Variation in floater and migrant activity at six Bald Eagle nest territories in northern Colorado's expanding breeding population

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ABSTRACT.—Seasonal patterns in outsider bald eagle (Haliaeetus leucocephalus) presence and territorial aggression were analyzed across six focal territories in the northern Colorado Front Range between 2016 and 2025. The study combined standardized camera and field observations to examine non-territorial bald eagle (OBE) counts, aggression events, and seasonal patterns in aggression intensity, with some metrics normalized to 100 observation hours. Results reveal substantial inter-territory variation in both OBE pressure and aggression, indicating that impacts are not uniform across the study area. Stream-connected territories (with direct access to major riparian corridors) generally sustained higher and more consistent OBE pressure than upland sites. Upland territories had consistently lower OBE counts across all years. The data show that territorial pairs are not equally affected by the regional population rise. Some territories—such as a long-established stream-connected site—showed sustained increases in non-resident presence without a proportional rise in aggression, while others—most notably an upland site on the edge of a declining roost system—experienced abrupt spikes linked to regional roost disruption and local instability. Territories adjacent to stable, long-standing communal roosts generally exhibited more consistent pressure and aggression, whereas those peripheral to a declining roost system were more vulnerable to episodic surges. The collapse of the Middle Roost and decline of the Confluence Roost have altered historic winter corridors, shifting pressure onto remaining roosts and previously marginal territories. These findings emphasize the importance of territory-specific context, roost proximity, and seasonal timing in assessing OBE impacts, and highlight management implications for proposed developments near declining roost systems.

INTRODUCTION

From October through April, the northern Colorado Front Range hosts a concentrated migratory population of bald eagles—primarily composed of non-territorial individuals of all ages. This group includes both local and regional non-breeding birds as well as eagles from outside the region, some of which may hold territories elsewhere but function as floaters while present here. For the purposes of this study, we refer to these non-territorial bald eagles collectively as "other bald eagles" (OBEs), a flexible category that encompasses visiting, intruding, or transient individuals not tied to a local breeding territory.

Territorial defense in bald eagles is driven by the need to maintain access to a defined set of spatially limited and biologically necessary resources (Gerrard and Bortolotti 1988, Buehler 2000). These include prey-rich habitat, favored perch sites used for hunting and surveillance, secure nest structures, and—particularly as the breeding season approaches—the opportunity to retain or acquire a mate and to defend or secure the territory itself (Anthony and Isaacs 1989, Watson 2010). The presence of non-territorial bald eagles—especially during the migratory period—introduces direct competition for these resources. While territorial adults typically do not use communal night roosts, many high-density roost sites are located within or adjacent to active territories, increasing the likelihood of intrusion (McClelland et al. 1994, Mojica et al.

2008). Visiting eagles drawn by prey availability, perch access, or roost proximity often test territorial boundaries. Although other raptor species may elicit defensive responses, it is other bald eagles—unaffiliated with the resident pair—that most directly challenge territorial integrity and provoke the strongest behavioral responses from local adults (Watts et al. 2006, Dwyer et al. 2020).

The influence of non-territorial bald eagles on local breeding pairs is not static—it varies across the annual cycle in ways shaped by broader migratory movement, prey availability, severe local weather, and territorial dynamics (McClelland et al. 1994, Harmata 1984, Watson 2010). In the northern Colorado Front Range, these pressures follow seasonal patterns, with peak intruder activity and territorial aggression often occurring outside the core breeding period. To interpret behavioral responses and spatial use meaningfully, a temporally structured approach is necessary. Here, we analyze OBE presence and territorial response within a seasonal framework derived from multi-year patterns of arrival, peak overwintering, and departure.

We then examine how territorial bald eagle pairs across six breeding territories in the northern Colorado Front Range respond to the seasonal presence of non-territorial eagles. Using multi-year observational data, we quantify OBE activity, territorial aggression, and patterns of spatial use across four defined seasonal periods. Our aim is to characterize site-specific differences in non-territorial intruder pressure and behavioral response, and to better understand how these dynamics reflect underlying territorial structure, seasonal vulnerability, and resource distribution in an expanding regional population (Bove et al. 2024a; Middleton et al. 2025). Within this context, we use the term floater to refer specifically to non-territorial bald eagles—typically in adult or near-adult plumage—that present a credible challenge to territory ownership or stability. This designation becomes especially important when interpreting territorial aggression severity, as captured in our TAT (Territorial Aggression Threshold) scoring system.

Study Area

In Bove et al. (2024a), we documented 86 active bald eagle nesting territories across the broader northern Colorado Front Range. The present study focuses on six of those territories (Fig. 1), all located within a 689 km² region defined in Bove et al. (2024a) as the "Midwestern Field Area." This region was selected for its landscape diversity, presence of several key communal roosts, and its suitability for comparing how territorial eagles respond to non-resident bald eagles across landscapes that differ in access to prey, stream corridors, and roost proximity. Three of the six focal territories—Hygiene, BOCR, and CR16.5— either overlap with or lie adjacent to communal roost sites. The same three territories are also situated along major stream corridors—primarily Boulder Creek and St. Vrain Creek—where migratory and non-resident bald eagles concentrate during the non-breeding season. Territories along these stream corridors consistently experience elevated use by non-territorial bald eagles—particularly during fall and winter—due to the seasonal concentration of migrants and the availability of prey-rich habitat, open water, and structurally diverse perch networks (FRNBES 2025).

In contrast, upland territories such as Stearns, ERLA, and Erie—defined in Bove et al. (2024a) as nests located more than 1.9 km from a Type 2 or greater stream—are spatially removed from these core migration corridors and typically receive fewer visits from non-resident individuals (Fig. 1). That said, proximity alone does not fully buffer upland sites from seasonal

pressure, as later patterns will show. This study incorporates three stream-connected territories and three upland sites, classified in Bove et al. (2024a) according to stream proximity and resource composition. This framework enables direct comparisons between areas that differ in their exposure to migratory activity and the resulting territorial responses. A seventh study territory, White Rocks, also lies within the Midwestern Field Area and has been a part of long-standing territorial studies, however this nest site was excluded from this study, as OBE pressure and aggression data were not consistently recorded (Fig. 1).

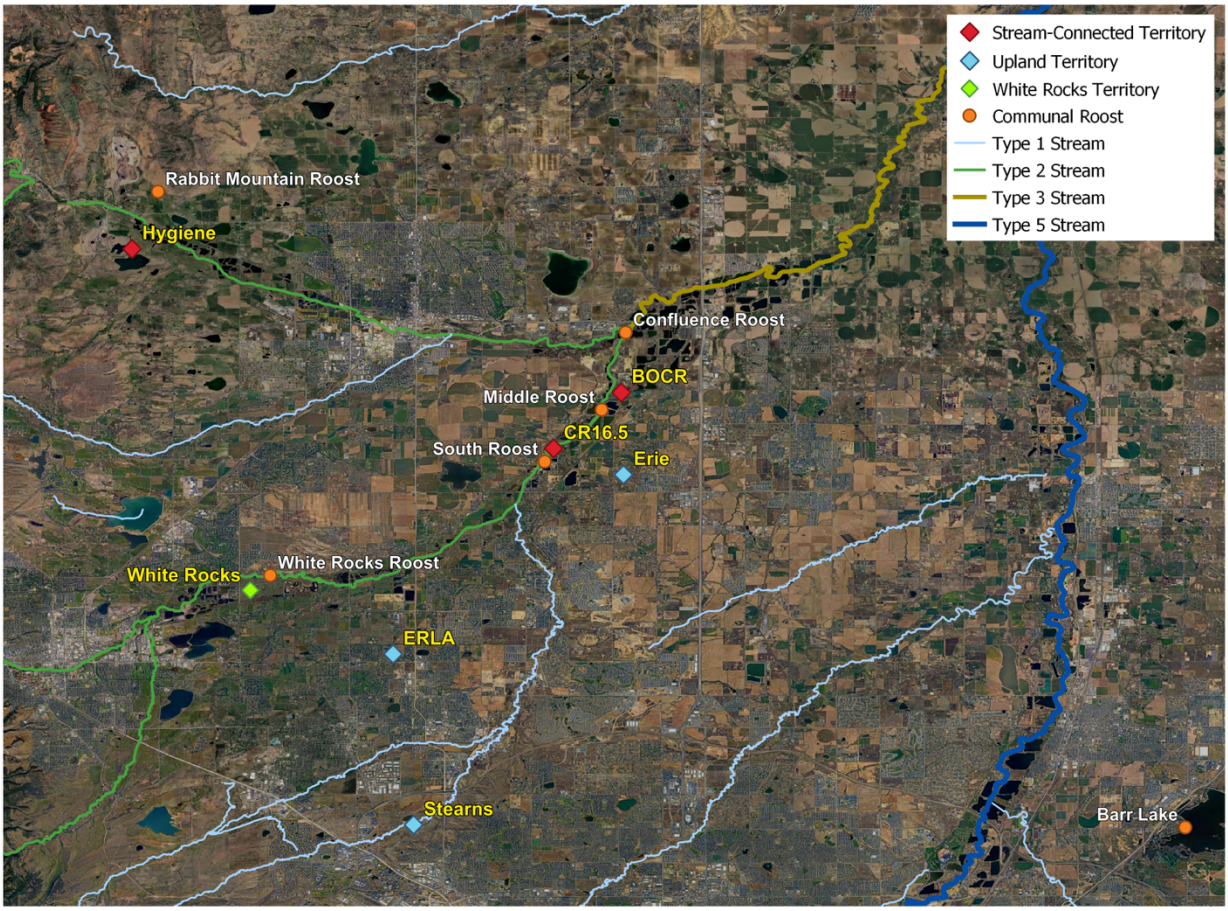

Figure 1. Locations of the six focal bald eagle nesting territories in the Midwestern Field Area of the northern Colorado Front Range, showing proximity to communal roosts and stream classifications from Bove et al. (2024b). Three territories—Hygiene, BOCR, and CR16.5—are stream-connected and situated along major migration corridors, while three—Stearns, ERLA, and Erie—are upland sites more than 1.9 km from a Type 2 or greater stream. White Rocks territory, also shown, was excluded from analyses due to incomplete data.

Territory Summaries

To provide spatial and contextual background for interpreting OBE variation, we briefly summarize each of the six focal bald eagle territories. These summaries synthesize site-level traits, prey base, communal roost influence, and known patterns of OBE pressure and territorial response. A more detailed breakdown of resource classifications, proximity to stream corridors,

and aggression metrics is presented in Table 1. The territories are grouped below not by habitat type, but by their position in the regional landscape—beginning with those situated along stream corridors and within major roost influence zones (Bove et al. 2024a), followed by those at upland sites. In contrast to territories along stream corridors, upland territories such as Erie, ERLA, and Stearns—as defined above—are spatially removed from these core migration corridors and typically receive fewer visits from non-resident individuals (Fig. 1).

HYGIENE TERRITORY.—The Hygiene territory covers approximately 2.9 km² and is bisected by St. Vrain Creek, a Type 2 stream as classified in Bove et al. (2024a). Its resource classification is "mixed/waterbody" (Bove et al. 2024a), reflecting the diverse composition of aquatic and terrestrial foraging zones. Territorial resources include 13% prairie dog colonies, 15% waterbodies (primarily reservoirs), and 11% quarry ponds—making Hygiene one of the most prey-rich and habitat diverse sites in the dataset. As a stream-connected corridor territory with substantial open water and quarry pond habitat, Hygiene lies along a primary migratory corridor commonly used by non-territorial bald eagles during the fall and winter months (Fig. 1).

A pair of bald eagles nested successfully in 2005 using a former red-tailed hawk nest near the current site. In 2010, a different banded pair established the territory more permanently, building a new nest in the tree still in use today (FRNBES 2025a). The area supports consistently high raptor presence. Golden eagles are frequently observed, likely due to the territory's proximity to nearby foothills and associated cliff nesting habitat. The Hygiene territory also regularly hosts at least one wintering ferruginous hawk that mutualistically shares the rich prey resources with the resident bald eagles (FRNBES 2025a). Proximity to the Rabbit Mountain communal roost (approximately 2.8 km to the north) contributes to frequent seasonal activity by non-territorial bald eagles, making Hygiene one of the more consistently visited territories in the study (Fig. 1). These patterns make it a useful comparison point when evaluating variation in territorial response across sites.

BOCRTERRITORY.—The BOCR territory covers approximately 3.3 km² and is situated along Boulder Creek near the historical overlap of the Middle and Confluence communal roost regions (Fig. 1). It qualifies as a stream-connected corridor territory, with a resource classification of "fish/quarry pond" (Bove et al. 2024a). Territorial resources include 21.6% quarry ponds and 5.2% prairie dog colony sites. These features provide strong aquatic foraging opportunities and have long supported both bald eagle and osprey nesting within the same area (Bove et al. 2024a; FRNBES 2025b).

The territory lies within the influence zone of what was once an interconnected series of three major communal roosts: the Middle Roost (now abandoned), the still-active Confluence Roost just over 1 km downstream, and the South Roost approximately 2.5 km upstream (Fig. 1). The Middle Roost collapsed by 2020 following years of cumulative disruption from oil and gas development, water pumping, and irrigation expansion in the surrounding landscape, and the Confluence Roost, while diminished, remains active and continues to shape seasonal eagle movement through the corridor (FRNBES 2025). More recently, construction activity during winter 2024–2025—less than 300 meters south of BOCR and about 1.6 km southwest of the Confluence Roost—may have further altered migratory flow and contributed to reduced use of remaining roost sites.

As of 2025, the territory contains at least four active osprey nests. These seasonal occupants compete for perch space, particularly along pond and creek edges. The number of commonly used territorial eagle perches drops from 17 to just 5 during osprey presence (FRNBES, unpublished data)—a significant reduction in functional foraging and surveillance space, resulting in a notable reduction in territorial resources. Despite this seasonal compression, the pair has persisted and remains one of the most consistently productive nests in our study area (Bove et al. 2024a).

CR16.5 TERRITORY.—The CR16.5 territory covers an approximately 4.3 km² area and is positioned directly along Boulder Creek—one of the most active migratory and wintering corridors in the northern Front Range (Fig. 1). It qualifies as a stream-connected corridor territory, with its resource classification listed as "mixed/quarry pond" (Bove et al. 2024a). Territorial resources include 15% quarry ponds and 7% prairie dog colony sites, with no reservoirs present (Bove et al. 2024a). A limited number of mature cottonwoods line the quarry pond edges and the Boulder Creek corridor, within the CR16.5 territory, perhaps offering a few viable options for nest placement near key foraging areas.

The territory lies within the southern section of the Boulder Creek communal roost system, which was comprised of three historically significant roosts: the now-defunct Middle Roost (abandoned by 2020), the declining Confluence Roost just downstream, and the still-active South Roost immediately upstream (Fig. 1). This stretch of the corridor has historically supported high seasonal use by non-territorial eagles. Following the loss of the Middle Roost and nearby construction activity in 2024–2025, non-resident eagle presence increased at CR16.5—likely contributing to elevated OBE counts and territorial aggression recorded during that period (FRNBES 2025).

From 2019 through early 2025, the CR16.5 territory was part of a rare polygamous triad (FRNBES 2025c) in which a single adult male supported two nest sites—CR16.5 and Erie (2.8 km to the west; Fig. 1). This configuration dissolved in January 2025, when the shared male was displaced from the CR16.5 territory and became the full-time partner to the Erie female. Since then, the CR16.5 nest has been occupied by a monogamous pair, consisting of the established resident female and the recently migratory male.

The shared male's final observed presence at CR16.5 occurred in mid-January 2025, after which a new male established consistent attendance and defense of the territory. This transition coincided with a period of elevated nest instability, as an unusual number of floaters were observed in proximity to the CR16.5 territory.

ERIE TERRITORY.—The Erie territory covers approximately 4.8 km² and lies 2.75 km from Boulder Creek, placing it beyond the core migratory travel corridor but close enough to receive occasional spillover activity (Fig. 1). The territory is classified as upland under Bove et al. (2024a), as it is located nearly 2.7 km east of the nearest Type 2 stream (Fig. 1). According to Bove et al. (2024a), 10.4% of the territory consists of prairie dog colony sites, with no waterbodies or quarry ponds present. Its resource classification is "prairie dog", reflecting a prey base dominated by terrestrial mammals and minimal aquatic input (Bove et al. 2024a). The

broader landscape is open and gently rolling, with only a few mature cottonwoods suitable for nesting and extremely limited alternatives if the primary nest tree fails.

As mentioned above, the Erie territorial female was part of a polygamous triad in which she paired with the shared male from the CR16.5 territory (FRNBES 2025d). Since the dissolution of that triad in January 2025, the CR16.5 male transitioned into the role of full-time partner to the Erie female. While Erie is geographically classified as an upland territory, its proximity to the South Roost and Boulder Creek corridor may help explain periodic surges in OBE pressure, particularly during transitional periods (Fig. 1).

ERLA TERRITORY.—The ERLA territory spans approximately 5.49 km² and is classified as upland under Bove et al. (2024a), located 3.8 km south of the nearest Type 2 stream (Fig. 1). Its territorial resource classification is "mixed/waterbody," with 4% prairie dog colony sites and 4% reservoir surface area (Bove et al. 2024a). Mammalian prey is relatively abundant, while fishing opportunities are more limited and dispersed compared to territories aligned with major stream systems. The territory was first established around 2020. In December 2022, the original adult female died during the peak of the regional HPAI outbreak and was replaced within five days by a young adult female, who remains resident as of 2025.

The resident pair exhibits typical incubation and chick-rearing behavior at the nest. However, outside of incubation and the mid-to-late post-fledging dependence period, both adults are frequently observed foraging in nearby protected open space and preserve lands with better fishing access, often 1.6–3.2 km away from the nest. This tendency to range farther from the immediate nest vicinity is consistent with the lower annual territorial attendance documented for ERLA compared to other study nests. The nearest communal roost, White Rocks, is located approximately 6 km to the northwest.

STEARNS LAKE TERRITORY.—Located in upland terrain on Boulder County's Carolyn Holmberg Preserve, the Stearns Lake territory covers approximately 4.8 km². According to Bove et al. (2024a), 23% of the territory consists of prairie dog colonies and 2% is open water (Stearns Lake, 0.12 km²). Its resource classification is "prairie dog" (Bove et al. 2024a), reflecting a prey base dominated by prairie dogs and other terrestrial mammals, with limited but still important fish resources. The site lacks major stream corridors, containing only a few small upland tributaries classified as Type 1 in Bove et al. (2024a). This upland position places the territory well outside the region's primary eagle migration and wintering corridors, contributing to its low baseline of non-territorial eagle traffic. The broader landscape is dominated by grassland and scattered cottonwoods—suitable for nesting but limited in number and often structurally compromised. These conditions have contributed to repeated nest failures and nest structure loss in recent years (FRNBES 2025e).

In 2024 and early 2025, following known disturbance events, the territorial pair temporarily relocated to a site 3.2 km west before returning mid-season. In 2025, they reoccupied a red-tailed hawk nest and later constructed a new nest from scratch (FRNBES 2024). Observations during the relocation period suggest that OBE activity increased at the western site while remaining low at Stearns, possibly reflecting an association between territory occupation and intruder use (FRNBES, unpublished data). The nearest major communal roost—White Rocks—

is located approximately 12 km to the north, likely contributing to the territory's consistently low baseline of OBE activity (Fig. 1). Stearns also exhibited a high diversity of interspecific raptor activity, including repeated interactions with red-tailed hawks, limited interactions with ferruginous hawks that also winter at Stearns, and occasionally golden eagles.

METHODS

Observation Protocol

Behavioral data were collected using a standardized 3-minute interval protocol applied across both field sessions and PTZ (pan-tilt-zoom) camera data. Table 2 describes sampling efforts for each nest. Field methods followed the approach described in Bove et al. (2024a), with sessions conducted at all six territories and typically ranging from 1 to 4 hours. Observers recorded the presence, location, and behavior of territorial adults and all Other Bald Eagles (OBEs)—defined as any non-paired eagle observed within or adjacent to the defended core of a territory. Encounters were categorized by behavior, age class, and in many cases, aggression level or proximity.

PTZ cameras were positioned approximately 50–400 meters from nest trees and programmed to run repeated fixed-area tours. These tours cycled through the nest and surrounding perches in a consistent pattern designed to simulate the structure and scan frequency of field observations. All camera coverage was recorded 24 hours per day, with session data logged from dawn to dusk on most days and across multiple seasons.

To reduce sampling bias and enable direct comparison with field-based sessions, camera footage was subsampled into randomized ~2-hour blocks of active session data, representing roughly 40% of the total potential data coverage. This stratified subsampling approach ensured broad seasonal and territorial representation while approximating the effort, timing, and detection scale of field sessions.

All behavioral entries from both sources were time-aligned using the 3-minute interval format and compiled into a master dataset. OBEs were distinguished based on identity, behavior, and spatial context, with intrusions, close circling, perching, and direct interactions fully documented.

Seasonal Framework

All data were organized into four biologically defined seasonal periods based on multi-year patterns of floater and migrant bald eagle activity in the northern Colorado Front Range. These seasonal periods reflect recurring regional patterns in arrival timing, migratory buildup, and seasonal decline, and were applied consistently across all sites and analyses:

- Early Fall Arrival (October) – Return of local and regional non-territorial eagles
- Migratory Surge (November–February*)* – Peak influx of overwintering and long-distance migrants
- Late-Stage Pressure (March*)* – Decline in numbers but continued presence of intruding eagles during pre-lay and incubation periods
- Breeding Season /Absence (April–September*)* – Period of minimal non-resident eagle activity

This framework provided a biologically meaningful structure for comparing seasonal aggression, OBE pressure, and territorial response across the six focal nests.

Standardization of OBE Metrics

To assess variation in floater and migrant activity, we calculated the number of OBEs observed per hour of active survey effort (OBE/hour) for both field and camera datasets. This standardized metric allows direct comparisons across territories and controls for differences in session duration.

Field-based sessions tend to capture higher rates of transient intrusions due to observer targeting and scan frequency. In contrast, unfiltered camera footage can underrepresent OBEs, particularly individuals that perch quietly, pass through swiftly, or remain at less frequently used perches. To reduce this asymmetry, the camera data were subsampled as described above, aligning them more closely with the detection likelihood and time resolution of field sessions.

Although modest detection biases remain—field sessions may slightly overstate OBE pressure, while camera data may understate it—the resampled datasets support a consistent comparative framework. Monthly OBE/hour values were calculated for each territory and averaged by year or season to identify site-level patterns and seasonal variation in pressure.

Intruder Scoring Methodology

To evaluate the severity of non-territorial eagle intrusions, we applied a standardized scoring system referred to as TAT scoring (Type–Age–Timing). This system quantifies the behavioral intensity and territorial threat posed by OBEs across all territories and years (Appendix I).

Each OBE encounter was scored based on: (1) behavior type and level of aggression, (2) intruder age class (based on molt and plumage), and (3) timing within the breeding cycle. Scores were further modified by duration of the intrusion and proximity to the nest tree.

Intrusions ranged from distant flyovers to direct displacement of resident adults or repeated use of nest tree perches. Higher scores were assigned for adult-aged intruders, aggressive behavior, extended presence, and events during high-sensitivity periods such as incubation or early chick-rearing.

Final TAT scores were used to classify each event into one of three severity levels: low (1–3), moderate (4–5), or high (6–10). When multiple intruders were present, the highest-scoring individual was used to represent the encounter. This framework allowed for consistent comparison of intrusion severity across territories and seasons. Full scoring criteria and modifiers are detailed in Appendix I.

Aggression Presence Rankings

To characterize territorial aggression specifically during periods when outsider bald eagles (OBEs) were present, we calculated aggression-to-OBE ratios and ranked three metrics using quartile-based thresholds. These rankings, referred to as aggression presence rankings, summarize how often and how strongly territorial eagles responded to non-resident individuals

across nests and seasons. The categories are descriptive only; they do not imply causation, directionality, or the initiator of aggression (see Appendix II for all seasonal aggression metrics by nest).

The metric *aggression rate during OBE presence (% months)* was defined as the proportion of months with OBE detections that also included aggression, indicating how often territorial interactions occurred when non-resident eagles were present—regardless of which party initiated the behavior or how strongly territorial adults engaged (Table 3). *Aggression per OBE minute* measured the frequency of aggressive behavior scaled to the total duration of OBE presence, providing a standardized view of response intensity per intrusion. *OBE frequency (% of months)* represented the overall percentage of months in which non-resident bald eagles were detected—regardless of whether aggression occurred—serving as a proxy for seasonal pressure from outsiders (Table 3).

Each metric was classified into low (0), moderate (1), or high (2) based on the 25th, 50th, and 75th percentiles of values across all nest-seasons. These rankings reflect relative levels of behavioral activity and should not be confused with aggression severity, which was assessed separately using TAT scores and is not included in this analysis (Table 3).

RESULTS

Territorial Presence Across Nests

Annual adult territorial presence—a measure of continuous occupation and active defense against non-resident eagles (OBEs), with values calculated to include any adult hiatus periods[1]—varied across the six study nests. Percentages ranged from 59.2 ± 25.4% at ERLA to 84.1 ± 15.7% at Stearns (Table 4, Fig. 2). These values encompass all major annual phases: (1) incubation, (2) hatch to fledge, (3) post-fledging dependence through dispersal, and (4) dispersal through nest building. During the dispersal-to-incubation period, which lies outside the direct productivity window and more closely reflects baseline levels of territorial defense, attendance ranged from 44.9 ± 17.2% at ERLA to 85.2 ± 13.2% at Stearns. At ERLA, both full-year and dispersal-to-incubation attendance were lower than at any other study nest (59.2 ± 25.4% and 44.9 ± 17.2%, respectively). Outside of incubation and the mid-to-late post-fledging dependence period, both adults are frequently observed foraging beyond the territory in nearby protected open space and preserve lands, where fishing opportunities are more concentrated and accessible. Within the territory, fishing sites are few and widely dispersed; the largest and primary site—one of only two—is located 0.84 km from the nest.

[1] Adult territorial presence is defined as the time during which at least one nesting adult is present in the delineated nest territory (Bove et al. 2024b).

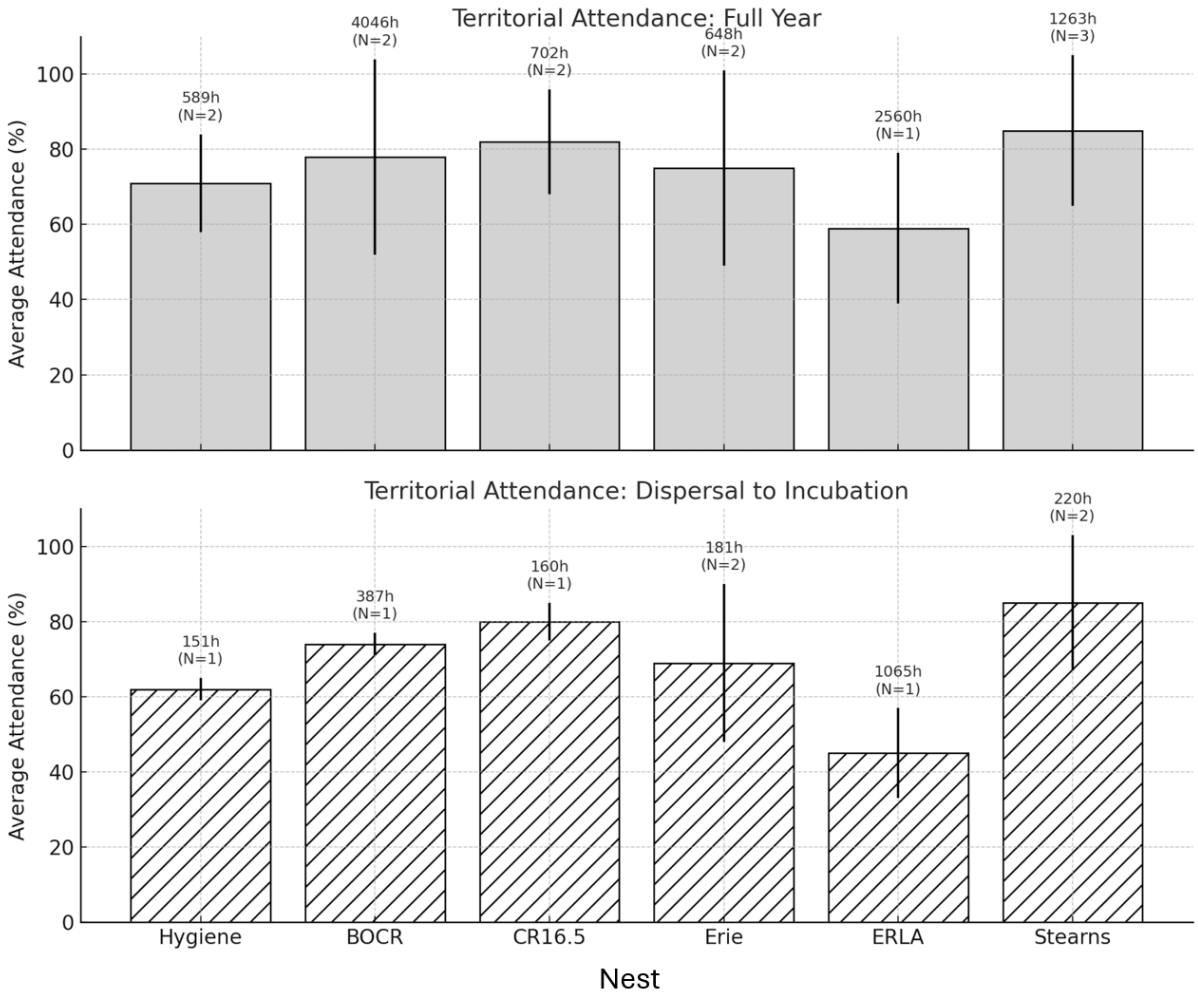

Figure 2. Average annual adult territorial attendance (top) and attendance during the dispersal-to-incubation period (bottom) for six focal territories. Attendance is defined as the proportion of time at least one nesting adult was present within the defended territory. Values combine all years of observation for each nest, with total observation hours (h) and number of years (N) shown above bars. Error bars represent ±1 SD. ERLA showed consistently lower attendance than all other nests in both metrics, while Stearns maintained the highest levels year-round.

OBE Activity Across Seasons

OBE presence across the six study territories showed month-by-month variation that tracked the general migratory timeline (Fig. 3). Monthly OBE/hour values peaked in January (0.36) and March (0.34), then declined sharply through April and reached their lowest point in July (0.01). A modest rise in October marked the beginning of the Early Fall Arrival period, suggesting the first wave of returning migrants. Immature birds are observed to be predominant among early arrivals, as determined from plumage. Historical telemetry from northern Saskatchewan has documented territorial adults initiating southward migration in early November, including a breeding adult female from the Besnard Lake region (Nijssen et al. 1985). Radio-tagged adults have also been recorded departing as early as 2 November following freeze-up (Harmata and

Toepfer 1985), consistent with observations of migratory bald eagles of older plumages during the Early Fall Arrival period.

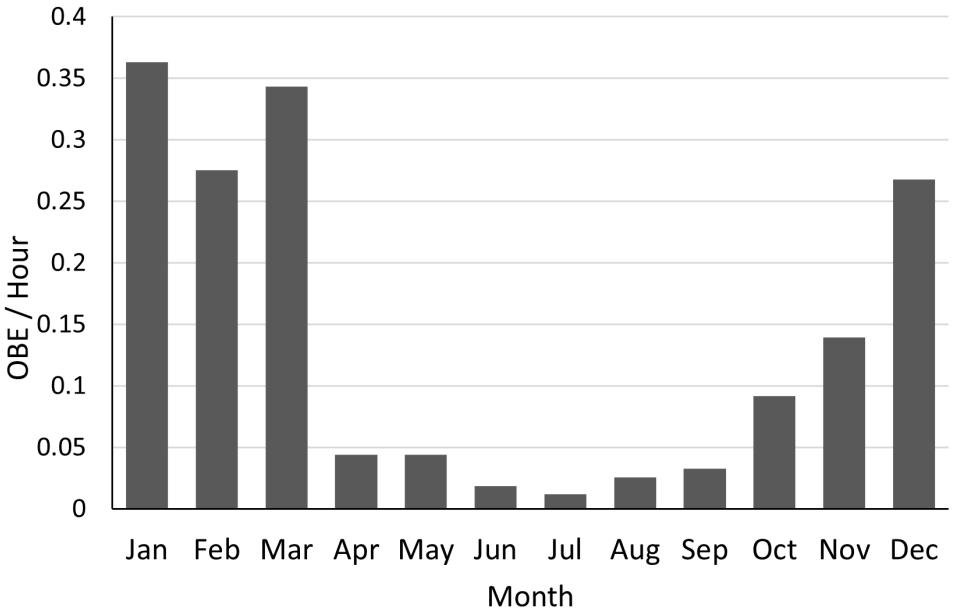

Figure 3. Monthly distribution of outsider bald eagle (OBE) detections standardized as OBEs per hour across all six focal territories. Values represent combined field and subsampled PTZ camera data. OBE activity was highest from January to March, lowest from April through September, and began increasing again in October and November.

Seasonal grouping of OBE counts per 100 hours (Fig. 4) reinforced these documented seasonal trends. During the Migratory Surge, all nests recorded elevated OBE activity, ranging from 1.6 to 69.2 OBEs per 100 hours. By contrast, the Breeding Season /Absence period showed minimal OBE activity at most sites, with rates typically under 1.0. The exception was ERLA, which consistently showed the lowest OBE rates, with little annual variation and values ranging from 0.0 to 1.5 OBEs per 100 hours.

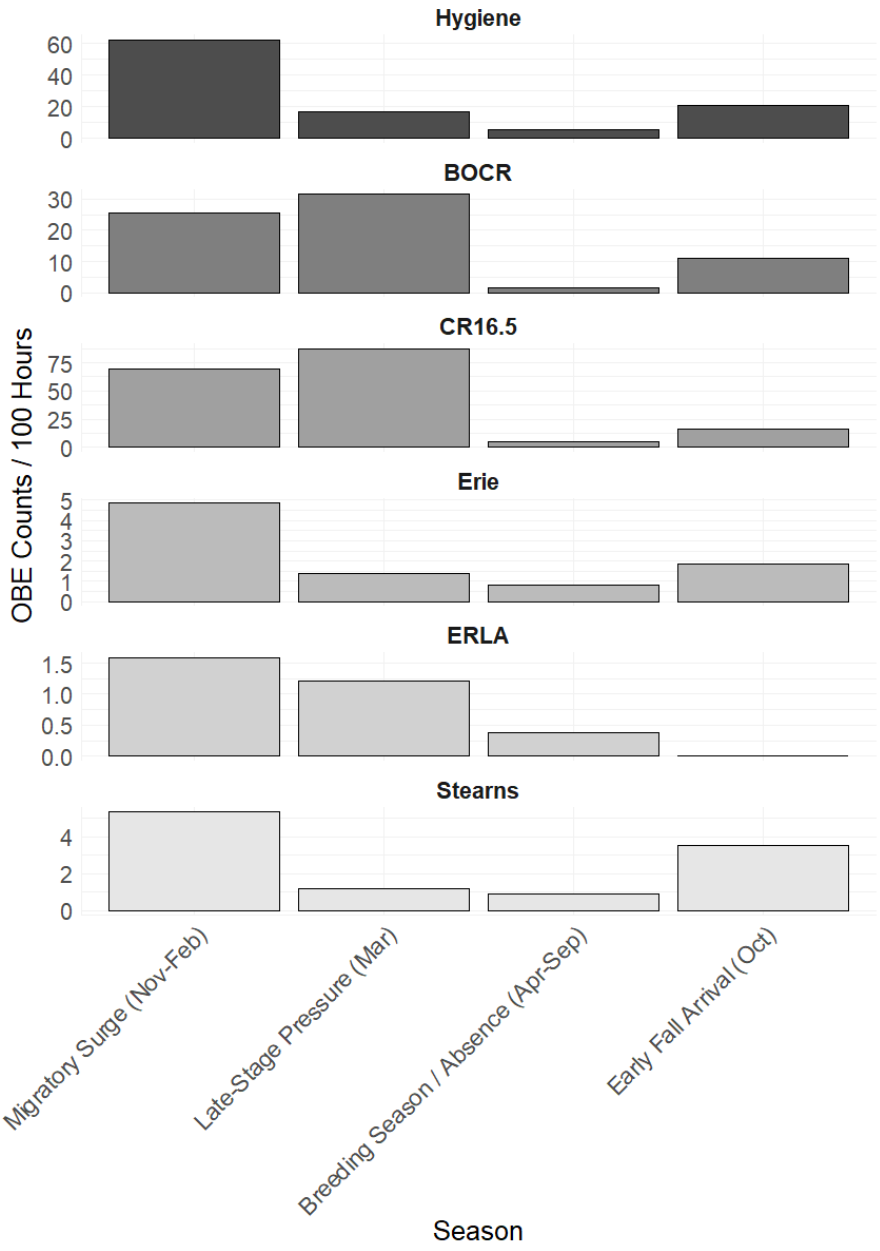

Figure 4. Seasonal variation in outsider bald eagle (OBE) counts per 100 survey hours for each of the six focal territories, grouped by Early Fall Arrival (October), Migratory Surge (November–February), Late-Stage Pressure (March), and Breeding Season/Absence (April–September). Values combine field and subsampled PTZ camera data and illustrate strong inter-nest differences in both the magnitude and seasonal distribution of OBE activity.

The Late-Stage Pressure period revealed substantial inter-nest variability (Fig. 4). Hygiene (17.0 OBEs per 100 hours), Stearns (5.9), and Erie (1.3) showed minimal activity, while BOCR (27.2) and CR16.5 (39.6) experienced renewed OBE pressure late in the season—likely a result of their proximity to the Boulder Creek corridor and adjacent roost systems. The Early Fall

Arrival period showed modest increases at five of six territories, with CR16.5 (14.8) and Hygiene (18.0) showing the most pronounced early upticks (Fig. 4).

Overall, these patterns confirm that OBE presence is strongly seasonal, with peak activity during the Migratory Surge and minimal activity during the Breeding Season /Absence period. While all territories followed a similar seasonal trend, the magnitude and timing of peaks varied considerably among sites—differences that were most evident during the Early Fall Arrival and Late-Stage Pressure periods (Fig. 4).

Aggression Patterns by Season

Aggression events per 100 survey hours followed a strongly seasonal pattern across all six study territories (Fig. 5). Monthly aggression rates peaked in January at 96 events per 100 hours and declined steadily through the spring, reaching a minimum of 4 events per 100 hours in June (Fig. 6). Monthly trends closely paralleled OBE/hour values, with aggression rates increasing during periods of elevated outsider eagle presence and declining during the breeding season when OBEs were largely absent (Fig. 7).

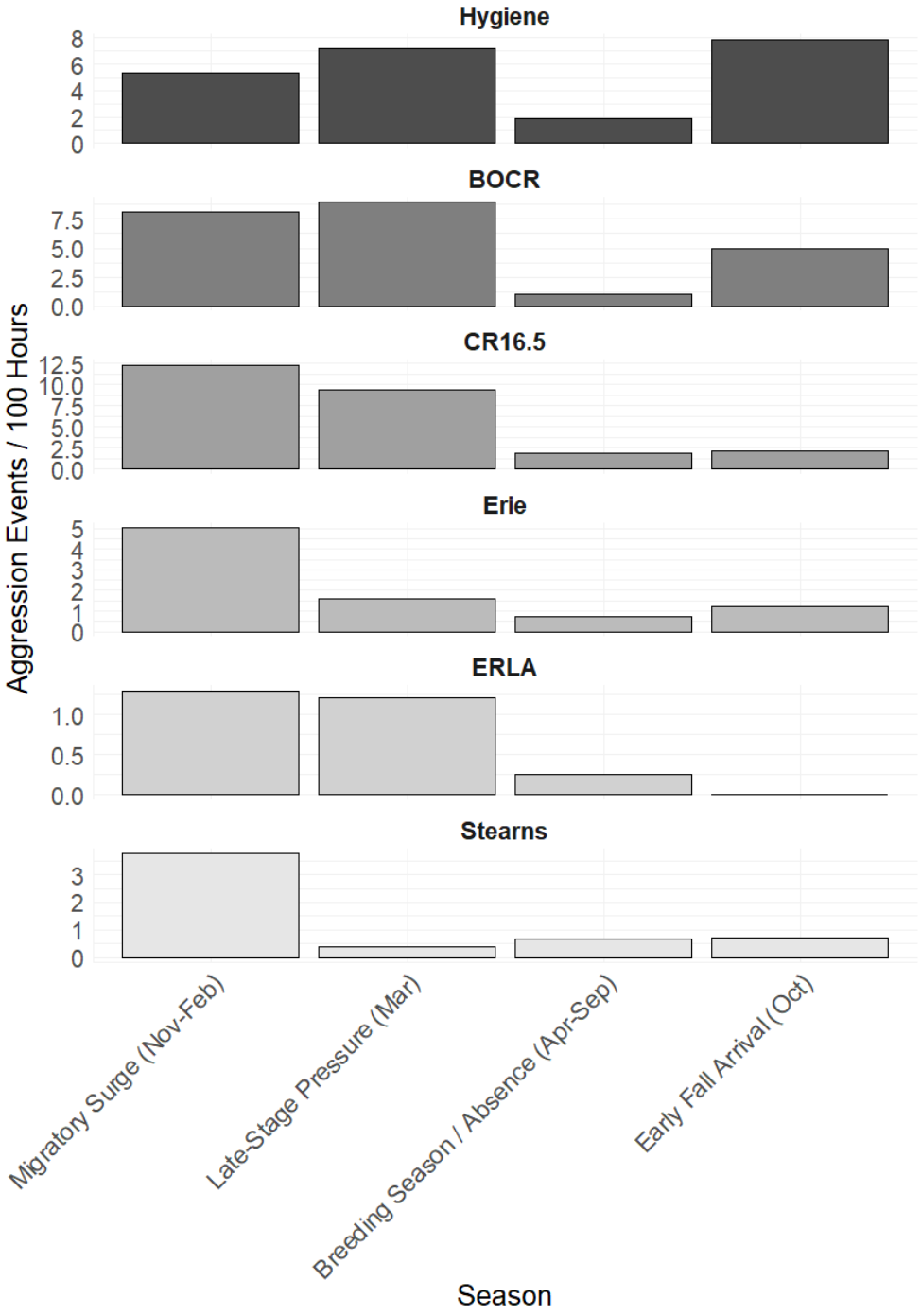

Figure 5. Seasonal patterns in aggression events per 100 survey hours involving outsider bald eagles (OBEs) across the six focal territories, grouped by Early Fall Arrival (October), Migratory Surge (November–February), Late-Stage Pressure (March), and Breeding Season/Absence (April–September). Data from field and subsampled PTZ camera sessions highlight pronounced variation among nests in both the frequency and seasonal distribution of aggressive encounters.

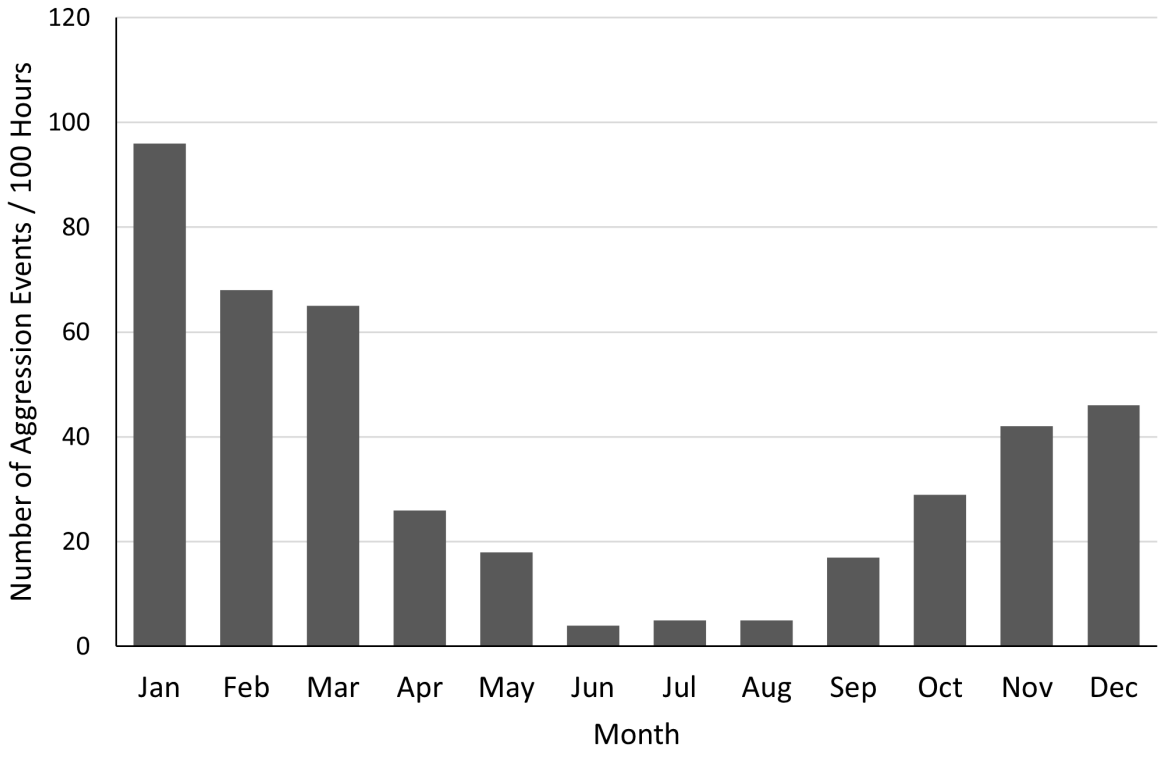

Figure 6. Monthly totals of aggression events involving outsider bald eagles (OBEs) across all six focal territories. Counts combine field and subsampled PTZ camera data. Aggression was highest from January to March, lowest from June through August, and began increasing again in October and November.

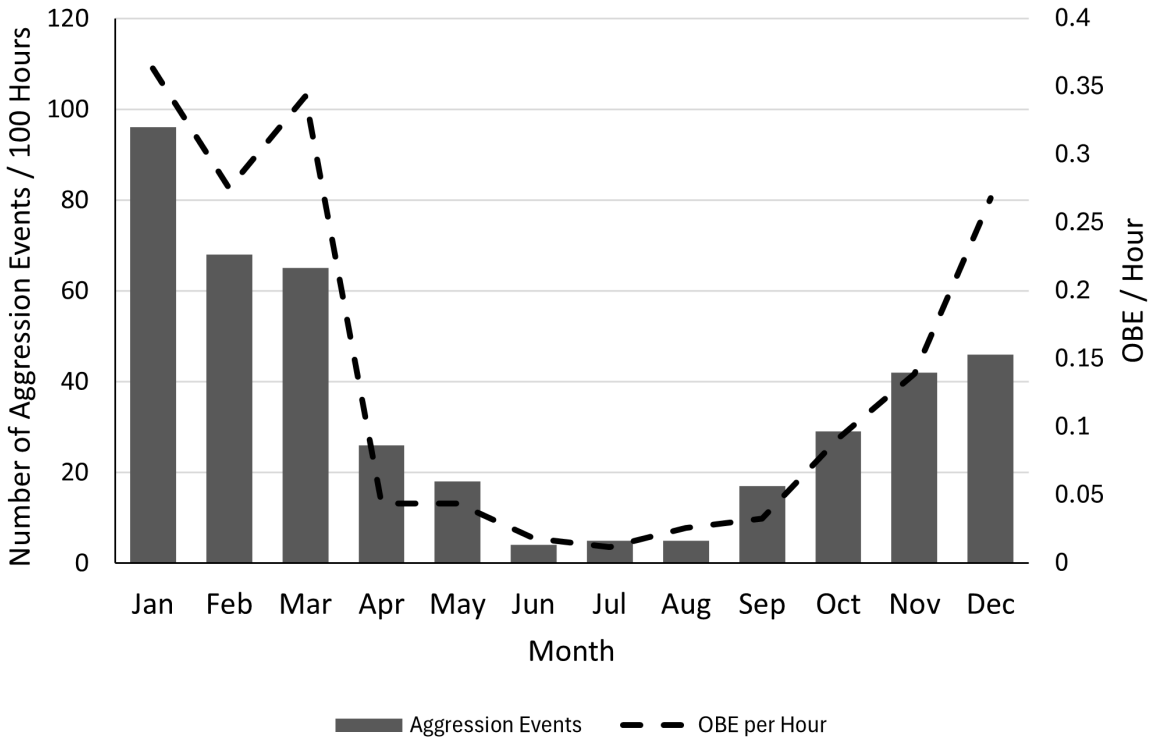

Figure 7. Relationship between monthly aggression events involving outsider bald eagles (OBEs) across all six focal territories (bars) and corresponding OBE occurrence rates expressed as OBEs per hour (dashed line). Data from field and subsampled PTZ camera sessions show that both aggression and OBE presence peak in January–March, decline to annual lows in summer, and rise again in late fall.

Examining aggression rates by seasonal period reinforced this relationship (Fig. 5). The highest aggression rates occurred during the Migratory Surge period, ranging from roughly 4 to 12 events/100 hrs across nests, followed by a second rise during the Late-Stage Pressure period (~2–7 events/100 hrs). Aggression levels dropped markedly during the Breeding Season/Absence period (<2 events/100 hrs) and rebounded modestly during the Early Fall Arrival period (~1–7 events/100 hrs). Most nests exhibited this seasonal pattern, though the magnitude and timing of aggression varied across sites.

Aggression severity was also analyzed by season and classified as non-territorial, territorial, or severe (Table 5). Non-territorial aggression was the most frequently observed category across all sites, with the highest seasonal rate—46.4 events per 100 hours—recorded at Hygiene during the Early Fall Arrival period in 2021 (Table 5). Severe aggression was rare overall, with five of six nests averaging fewer than 0.5 severe events per 100 hours (Table 6, Fig. 8). Most severe aggression occurred during the Migratory Surge and Late-Stage Pressure periods, while territorial aggression was distributed more broadly across seasons but rarely exceeded 1.0 event per 100 hours (Table 5, Fig. 8).

These findings indicate that aggression intensity and severity generally track seasonal fluctuations in OBE activity, with peaks during periods of elevated intruder presence and

minimal levels during the breeding season, a pattern also noted in previous observational studies (McClelland et al. 1994, Mojica et al. 2008, Buehler 2020).

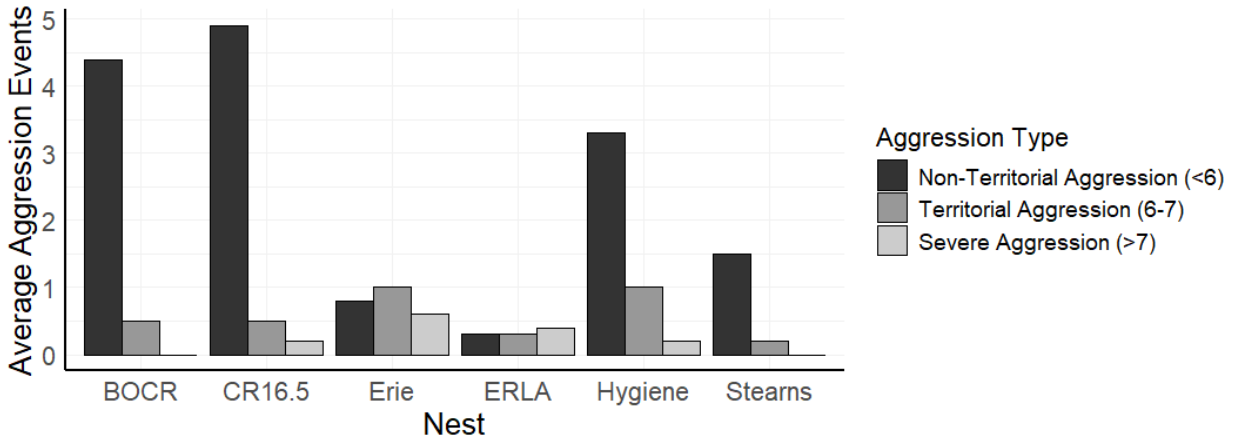

Figure 8. Distribution of aggression events by type across the six focal territories, categorized as non-territorial (<6), territorial (6–7), or severe (>7) under the TAT scoring framework. Bars show the total number of events in each category, illustrating differences among nests in both the frequency and intensity of aggressive interactions with outsider bald eagles (OBEs).

Territory summaries – aggression and OBE pressure

To evaluate site-level differences in outsider bald eagle (OBE) presence and territorial aggression, we compiled seasonal and annual values for all six focal territories. Each summary includes (1) a description of seasonal OBE/hour values, (2) a breakdown of aggression rates by severity class (non-territorial, territorial, severe), and (3) a short territorial profile highlighting context and patterns. Comparisons are organized by territory and follow the stream-corridor vs. upland classification system used throughout the study.

HYGIENE.—OBE pressure: Hygiene consistently recorded the highest OBE counts per 100 hours of any territory across all years and seasonal periods (Table 7, Figs. 5, 9). In 2016–2018, coverage was concentrated in months with typically lower OBE pressure, which may have influenced the magnitude of early-period values. In these early years, values ranged from 0 to 25, with most months under 15. A marked increase followed in 2019–2021, when monthly values ranged from 2 to 120, including the first triple-digit spike in November 2019. Rates in 2022–2024 expanded further, from a low of 2 to an all-time monthly peak of 195 in January 2022. In 2025 to date, values have ranged from 39 to 127, maintaining levels well above those seen in the early record. Even at its lowest, Hygiene's rates exceeded the high-end values seen at most other territories, which rarely surpassed 30 and often remained below 10 events/100 hours. Full monthly OBE count data for all years, including the 2016–2018 coverage period, are provided in the supplementary spreadsheet **"**Combined OBE/Aggression Statistics – Hygiene**"** available on the FRNBES website.

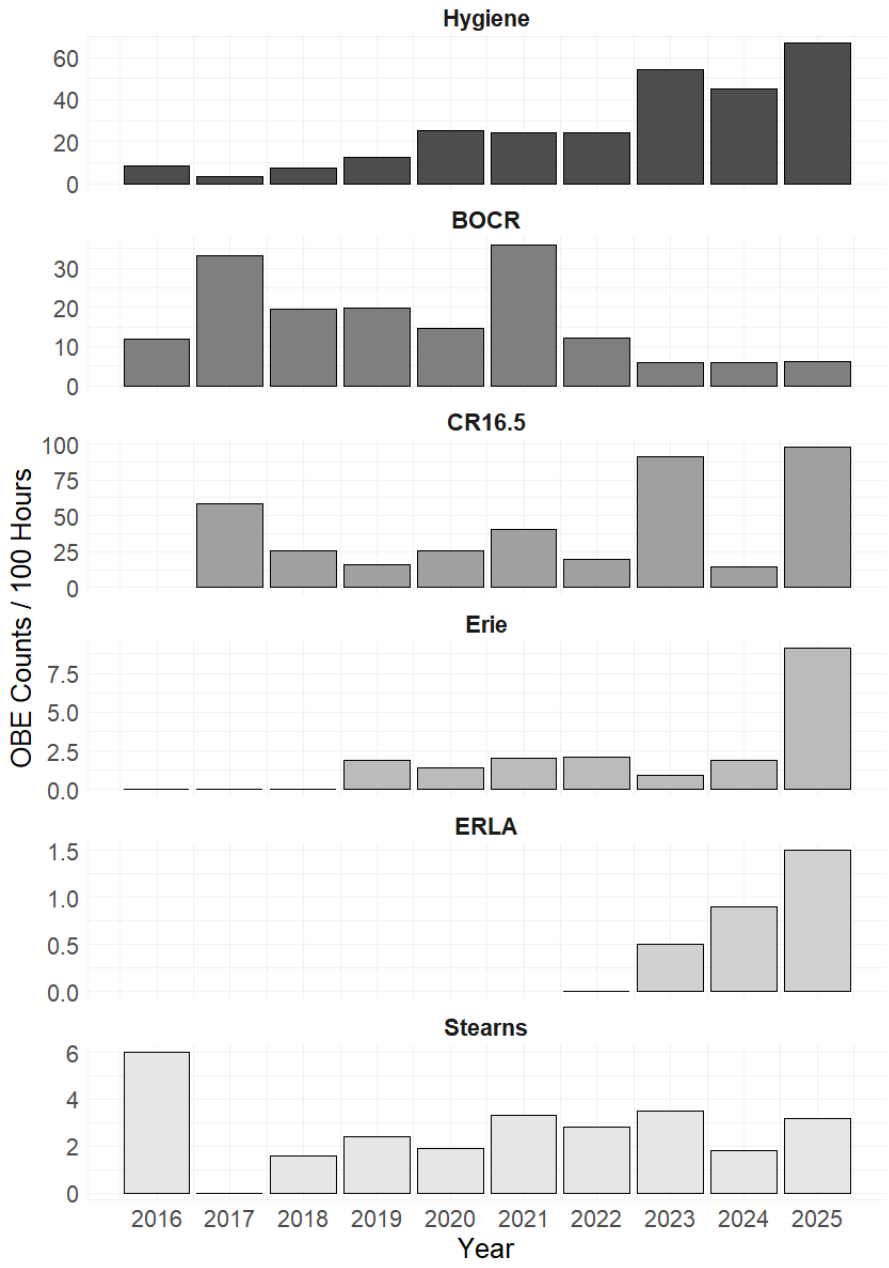

Figure 9. Annual rates of outsider bald eagle (OBE) detections per 100 survey hours for each of the six focal territories. Values combine field and subsampled PTZ camera data. Patterns vary widely among nests, with some (e.g., Hygiene, CR16.5, Erie, ERLA) showing recent increases, while others (e.g., BOCR, Stearns) remain stable or have declined over the study period.

Territorial intruder pressure was most elevated during the Migratory Surge and Early Fall Arrival, with several months exceeding 20 OBEs per hour (Table 7). Yearly OBE rates rose

steadily from 13 in 2019 to 67 in 2025, indicating a long-term increase in OBE pressure (Fig. 9). These elevated levels are consistent with the territory's position along St. Vrain Creek and its proximity to the Rabbit Mountain communal roost, approximately 2.8 km to the north (Fig. 1).

Aggression Rates: The Hygiene territory exhibited high aggression frequencies across all seasons except the Breeding Season /Absence period (Fig. 5). Non-territorial aggression averaged 3 events per 100 hours, territorial aggression 1, and severe aggression 0 (Table 6). The highest single-season value—46 non-territorial events per 100 hours—occurred during the Early Fall Arrival period in 2021 (Table 5). Aggression was distributed across all seasonal periods, with the highest values occurring in fall and winter (Fig. 5). Even in lower seasons, Hygiene's aggression levels were among the highest recorded across all territories in this study.

Territory Summary: As a prey-rich, stream-connected site near an active roost, Hygiene functions as a high-encounter territory with persistent outsider presence. Its consistently elevated OBE pressure and aggressive response rates make it one of the most defensively active and floater-exposed nests in the region. Aggression occurs across all seasonal periods, with particularly high rates during Migratory Surge and Early Fall Arrival, including the study's highest single-season value (46 non-territorial events per 100 hours in Early Fall Arrival 2021, Table 5). These patterns align with the territory's high seasonal aggression levels and its location within a resource-rich, stream-connected corridor.

BOCR.—OBE pressure: BOCR exhibited moderate OBE/100 hour values across most seasons and years (Figs. 4, 9). Counts were highest during the Migratory Surge and Late-Stage Pressure periods, with additional mild increases during the Early Fall Arrival (Table 7). OBE/100 hour values declined after 2021, coinciding with a period of reduced roost activity and construction in the surrounding corridor (Table 7, Fig. 9). Despite these declines, BOCR continues to show low to moderate seasonal OBE presence.

Aggression Rates: Aggression at BOCR was moderate in frequency and largely concentrated in winter and early spring (Table 5, Fig. 5). Average non-territorial aggression was 4.4 events per 100 hours, while territorial and severe aggression averaged 0.5 and 0.0, respectively (Table 6). Aggression peaked in 2023 with 40 total events, all in the non-territorial category except for a rare instance of territorial aggression during Early Fall Arrival (T = 3.8 territorial; Table 5). Seasonal breakdowns show elevated aggression during the Late-Stage Pressure period, with additional responses during Early Fall Arrival (Fig. 5). Overall, patterns indicate recurring but moderate territorial pressure at this stream-corridor site.

Territory Summary: BOCR represents a stream corridor-riparian territory with historically elevated OBE pressure and consistent seasonal aggression. Most aggression has occurred during the Migratory Surge and Late-Stage Pressure periods, with occasional events in Early Fall Arrival. While non-territorial aggression dominates the record, rare territorial interactions have been documented, including during Early Fall Arrival 2023. These patterns reflect the site's position along Boulder Creek, where high seasonal outsider traffic can generate recurring, moderate-level territorial pressure.

CR16.5.— OBE pressure: CR16.5 exhibited moderate to high OBE/hour rates, with notable year-to-year variation (Fig. 9). While values remained under 20 OBEs/100 hours in most years from 2017 to 2022, they increased sharply in 2023 (75.1) and peaked in 2025 at 98.2—higher than any other site in any year (Fig. 9). This territory is positioned along a high-traffic section of Boulder Creek and closely borders the South Roost, with additional historic influence from the now-defunct Middle Roost (Fig. 1). Monthly OBE/100 hour values were highest during the Migratory Surge and Late-Stage Pressure periods, particularly in 2025 (Table 7, Fig. 4).

Aggression Rates: Aggression levels at CR16.5 fluctuated, with high totals in 2020 (27 events) and 2021 (28 events) during both Migratory Surge and Late-Stage Pressure periods (Table 5). Activity declined sharply in 2022, then rose again in 2023, driven by high Late-Stage Pressure aggression (30.1 non-territorial events per 100 hours) but lower overall event counts (17) (Table 5, Fig. 10). Most aggression between 2017 and 2022 fell into the non-territorial category, suggesting steady behavioral pressure with only occasional escalation (Table 5). In January 2025, the resident male—formerly shared with the Erie territory—was displaced by an adult floater. This marked the collapse of the polygamous triad and the onset of monogamous occupancy at CR16.5. Aggression in early 2025 included multiple territorial and severe events, indicating a true shift in threat level.

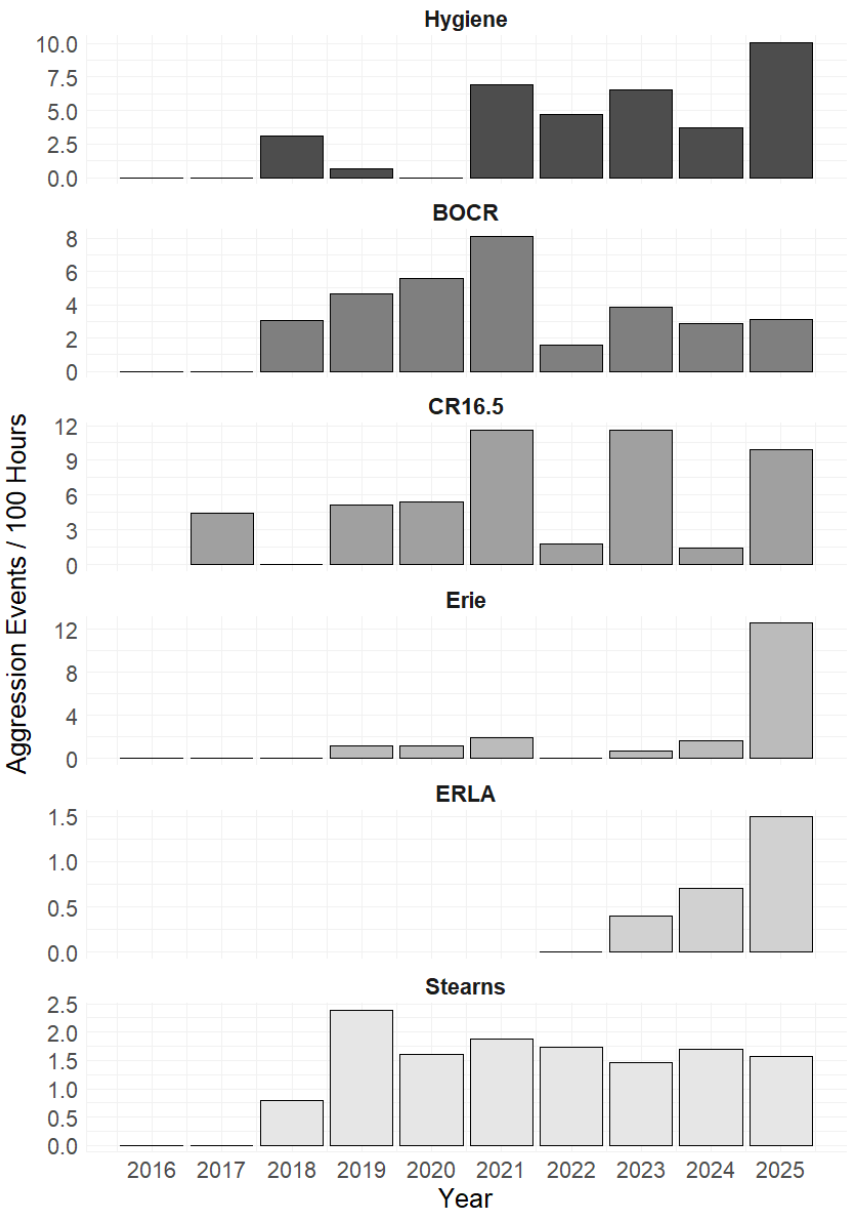

Figure 10. Annual aggression rates per 100 survey hours involving outsider bald eagles (OBEs) for each of the six focal territories. Values combine field and subsampled PTZ camera data. Trends differ substantially among nests, with some (e.g., Hygiene, CR16.5, Erie, ERLA) showing sharp recent increases, while others (e.g., BOCR, Stearns) remain relatively stable over time.

Territory Summary: CR16.5's aggression and OBE profiles reflect long-standing moderate pressure punctuated by three notable periods of instability. The first, in 2020–2021, involved elevated outsider presence and high total aggression rates, though most events were non-territorial and did not escalate to severe conflict. The second, in 2023, was marked by a Late-Stage Pressure spike (30.1 non-territorial events per 100 hours), indicating heightened outsider activity without direct territorial challenges. The third, in early 2025, corresponded to an abrupt

partner replacement event following multiple high-severity intrusions. These patterns highlight how sustained OBE activity—especially near key roosts and within migration corridors—can periodically escalate into events that disrupt territorial partnerships.

ERIE.—OBE pressure: Rates of OBE/hour at Erie remained low from 2018 through 2024, ranging from 0.0 to 1.9 (Fig. 9). In 2025, values rose sharply to 9.1 OBE counts per 100 hours, coinciding with the dissolution of the polygamous triad and the full-time return of the displaced male from CR16.5 (Fig. 9). This spike in pressure was temporally associated with a combination of territorial reconfiguration, displacement at CR16.5, and increased floater flow along the Boulder Creek corridor. While Erie has generally functioned as a stable upland territory, the 2025 data documents an abrupt escalation in aggression and OBE presence at a site that previously exhibited low activity.

Aggression Rates: Aggression between 2018 and 2024 remained low to moderate, with average non-territorial and territorial aggression rates of 0.8 and 1.0 events per 100 hours, respectively (Table 6, Fig. 5). Severe aggression averaged 0.6, most of it attributable to a spike in 2025 (Table 5). During the Migratory Surge period of that year, total aggression reached 17.6 events per 100 hours—the highest seasonal total across all sites—distributed across all severity categories (N = 6.3 non-territorial, T = 5.9 territorial, S = 5.4 severe; Table 5). These results indicate that Erie experienced a temporary but pronounced increase in outsider pressure and territorial conflict following a major shift in adult pair structure.

Territory Summary: Historically a relatively low-pressure upland site with modest OBE presence and limited severe aggression, the Erie territory experienced an unprecedented surge in 2025. That year, during the Migratory Surge period, the territory recorded the highest seasonal aggression rate among all sites—17.6 events per 100 observation hours—comprising 6.3 non-territorial, 5.9 territorial, and 5.4 severe events (Table 5). Much of this activity was concentrated in repeated dusk-period intrusions and high-intensity floater interactions documented through both camera and field sessions. Its proximity to Boulder Creek and the South Roost corridor may render the site vulnerable to elevated pressure during periods of broader landscape instability, as the 2025 season demonstrated.

ERLA.—OBE pressure: ERLA exhibited the lowest levels of OBE/100 hours across all six territories, with values remaining below 2.0 in all months and years (Fig. 9). Seasonal variation was minimal, with little change during the Migratory surge or Late-stage pressure periods (Fig. 4). Unlike more stream corridor-proximate territories, ERLA saw no sharp influx of non-resident eagles during fall or winter. These patterns are consistent with the territory's upland classification and distance from major stream corridors and roost sites. The nearest communal roost, White Rocks, is located approximately 6 km to the northwest (Fig. 1).

Aggression Rates: Aggression activity at ERLA was infrequent and typically low in frequency (Fig. 10). Across all years, aggression averaged non-territorial (0.3), territorial (0.3), and severe (0.4) events per 100 hours (Table 6). Although total event counts were low, the proportion of territorial and severe aggression was relatively high, indicating that when conflict occurred, it often escalated. Most aggression was concentrated in the Migratory Surge and Breeding Season /Absence periods (Table 5, Fig. 5).

Territory Summary: ERLA represents a consistently low-pressure site, shaped by its spatial separation from major migratory routes and roost networks. Despite the low background presence of non-resident eagles, the few interactions that did occur often reached elevated aggression levels. These were most commonly observed during the Migratory Surge and Breeding Season /Absence periods, suggesting a system of rare but consequential conflicts when outsiders appeared.

STEARNS.—OBE pressure: Stearns exhibited the lowest OBE/hour values across all sites, with minimal variation across seasons or years (Table 7, Figs. 4, 9). Seasonal OBE activity remained low even during the Migratory Surge, with 2025 values at just 4.6 OBEs per 100 hours (Table 7). These rates are consistent with its upland position, absence of stream corridors, and geographic distance from major migratory pathways. The nearest known communal roost, White Rocks, is approximately 13 km to the northwest (Fig. 1). No directional trend in OBE pressure was observed across the dataset.

Aggression Rates: Aggression at Stearns was among the lowest recorded in the study, averaging 1.5 non-territorial, 0.2 territorial, and 0.0 severe events per 100 observation hours (Table 6). Activity was concentrated primarily in the Migratory Surge and Breeding Season /Absence periods, with occasional events during Late-Stage Pressure, but remained minimal and low in intensity (Table 5, Fig. 5). No territorial or severe aggression was recorded in 2025 (Table 5). In addition, no measurable increase in aggression or OBE pressure was observed at either the fallback or primary nest site in early 2025.

Territory Summary: Stearns is part of the consistently low-pressure group in this study, along with ERLA. Its limited prey diversity, absence of stream corridors, and negligible communal roost influence have kept it peripheral to the broader network of outsider eagle activity. Most aggression occurred during the Migratory Surge and Breeding Season /Absence periods but remained low in both frequency and severity. These patterns are consistent with the site's upland setting and relative isolation from major migratory routes.

DISCUSSION

Territorial Presence Across Nests

Annual adult territorial presence varied considerably among the six study territories, ranging from 59.2 ± 25.4% at ERLA to 84.1 ± 15.7% at Stearns (Table 4, Fig. 2). These values, which span all major annual phases from incubation through nest building, reflect how consistently pairs maintained an active presence within their defended area. When isolating the dispersal-to-incubation period—a phase less constrained by direct parental duties and more indicative of baseline territorial coverage—attendance ranged from 44.9 ± 17.2% at ERLA to 85.2 ± 13.2% at Stearns (Table 4, Fig. 2).

ERLA's consistently lower attendance is distinctive within the dataset. This upland territory lies 3.8 km from the nearest major stream corridor and approximately 6 km from the nearest communal roost, with relatively limited aquatic foraging opportunities. Outside of incubation and mid–late post-fledging dependence, both adults frequently forage beyond territorial

boundaries, often in nearby protected open space where fishing access is better. In contrast, higher-attendance nests such as Stearns and CR16.5 maintained nearly continuous territorial presence even outside the breeding period. These patterns establish a baseline for evaluating how territorial presence aligns with other seasonal behaviors presented in subsequent sections.

Spatial and Seasonal Patterns of OBE Presence

Across all six territories, OBE/hour values follow a consistent seasonal cycle: rising in late October or early November, peaking between December and February, and tapering by mid-March. This pattern reflects the well-documented winter influx of non-territorial bald eagles into the northern Front Range. However, while the timing of this influx is similar across the region, the amount of pressure it brings varies greatly from one territory to another.

Hygiene is the only site to exhibit a clear long-term incline in OBE/hour values over the course of the study. Its proximity to both the Rabbit Mountain Roost (Fig. 1) and the St. Vrain Creek corridor (Type 2 stream; Bove et al. 2024a) likely contributes to its consistently high levels of non-resident eagle presence. The sustained increase may reflect a combination of strong local habitat quality and redistribution from other areas, though the drivers of this trend remain uncertain. The number of breeding territories in the northern Front Range has continued to rise in recent years, with 150 occupied nests reported in 2024, and over 300 statewide (Bove et al. 2024a; Middleton et al. 2025). However, it is not yet clear whether this growth is contributing to displacement or crowding among non-territorial individuals. Regardless, Hygiene stands out as the only nest site in the study with a consistent upward trajectory in winter use.

BOCR shows a gradual decline in OBE/100 hour rates over the past several years, in contrast to Hygiene's sustained increase, despite both being located along major stream systems (Fig. 9). This downward trend is consistent across all seasonal periods and is likely tied to the collapse of the Middle Roost—the central node of the interconnected Boulder Creek Roost system—and the ongoing decline of the Confluence Roost, its northernmost node (Watts and Dyer 2016, FRNBES 2025). Post–Early Winter 2022 peaks have never returned to pre-collapse levels (Table 7, Fig. 9). A major irrigation infrastructure project in winter–spring 2025, located just north of the former Middle Roost site, likely compounded these losses by further disrupting the south–north winter flow along Boulder Creek (FRNBES unpublished data). BOCR's pattern demonstrates that regional growth in eagle numbers does not translate to universal increases in non-resident pressure; instead, it underscores the importance of intact roost infrastructure in sustaining migratory flow.

In contrast to BOCR's steady decline, the nearby Erie territory experienced an abrupt and short-lived reversal of its long-term and relatively quiet OBE pattern. Erie recorded a pronounced spike in OBE/hour rates in 2025, rising from historic values of 0.0–2.1 between 2018 and 2024 to 9.1 (Fig. 9). This coincided with the displacement of the shared male from CR16.5 and his full-time return to the Erie upland territory. Aggression rates likewise surged in 2025, reaching 17.6 events per 100 hours during the Migratory Surge Period—the highest seasonal total documented at the Erie territory. These events were distributed across all severity categories (N = 6.3 non-territorial, T = 5.9 territorial, S = 5.4 severe, Table 5). In Erie's case, the spike appears to have been intensified by conditions that also affected BOCR, but with a different outcome: a southward concentration of migrants into the south end of the roost system, coupled with overflow from CR16.5 during a period of territorial reconfiguration. This

combination produced a short-term surge in migratory pressure in the South Roost area (Fig. 1) that spilled over to the Erie upland nest territory. Similar short-term spikes, rather than sustained increases, have been observed at several other territories in this study.

Stearns and ERLA, both upland sites, remained consistently low in OBE pressure across all years (Fig. 9). Annual means were 0.0–6.0 OBEs/100 hr at Stearns (typically 1–3.5; 6.0 in 2016) and 0.0–1.5 OBEs/100 hr at ERLA (Fig. 9). In contrast, stream-connected territories such as Hygiene and CR16.5 typically averaged 15–35 OBEs/100 hr, with some years substantially higher (e.g., ≥50 at both sites) (Fig. 9). This contrast underscores the role of stream access and roost proximity in this dataset; the relative isolation of upland sites, and their limited access to major migratory corridors, appears to buffer them from the seasonal influx of non-resident eagles.

Aggression Patterns and Territorial Variation

Aggression score per 100 hours varied significantly across territories and time (Fig. 10). While most months scored near zero, scores above 10 signaled periods of heightened territorial conflict—typically involving persistent perching, nest incursions, or displacement by adult to subadult intruders.

Although the ratio-based comparisons from the aggression frequency analysis (Appendix II) focused on the number of OBE presence events and aggressive encounters, they did not incorporate aggression intensity scores or late-day behavioral patterns.

Hygiene, despite its rising non-resident presence—exhibited only moderate aggression (Table 5, Fig. 10). Field notes confirm that the pair frequently intercepted intruding eagles 200–500 meters from the nest, reducing the need for escalated defense.

BOCR displayed sporadic aggression (Fig. 10), but overall intensity and frequency were low, consistent with its declining OBE presence (Fig. 9).

CR16.5, by contrast, has experienced intermittent high-aggression years (Table 5, Fig. 10), including notable peaks in 2020, 2021, and 2023. A smaller resurgence occurred in early 2025, coinciding with the breakup of the polygamous triad and the arrival of a new male. Periods of lower aggression between these peaks may reflect strong territorial defense and buffering by the Boulder Creek Roost system (Table 5, Fig. 10).

Erie experienced precisely these high-intensity, dusk-period intrusions that defined the transition following the shared male's shift to full-time residency after losing the CR16.5 territory to a new male. The behavioral data and field notes strongly suggest that floaters were probing both the stamina and commitment of the new resident male. In prior seasons, the Erie territory was often defended by the female alone for extended periods—potentially signaling to intruding males that the site was vulnerable or insufficiently held, particularly during the years when the shared male split his time between two nests.

This timing may not have been coincidental. As documented in field notes and video review, repeated dusk interactions began shortly after the male established full-time presence at Erie in early January. At the same time, the CR16.5 territory stabilized under a new pairing. This shift likely represented a perceived territorial opening in what had been a polygamous nesting

structure, during which multiple floaters began testing the viability of Erie as an alternative. Between January 8 and March 10, 2025, full-day camera sessions documented floater intrusions on 12 out of 28 days (~43%), with a notable concentration of those occurring in late afternoon or evening. Many of the highest-intensity TAT scores recorded during this time also occurred during these dusk periods.

Such behavior may reflect broader changes in regional territory competition. As communal roosts decline and open territories become rarer, floaters may increasingly apply persistent pressure and remain longer to assess and exploit weakly held sites. Erie—with its broad viewshed, prey availability, and reproductive history—remains a desirable target. The late-stage floater activity documented here, especially in the context of the shared male's recent displacement and Erie's prior under-defended status, illustrates how nest transitions and adult turnover can amplify outsider pressure. These interactions, occurring in the context of an unprecedented seasonal aggression level for this territory (17.6 events/100 hours), illustrate how rapid changes in adult pairing can trigger aggressive contests that reshape territorial stability ERLA had one of the highest apparent aggression rates relative to intrusion frequency (Table 5), even though intrusions were rare (Fig. 9). This pattern likely reflects a combination of factors.

Infrequent visits naturally inflate per-minute values, but the intrusions themselves also tended to be prolonged or escalated. Outside of incubation and the mid-to-late post-fledging dependence period, the resident pair is often absent from the immediate nest vicinity—frequently foraging 1.6–3.2 km away in nearby protected open space with better fishing access (see ERLA Territory). This relatively low territorial attendance may allow intruding eagles to remain in the area longer before being detected, leading to a stronger or more urgent response once the territory holders return. Alternatively, non-resident eagles may be responding to a perceived lapse in territorial control, interpreting temporary absence as vulnerability.

Stearns, another low-pressure territory, exhibited the lowest OBE/hour values across all sites, with minimal variation across seasons or years. Seasonal OBE activity remained low even during the Migratory Surge, with 2025 values at just 2.3 OBEs per 100 hours (Table 7). These rates are consistent with its upland position, absence of stream corridors, and geographic distance from major migratory pathways and communal roosts. Aggression at Stearns was among the lowest recorded in the study, averaging 1.5 non-territorial, 0.2 territorial, and 0.0 severe events per 100 observation hours (Table 6). Activity was concentrated primarily in the Migratory Surge and Breeding Season /Absence periods, with occasional events during Late-Stage Pressure, but remained minimal and low in intensity. No territorial or severe aggression was recorded in 2025. Like ERLA, its combination of limited prey diversity, upland setting, and negligible communal roost influence has kept Stearns peripheral to the broader network of outsider eagle activity.

This contrasts with the situation at Erie, where the shared male maintained high nest attendance during the same period, yet intrusions increased following his displacement from CR16.5 in January 2025—a pattern that may reflect perceived instability in territorial control, rather than physical absence. This relationship could be tested in future work by directly comparing aggression severity with adult presence levels during intrusion events, using synchronized intrusion and attendance datasets across territories.

Roost System Collapse and Regional Restructuring

The collapse of the Middle Roost by 2021 and degradation of the Confluence Roost have disrupted the historical south-to-north flow of overwintering bald eagles along Boulder Creek (FRNBES 2025). Loss of these hubs eliminated a key winter night-roosting site, forcing non-resident eagles to redistribute into marginal or fragmented shelter or reduce use of the corridor. Some likely shifted to alternative regional roosts functioning as sink sites—absorbing displaced birds but unlikely to support long-term territorial establishment. One example of a site potentially functioning in this way is Barr Lake, about 30 km southeast of the Confluence Roost (Fig. 1), a Colorado Parks and Wildlife–managed reservoir that rarely freezes in winter, offers consistent prey, and is relatively insulated from disturbance (Colorado Parks and Wildlife 2025; eBird 2025; Denver Audubon 2025). Sites like Barr Lake may increasingly absorb displaced wintering eagles from disrupted roost systems in the northern Front Range.

The Confluence Roost, once a winter hub for 40–50 eagles (historically as many as 60–80), often supported fewer than 10 individuals in recent years. Long-term analysis shows an average decrease of two eagles per year from 2002–2024 ($R^2 = 0.47$; FRNBES 2025), reflecting sustained decline linked to habitat loss from energy operations, irrigation development, and flood-related changes to hydrology and tree cover. The Middle Roost, formerly supporting up to 23 eagles nightly, is now effectively abandoned, with only two individuals recorded on a single night in three years. Its loss has likely disrupted roost-switching movements within the network and increased strain on the remaining roost sites. The South Roost, still active as of 2025, bears this increased burden—but its stability is uncertain (FRNBES 2025).

With these shifts in the regional network, territories like Erie, once peripheral to primary movement corridors, became focal points for non-resident eagles. Erie's 2025 aggression spike is best interpreted not as a symptom of regional growth in eagle numbers, but as a direct consequence of displaced wintering birds seeking nighttime shelter and territorial access (Bove et al. 2025). By contrast, Hygiene, which remains near a functional roost (Rabbit Mountain), appears to have absorbed increasing wintering birds more gradually, without behavioral escalation. The post-2021 decline in OBE activity at BOCR may reflect both the Middle Roost collapse and broader disruptions to the Boulder Creek corridor, where continued development and habitat loss could be diminishing its role as a wintering hub.

Territorial Instability and Broader Implications

The 2025 surge in OBE/hour rates and aggression at Erie coincided with the displacement of the shared male from CR16.5 and his full-time return to the territory. Aggression during the Migratory Surge period reached the highest seasonal total documented for Erie, with events distributed across all severity categories. This concentrated pressure likely reflects localized territorial reconfiguration combined with altered regional movement patterns following changes in the roost network. Similar short-term spikes, rather than sustained increases, have been observed at other territories in this study.

These findings emphasize how changes in the roost network can shift the distribution and intensity of non-resident eagle activity across the landscape. Territories positioned outside traditional high-traffic corridors may experience abrupt increases in intrusion pressure when nearby roost capacity declines or regional movement pathways are disrupted. In such cases,

elevated aggression may be temporary, reflecting short-term redistribution, but the potential for long-term effects remains if roost network stability is not maintained.

Conclusions

Non-resident bald eagle pressure and aggression on nesting territories in the northern Colorado Front Range show considerable variation, challenging the view that breeding pairs are consistently "thriving" because of their adaptability and generalist tendencies. Outcomes are shaped by territory-specific conditions, roost proximity, and broader landscape-level roost declines—most notably the collapse of the Middle Roost and continuing decline of the Confluence Roost, which have disrupted the historic Boulder Creek winter corridor and diverted displaced eagles into remaining roosts or territories previously marginal to winter use.

Such shifts can produce localized surges in pressure that are just as consequential for territorial stability as long-term trends—most clearly illustrated by the Erie spike in 2025, when regional displacement and local instability combined to produce the highest aggression rate recorded. By contrast, territories adjacent to long-standing active roosts, such as Hygiene, absorbed increased OBE activity with relatively stable aggression levels.

The Confluence Roost—once a wintering hub for 40–50 eagles, and historically as many as 60–80—now supports fewer than ten individuals on many counts. Additional disturbance near this already compromised roost system, as noted in Boulder Reporting Lab (2025), could accelerate the loss of wintering capacity, intensifying pressure on both buffered and vulnerable territories.

Effective management must account for the uneven distribution of non-resident pressure, the stabilizing role of roost infrastructure, and the potential for episodic destabilization. Future investigations should integrate behavioral intensity, timing of intrusion, and roost occupancy data to differentiate between chronic pressure and acute instability.

Acknowledgements

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Supplementary Material

Supporting tables and additional data summaries associated with this article are available at the Front Range Nesting Bald Eagle Studies website: https://frontrangeeagles.org/get-involved/reports/ [Accessed 10 Aug 2025]. The dataset archive includes standardized seasonal outsider bald eagle (OBE) counts, aggression rates per 100 survey hours, combined OBE/aggression statistics, and multispecies aggression tables with TAT bald eagle aggression scoring for each of the six focal territories, provided as Excel files with clearly labeled tabs.

LITERATURE CITED

ANTHONY R.G., AND ISAACS F.B. 1989. Characteristics of bald eagle communal roosts in Oregon. Northwest Science 63:60–66.

BOULDER REPORTING LAB. 2025. Distel–Tull land swap could trade farmland for compost site. Boulder Reporting Lab, Boulder, CO. Available from: https://boulderreportinglab.org/2025/01/17/distel-tull-land-swap-could-trade-farmland-for-compost-site/ [Accessed 5 Aug 2025].

BOVE, D.J., ANDERSON, H.A., SMITH, M.A., AND KUHN,T.A. 2024a. Nesting bald eagle population numbers, density, territorial resources, and relationship to human development in northern Colorado's Front Range. Western Birds 55:2–27. doi:10.21199/WB55.1.1.

BOVE, D.J., CONREY, R.Y., AND MIDDLETON, M. 2024b. Understanding territorial absences: insights into Bald Eagle hiatuses in the northern Colorado Front Range. Page 214 in Abstracts with programs, American Ornithological Society annual meeting, Estes Park, CO, USA.

BUEHLER, D.A. 2000. Bald eagle (*Haliaeetus leucocephalus*), version 2.0. Pages 1–40 in Poole A, Gill F, editors. The Birds of North America. No. 506. Ithaca (NY): Cornell Lab of Ornithology.

COLORADO PARKS AND WILDLIFE. 2025. Barr Lake State Park. Denver (CO): Colorado Parks and Wildlife. Available from: https://cpw.state.co.us/placestogo/parks/BarrLake [Accessed 9 August 2025].

DENVER AUDUBON. 2025. Barr Lake State Park. Littleton (CO): Denver Audubon. Available from: https://denveraudubon.org/barr-lake-state-park/ [Accessed 9 August 2025].

DWYER, J.F., FRASER, J.D., MORRISON, J.L., AND WATTS, B.D. 2020. Bald eagle defense behavior at nests increases with age and persists throughout the nestling period. Wilson Journal of Ornithology 132:28–39.

EBIRD. 2025. Barr Lake State Park, Adams County, Colorado, USA. Ithaca (NY): Cornell Lab of Ornithology. Available from: https://ebird.org/hotspot/L129127 [Accessed 9 August 2025].

FRASER, J.D., FRENZE, L.D., AND MATHISEN, J.E. 1985. The influence of human disturbance on the breeding behavior of bald eagles. Journal of Wildlife Management 49:585–592.

FRONT RANGE NESTING BALD EAGLE STUDIES [FRNBES]. 2024. Stearns Lake bald eagles: history, habitat, and management challenges. Louisville (CO): Front Range Nesting Bald Eagle Studies. Presentation by Dana Bove, 5 December 2024. YouTube. Available from: https://youtu.be/FkDKxI0YbrY [Accessed 9 August 2025].

FRONT RANGE NESTING BALD EAGLE STUDIES [FRNBES]. 2025. Protecting the Confluence Roost: assessing the impact of proposed development on bald eagle habitat. Boulder (CO): Front Range Nesting Bald Eagle Studies. [URL pending].

FRONT RANGE NESTING BALD EAGLE STUDIES [FRNBES]. 2025a. The Hygiene pair. Boulder (CO): Front Range Nesting Bald Eagle Studies. Available from: https://frontrangeeagles.org/our-eagles/the-hygiene-pair/.

FRONT RANGE NESTING BALD EAGLE STUDIES [FRNBES]. 2025b. The Boulder Creek pair. Boulder (CO): Front Range Nesting Bald Eagle Studies. Available from: https://frontrangeeagles.org/our-eagles/the-boulder-creek-pair/.

FRONT RANGE NESTING BALD EAGLE STUDIES [FRNBES]. 2025c. The CR16 bald eagle pair. Boulder (CO): Front Range Nesting Bald Eagle Studies. Available from: https://frontrangeeagles.org/our-eagles/cr16/.
Front Range Nesting Bald Eagle Studies [FRNBES]. 2025d. The Erie bald eagle pair. Boulder (CO): Front Range Nesting Bald Eagle Studies. Available from: https://frontrangeeagles.org/our-eagles/the-erie-nest/.
FRONT RANGE NESTING BALD EAGLE STUDIES [FRNBES]. 2025e. The Stearns Lake bald eagle pair. Boulder (CO): Front Range Nesting Bald Eagle Studies. Available from: https://frontrangeeagles.org/our-eagles/the-stearns-lake-pair/.
GERRARD, J.M., AND BORTOLOTTI, G.R. 1988. The Bald Eagle: Haunts and Habits of a Wilderness Monarch. Washington (DC): Smithsonian Institution Press.
HARMATA, A.R., AND TOEPFER, J.E. 1985. Fall migration of Bald Eagles produced in northern Saskatchewan. Blue Jay 43:232–237.
HARMATA, A.R., AND STAHLECKER, D.W. 1993. Fidelity of Bald Eagles to wintering grounds in south-central New Mexico. Journal of Field Ornithology 64:129–134.
ISAACS, F.B., AND ANTHONY R.G. 1987. Abundance, foraging, and roosting of Bald Eagles wintering in the Klamath Basin, California–Oregon. *Northwest Science* 61:114–121.
KEISTER, G.P., ANTHONY, R.G., AND ISAACS, F.B. 1987. Characteristics of Bald Eagle communal roosts in the Klamath Basin, Oregon. Journal of Wildlife Management 51:405–411.
KATZNER, T.E., SMITH, B.W., SLATER, S.J., AND PRESTON, C.R. 2012. Status, biology, and conservation priorities for North America's eastern Golden Eagle population. The Auk 129:168–176.
MCCLELLAND, B.R. 1975. Nesting ecology of Bald Eagles on the South Fork of the Flathead River [master's thesis]. Missoula (MT): University of Montana.
MCCLELLAND, B.R., MCCLELLAND, S.D., YOUNG L.S, AND CRENSHAW, J.G. 1994. Responses of nesting Bald Eagles to human activity. Wildlife Society Bulletin 22:626–635.
MIDDLETON, M., CONREY, R.Y., JAFFE, N., AND PEJCHAR, L. 2025. Bald eagle home range size and core-use areas in an urbanizing landscape. Available at SSRN: https://ssrn.com/abstract=5316650 or http://dx.doi.org/10.2139/ssrn.5316650 [Accessed 10 Aug 2025].
MILLSAP, B.A., BREEN, T.F., MCCONNELL, E., STEFFER, T., PHILLIPS, L.M., DOUGLASS, N., AND TAYLOR S. 2004. Comparative fecundity and survival of Bald Eagles fledged from suburban and rural natal areas in Florida. Journal of Wildlife Management 68:1018–1031.
NIJSSEN, A.L., HARMATA, A.R., AND GERRARD, J.M. 1985. The initial southward migration of an adult female Bald Eagle. Pages 86–90 in J.M. Gerrard and T.N. Ingram, editors, The Bald Eagle in Canada: Proceedings of Bald Eagle Days, 1983. White Horse Plains Publishing, Headingley, Manitoba, Canada, and The Eagle Foundation, Apple River, IL.
STALMASTER, M.V. 1987. The Bald Eagle. New York (NY): Universe Books.
STEENHOF, K., AND KOCHERT, M.N., AND DOREMUS, J.H. 1980. Nesting of subadult bald eagles in southwestern Idaho. Wilson Bulletin 92:510–514.
WATSON, J.W. 2010. Responses of nesting bald eagles to experimental pedestrian activity. Journal of Wildlife Management 74:1067–1072.
WATTS, B.D., THERRES, G.D., AND BYRD, M.A. 2006. Recovery of the Chesapeake Bay bald eagle nesting population. Journal of Wildlife Management 70:717–720.
WATTS, B.D., AND DYER, R.J. 2018. Structure and resilience of bald eagle roost networks. Wildlife Society Bulletin 42:195–203.

TABLE 1**.** A detailed breakdown of territory dynamics for each focal nest included in study.

Nest	Resource Richness	Stream Corridor Proximity	Communal Roost Influence	OBE Travel Pressure	Notes
Hygiene	High	Yes	Yes – Rabbit Mountain	High and Inclining	Most consistent winter OBE presence. High overall aggression and species diversity, close to former Middle roost.
BOCR	High	Yes	Partial – Confluence and Boulder Creek	Moderate – High but Declining	Historically high OBE pressure due to roost proximity. Pressure has dropped since Middle Roost collapse in 2021, resulting in lower 2024–2025 OBE counts.
CR16.5	High	Yes	Yes – South Roost	Moderate – High but Steady	Seasonal OBE peak. OBE pressure is likely redirected after BOCR/Middle Roost changes; increased Erie spillover.
Stearns	High	No	No	Low	Some winter OBE use. OBE use likely declined after habitat disruption and Cutoff Trail opening. Displacement noted.
Erie	Moderate	No	No	Low	Increasing pressure – with more adult floaters and aggression - in 2025 as floater spillover rises from CR16.5/BOCR.
ERLA	Low – Moderate	No	No	Low	Lowest OBE and aggression rates across all seasons with few visiting eagles. Upland territory.

TABLE 2. Survey effort for each nest territory included in the study.

Nest	Total Observation Hours	Study Period
Hygiene	1254	2016-2025
BOCR	2823	2016-2025
CR16.5	1592	2017-2025
Erie	3792	2016-2025
ERLA	2702	2022-2025
Stearns	3768	2016-2025

TABLE 3. Aggression presence metric rankings. Ranking levels reflect behavioral activity in response to intruders, not aggression severity.

Nest	Season	Reactivity Level	Conditional Aggression Level	OBE Minimum Aggression Level
Hygiene	Breeding Season / Absence	Low	Moderate	Moderate
Hygiene	Early Fall Arrival	Low	High	Moderate
Hygiene	Late-Stage Pressure	Moderate	Moderate	Moderate
Hygiene	Migratory Surge	Moderate	High	Low
BOCR	Breeding Season / Absence	Low	Moderate	Moderate
BOCR	Early Fall Arrival	Moderate	Moderate	Moderate
BOCR	Late-Stage Pressure	High	Moderate	Low
BOCR	Migratory Surge	Moderate	High	Low
CR16.5	Breeding Season / Absence	Low	Moderate	Moderate
CR16.5	Early Fall Arrival	Low	Low	High
CR16.5	Late-Stage Pressure	High	Moderate	Low
CR16.5	Migratory Surge	Moderate	High	Moderate
Erie	Breeding Season / Absence	Moderate	Low	High
Erie	Early Fall Arrival	Moderate	Moderate	High
Erie	Late-Stage Pressure	High	High	High
Erie	Migratory Surge	High	High	High
ERLA	Breeding Season / Absence	Moderate	Low	Moderate
ERLA	Early Fall Arrival	High	High	High
ERLA	Late-Stage Pressure	High	Low	High
ERLA	Migratory Surge	Moderate	Moderate	High
Stearns	Breeding Season / Absence	High	Moderate	Moderate
Stearns	Early Fall Arrival	Moderate	Low	Low
Stearns	Late-Stage Pressure	Low	Low	Low
Stearns	Migratory Surge	Moderate	Moderate	Moderate

TABLE 4. Average adult territorial presence for each nest where a) represents totals for the full year and b) represents totals from dispersal to incubation.

a)

Nest	Year Range	Seasons (N)	Average	SD	Hours
Hygiene	2021 - 2022	2	72.20	19.67	589
BOCR	2023 - 2025	2	78.25	15.20	4046
CR16.5	2020 - 2021	2	82.24	17.74	702
Erie	2021 -2022	2	75.31	29.26	648
ERLA	2024	1	59.23	25.43	2560
Stearns	2021 -2023	3	84.14	15.67	1263

b)

Nest	Year Range	Seasons (N)	Average	SD	Hours
Hygiene	2022 - 2023	1	61.84	4.52	151
BOCR	2024 - 2025	1	75.42	5.71	387
CR16.5	2020 - 2021	1	80.05	7.85	160
Erie	2021 - 2023	2	70.29	31.97	181
ERLA	2024 - 2025	1	44.92	17.16	1065
Stearns	2021 - 2023	2	85.20	13.22	220

TABLE 5**.** Yearly aggression totals and average seasonal aggression metrics by year and nest (per 100 survey hours). Aggression type for each season is denoted as N = Non-territorial, T = Territorial, and S = Severe.

Nest	Year	Total Aggression Events	Migratory Surge (Nov-Feb)			Late-Stage Pressure (Mar)			Breeding Season / Absence (Apr-Sep)			Early Fall Arrival (Oct)		
			N	T	S	N	T	S	N	T	S	N	T	S
Hygiene	2016	0	0.0	0.0	0.0	-	-	-	-	-	-	0.0	0.0	0.0
	2017	0	0.0	0.0	0.0	-	-	-	-	0.0	0.0	0.0	0.0	0.0
	2018	2	0.0	0.0	0.0	0.0	0.0	7.2	7.2	0.0	0.0	12.5	0.0	0.0
	2019	1	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2020	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2021	13	1.9	0.0	0.0	10.9	0.0	0.0	0.0	0.0	0.0	46.4	0.0	0.0
	2022	20	7.4	2.5	0.0	6.6	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2023	8	7.3	3.7	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2024	3	0.0	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2025	3	0.0	8.8	0.0	13.9	0.0	0.0	0.0	-	-	-	-	-
BOCR	2016	0	0.0	0.0	0.0	-	-	-	-	-	-	0.0	0.0	0.0
	2017	0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
	2018	3	2.4	1.2	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0
	2019	9	9.6	0.0	0.0	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2020	20	4.0	0.0	0.0	16.2	8.1	0.0	4.2	0.0	0.0	4.8	0.0	0.0
	2021	21	15.1	1.2	0.0	23.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0
	2022	3	3.7	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2023	40	12.9	0.0	0.0	5.3	0.0	0.0	0.7	0.0	0.0	3.1	3.8	0.0
	2024	15	5.1	0.0	0.0	4.7	0.0	0.0	0.5	0.0	0.0	2.4	0.0	0.0
	2025	4	5.1	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
CR16.5	2017	1	7.5	0.0	0.0	-	-	-	-	-	-	0.0	0.0	0.0
	2018	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2019	6	7.9	2.6	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
	2020	27	13.9	3.0	0.0	7.3	0.0	0.0	1.0	0.0	0.0	10.2	0.0	0.0
	2021	28	15.1	5.5	0.0	14.3	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0
	2022	2	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2023	17	19.4	3.2	0.0	30.1	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
	2024	4	0.0	0.0	0.0	7.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
	2025	11	11.9	0.0	5.1	0.0	2.7	0.0	0.0	0.0	0.0	-	-	-
Erie	2016	0	0.0	0.0	0.0	-	-	-	-	-	-	0.0	0.0	0.0
	2017	0	0.0	0.0	0.0	-	-	-	-	-	-	0.0	0.0	0.0
	2018	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2019	5	0.8	0.0	1.5	0.0	0.0	0.0	0.4	0.0	0.0	0.0	5.2	0.0
	2020	7	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	3.7	0.0	0.0
	2021	9	4.4	0.0	0.0	0.0	0.0	0.0	0.8	0.4	0.0	0.0	0.0	0.0
	2022	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2023	5	1.0	0.0	0.5	0.0	13.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0
	2024	14	2.8	0.0	0.0	0.7	1.5	0.0	0.5	0.0	0.0	4.1	0.0	0.0
	2025	44	6.3	5.9	5.4	0.0	2.8	0.0	0.0	5.1	0.0	-	-	-
ERLA	2022	0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
	2023	6	0.3	0.3	0.3	0.0	0.0	0.7	0.1	0.1	0.0	0.0	0.0	0.0
	2024	7	1.2	0.4	0.0	1.8	0.0	1.8	0.0	0.2	0.0	0.0	0.0	0.0
	2025	3	0.0	0.0	1.9	0.0	0.0	0.0	0.0	2.1	0.0	-	-	-
Stearns	2016	0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
	2017	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2018	3	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
	2019	9	6.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
	2020	5	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2021	8	7.2	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
	2022	8	2.3	0.0	0.0	0.0	2.6	0.0	1.3	0.3	0.0	0.0	0.0	0.0
	2023	7	3.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0

2024	15	3.3	1.2	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.9	0.0	0.0
2025	5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-

TABLE 6. Average aggression metrics for each nest territory (per 100 survey hours). N is the number of seasons included in statistic computation.

		Non-Territorial Aggression (<6)				Territorial Aggression (6-7)				Severe Aggression (>7)			
Nest	N	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Hygiene	35	3.3	8.4	0.0	46.4	1.0	2.6	0.0	9.6	0.2	1.2	0.0	7.2
BOCR	35	4.4	6.0	0.0	23.0	0.5	1.5	0.0	8.1	0.0	0.0	0.0	0.0
CR16.5	33	4.9	7.2	0.0	30.1	0.5	1.3	0.0	5.5	0.2	0.9	0.0	5.1
Erie	35	0.8	1.5	0.0	6.3	1.0	2.6	0.0	13.0	0.6	2.4	0.0	13.0
ERLA	12	0.3	0.6	0.0	1.8	0.3	0.6	0.0	2.1	0.4	0.7	0.0	1.9
Stearns	38	1.5	2.2	0.0	8.4	0.2	0.5	0.0	2.6	0.0	0.0	0.0	0.0

TABLE 7**.** Yearly total OBE counts, and average seasonal OBE counts (per 100 survey hours) included in study.

Nest	Year	Total OBE	Migratory Surge (Nov-Feb)	Late-Stage Pressure (Mar)	Breeding Season / Absence (Apr-Sep)	Early Fall Arrival (Oct)
Hygiene	2016	1	11.0	-	-	0.0
	2017	3	0.0	-	6.0	0.0
	2018	5	7.8	7.2	0.0	12.5
	2019	18	57.8	0.0	0.0	0.0
	2020	25	27.2	0.0	24.2	41.8
	2021	46	58.1	10.9	3.6	66.2
	2022	103	93.9	17.7	6.0	8.1
	2023	66	99.2	33.6	10.2	0.0
	2024	36	95.7	26.7	5.8	28.6
	2025	20	83.9	13.9	-	-
BOCR	2016	2	14.5	-	-	0.0
	2017	8	24.2	-	0.0	65.6
	2018	19	22.9	0.0	-	0.0
	2019	38	35.2	100.6	0.0	0.0
	2020	52	26.9	24.3	6.5	28.8
	2021	93	76.4	84.5	2.3	15.3
	2022	23	24.1	45.0	0.0	0.0
	2023	63	18.1	64.2	0.9	7.7
	2024	30	11.4	9.3	0.5	2.4
	2025	8	13.6	0.0	0.0	-
CR16.5	2017	13	97.7	-	-	0.0
	2018	10	48.7	0.0	0.0	0.0
	2019	19	15.8	300.0	3.0	21.7
	2020	126	84.2	38.1	1.3	56.1
	2021	105	63.0	124.0	5.2	0.0
	2022	21	34.9	35.8	0.0	11.5
	2023	141	80.8	375.9	17.5	0.0
	2024	40	31.1	16.4	4.4	5.1
	2025	109	160.9	32.0	13.9	-
Erie	2016	0	0.0	-	-	0.0
	2017	0	0.0	-	-	0.0
	2018	0	0.0	0.0	0.0	0.0
	2019	8	4.6	0.0	0.4	5.2
	2020	9	1.9	0.0	1.1	7.3
	2021	9	5.2	0.0	1.1	0.0
	2022	4	2.0	0.0	3.0	0.0
	2023	6	1.4	26.0	0.0	0.6
	2024	16	4.2	2.2	0.5	4.1
	2025	32	13.1	1.4	3.4	-
ERLA	2022	0	0.0	-	-	-
	2023	8	1.2	0.7	0.3	0.0
	2024	9	2.0	3.5	0.3	0.0
	2025	3	1.9	0.0	2.1	-
Stearns	2016	2	0.0	-	0.0	26.7
	2017	0	0.0	0.0	0.0	0.0
	2018	6	0.0	0.0	2.7	0.0
	2019	9	4.9	0.0	1.0	5.7
	2020	6	4.1	0.0	0.0	3.3
	2021	14	13.3	2.7	0.7	0.0
	2022	13	9.3	2.6	1.3	0.0
	2023	17	12.2	0.0	0.6	4.6
	2024	16	2.9	4.5	0.6	4.4

2025	10	4.6	0.0	0.0	-