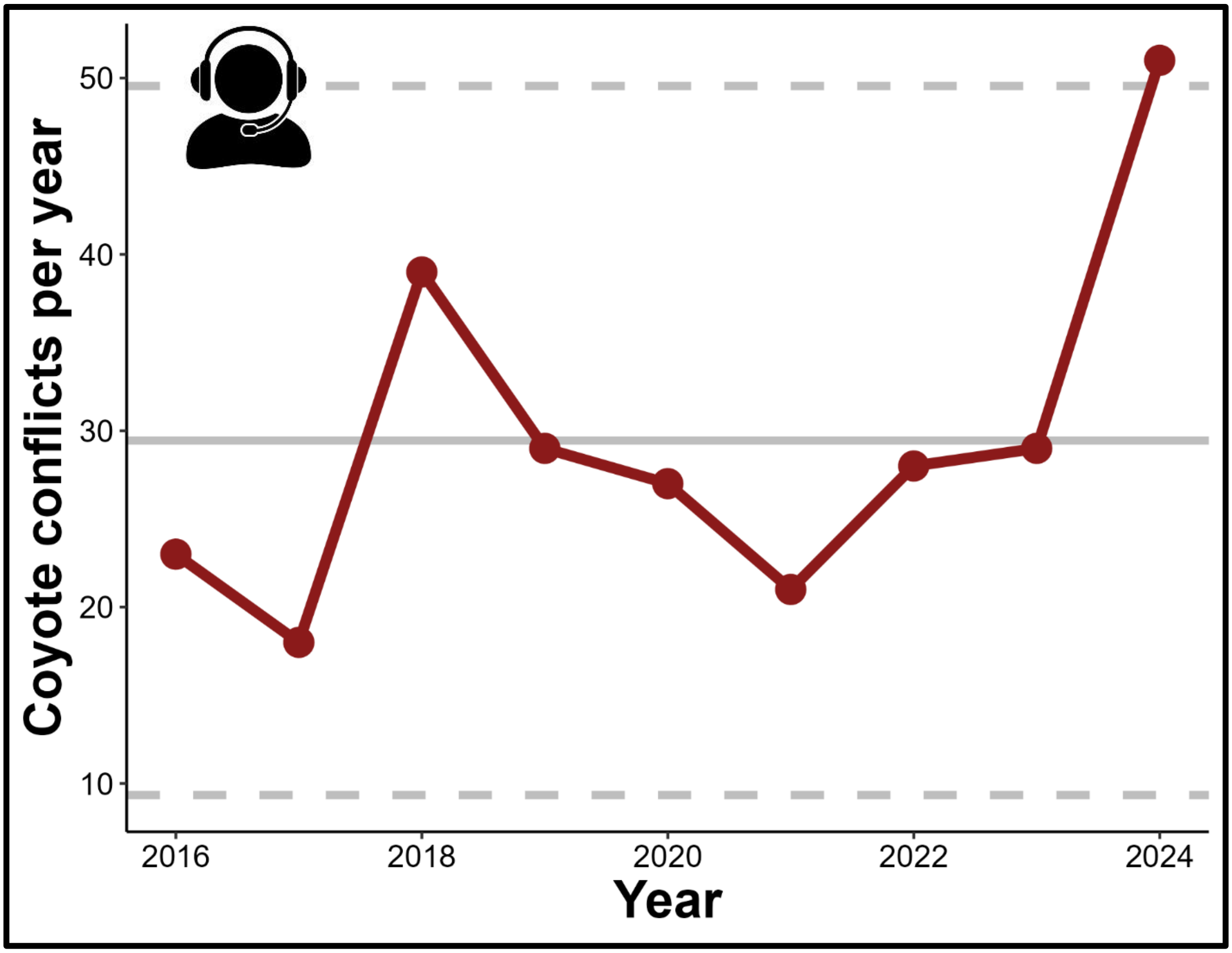


Figure 8. Annual reports of coyote conflicts, including pilot reports (PIREPs) and air traffic control (ATC) radio calls. The solid gray horizontal line represents the multi-year average, while dashed lines indicate upper and lower error limits. In 2024, the number of coyote conflicts reached a record high at Detroit Metropolitan Wayne County Airport, exceeding the upper error limit and representing a statistically significant increase.

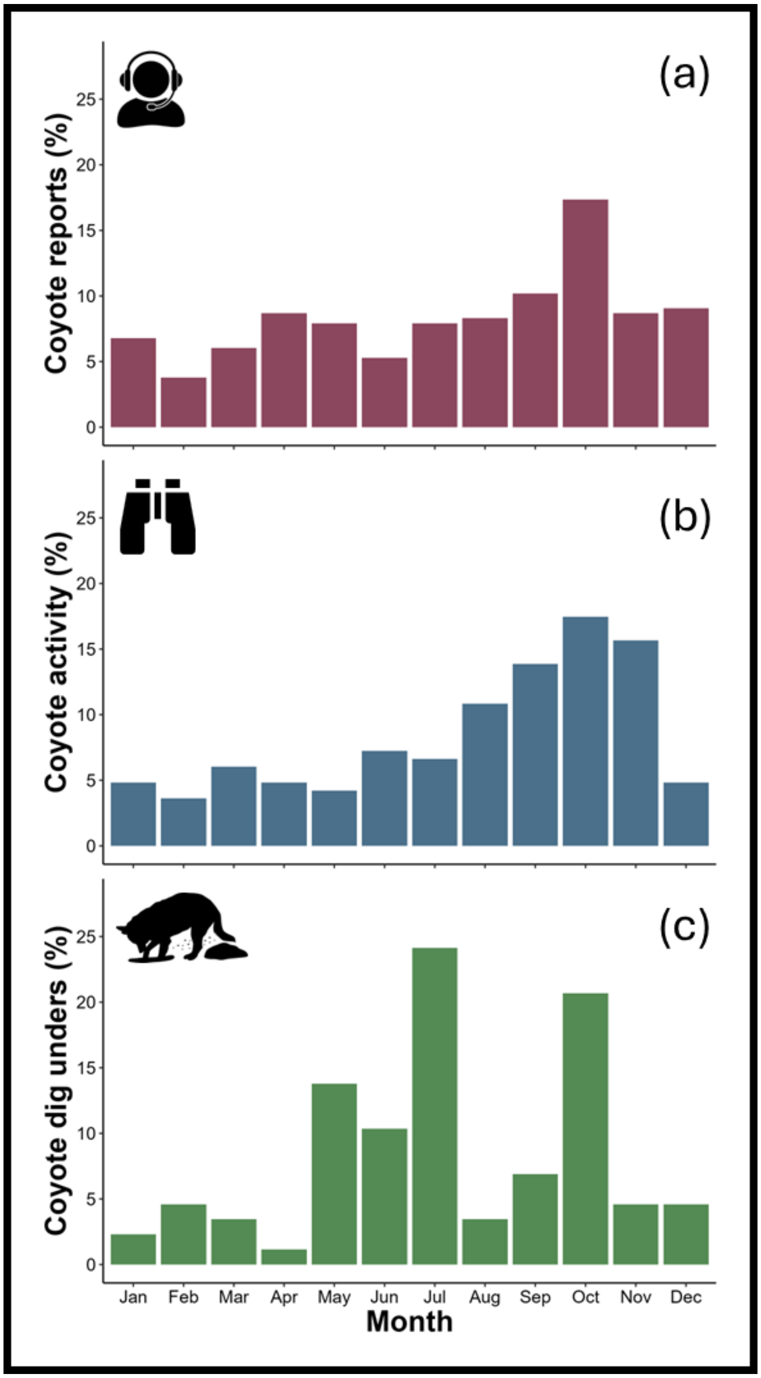


Figure 9. Proportion of coyote data by source, including (a) conflict reports, (b) activity observations, and (c) dig under reports. When used as an index of coyote activity on the airfield, these data suggest activity generally increased at Detroit Metropolitan Wayne County Airport from January to October and then decreased through December.

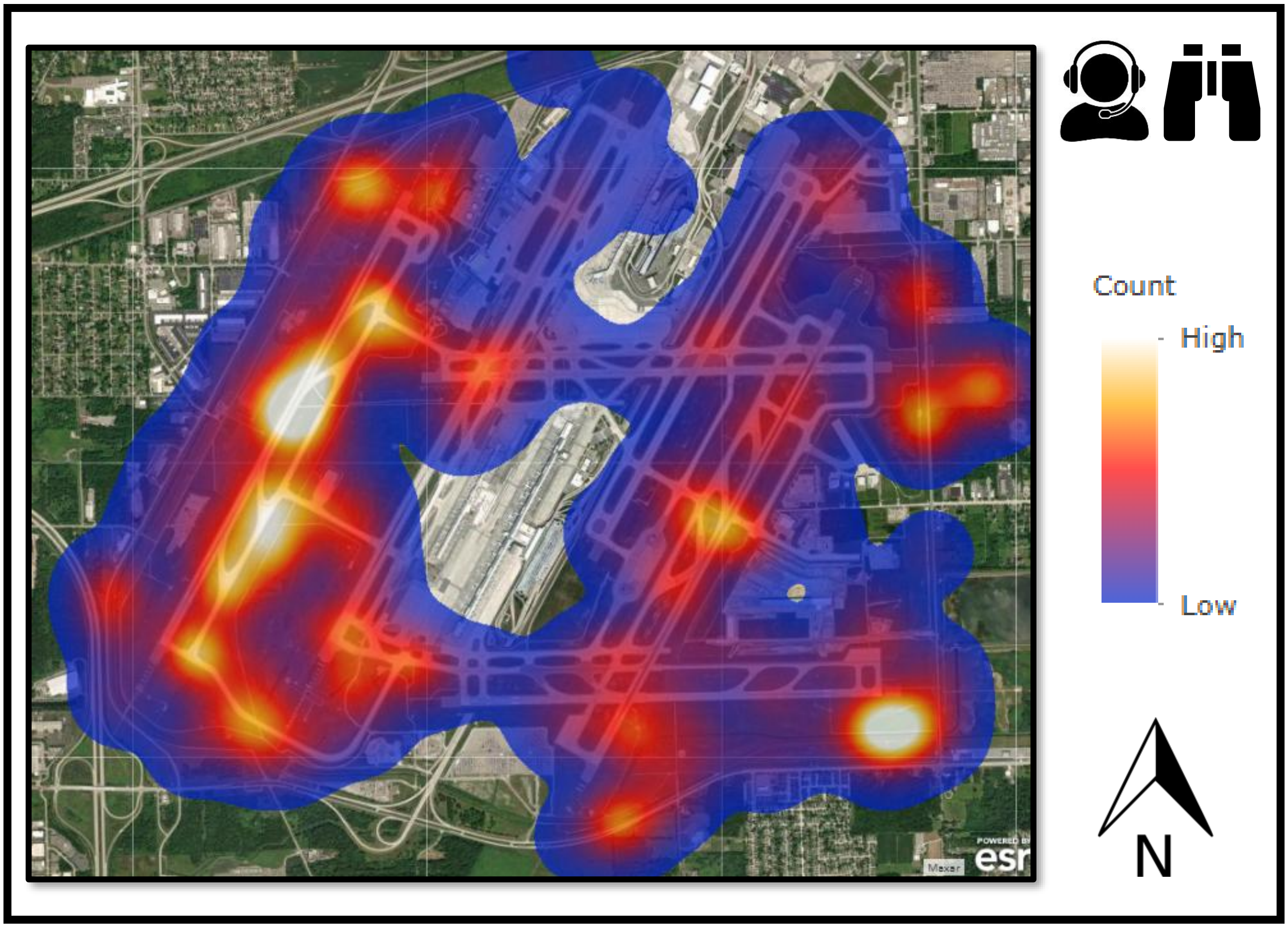


Figure 10. Detroit Metropolitan Wayne County Airport density map depicting coyote hotspots, including activity and conflict data. Coyote activity was documented across the airfield, but major hotspots included the west side along the 4L–22R runway and in the southeast near the Endangered Species Area (i.e., a designated protected-vegetation site).

Dig surveys

We identified 87 work orders containing sufficient spatial data to map dig-under locations, with 87% of these records originating from standardized surveys conducted in 2023–2024. Based on standardized survey data alone, we recorded an average of 38 dig-under work orders per year (SD = 24; range = 21–55). Density mapping revealed several dig-under hotspots, including a prominent cluster in the northwest section of the airfield near the approach to runway 22R (Figure 11). In 2025, we collected size and direction data for 12 dig unders. Most sites (67%) showed evidence of digging from the airfield to the public side (i.e., exiting the airfield). These dig unders had an average height of 7.6 inches (SD = 0.85; range = 6–9 inches) and an average width of 18.25 inches (SD = 3.62; range = 14–23 inches).

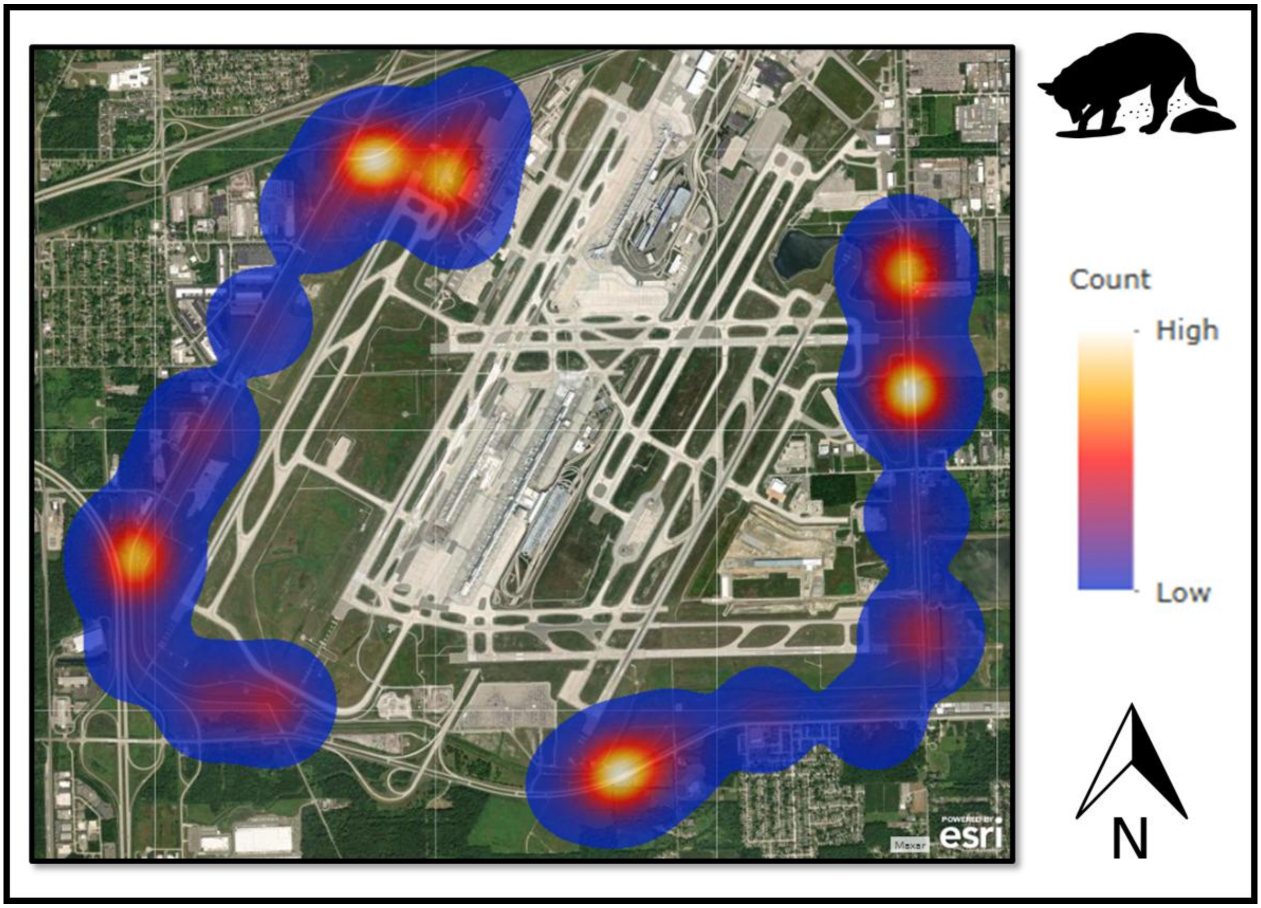


Figure 11. Detroit Metropolitan Wayne County Airport density map highlighting coyote-digging hotspots along the perimeter fence, including a major hotspot in the northwest near the approach of runway 22R.

Postmortem surveys

A total of five adult coyotes were lethally removed during a 6-month period (January–June) and measured opportunistically (Table 5). Due to variation in sample condition and evolving data collection protocols (e.g., the later inclusion of hip width), not all measurements were available for every individual. Recorded head widths ranged from 3.50–4.00", shoulder widths from 4.90–6.00", chest heights from 5.75–7.17", and hip widths from 5.00–6.00".

Table 5. Postmortem data collected from individual coyotes at Detroit Metropolitan Wayne County Airport, including mortality date (mm/dd/yyyy), age (adult or juvenile), and body measurements.

Date	Age class	Sex	Shoulder width	Chest height	Head width	Hip width
01/04/2025	Adult	Female	5.75	NA	NA	NA
01/21/2025	Adult	Female	5.98	7.17	NA	5.55
05/09/2025	Adult	Female	5.40	7.00	4.00	6.00
06/03/2025	Adult	Female	4.90	5.75	3.75	5.00
06/05/2025	Adult	Female	5.25	6.00	3.50	5.50

Site inspections

We assessed DTW's airfield perimeter to identify potential wildlife access points from adjacent public areas. We surveyed 93 sites of interest, including 7 fence sites, 57 gates, and 29 hydrologic sites (Appendix E). [redacted]

Camera trapping

In January and February 2025, we deployed camera traps at 10 hydrologic sites suspected of serving as coyote access points from the public side of the airfield, yielding a trapping effort of 225 trap nights. We detected coyotes at 5 sites, including 24 confirmed crossing events (Figure 12). Across all sites, we documented 24 coyote crossings, including 13 entries onto the airfield and 11 exits. One site accounted for a disproportionate number of detections, representing 71% of all crossing events. At this site, we observed coyote activity peaking at 3 crossings per day, sustained over a four-day period.

We also conducted a one-week opportunistic camera surveillance of an active dig-under site identified during routine perimeter inspections. Although no additional coyote activity was detected during this period, the site was frequently used by other mammals to access the airfield (Figure 13). In total, we documented 10 crossing events involving raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), and eastern cottontail (*Sylvilagus floridanus*).

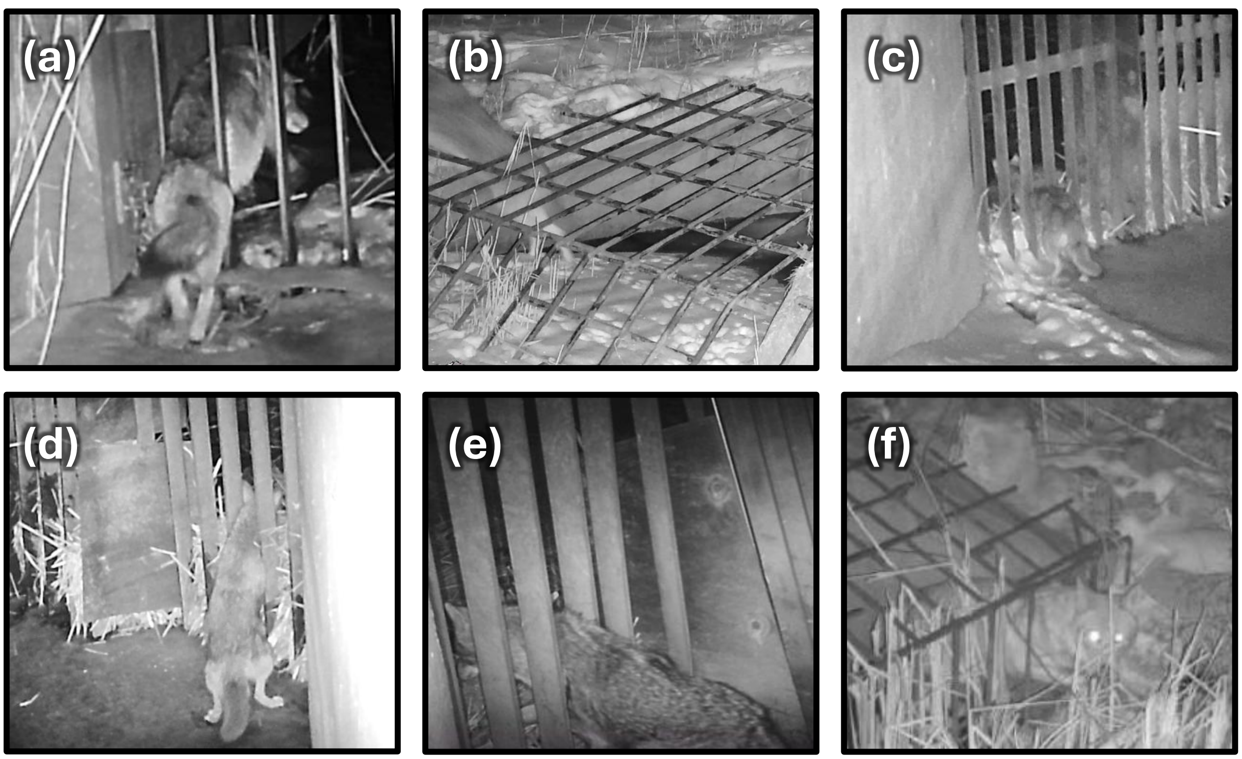


Figure 12. Video screenshots showing coyotes accessing the Detroit Metropolitan Wayne County Airport airfield through hydrologic sites along the perimeter. Examples include: (a) a 5"-wide gap, (b) a general 12" gap, (c–d) a 6"-wide gap, (e) a 5.5"-wide gap, and (f) a 6" × 11" gap (height x width).

Figure 13. Video screenshots from an open coyote dig-under site, which created an access point allowing other mammals to breach the Detroit Metropolitan Wayne County Airport perimeter fence. During a one-week surveillance period, we recorded 10 non-coyote crossing events, including (a) opossums, (b) skunks, (c) raccoons, and (d) rabbits.

Spatial analysis and site prioritization

Across the Greater DTW Area (~28 mi^2[~73 km^2]), land cover was comprised of 45% Open, 14% Forest, 37% Developed (≥50% impervious surface), and 4% Water (Figure 14). When simplified into binary categories, 63% of the areas were classified as Natural and 37% as Developed (≥50% impervious surface; Figure 15). After removing 2 sites that were repaired (i.e., excluded) during our study period, a total of 72 problem sites were considered for prioritization [redacted]. Specifically, our recommendations included general maximum gap size of 4” x 4”, with additional criteria requiring a maximum 3.5” gap width when height exceeded 4”, and a maximum 3.5” gap height when width exceeded 4” (Figure 1).

We combined average maximum gap sizes, spatial land cover data, and confirmed coyote access to calculate composite scores for prioritizing sites for exclusion. We confirmed coyote access at 5 hydrologic sites (one site was repaired and thus removed from prioritization). We mapped problem sites along with 1.26-km (0.78-mi) buffers approximating coyote home-range size to visualize potential access sites and adjacent land cover (Figure 16). We assigned problem sites to five priority levels based on composite scores: 9 sites were classified as Very High priority, 16 as High, 22 as Medium, 14 as Low, and 11 as Very Low (Table 6). We found the proportion of site type varied by priority level (Figure 17). [redacted]

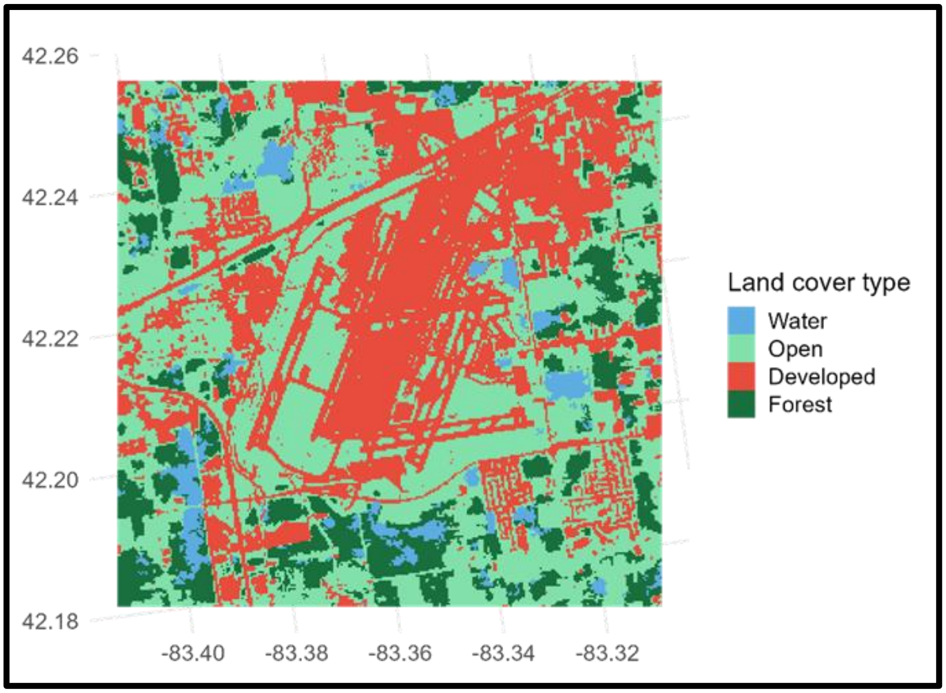


Figure 14. Land cover distribution across the Greater DTW Area, derived from the National Land Cover Database (USGS 2024) and reclassified into four categories based on relevance to coyote space use.

Figure 15. Distribution of Natural and Developed land cover across the Greater DTW Area. Coyotes select for natural habitat patches and generally avoid developed areas.

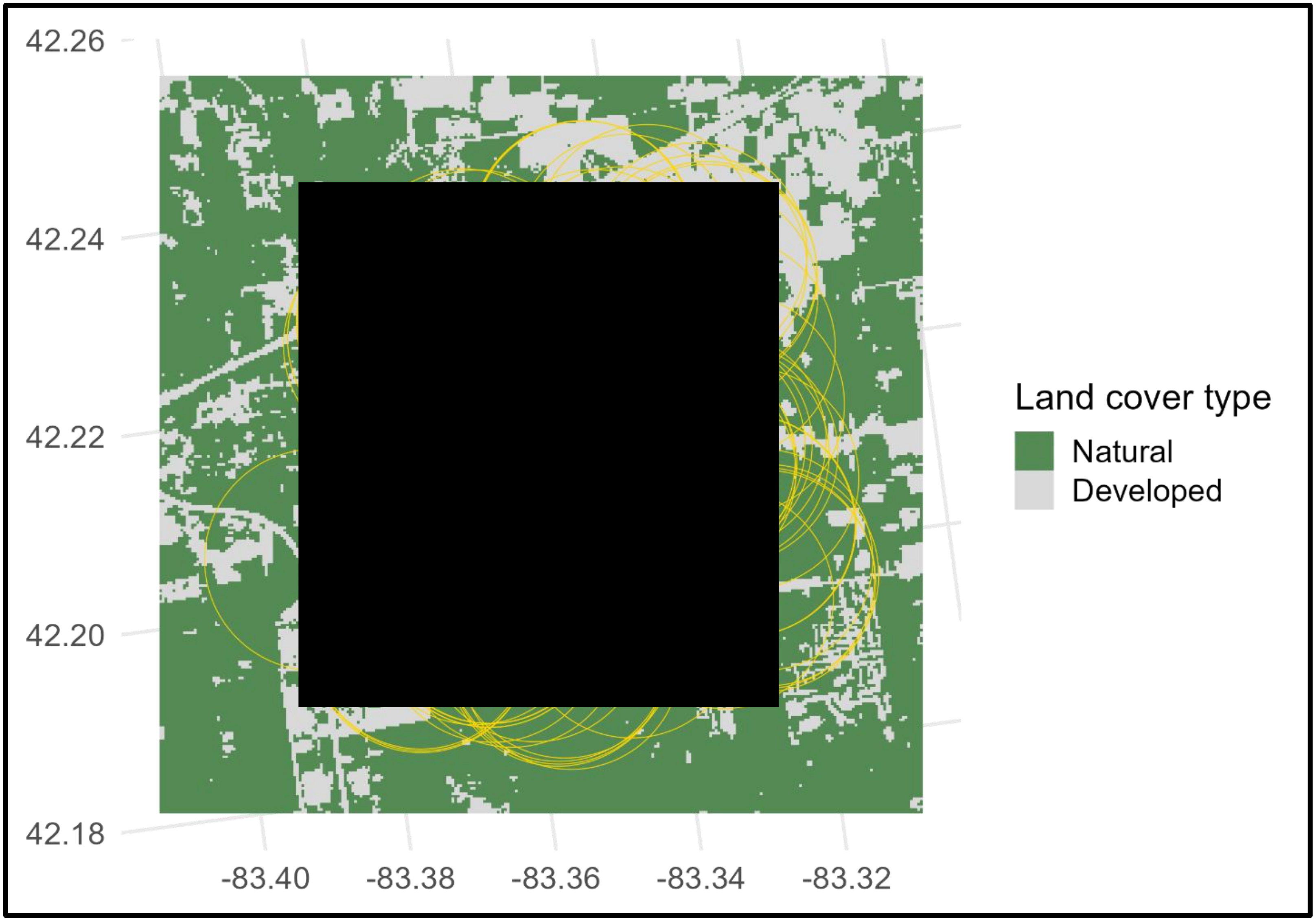


Figure 16. Distribution of Natural and Developed land cover across the Greater DTW Area, sites problematic to coyote exclusion (orange dots), and buffers around each site approximating coyote home-range size (orange rings).

Table 6. Sites problematic or potentially problematic to coyote exclusion at Detroit Metropolitan Wayne County Airport, ranked by priority level and site type, with associated Wayne County Airport Authority identifiers (WCAA ID), unique site labels (Unique ID), and geographic coordinates (latitude and longitude). Sites were ranked and scored based on normalized values (0–1) incorporating the percentage of natural land cover within a surrounding buffer, size of gap at the site, and a bonus weighting for confirmed coyote access (e.g., video evidence).

Rank	Priority Level	Site type	WCAA ID	Unique ID	Lat	Long	% Natural	Mean gap size (inches)	Normalized % natural	Normalized mean gap size	Confirmed access (Y/N)	Score
1	Very High	[redacted]	[redacted]	902	[redacted]	[redacted]	[redacted]	[redacted]	0.954	1.000	N	0.977
2	Very High	[redacted]	[redacted]	1303	[redacted]	[redacted]	[redacted]	[redacted]	0.949	0.378	Y	0.914
3	Very High	[redacted]	[redacted]	903	[redacted]	[redacted]	[redacted]	[redacted]	0.965	0.733	N	0.849
4	Very High	[redacted]	[redacted]	1305	[redacted]	[redacted]	[redacted]	[redacted]	0.955	0.200	Y	0.827
5	Very High	[redacted]	[redacted]	302	[redacted]	[redacted]	[redacted]	[redacted]	0.834	0.267	Y	0.800
6	Very High	[redacted]	[redacted]	901	[redacted]	[redacted]	[redacted]	[redacted]	0.936	0.156	Y	0.796
7	Very High	[redacted]	[redacted]	906	[redacted]	[redacted]	[redacted]	[redacted]	1.000	0.467	N	0.733
8	Very High	[redacted]	[redacted]	1304	[redacted]	[redacted]	[redacted]	[redacted]	0.998	0.467	N	0.732
9	Very High	[redacted]	[redacted]	1409	[redacted]	[redacted]	[redacted]	[redacted]	0.974	0.467	N	0.720
10	High	[redacted]	[redacted]	603	[redacted]	[redacted]	[redacted]	[redacted]	0.748	0.489	N	0.618
11	High	[redacted]	[redacted]	1301	[redacted]	[redacted]	[redacted]	[redacted]	0.952	0.200	N	0.576
12	High	[redacted]	[redacted]	1801	[redacted]	[redacted]	[redacted]	[redacted]	0.781	0.369	N	0.575
13	High	[redacted]	[redacted]	1302	[redacted]	[redacted]	[redacted]	[redacted]	0.978	0.156	N	0.567
14	High	[redacted]	[redacted]	904	[redacted]	[redacted]	[redacted]	[redacted]	0.926	0.200	N	0.563
15	High	[redacted]	[redacted]	1407	[redacted]	[redacted]	[redacted]	[redacted]	0.637	0.467	N	0.552
16	High	[redacted]	[redacted]	1306	[redacted]	[redacted]	[redacted]	[redacted]	0.900	0.200	N	0.550
17	High	[redacted]	[redacted]	1408	[redacted]	[redacted]	[redacted]	[redacted]	0.974	0.111	N	0.543
18	High	[redacted]	[redacted]	1802	[redacted]	[redacted]	[redacted]	[redacted]	0.809	0.244	N	0.527
19	High	[redacted]	[redacted]	301	[redacted]	[redacted]	[redacted]	[redacted]	0.891	0.156	N	0.523
20	High	[redacted]	[redacted]	1501	[redacted]	[redacted]	[redacted]	[redacted]	0.627	0.400	N	0.514
21	High	[redacted]	[redacted]	1701	[redacted]	[redacted]	[redacted]	[redacted]	0.604	0.422	N	0.513
22	High	[redacted]	[redacted]	304	[redacted]	[redacted]	[redacted]	[redacted]	0.847	0.156	N	0.501

23	High	[redacted]	[redacted]	303	[redacted]	[redacted]	[redacted]	[redacted]	0.841	0.156	N	0.498
24	High	[redacted]	[redacted]	905	[redacted]	[redacted]	[redacted]	[redacted]	0.774	0.200	N	0.487
25	High	[redacted]	[redacted]	1402	[redacted]	[redacted]	[redacted]	[redacted]	0.641	0.311	N	0.476
26	Medium	[redacted]	[redacted]	1505	[redacted]	[redacted]	[redacted]	[redacted]	0.733	0.178	N	0.456
27	Medium	[redacted]	[redacted]	1503	[redacted]	[redacted]	[redacted]	[redacted]	0.800	0.089	N	0.444
28	Medium	[redacted]	[redacted]	202	[redacted]	[redacted]	[redacted]	[redacted]	0.596	0.289	N	0.443
29	Medium	[redacted]	[redacted]	204	[redacted]	[redacted]	[redacted]	[redacted]	0.594	0.289	N	0.441
30	Medium	[redacted]	[redacted]	604	[redacted]	[redacted]	[redacted]	[redacted]	0.676	0.200	N	0.438
31	Medium	[redacted]	[redacted]	1502	[redacted]	[redacted]	[redacted]	[redacted]	0.698	0.156	N	0.427
32	Medium	[redacted]	[redacted]	605	[redacted]	[redacted]	[redacted]	[redacted]	0.674	0.178	N	0.426
33	Medium	[redacted]	[redacted]	1803	[redacted]	[redacted]	[redacted]	[redacted]	0.844	0.000	N	0.422
34	Medium	[redacted]	[redacted]	207	[redacted]	[redacted]	[redacted]	[redacted]	0.579	0.222	N	0.401
35	Medium	[redacted]	[redacted]	1405	[redacted]	[redacted]	[redacted]	[redacted]	0.636	0.156	N	0.396
36	Medium	[redacted]	[redacted]	907	[redacted]	[redacted]	[redacted]	[redacted]	0.764	0.022	N	0.393
37	Medium	[redacted]	[redacted]	1403	[redacted]	[redacted]	[redacted]	[redacted]	0.637	0.133	N	0.385
38	Medium	[redacted]	[redacted]	607	[redacted]	[redacted]	[redacted]	[redacted]	0.657	0.111	N	0.384
39	Medium	[redacted]	[redacted]	205	[redacted]	[redacted]	[redacted]	[redacted]	0.594	0.156	N	0.375
40	Medium	[redacted]	[redacted]	1404	[redacted]	[redacted]	[redacted]	[redacted]	0.636	0.111	N	0.374
41	Medium	[redacted]	[redacted]	206	[redacted]	[redacted]	[redacted]	[redacted]	0.579	0.156	N	0.367
42	Medium	[redacted]	[redacted]	608	[redacted]	[redacted]	[redacted]	[redacted]	0.655	0.067	N	0.361
43	Medium	[redacted]	[redacted]	606	[redacted]	[redacted]	[redacted]	[redacted]	0.658	0.056	N	0.357
44	Medium	[redacted]	[redacted]	1406	[redacted]	[redacted]	[redacted]	[redacted]	0.606	0.089	N	0.348
45	Medium	[redacted]	[redacted]	210	[redacted]	[redacted]	[redacted]	[redacted]	0.661	0.022	N	0.342
46	Medium	[redacted]	[redacted]	505	[redacted]	[redacted]	[redacted]	[redacted]	0.297	0.378	N	0.337
47	Medium	[redacted]	[redacted]	1413	[redacted]	[redacted]	[redacted]	[redacted]	0.652	0.011	N	0.331
48	Low	[redacted]	[redacted]	1412	[redacted]	[redacted]	[redacted]	[redacted]	0.615	0.000	N	0.307
49	Low	[redacted]	[redacted]	209	[redacted]	[redacted]	[redacted]	[redacted]	0.579	0.022	N	0.301
50	Low	[redacted]	[redacted]	208	[redacted]	[redacted]	[redacted]	[redacted]	0.373	0.222	N	0.298
51	Low	[redacted]	[redacted]	504	[redacted]	[redacted]	[redacted]	[redacted]	0.349	0.222	N	0.285
52	Low	[redacted]	[redacted]	1202	[redacted]	[redacted]	[redacted]	[redacted]	0.282	0.267	N	0.274

53	Low	[redacted]	[redacted]	502	[redacted]	[redacted]	[redacted]	[redacted]	0.164	0.378	N	0.271
54	Low	[redacted]	[redacted]	506	[redacted]	[redacted]	[redacted]	[redacted]	0.294	0.244	N	0.269
55	Low	[redacted]	[redacted]	811	[redacted]	[redacted]	[redacted]	[redacted]	0.000	0.489	N	0.244
56	Low	[redacted]	[redacted]	808	[redacted]	[redacted]	[redacted]	[redacted]	0.051	0.422	N	0.237
57	Low	[redacted]	[redacted]	806	[redacted]	[redacted]	[redacted]	[redacted]	0.094	0.378	N	0.236
58	Low	[redacted]	[redacted]	503	[redacted]	[redacted]	[redacted]	[redacted]	0.167	0.289	N	0.228
59	Low	[redacted]	[redacted]	803	[redacted]	[redacted]	[redacted]	[redacted]	0.106	0.300	N	0.203
60	Low	[redacted]	[redacted]	501	[redacted]	[redacted]	[redacted]	[redacted]	0.159	0.244	N	0.202
61	Low	[redacted]	[redacted]	1205	[redacted]	[redacted]	[redacted]	[redacted]	0.164	0.222	N	0.193
62	Very Low	[redacted]	[redacted]	809	[redacted]	[redacted]	[redacted]	[redacted]	0.049	0.267	N	0.158
63	Very Low	[redacted]	[redacted]	801	[redacted]	[redacted]	[redacted]	[redacted]	0.090	0.222	N	0.156
64	Very Low	[redacted]	[redacted]	802	[redacted]	[redacted]	[redacted]	[redacted]	0.094	0.200	N	0.147
65	Very Low	[redacted]	[redacted]	810	[redacted]	[redacted]	[redacted]	[redacted]	0.049	0.244	N	0.147
66	Very Low	[redacted]	[redacted]	1201	[redacted]	[redacted]	[redacted]	[redacted]	0.087	0.200	N	0.144
67	Very Low	[redacted]	[redacted]	1203	[redacted]	[redacted]	[redacted]	[redacted]	0.153	0.111	N	0.132
68	Very Low	[redacted]	[redacted]	805	[redacted]	[redacted]	[redacted]	[redacted]	0.088	0.156	N	0.122
69	Very Low	[redacted]	[redacted]	807	[redacted]	[redacted]	[redacted]	[redacted]	0.083	0.111	N	0.097
70	Very Low	[redacted]	[redacted]	1204	[redacted]	[redacted]	[redacted]	[redacted]	0.104	0.067	N	0.085
71	Very Low	[redacted]	[redacted]	812	[redacted]	[redacted]	[redacted]	[redacted]	0.018	0.111	N	0.065
72	Very Low	[redacted]	[redacted]	804	[redacted]	[redacted]	[redacted]	[redacted]	0.101	0.022	N	0.062

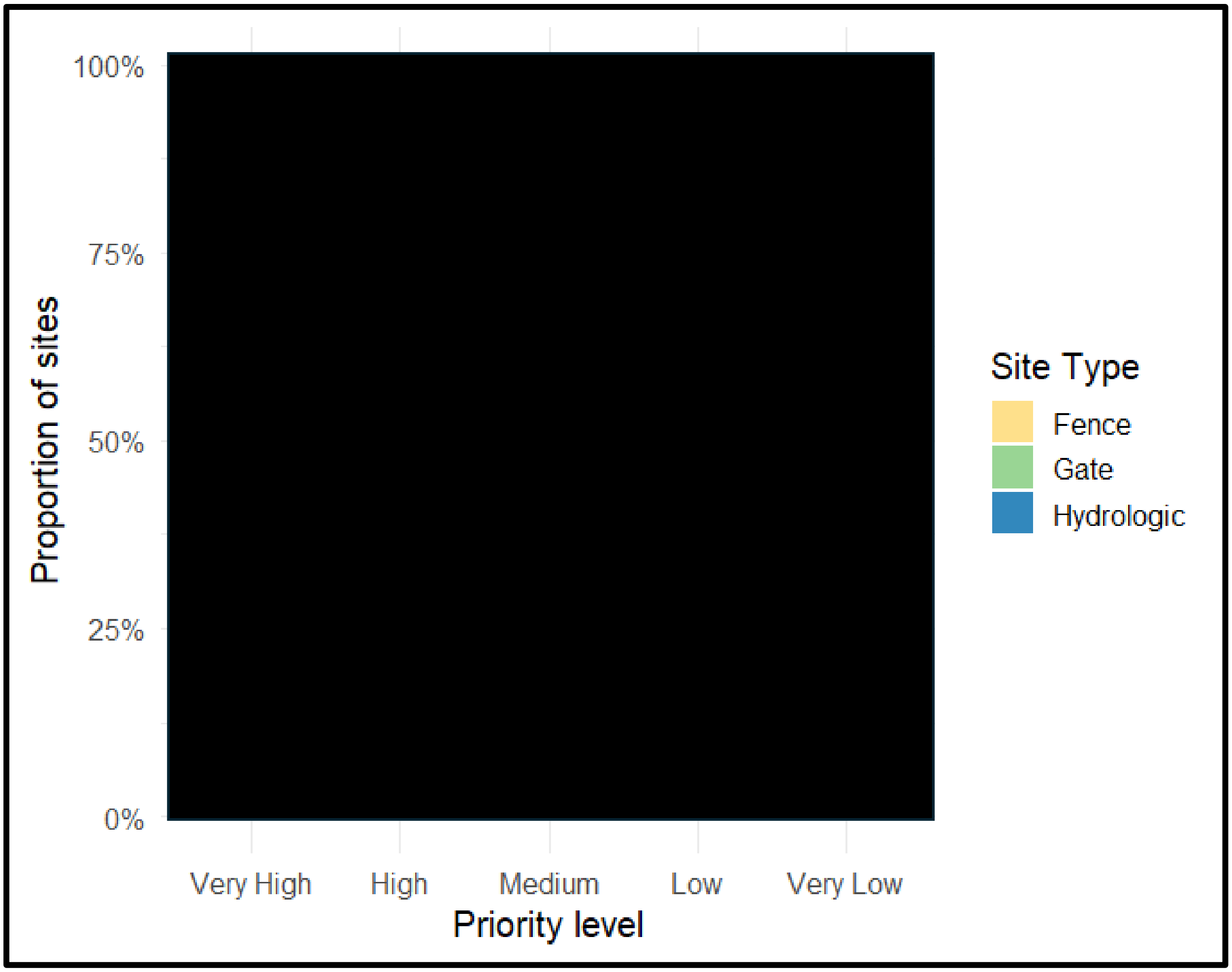


Figure 17. Proportion of problem sites (% of total) by priority level and site type. [redacted]

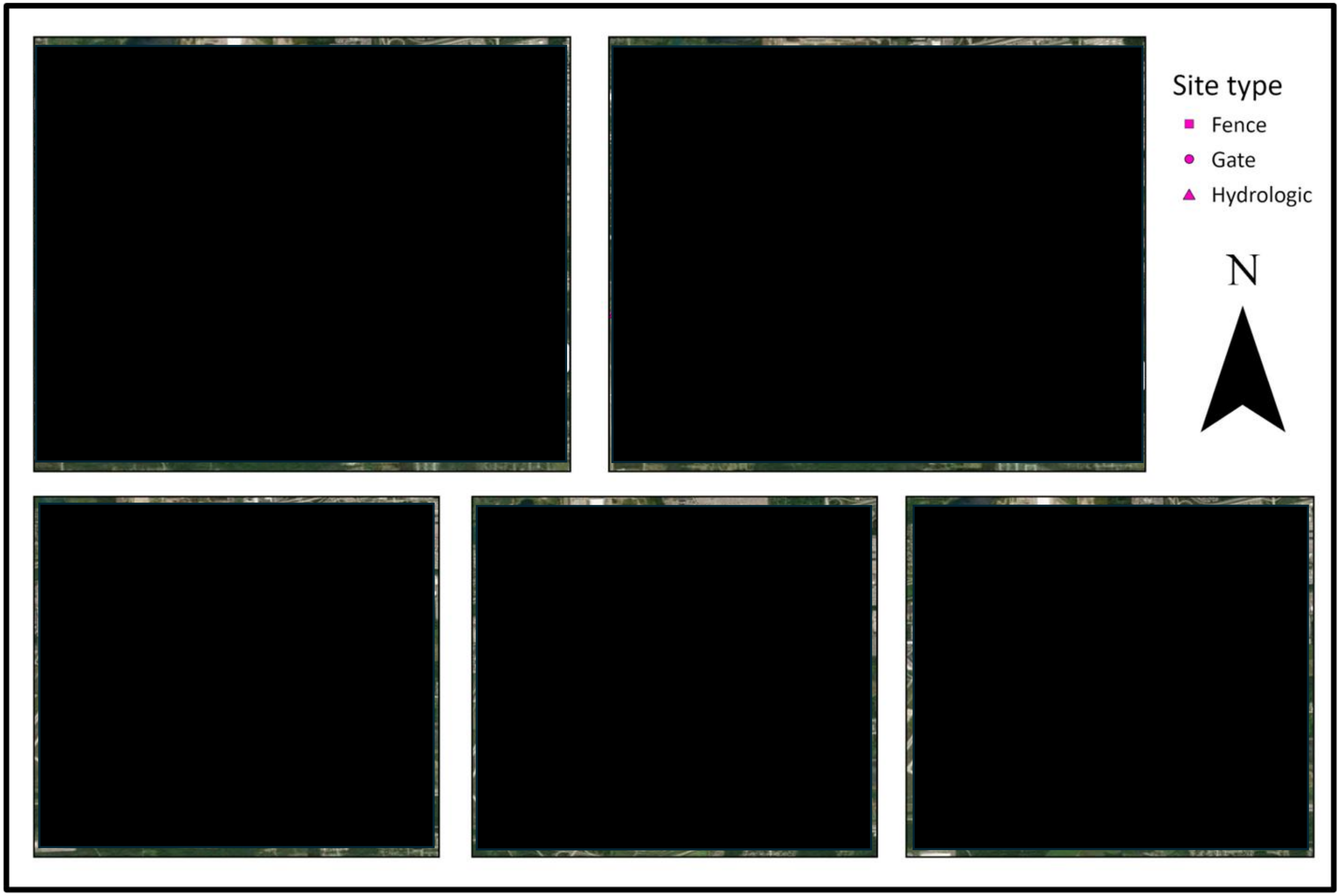


Figure 18. Spatial distribution of problem sites at Detroit Metropolitan Wayne County Airport by priority level. [redacted]

Discussion

Coyotes represent a serious and often underrecognized hazard to aircraft operations—particularly at certain airports like DTW, where their risk appears to be elevated. In this first comprehensive evaluation of coyote exclusion and management at DTW, we found that coyotes represent a relatively high-risk species. Using empirical data (i.e., FAA strike metrics), we ranked and evaluated wildlife species posing the greatest hazard to aircraft operations at DTW. This analysis represents an important step in prioritizing species-specific management efforts, with the goal of mitigating risks specific to DTW. Notably, coyotes emerged as a high-priority species. At DTW, coyotes were ranked among the most hazardous species (6th most hazardous; Table 1), and remarkably higher than in national rankings. For instance, when excluding species not present at DTW, coyotes would rank as the 21st most hazardous species at the national level (DeVault et al. 2011). This discrepancy suggests that DTW faces a unique and elevated coyote hazard relative to other U.S. airports.

We found that the most hazardous species at DTW were associated with aquatic habitat types—emphasizing the importance of effectively managing water-related attractants (e.g., stormwater, aquatic vegetation) to reduce wildlife strike risks. In urban or developed environments, coyotes often select habitats near stormwater retention ponds, which often offer reliable resources such as concealment and protection from wind (Gehrt et al. 2009). In addition to coyotes, other water-associated, hazardous species at DTW included double-crested cormorants (*Phalacrocorax auritus*), gull species (*Larus* spp.), Canada geese (*Branta canadensis*), and mallards (*Anas platyrhynchos*; Table 1). Our findings align with national patterns, where the most hazardous bird species were often water-associated (DeVault et al. 2011). As such, modifying stormwater infrastructure and surrounding vegetation may simultaneously reduce habitat suitability for both coyotes and high-risk bird species. For U.S. airports, AC 150/5200-33 advises operators to design stormwater detention ponds with a maximum 48-hour detention period and to maintain any longer-holding facilities free of emergent and submergent vegetation due to the wildlife hazard posed by open water and vegetation—recommendations that DTW does not currently meet.

Our strike analysis revealed that coyotes more frequently disrupted flight operations than caused physical damage (Table 1). In particular, aborted takeoffs were common when pilots observed coyotes on runways, highlighting the operational risk posed by coyotes. This pattern was consistent with national trends, where "effect on flight" was a key driver behind the hazard ranking of coyotes (DeVault et al. 2011). Although these disruptions were the most frequent outcome at DTW, it is critical not to overlook the fact that coyotes cause substantial aircraft damage at the national scale (FAA & USDA 2024). In the U.S., damaging coyote-aircraft strikes averaged $72,000 of direct costs and 217 hours of aircraft downtime per event (FAA & USDA 2024). Therefore, these events remain a serious concern and highlight the ongoing risk of a damaging strike occurring at DTW if proactive management measures are not taken. This concern is even more relevant considering nationwide increases coyote populations, territory expansion, and their growing ability to thrive in developed environments (Gompper 2002, Kilgo et al. 2010).

We found it concerning that DTW experiences at least one coyote strike or near-strike event per year—especially given the relatively large body mass of coyotes and associated potential for causing aircraft damage (DeVault et al. 2011, Schwartz et al. 2014). These strike and near-strike events were highly concentrated along the western portion of the airfield, particularly near runway 4L–22R (Figure 6). This pattern was consistent with spatial trends identified from our other data sources, including activity observations and conflict reports (Figure 10). Importantly, the alignment between strike reports and our integrated data suggests this is not merely an artifact of detection bias—we are likely observing a true hotspot of coyote activity in the western airfield. Together, our hazard-ranking and strike-summary results underscore the importance of prioritizing proactive coyote management strategies, including improved exclusion measures along the airfield perimeter.

Our integrated data approach revealed notable frequency and spatial trends that raise important wildlife management concerns. Our control chart analysis indicated that the coyote management system was out of control in 2024, supporting our hypothesis that coyote activity exceeded typical levels during this period (Figure 8). These elevated activity levels and associated conflicts were primarily concentrated near Runway 4L-22R, a known wildlife hotspot associated with the largest green space at DTW. This area may serve as an attractant for coyotes and other hazardous wildlife due to its relatively undeveloped landscape and habitat features. The 4L-22R area presents significant challenges for vegetation control, with seasonally tall grass that provides persistent cover (Figure 19). Additionally, the high density of ditches and ongoing construction of berms further complicate management efforts by offering ample concealment and movement corridors for coyotes. These habitat conditions have created a relatively suitable environment for coyotes, including confirmed instances of pup rearing in the area.

Moreover, these same habitat features support a broader community of wildlife, including raptors such as hawks and owls, and small mammals like meadow voles (*Microtus pennsylvanicus*)—species commonly found in the diets of mammalian and avian predators at airports (Baker and Brooks 1981; Stucker and Dunlap 2002; Figueroa and González-Acuña 2006). Red-tailed hawks (*Buteo jamaicensis*) are frequently observed near the 4L-22R area, attracted not only by prey availability but also by thermal updrafts generated by the surrounding berms, which facilitate soaring behavior. This area has also given rise to a conservation dilemma, functioning as an ecological trap (Schlaepfer et al. 2002) for the state-listed endangered short-eared owl (*Asio flammeus*). During the winter of 2025, groups of 20–50 short-eared owls were observed utilizing this densely vegetated area. While this area appears to provide suitable overwintering habitat for short-eared owls, a record annual high of 7 individuals were reported struck during the winter of 2025. This scenario underscores the ongoing conflict between wildlife conservation goals and aviation safety objectives.

Our integrated analysis also identified a secondary coyote activity hotspot within a designated protected-vegetation site known as the Endangered Species Area, prompting a reevaluation of the current value and purpose of preserving this habitat. The site includes water features and open fields, along with fruit-producing and relatively tall vegetation that offer suitable conditions for coyotes, including both food and bedding opportunities (Figure 20). Notably, this 13-acre area is situated near runway 9L-27R, which, although currently closed, is scheduled to reopen in 2025. While this is a crosswind runway and may not experience the same traffic volume as primary runways, its reopening could increase the likelihood of coyote-aircraft conflicts in the immediate vicinity. It is also notable that Detroit Local 4 News recently documented coyote activity in this area, bringing public attention to the issue (Figure 21). Compounding concerns, the management plan for the Endangered Species Area is nearly two decades old and no longer reflects current conservation priorities. Plant species originally targeted for protection—such as three-awned grass (*Aristida longespica*)—are no longer classified as state-threatened or endangered (MNFI 2025). Accordingly, the continued protection of this site warrants reassessment, particularly in weighing the ecological value of maintaining these plant communities against the potential safety risks posed by the habitat they provide for coyotes and other wildlife.

The prevalence of wildlife hazards in airport environments is often underestimated during land-use planning (Blackwell et al. 2009), yet habitat management plays a critical role in influencing wildlife strike frequency (Cleary and Dolbeer 2005; Blackwell and Wright 2006; Dolbeer 2006). When habitat-related attractants are not adequately addressed, aviation safety can be compromised, and conditions may inadvertently support both common and protected hazardous species (Kelly and Allan 2006). These dynamics are particularly relevant to DTW's wildlife management program and are likely contributing to the observed wildlife trends at the airport. Coordinated habitat modification and adaptive management strategies are therefore essential for reducing strike risk while accounting for complex ecological and regulatory factors. Examples of proactive management actions include relocating spoils piles offsite, implementing a routine mowing schedule—particularly in historically problematic areas and implementing preemptive vegetation management to prevent growth beyond optimal height thresholds. Timely mowing not only limits cover for hazardous wildlife species but also helps reduce seed production and long-term vegetation density. It is important to note that when vegetation is allowed to grow taller before mowing, it generates a greater volume of thatch. This dense layer of organic material can provide cover and protection for small mammals such as voles, potentially contributing to population increases and elevating associated predator strike risks. For example, increased prey availability can attract higher predator activity and positively influence predator abundance through enhanced reproduction, including among coyotes and raptors (Gese 2005, Robillard et al. 2016).

Using conflict reports, activity observations, and dig-under detections as indices of coyote activity, we found that activity generally increased throughout the year before declining in December. These seasonal patterns aligned with findings from similar studies (Schwartz et al. 2014; Crain et al. 2015), suggesting that our indices may serve as reasonable proxies for realized coyote activity across the landscape. Importantly, these insights can assist wildlife managers in anticipating and more effectively responding to changes in coyote activity patterns. Several factors may help explain the observed temporal trends. First, reduced winter activity is consistent with coyote behavioral ecology, as individuals tend to exhibit more restricted movement during colder months (Bekoff and Gese 2003). Second, activity typically increases in early summer, coinciding with the emergence of pups from dens at approximately 8–10 weeks of age (June–July). During this period, adult breeders may take more risks and range more widely to provision for dependent young, leading to elevated detection rates (Sacks et al. 1999). Further, juvenile dispersal generally begins around October, which coincided with a peak across our activity-indices. The subsequent decline in activity later in the year may reflect a natural tapering following the weaning period, as well as behavioral changes associated with the onset of breeding and pup-rearing seasons.

One of our routine and time-consuming challenges involved open dig-unders along the perimeter fence, which not only provided access for coyotes but also allowed other mammals to enter the airfield—many of which serve as prey for more hazardous species such as raptors (Figure 13). On average, monthly perimeter fence inspections at DTW required the Wildlife Division approximately 2.5 hours to complete, with an additional 30 minutes spent on each exclusion repair (see spot-treatment example in Appendix F). Historically, WCAA's Field Maintenance team has managed perimeter fence repairs, requiring annual labor equivalent to two full-time employees (Appendix C), in addition to costs for materials and equipment. This substantial maintenance demand highlights the ongoing deterioration of the fence infrastructure. Recent cost estimates further emphasize the financial impact: $78 per foot for complete fence replacement and $48 per foot for skirting alone (rough estimates provided by contractor). When combined with the labor costs already incurred, it becomes clear that ongoing repairs may be less cost-effective than more permanent solutions—like adding skirting material or installing new fencing. To prevent digging and washouts, effective wildlife-deterrent fencing is recommended to extend up to 3–4 ft below ground (Cleary and Dolbeer 2005; DeVault et al. 2008; see Appendix A, Figure A10).

Spatial analysis revealed significant clustering of dig-unders in the northwest area of the airfield, many of which originated from the public side and extended into the secure airfield side. This finding is particularly important given that most coyote-related incidents were also concentrated in the western portion of the airport. The presence of a nearby railroad in this region may serve as a micro-corridor facilitating coyote movement towards the airfield (Way & Eatough 2006). This area may also function as a funnel, further channeling wildlife movement towards the airfield. Vegetation adjacent to these entry points—such as phragmites—can provide important cover for coyotes (Gehrt et al. 2009). In the southern portion of the airfield, another hotspot was identified along a section of fencing that is prone to erosion, making it relatively easy to dig through. This southern digging hotspot was also adjacent to the only nearby agricultural field, a habitat type coyotes are known to prefer over forested areas (Hinton et al. 2015), suggesting that landscape features both inside and outside the perimeter fence are influencing wildlife use of the airfield. Further, this southern stretch of perimeter fencing has been a longstanding concern for WCAA's Public Safety/Security Department due to ongoing issues with fence integrity (Appendix B). These findings, combined with those from the Field Maintenance Department (Appendix C), suggest there is promise in leveraging interdepartmental coordination and data-sharing to build stronger support for perimeter fence improvements.

While informative, our limited sample of body measurements should be interpreted as a baseline reference rather than a comprehensive representation of coyote size. All individuals sampled were older than 7–8 months (youngest estimated to be ~1 year), and some had developed thick winter coats, which likely led to overestimates of body size by excluding younger individuals and seasonal variation in coat characteristics. Additionally, static measurements may not fully capture a coyote's ability to compress or contort its body to fit through smaller openings. For example, video evidence documented individuals passing through gaps approximating our minimum recorded hip width (i.e., 5"). Indirect observations further suggested that coyotes could pass through openings less than 5" wide. This observation followed a fresh snowfall and included unidirectional coyote tracks and hair deposits passing through an excluded hydrologic site (Appendix E, Figure E25). These findings collectively suggest a degree of body flexibility and maneuverability that is not fully captured by static morphometric data.

We accounted for these limitations when evaluating the relationship between coyote body size and the size of gaps they can cross through—and we incorporated these considerations into our management recommendations. Specifically, we proposed gap-space limits that were slightly smaller than our minimum coyote hip width and chest height measurements (Figure 1). Our intent with this approach was to accommodate seasonal variation in body condition and fur characteristics, account for body flexibility, and ensure exclusion across multiple age classes (e.g., older juveniles and adults). Additionally, these smaller gap-limit recommendations may help prevent access by other mammals that pose risks to airfield operations or serve as important prey for hazardous species.

Our site inspections revealed widespread noncompliance with WCAA's Public Safety/Security SP20 gap-size standards, including exceeding the original [redacted] limits. These results may be due to structures shifting or deteriorating over time. However, some of the deficiencies identified along the perimeter were present even in newly constructed infrastructure, indicating that the challenge of implementing Security SP20 standards is both historic and ongoing (e.g., Appendix E, Figure E21). This is an important challenge because when non-compliance occurs repeatedly—especially without consistent correction—it can persist or even worsen over time (i.e., operant conditioning; Skinner 1938). Further, this type of compliance erosion can extend beyond the immediate issue, diminishing the credibility and effectiveness of related standards meant to uphold quality, safety, and compliance. Addressing these vulnerabilities proactively is therefore essential not only to mitigate immediate risks, but also to preserve the integrity and authority of the broader regulatory framework at DTW.

During this study, we collaborated with the Public Safety/Security Department to revise the SP20 document to incorporate our recommendations (Figure 1). When assessed against the updated 2025 SP20 standards, 80% of the surveyed sites (74/93) failed to meet the new criteria. These included [redacted] gate sites, [redacted] hydrologic sites, and [redacted] fence sections. [redacted]

[redacted] Our findings here suggest that culvert swing gates and fence gates may not effectively exclude coyotes from entering the airfield.

Common gate deficiencies included large gaps at the bottom corners where the gate leaf met either a fence post or an adjoining gate leaf (e.g., Appendix E, Figures E34 and E52). [redacted] Maintenance issues were also frequently documented at culverts and other hydrologic features (e.g., drains, ditches, wetlands), including broken components caused by mechanical failure or erosion, as well as culvert gates left lodged open—conditions that significantly reduced their effectiveness (e.g., Appendix E, Figures E5 and E15). These findings highlight the importance of standardizing exclusion practices and implementing a routine maintenance program for perimeter fencing and associated structures to ensure long-term effectiveness (DeVault et al. 2008; Crain et al. 2015).

Coyotes were identified as a relatively high-risk species at DTW, with evidence showing they were gaining access to the airfield through multiple poorly secured areas. These findings supported our hypothesis that coyotes were entering the airfield by means other than digging. Although our camera-trap data came from a limited number of sites and represented a relatively small sample, the results were surprising. We documented coyotes both entering and exiting the airfield, indicating bidirectional movement—particularly at hydrologic sites—and often observed multiple individuals moving together. In several locations, coyotes were breaching the perimeter with notable frequency through gaps 5–6" in width. For instance, at one site where we monitored a portion of a culvert gate, coyotes were observed passing through the exclusion device (i.e., gate) multiple times per day, and on consecutive days (3 crossings per day, sustained over a 4-day period). Since entire sites were not surveyed and our metrics rely on observations from only a subset of locations, our results likely underestimate the true frequency of use. This is an important distinction, as it indicates that although our reported values may appear high, the actual frequency of the problem is likely much higher—underscoring the need for more comprehensive perimeter monitoring and enhanced exclusion efforts at DTW.

Digging into the airfield may represent a secondary mode of entry, with primary access more likely occurring through structural gaps—such as those found in culvert gates. Notably, 67% of recorded dig-under events were directed from the airfield to the public side, supporting this interpretation. It is also important to consider the role of seasonality, which may influence the location and use of these primary access points (e.g., Appendix E, Figures E7 and E8). For instance, culverts may be more heavily used during periods of low water flow or when frozen, functioning as dry or semi-dry corridors (Tigas et al. 2002). At our most active winter site (Site 1305), camera-trap data from the summer monitoring period (23 June–30 July) included zero coyote crossing events. This lack of activity may be attributed to seasonal inundation, which contrasts with frozen winter conditions that likely facilitate easier movement across the site. However, it is important to note that coyote tracks were observed in the mud at this location during a previous dry summer (Appendix E, Figure E10), and we have recently documented coyotes traversing culvert swing gate gaps even in water depths of approximately 1–3 feet (Figure 22).

Although the postmortem sample size in this study was limited, it was notable that all lethally removed coyotes were female—a pattern consistent with other airport wildlife management programs reporting female-biased removals [redacted]. Anecdotal evidence from early stages of DTW's wildlife program (~2016) suggests a higher proportion of males were removed at that time, indicating potential shifts in demographic composition or behavior over time. Older coyotes may be more vulnerable to lethal control after breeding, limiting the population reduction potential of such management. Ideally, removal efforts should target individuals across all age and sex classes—including pups and lactating females—to more effectively suppress population growth and immediate hazard risks. However, indiscriminate lethal removal can provoke social conflict (Martínez-Espiñeira 2006; Buteau et al. 2022). As societal values evolve, opposition to lethal wildlife management is increasing, reflecting a shift from control-focused approaches toward coexistence (Bergstrom 2017). Therefore, management strategies emphasizing exclusion rather than lethal control may be more acceptable to both WCAA staff and the public.

Our data also highlights limitations of current removal efforts. Despite 55 reported conflicts, only 7 coyotes were lethally removed via firearms, yielding a removal rate of approximately 13 coyotes per 100 reported conflicts. Further, from November 2024 to March 2025, trapping efforts (coil-spring traps and snares) involving approximately 1,200 trap nights (24-hour active trap periods) resulted in only 3 coyotes removed—a success rate of 0.25 individuals per 100 trap nights—underscoring the challenges of managing coyote hazards through lethal means alone. Collectively, these findings suggest that while lethal management contributes to hazard mitigation, integrating enhanced exclusionary strategies could improve both effectiveness and social acceptance of coyote management at DTW.

This study provides a systematic, data-driven tool for identifying and ranking structural exclusion needs. By integrating morphometric-informed gap standards with land cover data and confirmed coyote access points, we developed a composite scoring system that balances both structural vulnerability and ecological context. Our findings offer a nuanced understanding of how physical site features and landscape-scale habitat patterns interact to influence the likelihood of coyote access, providing a defensible framework for exclusion prioritization. One of the most notable outcomes was the clear association between site type and priority level. All Very High priority sites were hydrologic [redacted], and most High priority sites were hydrologic (56%). These results emphasize the importance of landcover composition on coyote activity and the significance of hydrologic sites, specifically culverts, as movement corridors for coyotes accessing the airfield. In particular, culvert sites represented key vulnerability points along the DTW perimeter—likely due to their complex structural designs and frequent adjacency to natural cover. These patterns support our hypothesis that not all structure types pose equal risk, and that exclusion efforts may be more effective if focused on specific, high-risk categories—particularly those associated with water-management infrastructure.

The spatial distribution of priority sites further reinforces this conclusion. Higher-ranked sites clustered along the southern and southwestern perimeters, while lower-priority sites were more common in the northern and northeastern regions (Figure 18). This geographic trend aligns with the surrounding landscape composition: southern portions of the airport are generally adjacent to more contiguous patches of natural land cover. The presence of these habitats likely increases the probability of coyote presence and movement near structural vulnerabilities, reinforcing the utility of incorporating land cover into the prioritization process. Our results also validated the incorporation of confirmed access data into the prioritization model. By assigning a bonus score to sites with documented coyote use, we ensured that empirically verified vulnerabilities received appropriate weight without disproportionately diminishing the importance of structurally or ecologically high-risk sites lacking direct observations. This balanced approach enhances the model's utility for real-world management, particularly in resource-limited contexts. Although the model has inherent limitations—such as reliance on user-defined weight assignments—its predictive robustness remained evident. For example, when confirmed access data were excluded from the model, sites with known coyote access still ranked as Very High or High priority. This outcome reinforced the model's reliability and value as a practical decision-support tool for exclusion planning.

Future investigations may be necessary to better understand and reduce coyote access and activity at DTW. One area of interest is coyote use of culverts and other structures located within the airfield perimeter. DTW staff have observed coyotes using these features for cover, and similar use of culverts as movement corridors across airfields has been reported at other airports [redacted]. Additionally, observations at DTW suggest potential pup-rearing activity occurring within the airfield, stressing the value of early detection. Identifying denning sites prior to parturition could allow for more proactive management, potentially using thermal-imagery unmanned aerial vehicles (i.e., drones; Bushaw et al. 2019; Ranglack et al. 2024). In parallel, evaluating the effectiveness of upgraded exclusion devices may include real-time monitoring data and tracking mitigation outcomes at excluded sites (e.g., camera trapping). It may also be important to track changes in coyote spatial patterns in response to management actions, as new access points or hotspots may emerge over time. Lastly, future efforts may include working with departments such as Public Safety/Security and Field Maintenance to identify shared problem areas through spatial analysis, allowing for more targeted and cost-effective treatments.

We recognize that our results were derived from historical data, reflecting past patterns rather than real-time risks. As wildlife populations, behavior, and surrounding land use continues to change, we acknowledge that ongoing monitoring and adaptive management may be necessary to identify and address emerging wildlife hazards. Other limitations of this study included the use of non-standardized surveys, variation in survey effort, imperfect detection, data drawn from different time periods, incomplete datasets, small sample sizes, and location uncertainty in some records. Many of these limitations reflected the need to balance competing, time-sensitive, and often unpredictable work obligations—such as responding to wildlife-aircraft strikes or addressing immediate hazards near runways. Lastly, we assumed to have surveyed all potential access points along the perimeter, but it is possible that some additional sites may exist. Despite these constraints, we identified consistent trends with important implications for wildlife management and public safety—both at DTW and other airports.

While completely preventing coyotes from accessing DTW's airfield may be unrealistic—for example, they may scale fences [redacted]—a more feasible long-term goal is to simultaneously reduce the frequency of coyote conflicts and the need for lethal management. Therefore, maintaining a low frequency of coyote conflict is likely to be most effective when multiple management techniques are used in combination (Schwartz et al. 2014). Further, long-term management plans are critical for realizing the cost- and risk-reducing benefits of airport wildlife management programs, especially when they build on historical knowledge and practices like those presented here (Altringer et al. 2024). Examples of such strategies include multi-year efforts like habitat modification, prescribed land-use changes, and—in our case—enhanced perimeter exclusion (Blackwell et al. 2009; Pfeiffer et al. 2018). Importantly, the benefits of such long-term management programs can exceed their costs by a ratio of 7:1, primarily due to reductions in wildlife strike-related expenses (Altringer et al. 2024). Therefore, taking a more proactive approach to integrated, long-term wildlife hazard management is not only ecologically and operationally sound, but also economically justified.

In summary, our results provided meaningful baseline metrics and supported the development of centralized databases to inform future assessments at DTW—laying the groundwork for enhancing long-term exclusion and wildlife hazard management practices. As mammalian species composition can vary across airports, site-specific management strategies may be necessary to address the unique risks at each location (Biondi et al. 2014). Although our study focused on coyotes, our approach could be adapted to assess other hazardous mammalian species. Applying this approach more broadly could inform targeted improvements to exclusion practices and wildlife management strategies at other airports—further enhancing public safety, efficiency of operations, and airfield security at the national scale.

Figure 19. Top and bottom images showing seasonally tall vegetation on the west side of the Detroit Metropolitan Wayne County Airport airfield. This vegetation provides cover for hazardous wildlife species and associated prey, contributing to increased strike risk.

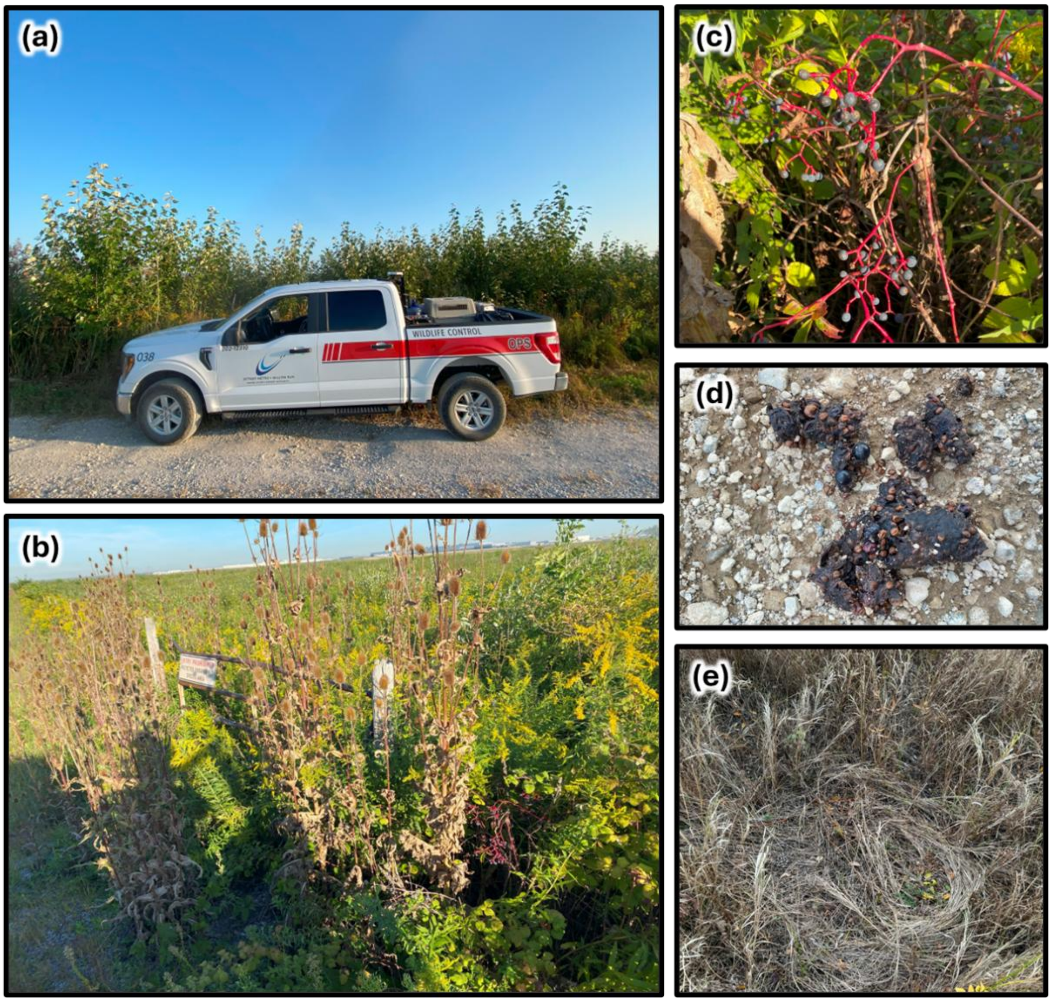


Figure 20. Site characteristics and field observations within Detroit Metropolitan Wayne County Airport's Endangered Species Area—a 13-acre designated protected vegetation site—including: (a, b) areas of tall vegetation; (c) presence of fruit-producing plant species; (d) evidence of fruit consumption in coyote scat; and (e) signs of coyote bedding activity.

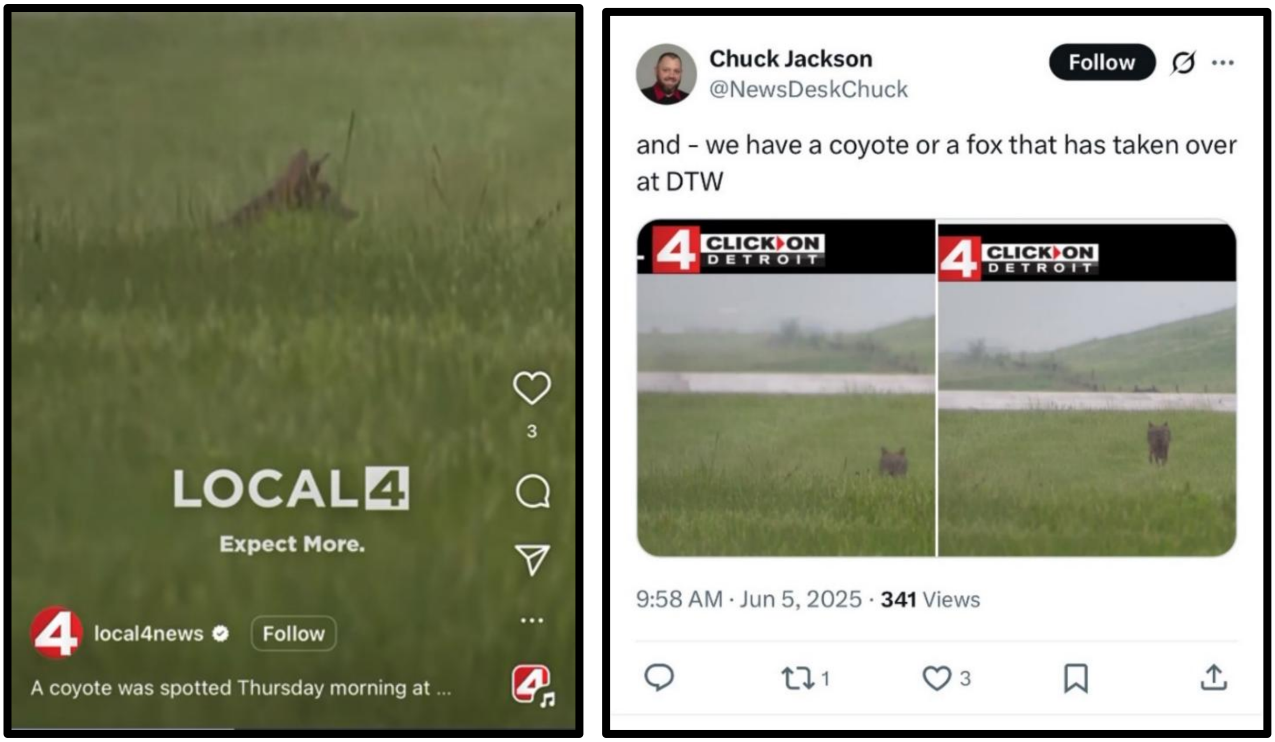


Figure 21. Screenshots from Detroit Local 4 News broadcasts documenting coyote activity on the Detroit Metropolitan Wayne County Airport airfield, in the vicinity of Runways 27L/9R, adjacent to a designated protected-vegetation site known as the Endangered Species Area.

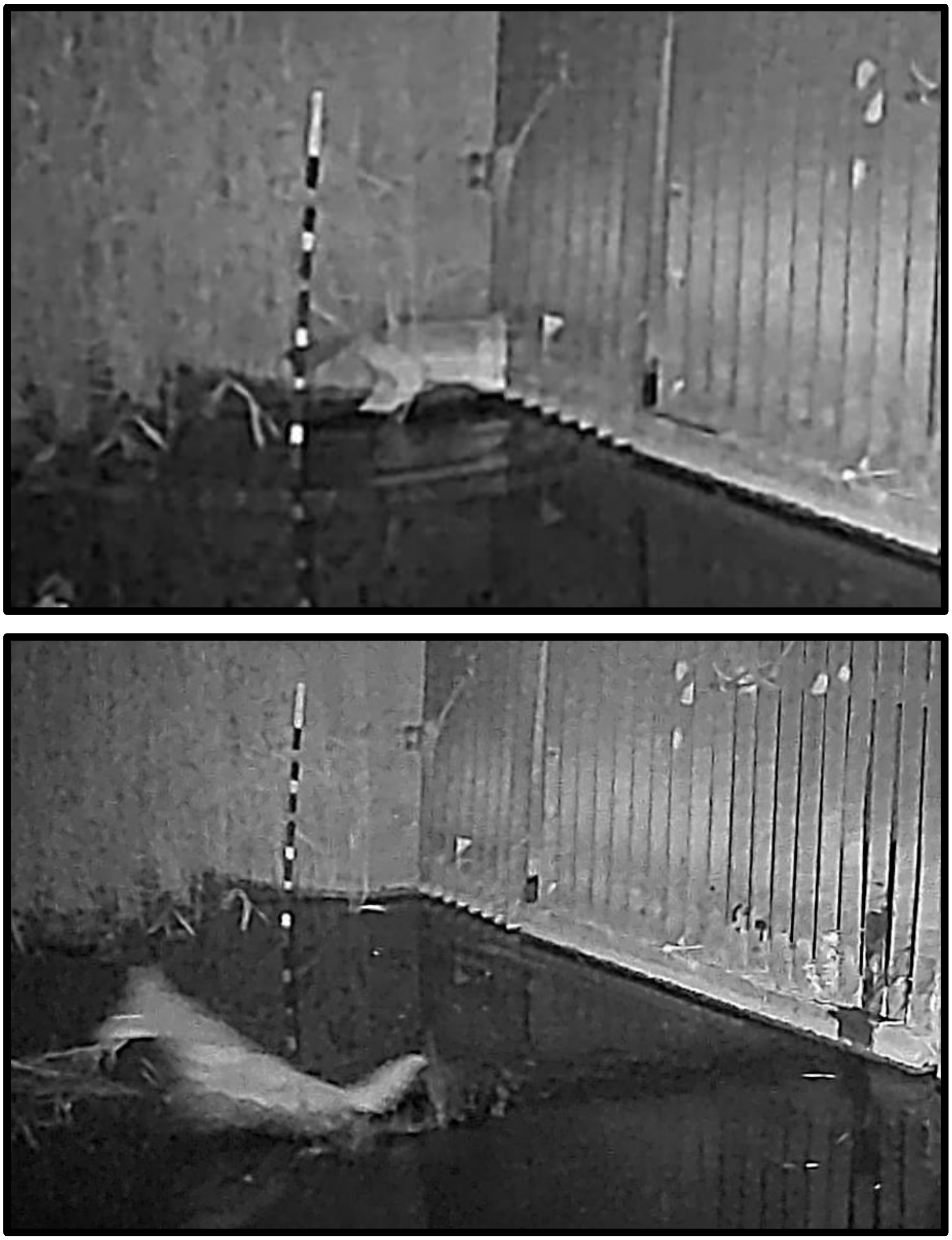


Figure 21. Video screenshots from Detroit Metropolitan Wayne County Airport of coyotes moving through water approximately 1 to 3 feet deep in order to cross a culvert gate at the perimeter of the airfield.

Ethics statement

This research acknowledges the ethical considerations involved in the lethal management and handling of wildlife at airports. All wildlife removal activities referenced in this study were conducted under appropriate federal and state permits, including those issued by the U.S. Fish and Wildlife Service and relevant state wildlife agencies. These actions were carried out in accordance with established legal and ethical guidelines and were aimed at protecting human life and ensuring aviation safety by mitigating the risk of wildlife-aircraft strikes. The research does not endorse unnecessary harm to wildlife and supports the use of non-lethal methods whenever feasible. Ethical wildlife management practices, including habitat modification and deterrence, are emphasized as primary strategies, with lethal control considered only as a last resort and in full regulatory compliance.

Data availability

The R code used for main analyses in this study are available at the GitHub repository: https://github.com/Steven-M-Gurney/Coyote_Management_Assessement. Note that some data used were security sensitive and therefore were not made available with the code. These internal data were housed with the WCAA Airfield Operations/Wildlife Special Publications database.

Appendix A: WCAA-USDA recommendation 2024

United States Department of Agriculture

ATTN: March 27, 2024

Wayne County Airport Authority
11050 W Rogell Drive
Building 602
Detroit, MI 48242

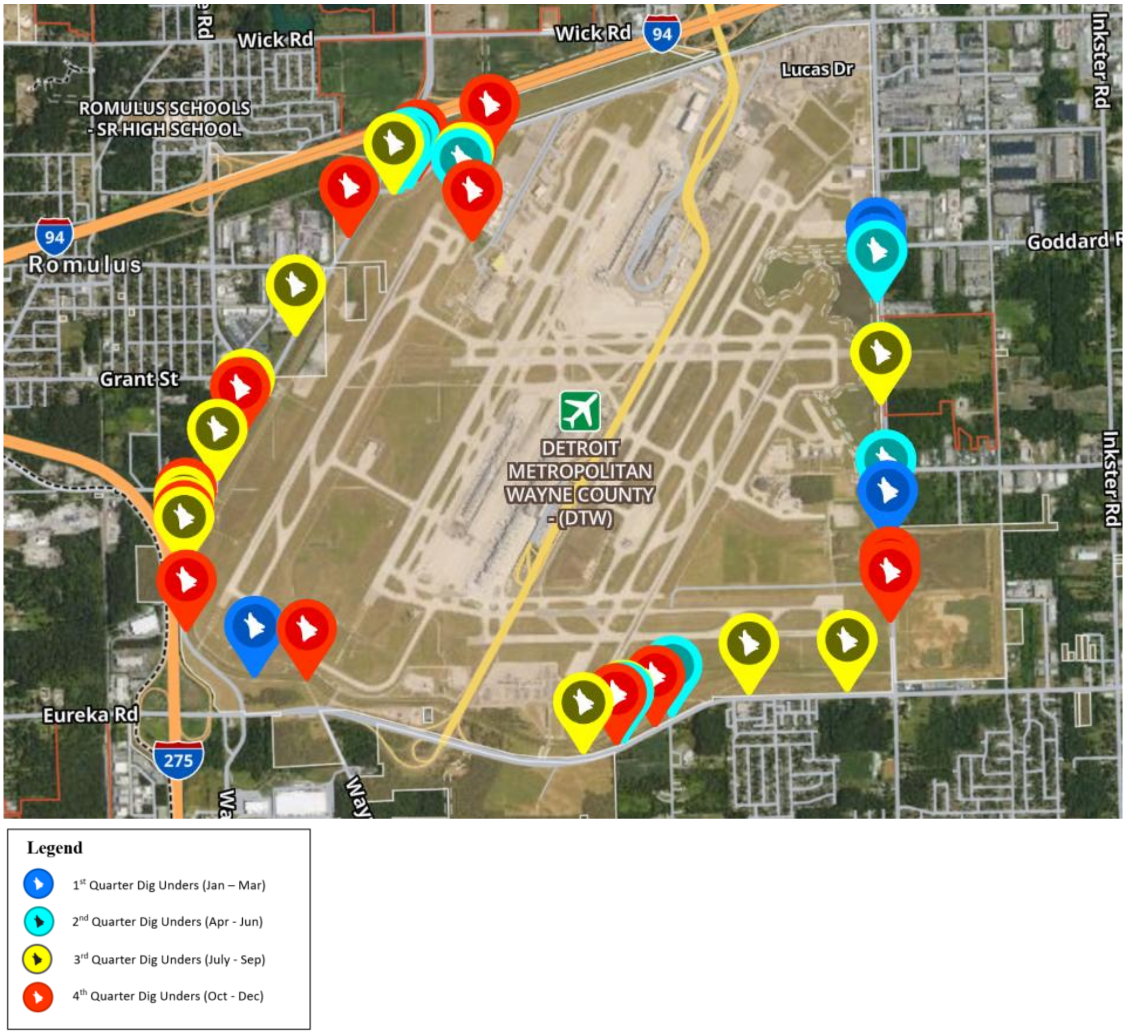
To Whom it May Concern,

This is a formal recommendation provided by USDA Wildlife Services and Wayne County Airport Authority (WCAA) Wildlife staff regarding wildlife deterrent skirt fencing at Detroit Metropolitan Airport (DTW). WCAA and USDA Wildlife Biologists have observed a significant amount of coyote (*Canis latrans*) on the airfield (approximately 20 observations per year). Coyotes pose a threat to airfield safety and, when one is seen on the airfield, it is considered a high priority situation. According to the FAA's Wildlife Strikes to Civil Aircraft in the United States, (1990-2022), there have a total of 824 strikes involving coyotes over the past 30 years. Of these, 66 were damaging strikes causing a total of $4,650,500 in damage and 16,830 hours of aircraft downtime. It is also notable that 177 of the strikes involving coyotes had a negative effect on flight (NEOF).

Current management strategies include exclusion via wildlife deterrent fencing ("skirting"), harassment, and lethal removal. Lethal removal is carried out by either firearm or foothold traps; however, there are limitations when it comes to lethally removing coyotes from the airfield. Foothold traps are labor intensive (requiring daily checks) and can be inconsistent depending on time of year, weather, and skill level. Shotguns have a limited range which require proximity to the animal, and rifles cannot be used without a proper backstop which are limited across the airfield. On average of approximately 20 coyotes observed annually, five are able to be lethally removed.

Wildlife staff are taking a proactive approach to exclude coyotes from entering the airfield by conducting perimeter fence checks. Perimeter fence checks began in January 2023 and are conducted monthly. Supplemental checks are also conducted when there are coyote sightings on the airfield. Perimeter checks are conducted by two wildlife staff driving an ORV around the entire perimeter fence to look for dig unders. Dig unders are then mapped, and a work order is submitted to WCAA Airfield Maintenance to install underground skirting and backfill the dig under (Figure A3). Skirting has been sporadically used by maintenance but is not done consistently every time a work order is placed. Potential reasons for this inconsistency include budgetary constraints, supplies, or lack of staffing.

Dig under locations have been documented around the entire airfield (Figure A1), with "hot spots" emerging over time. Different color markers indicate the time of year that the dig under was identified (see legend). Hot spots are defined by areas of repeated dig unders within the same area (Figures A4-A7). For example, a new dig under will be identified 15-20 yards away from an area that has been "spot treated" with a small section of skirting. These hot spots lead to repeated work order submissions.



1. Perimeter fence dig unders (January 2023 – present).

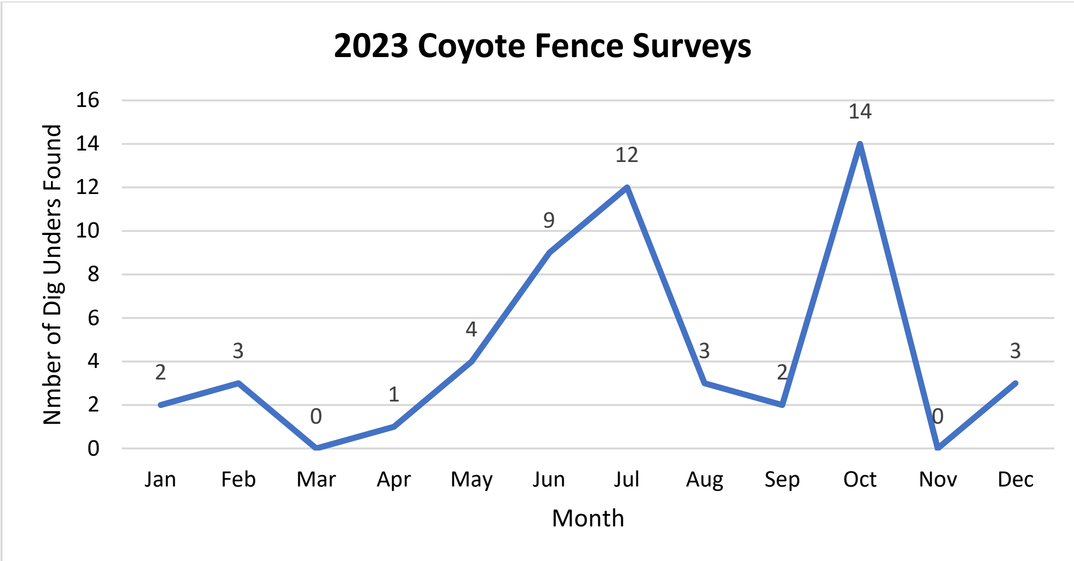
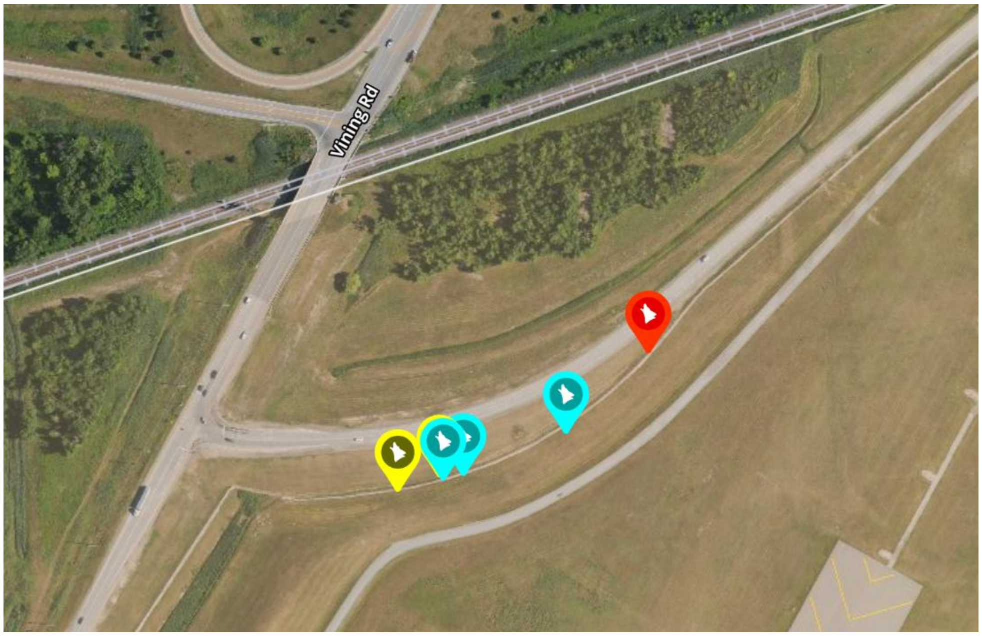


Figure A2. Dig unders identified during perimeter fence checks by month in 2023.

Date	Work Order #	Coordinates
1/6/2023	22812313	[redacted]
1/6/2023	22812313	
2/14/2023	22884722	
2/14/2023	22884729	
2/14/2023	22884730	
4/20/2023	23168639	
5/16/2023	23220502	
5/16/2023	23220509	
5/16/2023	23220510	
5/16/2023	23220511	
6/2/2023	23255570	
6/2/2023	23255572	
6/2/2023	23255573	
6/2/2023	23255574	
6/2/2023	23255575	
6/2/2023	23255576	
6/15/2023	23281663	
6/15/2023	23281664	
6/15/2023	23281665	
7/11/2023	23343718	
7/11/2023	23343719	
7/11/2023	23343721	
7/27/2023	23374033	
7/27/2023	23374035	
7/27/2023	23374037	
7/27/2023	23374039	
7/27/2023	23374040	
7/27/2023	23374041	
7/27/2023	23374043	
7/27/2023	23374044	
7/27/2023	23374045	
8/16/2023	23412723	
8/17/2023	23412724	
8/18/2023	23412725	
9/21/2023	23485511	
9/21/2023	23485512	
10/19/2023	23545087	
10/19/2023	23545090	
10/25/2023	23555045	
10/25/2023	23555046	
10/25/2023	23555047	
10/25/2023	23555048	
10/26/2023	23557531	
10/26/2023	23557533	
10/26/2023	23557535	
10/26/2023	23557537	
10/26/2023	23557538	
10/26/2023	23557539	
10/26/2023	23557540	
10/31/2023	23578047	
12/5/2023	23645759	
12/21/2023	23676209	
12/21/2023	23676210	

Figure A3. Work orders submitted for perimeter fence dig unders (January 2023 - present).

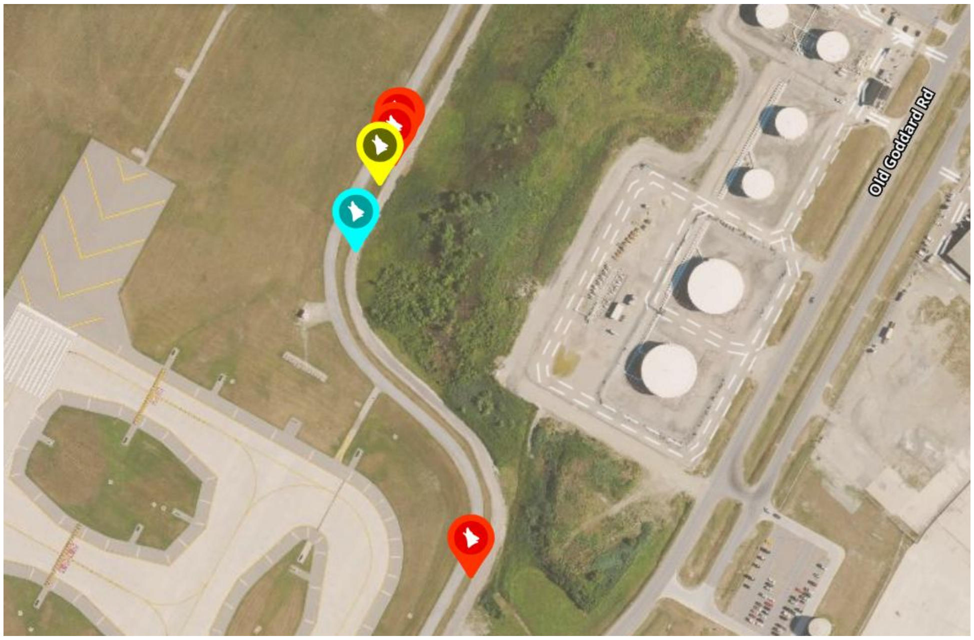


NW Perimeter Hotspot		
5/16/2023	23220510	[redacted]
6/2/2023	23255576	
6/15/2023	23281665	
7/11/2023	23343718	
7/27/2023	23374035	
9/21/2023	23485512	

Figure A4. Dig unders along NW perimeter fence in the vicinity of Vining Rd (January 2023 - present).

SW Perimeter Hotspot		
7/11/2023	23343721	[redacted]
7/27/2023	23374041	
7/27/2023	23374040	
9/21/2023	23485511	
10/26/2023	23557539	
10/26/2023	23557538	
12/21/2023	23676210	

Figure A5. Dig under locations along southwest perimeter fence adjacent to Wayne Rd (January 2023 - present).



Fuel Farm Hotspot		
5/16/2023	23220511	[redacted]
7/27/2023	23374033	
10/19/2023	23545090	
10/19/2023	23545087	
10/25/2023	23555048	
10/31/2023	23578047	
12/5/2023	23645759	

Figure A6. Coyote dig unders along perimeter fence near Fuel Farm (January 2023 - present)**.**

Eureka Rd Hotspot		
6/2/2023	23255570	[redacted]
6/2/2023	23255572	
7/27/2023	23374043	
8/17/2023	23412724	
8/18/2023	23412725	
10/26/2023	23557533	
10/26/2023	23557531	

Figure A7. Dig unders along Eureka Road (January 2023 - present).

Figure A8. Failed dig under attempt highlighting efficacy of skirting. The hole is 2.5-3' in depth**.**

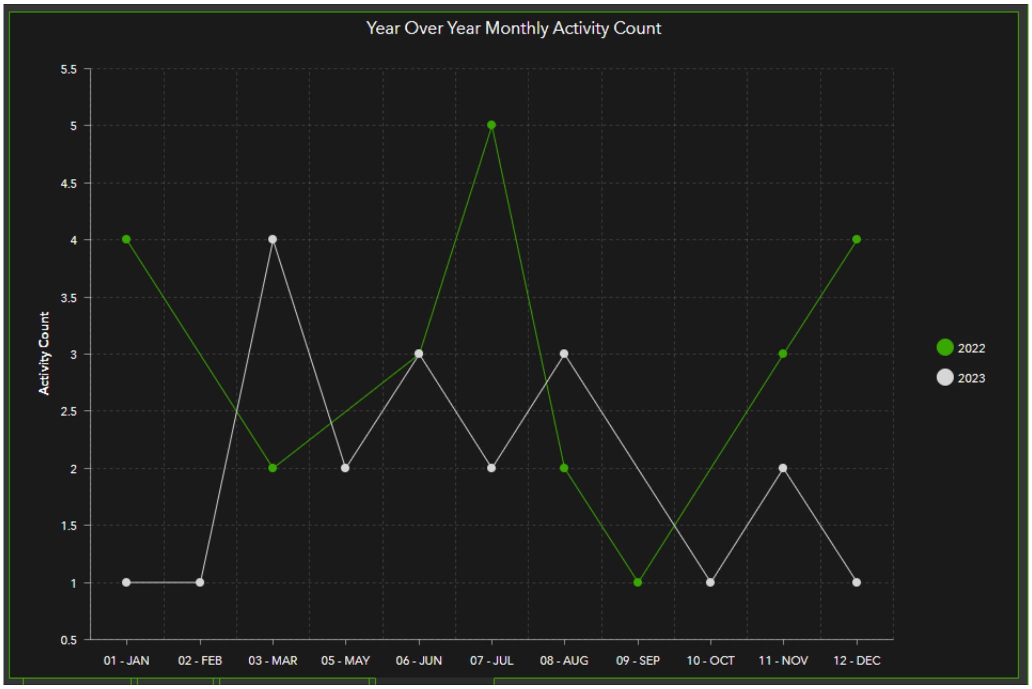


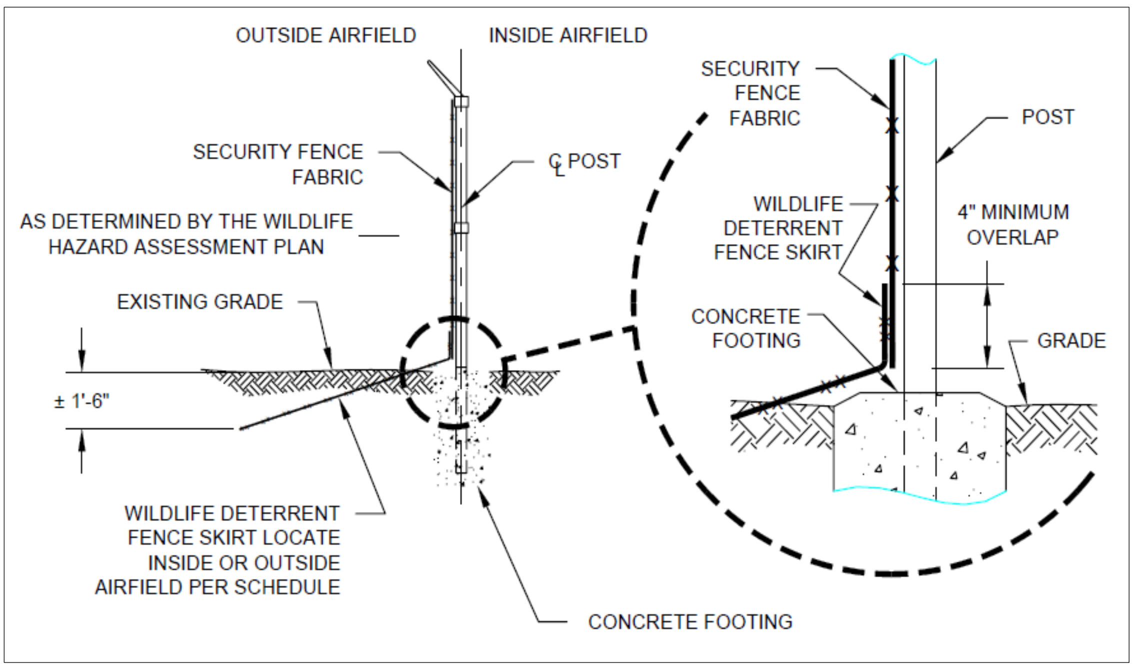
Figure A9. Coyote observations (2022-2023). Note seasonal fluctuations of activity but overall decrease in observations since perimeter fence checks began in early 2023.

Recommendations:

- Installing of skirting along the entire airfield perimeter fence.
- Skirting should be installed according to CertAlert 16-03 (Figure A10).

Spot treating the perimeter fence is not a long-term solution as coyotes continue to dig under the fence within days to weeks after a small section of skirting is installed. Installing skirting around the entire perimeter fence is a more durable solution for reducing the number of coyotes on the airfield. This will, in turn, positively impact the safety of the flying public.

Figure A10. Proper installation of skirt fencing according to FAA Part 139 CertAlert No. 16-03.



Appendix B: Public Safety/Security perspective

In collaboration with WCAA's Public Safety/Security department, this summary was developed to highlight challenges the department faces relevant to perimeter fencing at DTW. Perimeter fence integrity at DTW has been a long-standing concern for WCAA's Public Safety/Security Department, with limited progress made despite repeated attempts to address the issue. The TSA-approved Airport Security Program (ASP), under 49 CFR Part 1542 § 1542.203, mandates that the airport adhere to, at a minimum, FAR 139 safety standards. [redacted]

Over the years, a range of problems have been consistently documented, including severe erosion, compromised decorative fencing, heaving fence posts, leaning sections, and significant gaps (~1 foot) between the upper fence fabric and the barbed wire (Figures B1–B4). [redacted] Additionally, the fence is ineffective in excluding wildlife in several areas [redacted]. Many of these deficiencies are worsened by persistently wet ground conditions and the lack of protective barriers against vehicle collisions, which can further accelerate structural failure. One of the most problematic segments is a 1.6-mile stretch located along Eureka Road, which has become a persistent source of concern for other departments as well, including Airfield Operations/Wildlife and Field Maintenance. This area has required repeated work orders over several years in an attempt to maintain minimal security and regulatory compliance. Without a comprehensive rehabilitation effort, the perimeter fencing will continue to pose safety and security risks, increase operational burdens, and fall short of federal requirements.

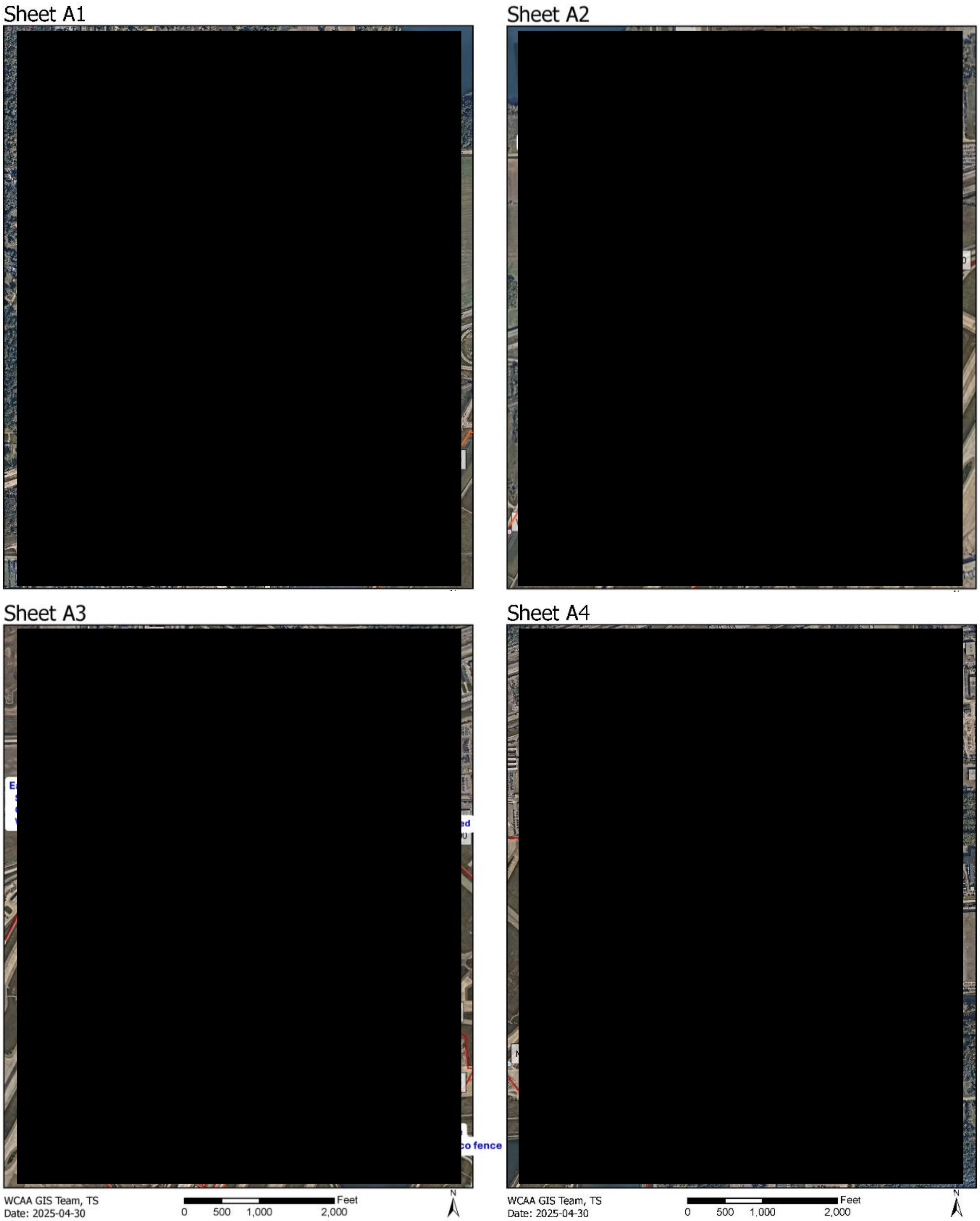


Figure B1. Annotated northern-DTW service area maps (Sheet A1–A4) produced by Public Safety/Security, highlighting high-priority perimeter sites identified for infrastructure repair and replacement.

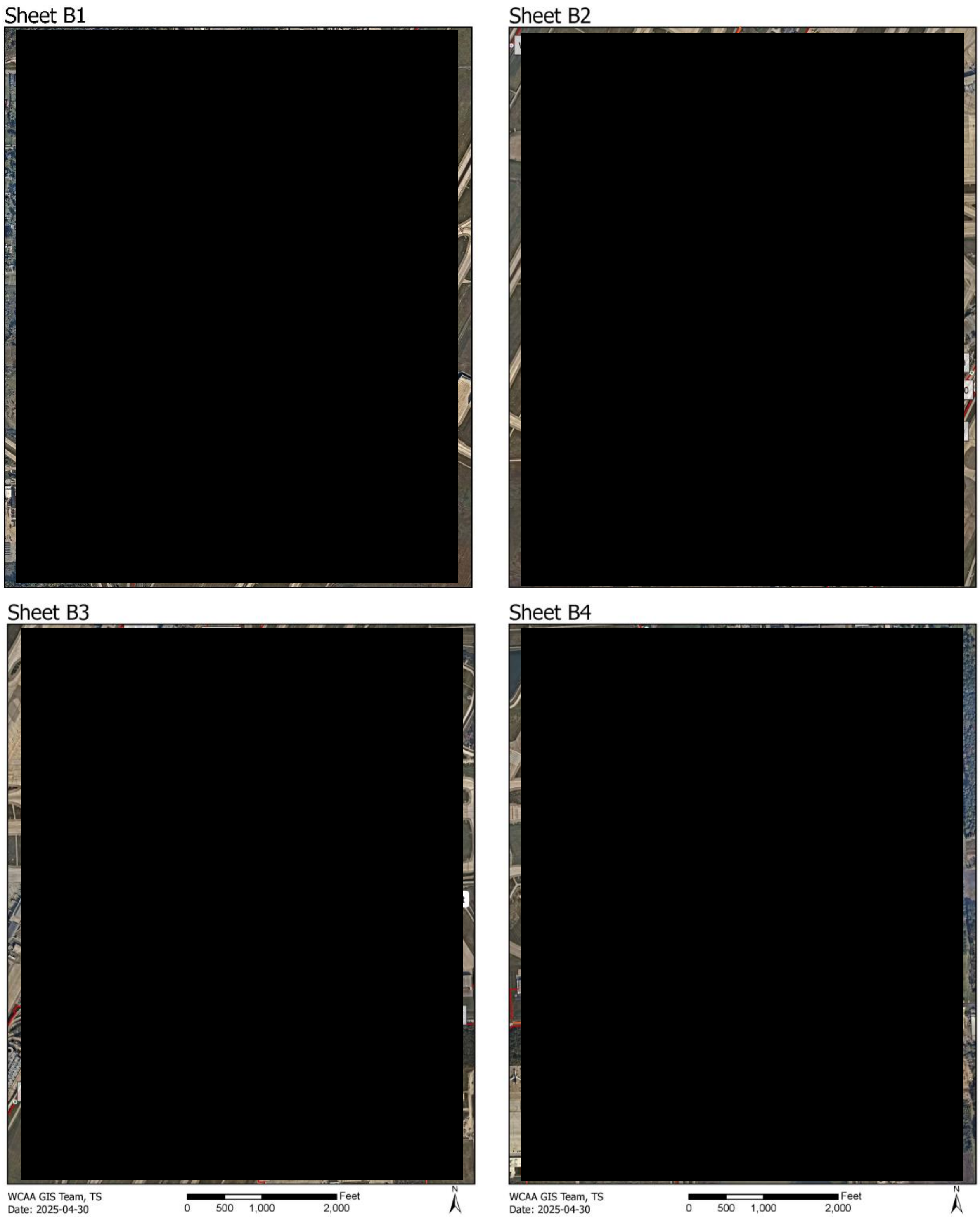


Figure B2. Annotated central-DTW service area maps (Sheet B1–B4) produced by Public Safety/Security, highlighting high-priority perimeter sites identified for infrastructure repair and replacement.

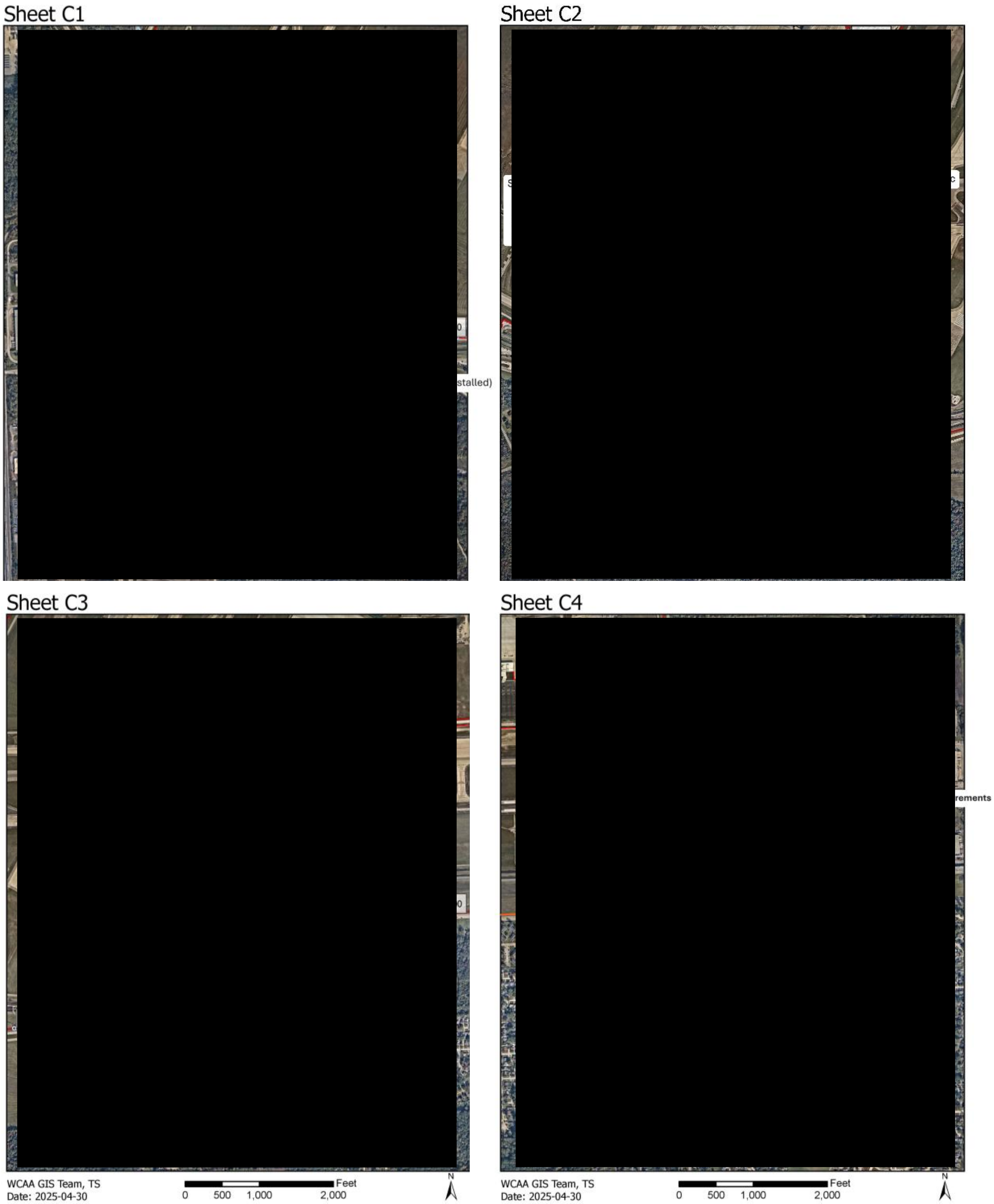


Figure B3. Annotated southern-DTW service area maps (Sheet C1–C4) produced by Public Safety/Security, highlighting high-priority perimeter sites identified for infrastructure repair and replacement.

Figure B4. Examples of perimeter-fence problems at DTW, highlighting the need for infrastructure repair and replacement. From top to bottom, left to right: large gaps between the upper fence fabric and the barbed wire, leaning sections of fencing, and heaving fence posts.

Appendix C: Field Maintenance perspective

In collaboration with WCAA's Field Maintenance department, this summary was developed to highlight challenges the department faces relevant to perimeter fencing at DTW. Data here were collected using a work-order query from January 1st, 2020, through July 22nd, 2025. This approach included Maximo keyword searches using the word "perimeter" and summarizing data by year, including the total number of work orders completed and the amount of associated labor hours. Note that because of inconsistent data collection these results should be viewed as baseline metrics and not used for evaluating year-to-year trends.

Between 2020 and 2024, DTW averaged approximately 293 perimeter-fence-related work orders annually, with a peak of 473 in a single year (Figure C1). These work orders translated into an average of 2,315 labor hours per year and reached as high as 3,702 labor hours in a single year—equivalent to nearly two full-time employees (Figure C1). This sustained workload reflects the significant and recurring maintenance burden posed by the current state of the perimeter fence. Further, much of the perimeter fence is poorly placed in ditch lines and narrow spaces, making it challenging to access and maintain. Note that Field Maintenance response times may be delayed for perimeter-related issues, especially during the growing season when overall workload increases, and priorities tend to be focused on areas closer to runways. Investing in comprehensive repairs or upgrades may not only reduce the ongoing strain on maintenance resources but could also result in long-term cost savings and operational efficiency. Overall, the high level of effort reported is an important consideration in evaluating the value and urgency of addressing the fence's deficiencies.

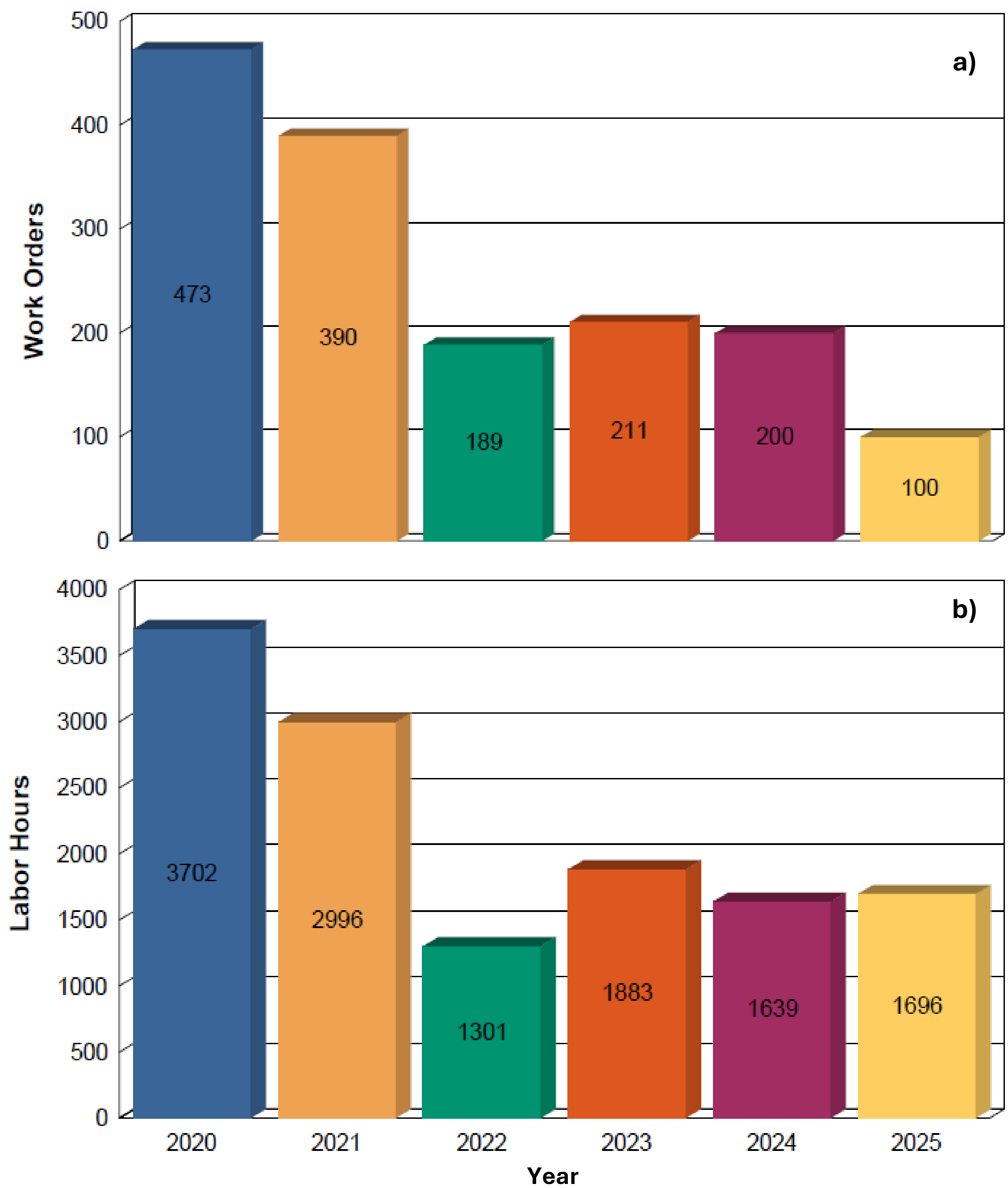


Figure C1. Summary of perimeter-fence related work orders by year, including a) the total number of work orders completed and b) the amount of associated labor hours, January 1st, 2020 through July 22nd, 2025. Between 2020 and 2024, DTW averaged approximately 293 perimeter-fence-related work orders annually, with a peak of 473 in a single year, translating to an average of 2,315 labor hours per year and as high as 3,702 labor hours—equivalent to nearly two full-time employees. Note that because of inconsistent data collection these results should be viewed as baseline metrics and not used for evaluating year-to-year trends.

Appendix D: Coyote aging resources

The following notes provide key information on coyote life history traits, anatomy, and behavioral patterns relevant to age classification and management considerations:

- Tooth wear and replacement patterns are useful indicators for estimating canine age (Table D1; Figures D1–D3; Gipson et al. 2000, Maher 2002, McKenzie et al. 2020).
- Coyotes are capable of breeding at one year of age, though most individuals that reproduce are at least two years old.
- The breeding season typically occurs from mid-January through early March.
- Gestation lasts approximately 60 days, with litters (4–7 pups) usually born in April or May.
- Pups begin emerging from dens at around 8–10 weeks of age (June–July), at which point they begin transitioning to solid food. During this period, adults may exhibit increased risk-taking behavior to provision for their young (Sacks et al. 1999).
- Juveniles under five months old can often be identified by the presence of milk teeth. Permanent teeth typically replace milk teeth by 6 months of age (October–November), with canine teeth erupting between 4 and 5 months (August–October; Figure D1; McKenzie et al. 2020).
- Because coyotes may chew preferentially on one side of the mouth, dental wear can be asymmetrical; therefore, both sides should be examined for accurate assessment.
- In adult coyotes, the lower canine teeth exhibit distinct wear patterns that can assist in age determination (Figure D2; Maher 2002).
- For the purposes of this study, coyotes were classified as adults beginning in January of the calendar year in which they reached approximately 8–9 months of age.

Table D1. Coyote aging guide based on dental characteristics for juveniles and adults, adapted from Gipson et al. 2000 and Maher 2002.

Age class	**Incisors**	**Canines (lower)**	**Carnassial**
Juvenile (<1 yr)	• May include milk teeth or evidence of tooth replacement • Bright white • Sharp edges project slightly beyond lobes	• May include milk teeth or evidence of tooth replacement • Bright white • Pointed • No wear on posterior tip of crown • Prominent ridges on posterior and anterior edges	• May include milk teeth or evidence of tooth replacement • Bright white • Sharp edges • No visible wear
Adult (≥1 yr)	• Wear on sharp edges or lobes worn flat	• Potential tartar build-up • Ridges worn and less distinct • Slight rounding at the tip or shortened profile with point worn flat and oval shaped • Wear on posterior surface, angular like	• Progressive wear, from no visible wear, to wear on major points, to wear on major and minor points • It takes a few years to show any wear (>3 years)

Figure D1. Examples of coyote tooth replacement and wear patterns by age class (McKenzie et al. 2020), from top row to bottom: <6 months, 1–2 years, 3–5 years, and 6–9 years. Note that we only classified individuals as juvenile or adult.

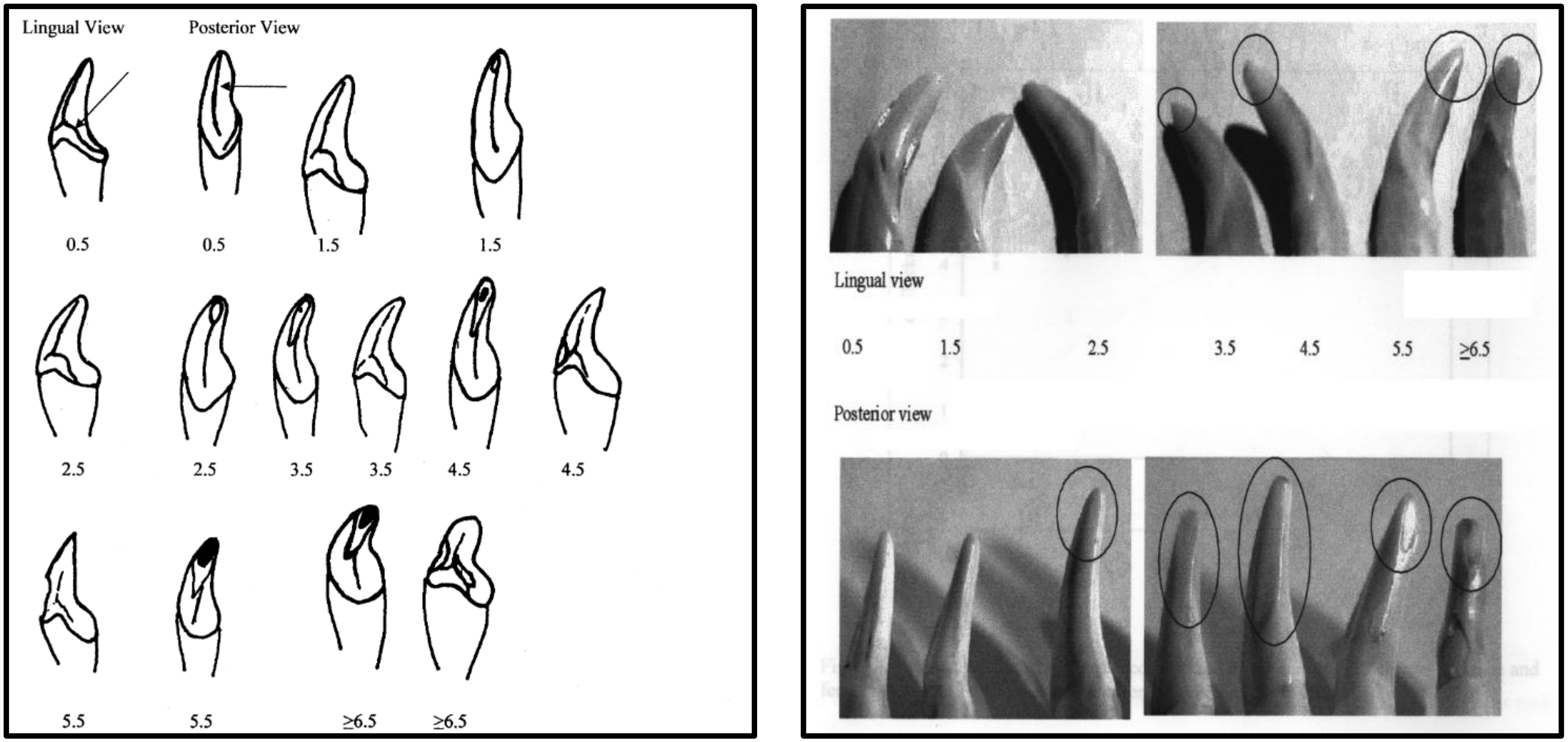


Figure D2. Examples of lower canine tooth wear in coyotes by age class (Maher 2002).

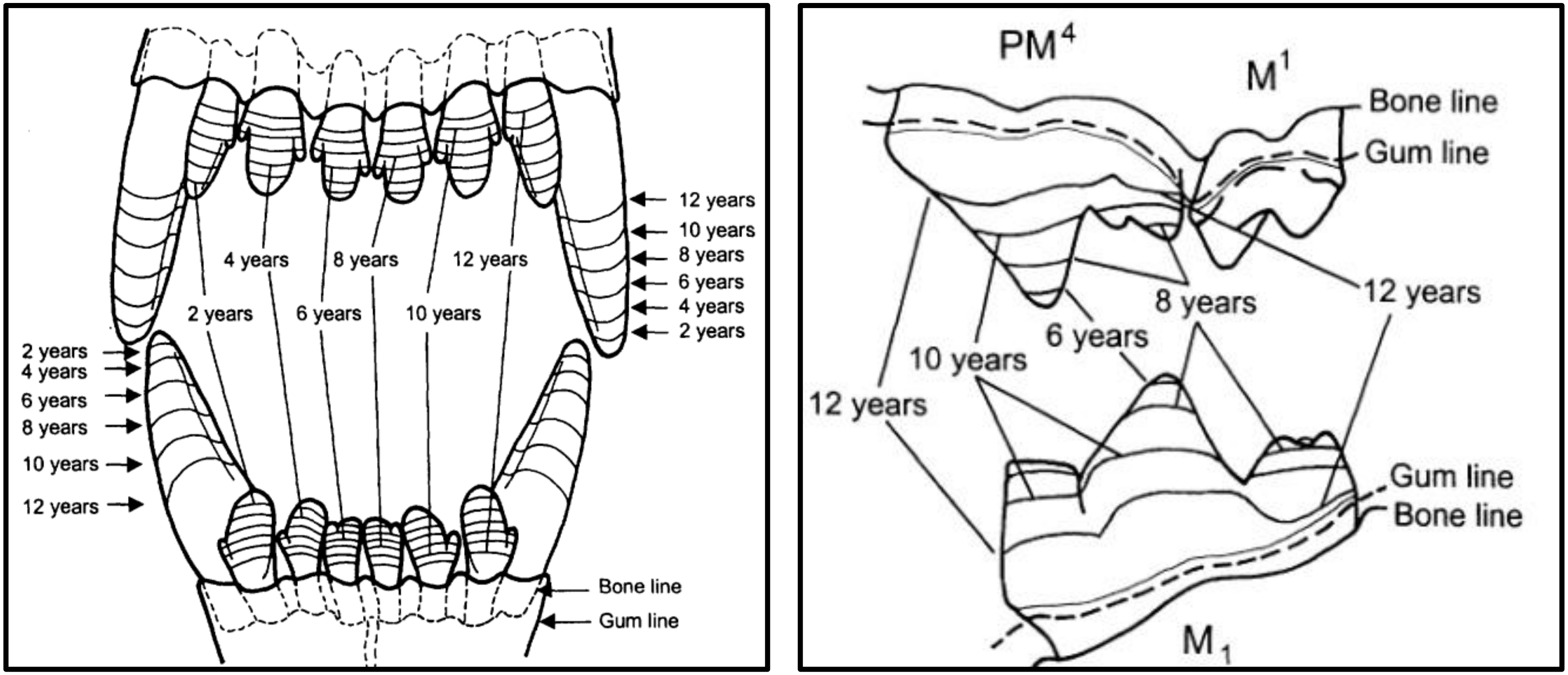


Figure D3. Example of canine tooth wear over time (Gipson et al. 2000).

Appendix E: Perimeter inspection documentation

Site [redacted]

Description: Side-by-side, large, steel-lined culverts that had chain-link exclusion devices (Figure E1). Exclusion devices were bolted into concrete, staked into the ground, and covered the culvert openings. Gaps [redacted] exposed at the fence bottom during dry periods (Figure E2).

Recommendation: Resecure or replace the entire exclusion device. Consider direction of water movement when excluding site. If not replaced, add additional exclusion device along bottom edges and corners of existing exclusion device. Monitor fasteners for weathering and breaking down.

Coordinates: [redacted]

WCAA Drain ID: [redacted]

Figure E1. Site [redacted] images going left to right: chain-link exclusion devices over dual culverts, bottom corners of exclusion device were not tight to the ground, and the associated drain.

96 ADDITIONAL PAGES OF SITE DOCUMENTATION CENSORED

Appendix F: Dig-under spot treatment

Below is a step-by-step guide for applying the WCAA Airfield Operations/Wildlife recommended spot treatment for coyote dig-unders along the perimeter fence (see also Figure F1):

1. Identify and mark the dig-under location.

- Confirm signs of wildlife entry along the perimeter (e.g., coyote dig-under).
- Mark the site and document the occurrence.

2. Gather necessary tools and materials.

- Dig Defense grate (Special order from Home Depot; XL 4-gauge galvanized steel, 24” wide × 15” deep with 1.5” spike spacing)
- 4" × 4" gapped cattle fencing
- Large and small aggregate (~1” and 2–3” gravel, respectively)
- Wire ties and wire cutters
- Mallet
- Hoe and shovel

3. Excavate the treatment area.

- Dig a trench approximately 1’ deep, 3 feet wide, and extending about 1” beyond the fence’s outer edge.
- Clear debris to ensure the cattle fencing can lie relatively flat.
- Use the hoe to level ground on both sides of the fence.
- Keep the excavated soil nearby for backfilling later.

4. Install exclusion devices.

- Lay the cattle fencing in the trench with its natural curve facing downward and inward toward the fence. It should fill the entire 1' × 3' trench.
- Weave the Dig Defense grate through the cattle fencing.
- Use the mallet to pound the Dig Defense into the ground so the top overlaps the base of the chain-link fence by approximately 3 inches.
- Trim the cattle fencing as needed so it overlaps the chain-link by ~4 inches at the top and extends ~8 inches beyond the Dig Defense on both sides for added coverage.

5. Secure the barrier to the fence.

- Use wire ties or cut-to-length wire to fasten the exclusion assembly (Dig Defense + cattle fencing) securely to the base of the chain-link fence.
- Place multiple wire ties evenly around the perimeter of the cattle fencing.
- Add additional ties to secure the top edge of the Dig Defense and ensure it binds tightly with the chain-link and cattle fencing.
- Ensure there are no gaps or loose sections.

6. Backfill the trench.

- Cover the exclusion devices with the previously excavated substrate and compress by stepping on it.
- Add a layer of small aggregate (~1” gravel) to fill in gaps and compress again.
- Finish with a layer of large aggregate (2–3” gravel) to stabilize the area and discourage future digging.

7. Inspect and finalize.

- Ensure everything is tightly secured, document the repair, and update records.

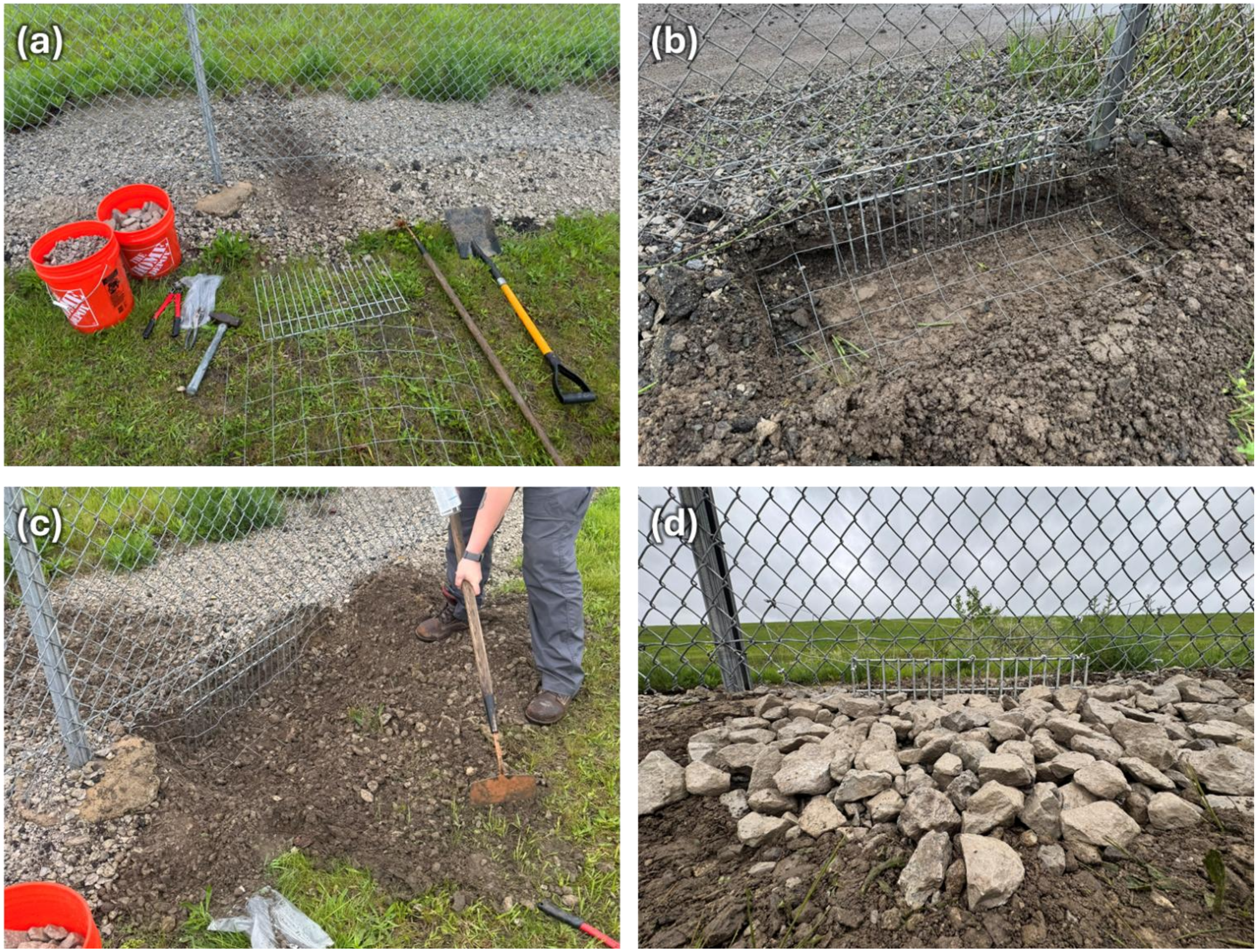


Figure F1. Example of dig-under spot treatment, including: (a) tools and materials used—such as large and small aggregate, wire cutters, wire ties, mallet, Dig Defense grate, 4"× 4" gapped cattle fencing, hoe, and shovel; (b) site preparation and installation—digging a ~1' deep hole approximately 3' wide and extending ~1’ outward from the fence, with the Dig Defense grate woven through the cattle fencing; (c) backfilling and leveling the site from both sides of the fence; and (d) securing exclusion materials to the chain-link fence using wire ties, followed by layered filling with small and large aggregate.

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