



Prairie and Peregrine Falcon Occupancy and Productivity Monitoring at Pinnacles National Park

2021 Annual Report

Natural Resource Report NPS/SFAN/NRR—2022/2449



ON THE COVER

Prairie falcon fledglings, Discovery Wall, Pinnacles National Park, California.

NPS / GAVIN EMMONS

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Executive Summary

Pinnacles National Park (“Pinnacles”) provides diverse habitats for numerous cliff-nesting raptors, including prairie falcons (*Falco mexicanus*) and peregrine falcons (*F. peregrinus*), as well as a spectacular array of summits and cliff-wall routes for rock-climbers. This monitoring program was established to determine long-term trends in the number of occupied territories and productivity of nesting prairie and peregrine falcons. The monitoring program grew out of a need to reduce potential disturbance that climbers and off-trail hikers may have on cliff-nesting raptors. The falcon monitoring program began with a pilot effort in 1984, and after two years of no monitoring efforts in 1985 and 1986, monitoring data have been collected annually from 1987 to the present. This report summarizes the results from the 2021 breeding season and represents the 36th year of monitoring at the park, consistent with the standardized methods and procedures detailed in the Prairie Falcon Monitoring Protocol for Pinnacles National Monument (Emmons et al. 2011).

To monitor falcons, field technicians surveyed all potential nest sites three times per breeding season, with visits spaced 21 to 28 days apart. We revisited those nests determined to be active to confirm rearing of nestlings and fledging of young. In 2021, we conducted monitoring from 1 January 2021 until 23 July 2021, with a total of over 150 possible and active nest sites monitored during 850 observation hours.

We documented 13 territorial pairs of prairie and peregrine falcons this year, with 13 pairs actively nesting. Twelve nests successfully fledged 40 young; one nest failed. Falcon fecundity for the 2021 season was the highest documented since 2013. The data from 36 years of falcon monitoring at Pinnacles suggest an apparent cyclic population pattern in annual prairie falcon productivity, supplemented by increased peregrine falcon breeding efforts in recent years (Appendix C).

Acknowledgments

C. Dimmick and P. Johnson provided key oversight and support for the 2021 falcon monitoring efforts, and J. R. Hickey—as the program manager of the San Francisco Bay Area Network (SFAN) Inventory and Monitoring (I&M) Program—was critical in keeping the Pinnacles raptor monitoring program funded annually and on a permanent basis. S. Wakamiya and E. Edson also provided valuable assistance in their roles as the SFAN I&M Program data managers confirming QA/QC checks and validations of data for the raptor monitoring database. J. R. Hickey, L. Grace, and P. Johnson also provided recommendations, reviewer suggestions, and formatting revisions for the 2021 annual report, contributing to a concise and efficient document consistent with I&M standards.

The following volunteers, interns, and staff provided invaluable raptor monitoring observations and survey efforts throughout the 2021 season: M. Gnekow, M. Baird, J. Belli, D. Mouton, L. Regan, and A. Welch.

Introduction

Pinnacles National Park (“Pinnacles”) is a National Park Service (NPS) unit and was legislatively converted from a national monument to a national park in January 2013. Pinnacles provides diverse habitats for cliff-nesting raptor species, including sensitive species such as prairie falcons (*Falco mexicanus*), peregrine falcons (*F. peregrinus*), and golden eagles (*Aquila chrysaetos*). The dramatic landscapes, extensive trails, arrays of summits, and cliff-wall routes at Pinnacles are also used intensively for recreation by rock-climbers and hikers. All raptors provide an important ecosystem function as predators of smaller species. However, activities of climbers and off-trail hikers can disturb the reproductive success of cliff-nesting raptors, and prairie falcons nest in the Pinnacles cliffs at sufficiently high density to track trends in reproduction over time. Therefore, the prairie falcon is the central focus of the monitoring program (Emmons et al. 2011). Additionally, peregrine falcons also nested at Pinnacles historically, are sensitive to human disturbance, are obligate cliff-nesters, and have identical nest phenology patterns as prairie falcons. Because they directly compete with prairie falcons for nesting habitat and prey, we also documented peregrine falcon monitoring in this report. For the purposes of this report, “falcons” refers to prairie and peregrine falcons and excludes American kestrels (*Falco sparverius*) because kestrels are abundant and are not obligate cliff nesting raptors. Other raptor species in the park either nest in forested habitats or do not nest in sufficient densities within the park to warrant a similar level of monitoring effort.

Many scientific studies have documented the negative impacts of human disturbance on raptor nest and roost sites, and the resulting nest failures and territory abandonment associated with these disturbances. Nesting raptor species at Pinnacles that are sensitive to human disturbance include prairie falcons (Fyfe and Olendorff 1976; Ogden and Hornocker 1977; Harmata et al. 1978; Sitter 1983; Steenhof 1998), peregrine falcons (particularly in remote locations: see Hickey 1942, 1969; Bond 1946; Steenhof 1998), golden eagles (Newton 1979, 1990; Scott 1985; Steidl et al. 1993; Watson 1997; Steenhof et al. 1997; Kochert et al. 1999), sharp-shinned hawks (*Accipiter striatus*; Delannoy and Cruz 1988), and long-eared owls (*Asio otus*; Marks 1986; Marti and Marks 1989; Bloom 1994).

Studies of prairie and peregrine falcon nest occupancy and productivity have also shown these species to be especially sensitive to human disturbance from mining (Becker and Ball 1981; Bednarz 1984), recreation (Boyce 1982), agriculture (USDI 1979), habitat destruction and nest-site limitation (Becker and Ball 1981; Steenhof et al. 1997), and proximity to major roadways (Platt 1974; Boyce 1982).

The main sources of human disturbance of cliff-nesting falcons at Pinnacles are visitors who are rock-climbing and hiking on- and off-trail in the park. Scientific studies have consistently demonstrated that these recreational activities can be balanced against raptor nesting by establishing closures or advisory areas that act as buffers between human activity and raptor nesting during the breeding season (Fyfe and Olendorff 1976; Olsen and Olsen 1978; Becker and Ball 1981; Suter and Jones 1981; Porter et al. 1987; Holthuijzen et al. 1990; Cade et al. 1996; White et al. 2002).

Falcon monitoring data have been collected at Pinnacles for 36 years beginning with a pilot effort in 1984, and consecutively from 1987 to present. (No monitoring was conducted during 1985 and 1986 due to lack of funding.) Annual raptor monitoring data collected at Pinnacles support the establishment of climbing/hiking advisories in core areas each breeding season to help protect cliff-nesting raptor species from human disturbance. Core areas are locations at Pinnacles suitable for prairie and peregrine falcon cliff-nesting where climbing impacts could occur, based on the presence of historical climbing routes accessible to visitors. Non-core areas refer to all other areas within Pinnacles suitable for cliff-nesting. The core versus non-core sampling design is detailed further in the Methods section.

The Prairie Falcon Monitoring Protocol for Pinnacles National Monument (Emmons et al. 2011) provides standardized methods and procedures for prairie and peregrine falcon monitoring at Pinnacles and further details the program specifics. The program established two long-term monitoring objectives to:

- Track changes in the total numbers of territorial falcon pairs in core areas and non-core areas.
- Track changes in average annual productivity (hatchlings/pair, fledglings/pair) in core areas and non-core areas.

Study Area and Field Methods

Pinnacles is located in the Gabilan Mountains of the central Coast Range of California. The national park encompasses 10,694 hectares (26,425 acres) with elevation ranging from 244 to 1,007 meters (800 to 3,304 feet). The climate is Mediterranean with hot, dry summers and cool, damp winters. Temperatures range from a seasonal mean of 5.2°C in winter to 25.2°C in summer (41.4° to 77.4°F). The average yearly rainfall is 42.3 cm (16.6 inches), with the majority of precipitation occurring from November to April (WRCC 2013).

Pinnacles provides a diverse range of habitat types for birds and other species. These habitats include volcanic rock formations and outcroppings, California mixed chaparral, pine-oak woodlands, grasslands, and riparian creek corridors.

Sample Design

Sampling of prairie and peregrine falcons is focused on both core areas and non-core areas. Each core and non-core area is a potential nesting territory, and in this context the terms “area” and “territory” can be used interchangeably. Within a given year, prairie or peregrine falcons may actively defend one or more of these areas or territories. Core areas (Figure 1) are locations in Pinnacles that can support falcon cliff nesting, and where impacts to raptors due to rock climbing activities can occur as determined from historical rock-climbing use and access patterns. Core area monitoring is conducted through a census, because the area is sufficiently small to allow for complete coverage.

Non-core areas refer to all other areas within the park that can support prairie and peregrine falcon cliff nesting. The Prairie Falcon Monitoring Protocol for Pinnacles National Monument (Emmons et al. 2011) calls for sampling non-core areas on a rotating basis. For 2003 to 2021, non-core area monitoring was conducted through a census along with core area censuses. This Park-wide censusing of core and non-core areas was possible because of comprehensive historical data on prairie and peregrine falcon nest sites gathered over the past 36 years, extensive monitoring experience of the raptor biologist, and supplemental raptor monitoring efforts by interns, volunteers, and other Pinnacles employees. In addition, GIS modeling completed in 2008 (by Stephen Skartvedt with the San Francisco Bay Area Network, unpublished) confirmed that all potential prairie and peregrine falcon nesting areas in the park have been surveyed annually during the past 19 years.

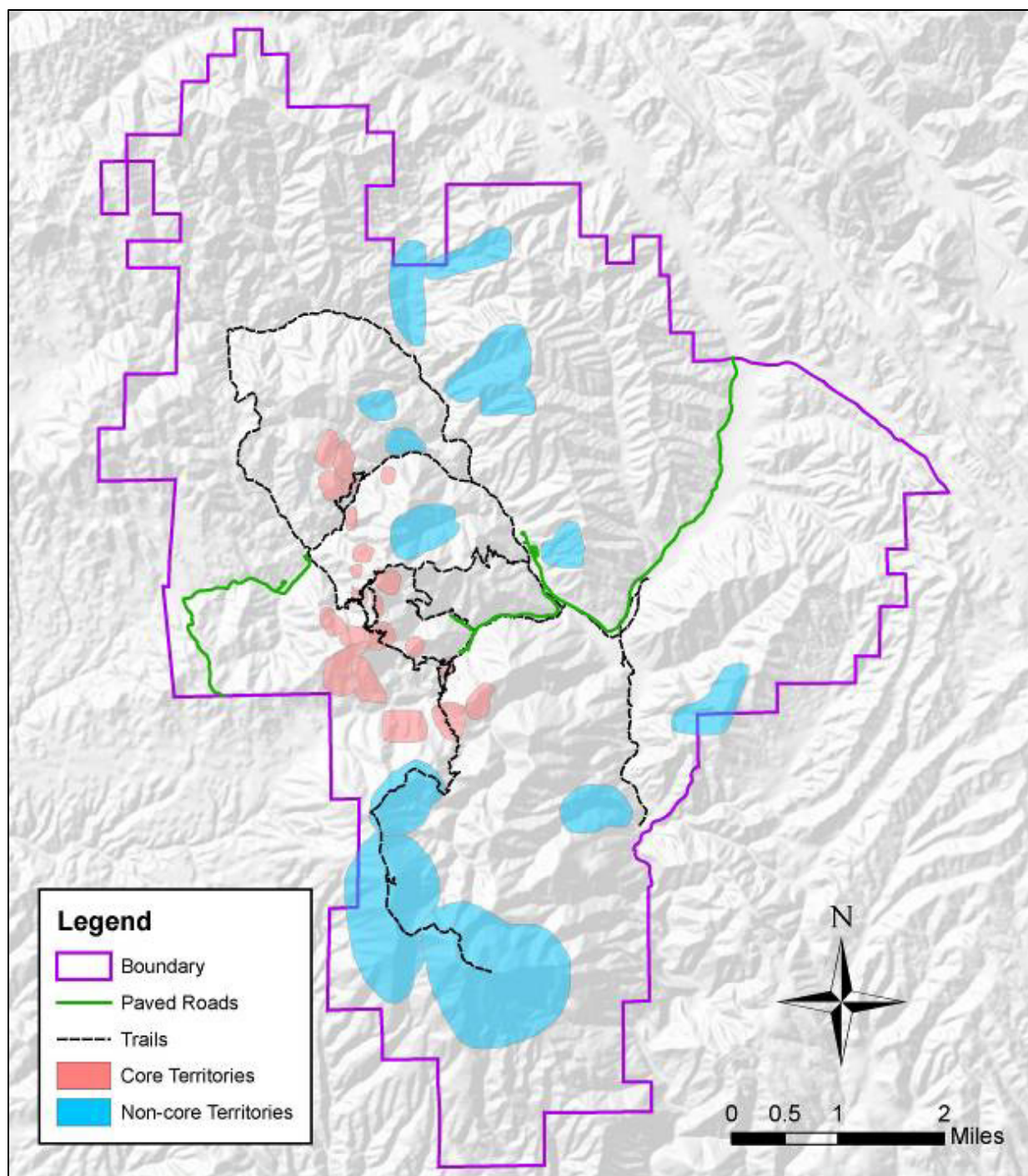


Figure 1. Core and non-core areas within and overlapping the Pinnacles National Park boundary.

Field Methods

Survey methods followed the standard operating procedures detailed in the Prairie Falcon Monitoring Protocol for Pinnacles National Monument (Emmons et al. 2011).

We surveyed potential and established prairie and peregrine falcon territories in core and non-core areas using Swarovski HD STS-80 and ATS-65 20–60x spotting scopes and Zeiss Victory FL 10×32 binoculars. We made observations from the locations that provided the best view of a given eyrie (cliff nest) or territory and adjusted those watch spots depending on where the pairs ultimately nested. We used Magellan Triton 500 and DeLorme Earthmate PN-60 GPS units to plot every observation point. We recorded field data on standardized datasheets and field notebooks, and later we entered the data into a Microsoft Access database (Appendix D).

Many researchers have recommended three- to five-hour observation periods to document territorial occupancy of peregrine falcons and prairie falcons (USFWS 1984; Cade et al. 1996; Smith and Hutchins 2006). Steenhof et al. (1999) employed two-hour observation periods during point surveys to document territory occupancy of prairie and peregrine falcons in the Snake River region of Idaho. For a potential falcon territory to be classified as unoccupied at Pinnacles, we adopted a conservative standard of visiting potential nest sites on at least three separate occasions per breeding season, with survey occasions spaced 21–28 days apart, to confirm territorial occupancy, courtship, and incubation of eggs within a breeding season (Fuller and Mosher 1981; Fraser et al. 1983; Steenhof 1998). Survey duration was ultimately dependent upon visibility, but at least three 4-hour surveys (12 hours total) were required to conclude that no breeding falcons were present. We revisited nests determined to be active to confirm rearing of nestlings and fledging of young. We monitored nests in core areas more frequently than non-core areas and during weekend days when climbers were more likely to be present.

While other monitoring programs infer fledging success at 90% fledge age (Steenhof and Kochert 1982; Anderson and Squires 1997; Steenhof 1998), our protocol continues surveys until all young falcons are confirmed as fledged.

During the falcon breeding season, status was defined as follows:

Territories: Territorial behavior included focused, defensive, and repeated perching and flying at specific locations with cliff nesting potential or historical use, territorial disputes and defense, stooping and scold calling, and consistent and repeated sleep-roosting at specific locations with cliff nesting potential or historical use.

Courtship: Courtship behavior included copulation, food drops and swapping, and potential nest-site inspections and preparation.

Incubation: We determined incubation status by observing prairie falcons flying into a cliff cavity or hole and not re-emerging for extended periods of time. During this time, we conducted egg counts whenever possible (e.g., when lighting conditions allowed and when incubating falcons temporarily left the nest during food drops and/or nest switches). Soft incubation—the onset of incubation—was determined by a small number of eggs laid and the female incubating for short durations (15 to 75

minutes of incubation and 20 minutes or more not incubating the eggs). Hard incubation was characterized by the adult falcons—primarily the females—incubating a full clutch of eggs for hours in duration.

Nestlings: We aged hatched young prairie and peregrine falcons by physical features, based on an aging guide (Moritsch 1983). We determined hatch dates by counting backwards from at least two (preferably three or more) independent aging estimates.

Fledging: We confirmed fledging by seeing young perched and/or in flight away from the nest site. We estimated fledging dates by the coordination and strength of flight, the size of perches that falcon young of year landed on, and the amount of vocalization during flight.

Monitoring Schedule

The prairie and peregrine falcon monitoring season started on 1 January and continued through the end of the nesting season, ending on 23 July (Table 1).

Table 1. Timing of nesting behavior of prairie falcons at Pinnacles National Park. “X” indicates behavior was observed (also shown in gray).

Behavior	January	February	March	April	May	June	July
Territorial Falcons	X	–	–	–	–	–	–
Courtship Behavior	X	X	X	–	–	–	–
Nesting	–	–	–	X	X	–	–
Fledging	–	–	–	–	–	X	X

Weather was always an important factor. During temperature extremes, heavy fog, or rain, most birds of prey were generally inactive and therefore monitoring was not done during these periods.

Data Management

We entered the data into a Microsoft (MS) Access database designed by the network data manager for the San Francisco Bay Area Network Inventory and Monitoring Program and we implemented quality assurance and control procedures as described in the Data Management standard operating procedures (SOP) of the Pinnacles Falcon Monitoring Protocol (Emmons et al. 2011). We archived original data sheets with Pinnacles Resource Management and, as backup we archived a static copy of the Access database on the Golden Gate National Recreation Area computer network drive. To share data more broadly, we submitted nest data to the California Department of Fish and Wildlife (previously California Department of Fish and Game) California Natural Diversity Database.

We derived the tabular data in the Results section of this report from queries to the Breeding Raptors and Raptor Observations tables in the MS Access database.

Climbing Advisories

Climbing advisories went into effect by mid-January. Park staff installed informational signs near territories that had been occupied by prairie and peregrine falcons at least once during the preceding three years. Park staff advised visitors to avoid these areas and that compliance was voluntary.

Advisory areas with posted signs (Figure 2) included the Balconies, Hawkins, Scout Peak, and Little Pinnacles territories.



Figure 2. Setting up advisory sign (NPS/GAVIN EMMONS, 2014).

Results

During the 2021 field season, Pinnacles staff spent 500 hours in the field surveying for prairie and peregrine falcons, and volunteers contributed 350 hours of time. We detail results specifically for prairie falcon monitoring below, whereas Appendixes A and B detail the results for peregrine falcon monitoring and tabular data for combined prairie and peregrine falcon productivity. Our 35-year means refer to annual monitoring efforts in 1984 and in 1987–2020, with 1985 and 1986 excluded due to lack of any monitoring efforts during those two years.

Prairie Falcons

Nine prairie falcon pairs nested this year, one of which failed during egg or hatchling incubation. The remaining eight nesting pairs successfully produced 31 nestlings / fledglings, compared to our 35-year means (SD) of 9.6 (2.2) nesting pairs, 27.7 (9.6) total nestlings, 7.3 (2.4) successful nests, and 25.6 (9.1) fledglings (Table 2).

Table 2. 2015 to 2021 Pinnacles prairie falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2015	11	8	5	21	21	4.2 (0.8)
2016	11	6	5	19	19	3.8 (0.8)
2017	10	9	4	27	15	3.8 (0.5)
2018	10	10	6	26	22	3.7 (1.0)
2019	11	7	5	15	15	3.0 (1.2)
2020	9	7	4	18	14	3.5 (0.6)
2021	9	9	8	31	31	3.9 (1.0)
Mean (SD) Total (1984 to 2020)*	11.7 (0.7)	9.6 (2.2)	7.3 (2.4)	27.7 (9.6)	25.6 (9.1)	3.4 (0.8)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Occupied Territories

Through the 2021 season, we confirmed nine territorial pairs of prairie falcons over the course of the breeding season. While this number is lower than our mean (SD) territorial occupancy of 11.7 (0.7) pairs (1984 to 2020; Table 2), statistical analyses have yet to be conducted to determine if the difference is significant. Of the nine territorial pairs, nine (100%) nested this year.

Core Areas: In 2021, there were five territorial prairie falcon pairs within the core areas, which is lower than our mean (SD) of 7.1 (1.4) territorial falcon pairs in the core areas over the previous 35 years.

Non-Core Areas: In 2021, we confirmed four territorial prairie falcon pairs within the non-core areas, which is comparable to our mean (SD) of 4.5 (1.5) territorial falcon pairs in the non-core areas over the last 35 years.



Prairie falcon fledgling at South Balconies (NPS/GAVIN EMMONS, 2009).

Annual Productivity

Nine prairie falcon pairs nested during the 2021 season. Of the nine nesting pairs, eight successful nesting attempts fledged a total of 31 young (Tables 2, 3). One nest failed during egg or hatchling incubation. Total nesting falcon pairs were lower than the 35-year averages, but the number of successful nests and total fledgling production within core and non-core areas this season were higher than the 35-year averages (Table 2, Figure 3). Statistical analyses have yet to be conducted to determine if these differences are significant.

Table 3. 2021 Pinnacles prairie falcon breeding summary.

Territory	Nest Used/ Last Year Used	# Eggs Laid	# Young Hatched	# Young Fledged
Citadel*	CI-1/ 2020	—	—	0/0
Crowley Towers*	CT-1/ 2017	2	2	2/2
Drywall Slide	DRY-2/ 2008	4	4	4/4
South Chalone	SC-14/ NEW	4	4	4/4
North Chalone	NC-1/ 2020	5	5	5/5
Prescribed Burn Cliffs	PB-3/ 2018	5	5	5/5
Resurrection Wall*	RW-2/ 2019	4	4	4/4
South Balconies*	SGB-23/ NEW	3	3	3/3
Willow Spring Slide	WSS-2/ 2020	4	4	4/4

* Nests within the core areas.

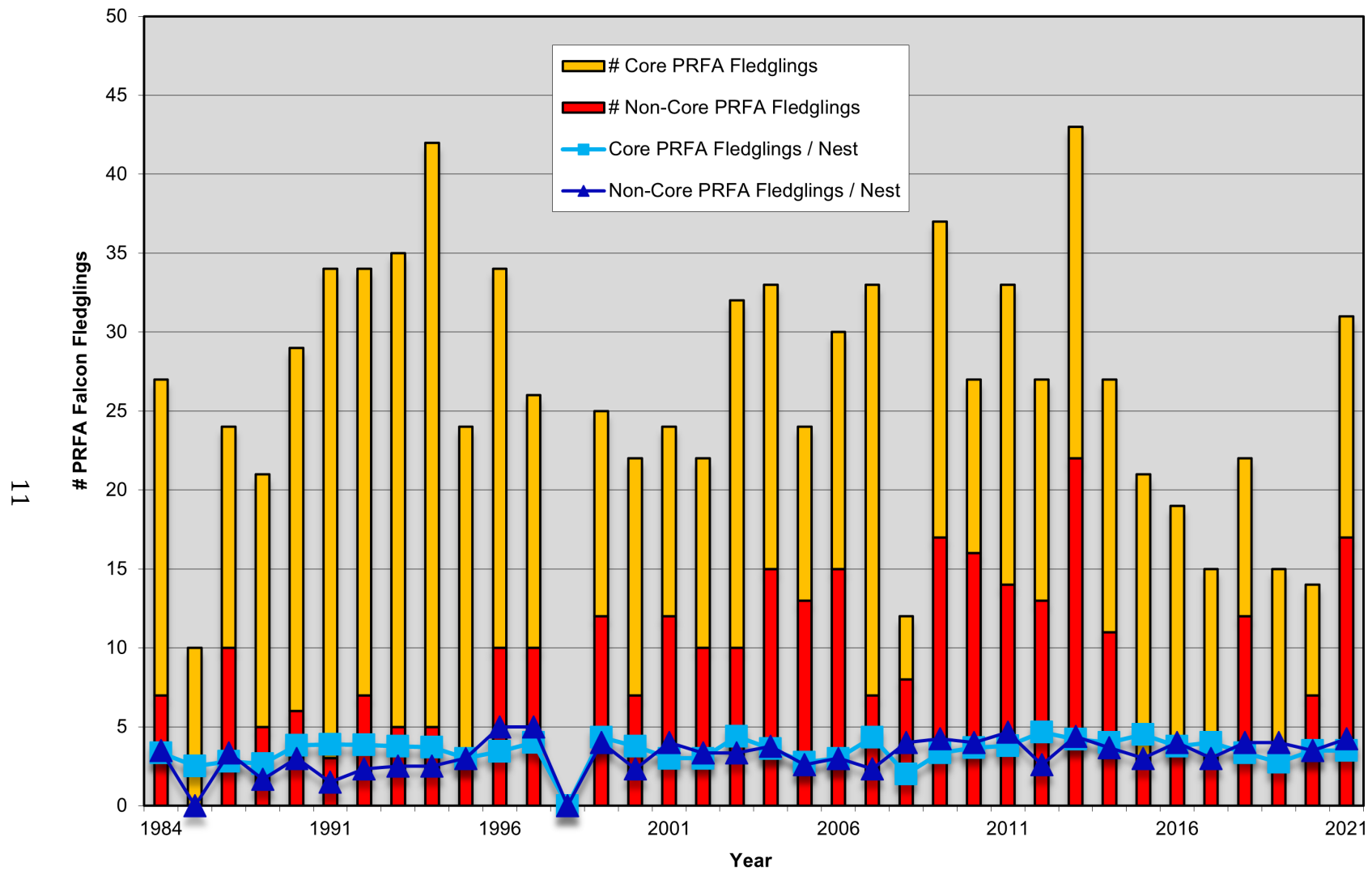


Figure 3. Core vs. non-core prairie falcon fledgling productivity at Pinnacles from 1984 to 2021. Data for 1998 reflects total nest failure and no successful fledging of young due to extreme flooding throughout Park. No monitoring conducted in 1985 and 1986.

Core Areas: Of the five territorial prairie falcon pairs in the core areas in 2021, four nested successfully, producing 14 total fledglings and a mean (SD) of 3.5 (1.3) fledglings per nest (Table 4). Productivity was comparable to the 35-year (1984 to 2020) mean (SD) of 4.7 (2.0) successful nests per season and 16.8 (7.7) total fledglings, although it is important to note that statistical analyses have yet to be conducted to determine if these results are significant. See Appendix A for additional historical data.

Table 4. 2015 to 2021 Pinnacles prairie falcon nesting productivity—core areas only—and historical average.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2015	6	4	4	18	18	4.5 (0.6)
2016	7	4	4	15	15	3.8 (1.0)
2017	6	6	3	22	12	4.0 (0)
2018	7	7	3	14	10	3.3 (1.2)
2019	7	5	4	11	11	2.8 (1.3)
2020	6	4	2	11	7	3.5 (0.7)
2021	5	5	4	14	14	3.5 (1.3)
Mean (SD) Total (1984 to 2020)*	7.1 (1.4)	6.1 (1.6)	4.7 (2.0)	18.1 (8.0)	16.8 (7.7)	3.4 (0.9)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Non-Core Areas: Of the four territorial prairie falcon pairs in the non-core areas in 2021, all four nested successfully, producing seventeen total fledglings and a mean (SD) of 4.3 (0.5) fledglings per nest (Table 5). While these numbers were higher than our 1984 to 2020 means (SD) of 3.6 (1.5) nesting pairs, 2.6 (1.3) successful nests per season, 8.8 (5.1) total fledglings, and 3.2 (1.2) fledglings per nest, statistical analyses have yet to be completed to determine if these differences are significant. See Appendix A for additional historical data.

Table 5. 2015 to 2021 Pinnacles prairie falcon nesting productivity—non-core areas only—and historical average.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2015	5	4	1	3	3	3.0 (0)
2016	4	2	1	4	4	4.0 (0)
2017	4	3	1	5	3	3.0 (0)
2018	3	3	3	12	12	4.0 (1.0)
2019	4	2	1	4	4	4.0 (0)
2020	3	3	2	7	7	3.5 (0.7)
2021	4	4	4	17	17	4.3 (0.5)
Mean (SD) Total (1984 to 2020)*	4.5 (1.5)	3.6 (1.5)	2.6 (1.3)	9.6 (5.3)	8.8 (5.1)	3.2 (1.2)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Phenology

We observed the first prairie falcon pair at Citadel on 7 January 2021 (Appendix B). Incubation was first observed at North Chalone Peak on 22 March. The first hatching occurred between 13 April and 15 April at South Chalone Peak, and the first fledging occurred between 27 May and 28 May at the same nest. The last fledging occurred at Drywall Slide between 17 June and 20 June.

Other Notes

Of the nine eyries chosen in 2021, prairie falcons had previously used seven. The South Chalone Peak and South Balconies eyries were previously undocumented; however, all prairie falcon eyries were within historically documented territories. One nesting attempt failed this year, during egg or hatchling incubation. Two territories that prairie falcon pairs had occupied in the past five years—Pig Canyon and NE Section 15—were vacant this year.

Discussion

Prairie falcon productivity rates for the 2021 season were higher than the 35-year averages of the Pinnacles raptor monitoring program. However, these differences must be statistically analyzed to determine if they are significant, particularly given an apparent cyclic pattern in falcon productivity in prior years (Figure 3). In 2021, nine prairie falcon pairs attempted nesting and eight nests successfully produced 31 fledglings. For comparison, our 35-year means (SD) were 9.6 (2.2) nesting pairs, 7.3 (2.4) successful nests, and 25.6 (0.8) fledglings per year (Table 2). Although reproductive rates throughout the park were higher than past averages, core-area counts of total successful nests, nestlings, and fledglings were lower in 2021 than the 35-year averages (Table 4). By comparison, counts in non-core areas of total successful nests, nestlings, and fledglings were higher in 2021 than their historical averages (Table 5), thereby offsetting the decline in core areas. Importantly, when combined, counts of total successful prairie and peregrine falcon nests, nestlings, and fledglings were notably higher than long-term averages (Appendix C), and suggest a value in examining overall falcon productivity at Pinnacles, rather than focusing on that of only the prairie falcon.

In 2021 we documented one nest failure, at the Citadel nest site. The nest attempt failed during egg or hatchling incubation. We suspected that the falcon nest failed due to predation but were not able to confirm the cause of failure due to discontinuous monitoring.

Prairie falcon productivity was higher in 2021 than in any year since 2013. Multiple factors may have contributed to high prairie falcon productivity in 2021. For example, we suspect that the timing of precipitation events in the past winter—with very limited rain in December 2020 and major precipitation events only arriving by February and March 2021—may have contributed to less growth of grassy cover in 2021. The decreased grass and associated ground cover may have exposed primary prey species like California ground squirrels (*Otospermophilus beecheyi*), thereby making them easier to capture. If timing of precipitation reduced grassy cover in this manner, falcon pairs may have hunted more efficiently throughout the nesting season resulting in the observed high productivity.

Statistical analyses will be completed to determine if occupancy trends and annual differences in productivity rates are significant and those results will be presented in future documents.

Conclusions, Management Implications and Recommendations

Prairie Falcons: Climbing / Hiking Advisories

In January, we instituted advisories directed at park visitors to avoid rock-climbing and other activities in active falcon territories with historical climber usage. We posted signs detailing climbing / hiking advisories for Little Pinnacles, Balconies, Hawkins, Scout Peak, Crowley Towers, and Goat Rock / Resurrection Wall territories. In March and April, park staff updated advisories and lifted them in territories that were confirmed as unoccupied by prairie and peregrine falcon pairs.

We instituted a partial advisory at Balconies after confirming a prairie falcon nest site at South Balconies and a peregrine falcon nest site at General Balconies. The park opened North Balconies to climber use after the Balconies falcon pairs shifted nesting efforts to the General and South Balconies nest sites.

To prevent theft, park staff affixed all regular advisory signs to metal brackets and cement foundations. For historic perspective of sign tampering, the General Balconies advisory sign was vandalized and replaced in 2014 but was not visibly altered from 2015 to 2020. However, the Little Pinnacles advisory sign showed minor signs of vandalism in 2016 and 2017. No additional signs were disturbed or stolen.

In 2021, we documented four incidents of climbers in advisory areas, although the falcon biologists did not observe territorial defense behavior by prairie or peregrine falcons during those incidents.

Human-Falcon Interactions and Nest Failures

Falcon adults in the Hawkins Peak, General Balconies, Crowley Towers, and South Chalone Peak territories responded to the presence of on-trail hikers and raptor biologists with agitated behavior by circling and wailing above their respective territories.

Educational Opportunities

Throughout the year, the raptor biologist and park staff participated in public-outreach opportunities to inform visitors about raptor conservation. Educational opportunities included two scheduled PowerPoint presentations for staff at the East Side Search and Rescue Cache, as well as informal events (e.g., visitor contacts in high-use areas such as High Peaks, Balconies Cliff Trail, and the Bear Gulch Reservoir). Refer to Appendix E for further information on public interest highlights for the 2021 season.

Management Recommendations

- Continue to establish climbing/hiking advisories in core areas (high visitor-use areas) each breeding season to help reduce human disturbance of cliff-nesting raptor species.
- Increase opportunities for visitor-use assistants and park rangers to educate park visitors about climbing / hiking advisories. Prior to 2004, park rangers and interpreters spoke with climbers and hikers at trailheads and regularly roved on trails to provide interpretation and protection of resources. In 2016 interpretation rangers renewed “climber coffee” outreach efforts at east side

park trailheads and the East Side Nature Center, but these efforts have been sporadic in subsequent years due to staff turnover, loss of staff capacity, and greater prioritization on parking cars as opposed to visitor outreach and communication. More on-trail roving opportunities should be explored. Renewing this strategy of interfacing with visitors on trails may help to increase compliance with climbing advisories, as annual visitation increases at the park.

- Enforce advisories with law enforcement rangers. Although advisories are voluntary, disturbing wildlife is a citable offense as noted in text on advisory signs, on the official park website, and on park interpretive displays and trailhead bulletin boards. Law enforcement rangers should continue to enforce this regulation to discourage visitors from willfully threatening nesting efforts of breeding raptors at Pinnacles.
- Continue use of staff and visitors to observe raptor activity in the field. Such raptor surveillance can be achieved through regular communication with NPS staff and visitors, continued use of monthly monitoring updates on raptor status at the park, and reminders about filling out wildlife-observation cards.
- Purchase remote video-surveillance equipment to monitor falcon nest sites on a continuous basis to help determine causes of nest failures.

Literature Cited

- Anderson, S. H., and J. R. Squires. 1997. The prairie falcon. University of Texas Press. Austin, Texas.
- Becker, D. M., and I. J. Ball. 1981. Impacts of surface mining on prairie falcons: Recommendations for monitoring and mitigation. Montana Cooperative Wildlife Research Unit Unpublished Report, Montana State University, Missoula.
- Bednarz, J. C. 1984. Effect of mining and blasting on breeding prairie falcon (*Falco mexicanus*) occupancy in the Caballo Mountains, New Mexico. Raptor Research 18:16–19.
- Bloom, P. H. 1994. The biology and current status of the long-eared owl in coastal southern California. Bulletin California Academy of Science 93:1–12.
- Bond, R. M. 1946. The peregrine populations of western North America. Condor 48:101–116.
- Boyce, D. A., Jr. 1982. Prairie falcon fledgling productivity in the Mojave Desert, California. Thesis. Humboldt State University, Arcata, California.
- Cade, T. J., J. H. Enderson, and J. Linthicum. 1996. Guide to management of peregrine falcons at the eyrie. The Peregrine Fund, Boise, Idaho.
- Dekker, D., and R. Corrigan. 2006. Population fluctuations and agonistic interaction of peregrine and prairie falcons in central Alberta, 1960–2006. Journal of Raptor Research 40:255–263.
- Delannoy, C. A., and A. Cruz. 1988. Breeding biology of the Puerto Rican sharp-shinned hawk (*Accipiter striatus venator*). Auk 105:649–662.
- Emmons, G., J. Pettersen, M. Koenen, and D. Press. 2011. Prairie falcon monitoring protocol for Pinnacles National Monument: narrative – version 2.3. Natural Resource Report NPS/SFAN/NRR—2011/466. National Park Service, Fort Collins, Colorado.
- Fraser, J. D., L. D. Frenzel, J. E. Mathisen, F. Martin, and M. E. Shough. 1983. Scheduling bald eagle reproduction surveys. Wildlife Society Bulletin 11:13–16.
- Fuller, M. R., and J. A. Mosher. 1981. Methods of detecting and counting raptors: a review. Studies in Avian Biology 6:235–246.
- Fyfe, R. W., and R. R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Canadian Wildlife Service Occasional Papers No. 23:1–17.
- Harmata, A. R., J. E. Durr, and H. Geduldig. 1978. Home range, activity patterns and habitat use of Prairie Falcons nesting in the Mojave Desert. Colorado Wildlife Services Unpublished Report, Fort Collins, Colorado for U.S. Department of the Interior, Bureau of Land Management, Riverside, California (Contract No. YA-512-CT8-4389).

- Hickey, J. J. 1942. Eastern population of the duck hawk. *Auk* 59:176–204.
- Hickey, J. J. 1969. Peregrine falcon populations: their biology and decline. University of Wisconsin Press, Madison, Wisconsin.
- Holthuijzen, A. M. A., W. G. Eastland, A. R. Ansell, M. N. Kochert, R. D. Williams, and L. S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. *Wildlife Society Bulletin* 18:270–281.
- Kochert, M. N., K. Steenhof, L. B. Carpenter, and J. M. Marzluff. 1999. Effects of fire on golden eagle territory occupancy and reproductive success. *Journal of Wildlife Management* 63:773–780.
- Marks, J. S. 1986. Nest-site characteristics and reproductive success of long-eared owls in southwestern Idaho. *Wilson Bulletin* 98:547–560.
- Marti, C. D., and J. S. Marks. 1989. Medium-sized owls. *Proceedings of the Western Raptor Management Symposium and Workshop*. National Wildlife Federation Science and Technology Series No. 12, Washington, D.C.:124–133.
- Moritsch, M. Q. 1983. Photographic guide for aging nesting prairie falcons. United States Department of the Interior, Bureau of Land Management, Snake River Birds of Prey Project. Boise District, Idaho.
- Newton, I. 1979. Population ecology of raptors. Buteo Books. Shipman, Virginia.
- Newton, I. 1990. Birds of prey. Facts on File, Inc. New York, New York.
- Ogden, V. T., and M. G. Hornocker. 1977. Nesting density and success of prairie falcons in southwestern Idaho. *Journal of Wildlife Management* 41:1–11.
- Olsen, P., and J. Olsen. 1978. Alleviating the impact of human disturbance on the breeding peregrine falcon. *Ornithologists Corella* 2(1):1–7 and 4(3):54–57.
- Platt, S. W. 1974. Breeding status and distribution of the prairie falcon in northern New Mexico. Thesis. Oklahoma State University, Stillwater, Oklahoma.
- Porter, R. D., and C. M. White. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. *Brigham Young University Science Bulletin, Biological Series* 18:1–74.
- Porter, R. D., M. A. Jenkins, and A. L. Ganski. 1987. Working bibliography of the peregrine falcon. National Wildlife Federation Science and Technology Series No. 9, Washington, D.C.
- Scott, T. A. 1985. Human impacts on the golden eagle population of San Diego County. Thesis. San Diego State University, San Diego, California.

- Sitter, G. 1983. Feeding activity and behavior of prairie falcons in the Snake River Birds of Prey Natural Area in southwestern Idaho. Thesis. University of Idaho, Moscow, Idaho.
- Smith, J. P., and A. Hutchins. 2006. Northeast Nevada raptor nest survey 2005. Hawkwatch International, Inc., Salt Lake City, Utah. 34 pp.
- Steenhof, K. 1998. Prairie falcon (*Falco mexicanus*). The Birds of North America, No. 346. Cornell Laboratory of Ornithology, Ithaca, New York.
- Steenhof, K., and M. N. Kochert. 1982. An evaluation of methods used to estimate raptor nesting success. *Journal of Wildlife Management* 46:885–893.
- Steenhof, K., M. N. Kochert, L. B. Carpenter, and R. N. Lehman. 1999. Long-term prairie falcon population changes in relation to prey abundance, weather, land uses, and habitat conditions. *Condor* 101:28–41.
- Steenhof, K., M. N. Kochert, and T. L. McDonald. 1997. Interactive effects of prey and weather on golden eagle reproduction. *Journal of Animal Ecology* 66:350–362.
- Steidl, R. J., K. D. Kozie, G. J. Dodge, T. Pehovski, and E. R. Hogan. 1993. Effects of human activity on breeding behavior of golden eagles in Wrangell-St. Elias National Park and Preserve; a preliminary assessment. WRST Research and Resource Management Report No. 93-3. National Park Service, Wrangell-St. Elias National Park and Preserve, Copper Center, Alaska.
- Suter, G. W., and J. L. Jones. 1981. Criteria for golden eagle, ferruginous hawk, and prairie falcon nest site protection. *Raptor Research* 15:12–18.
- United States Department of the Interior (USDI). 1979. Snake River Birds of Prey special research report to the Secretary of the Interior. Boise District Bureau of Land Management, Boise, Idaho.
- United States Fish and Wildlife Service (USFWS). 1984. American peregrine falcon Rocky Mountain/Southwest population recovery plan. Rocky Mountain/Southwest Peregrine Falcon Recovery Team, U.S. Fish and Wildlife Service, Denver, Colorado.
- Walton, B. J. 1973. Peregrine prairie falcon interaction. *Raptor Research* 12: 46–47.
- Watson, J. 1997. The golden eagle. London, United Kingdom.
- Western Regional Climate Center (WRCC). 2013. Climate data for Pinnacles National Monument. Available from <https://wrcc.dri.edu/> (accessed August 2013).
- White, C. M., N. J. Clum, T. J. Cade, and W. G. Hunt. 2020. Peregrine falcon (*Falco peregrinus*), version 1.0. S. M. Billerman, editor. Birds of the world online. Cornell Lab of Ornithology, Ithaca, New York. Available at <https://birdsoftheworld.org/bow/species/perfal/cur/introduction> (accessed 8 September 2021).

Appendix A. 1984 to 2021 Nest Productivity for Prairie Falcons

Table APP A.1. 1984 to 2021 Pinnacles prairie falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
1984	10	9	8	30	27	3.4 (0.9)
1987	6	4	4	13	10	2.5 (1.7)
1988	12	9	8	24	24	3.0 (1.2)
1989	12	11	9	24	21	2.3 (1.1)
1990	14	10	8	31	29	3.6 (0.9)
1991	14	11	10	34	34	3.4 (1.3)
1992	13	11	10	38	34	3.4 (1.5)
1993	13	12	10	39	35	3.5 (1.1)
1994	13	13	12	45	42	3.5 (1.1)
1995	13	11	8	24	24	3.0 (0.5)
1996	12	10	9	35	34	3.8 (1.0)
1997	12	8	6	26	26	4.3 (0.8)
1998	10	7	0	0	0	0 (0)
1999	10	8	6	25	25	4.2 (0.8)
2000	8	8	7	22	22	3.1 (1.2)
2001	10	10	7	24	24	3.4 (1.1)
2002	11	9	7	26	22	3.1 (1.1)
2003	12	9	8	33	32	4.0 (1.1)
2004	12	11	9	36	33	3.7 (1.4)
2005	13	10	9	29	24	2.7 (1.1)
2006	15	14	10	35	30	3.0 (0.8)
2007	14	12	9	35	33	3.7 (1.3)
2008	12	5	4	12	12	3.0 (1.2)
2009	12	11	10	41	37	3.7 (1.4)
2010	13	11	7	27	27	3.9 (0.7)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP A.1 (continued). 1984 to 2021 Pinnacles prairie falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2011	13	12	8	33	33	4.1 (0.6)
2012	12	11	8	28	27	3.4 (1.2)
2013	12	11	10	47	43	4.3 (0.8)
2014	12	10	7	30	27	3.9 (1.2)
2015	11	8	5	21	21	4.2 (0.8)
2016	11	6	5	19	19	3.8 (0.8)
2017	10	9	4	27	15	3.8 (0.5)
2018	10	10	6	26	22	3.7 (1.0)
2019	11	7	5	15	15	3.0 (1.2)
2020	9	7	4	18	14	3.5 (0.6)
2021	9	9	8	31	31	3.9 (1.0)
Mean (SD) Total (1984 to 2020)*	11.7 (0.7)	9.6 (2.2)	7.3 (2.4)	27.7 (9.6)	25.6 (9.1)	3.4 (0.8)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP A.2. 1984 to 2021 Pinnacles prairie falcon nesting productivity—core areas only.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
1984	7	6	6	22	20	3.3 (1.0)
1987	5	4	4	13	10	2.5 (1.7)
1988	8	6	5	14	14	2.8 (1.3)
1989	8	8	6	16	16	2.7 (1.2)
1990	9	7	6	23	23	3.8 (1.0)
1991	9	8	8	31	31	3.9 (0.8)
1992	9	7	7	29	27	3.9 (1.3)
1993	10	9	8	34	30	3.8 (0.7)
1994	10	10	10	38	37	3.7 (1.0)
1995	10	9	7	21	21	3.0 (0.6)
1996	9	8	7	28	24	3.4 (0.7)
1997	8	6	4	16	16	4.0 (0.8)
1998	7	5	0	0	0	0 (0)
1999	6	5	3	13	13	4.3 (0.6)
2000	5	5	4	15	15	3.8 (1.0)
2001	7	6	4	12	12	3.0 (1.2)
2002	5	5	4	12	12	3.0 (1.2)
2003	5	5	5	22	22	4.4 (0.9)
2004	7	7	5	21	18	3.6 (1.9)
2005	6	5	4	12	11	2.8 (1.3)
2006	7	6	5	17	15	3.0 (0.7)
2007	6	6	6	26	26	4.3 (0.5)
2008	7	3	2	4	4	2.0 (0)
2009	7	7	6	24	20	3.3 (1.6)
2010	8	6	3	11	11	3.7 (0.6)
2011	8	7	5	19	19	3.8 (0.4)
2012	7	6	3	14	14	4.7 (0.6)
2013	6	6	5	25	21	4.2 (0.8)
2014	6	4	4	16	16	4.0 (1.4)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP A.2 (continued). 1984 to 2021 Pinnacles prairie falcon nesting productivity—core areas only.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2015	6	4	4	18	18	4.5 (0.6)
2016	7	4	4	15	15	3.8 (1.0)
2017	6	6	3	22	12	4.0 (0)
2018	7	7	3	14	10	3.3 (1.2)
2019	7	5	4	11	11	2.8 (1.3)
2020	6	4	2	11	7	3.5 (0.7)
2021	5	5	4	14	14	3.5 (1.3)
Mean (SD) Total (1984 to 2020)*	7.1 (1.4)	6.1 (1.6)	4.7 (2.0)	18.1 (8.0)	16.8 (7.7)	3.4 (0.9)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP A.3. 1984 to 2021 Pinnacles prairie falcon nesting productivity—non-core areas only.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
1984	3	3	2	8	7	3.5 (0.7)
1987	1	0	0	0	0	0 (0)
1988	4	3	3	10	10	3.3 (1.2)
1989	4	3	3	8	5	1.7 (0.6)
1990	5	3	2	8	6	3.0 (0)
1991	5	3	2	3	3	1.5 (0.7)
1992	4	4	3	9	7	2.3 (1.5)
1993	3	3	2	5	5	2.5 (2.1)
1994	3	3	2	7	5	2.5 (2.1)
1995	3	2	1	3	3	3.0 (0)
1996	3	2	2	7	10	5.0 (2.1)
1997	4	2	2	10	10	5.0 (0)
1998	3	2	0	0	0	0 (0)
1999	4	3	3	12	12	4.0 (1.0)
2000	3	3	3	7	7	2.3 (1.2)
2001	3	4	3	12	12	4.0 (1.0)
2002	6	4	3	14	10	3.3 (1.2)
2003	7	4	3	11	10	3.3 (1.2)
2004	5	4	4	15	15	3.8 (0.5)
2005	7	5	5	17	13	2.6 (1.1)
2006	8	8	5	18	15	3.0 (1.0)
2007	8	6	3	9	7	2.3 (1.5)
2008	5	2	2	8	8	4.0 (0)
2009	5	4	4	17	17	4.3 (1.0)
2010	5	5	4	16	16	4.0 (0.8)
2011	5	5	3	14	14	4.7 (0.6)
2012	5	5	5	14	13	2.6 (0.8)
2013	6	5	5	22	22	4.4 (0.9)
2014	6	6	3	14	11	3.7 (0.7)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP A.3 (continued). 1984 to 2021 Pinnacles prairie falcon nesting productivity—non-core areas only.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2015	5	4	1	3	3	3.0 (0)
2016	4	2	1	4	4	4.0 (0)
2017	4	3	1	5	3	3.0 (0)
2018	3	3	3	12	12	4.0 (1.0)
2019	4	2	1	4	4	4.0 (0)
2020	3	3	2	7	7	3.5 (0.7)
2021	4	4	4	17	17	4.3 (0.5)
Mean (SD) Total (1984 to 2020)*	4.5 (1.5)	3.6 (1.5)	2.6 (1.3)	9.6 (5.3)	8.8 (5.1)	3.2 (1.2)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Appendix B. 2021 Nest Phenology and Success for Prairie and Peregrine Falcons

Table APP B.1. 2021 Pinnacles nest phenology and success for prairie and peregrine falcons.

Nest Species	Territory Occupied	Nest Code	Arrival Date	Begin Incub	Hatch Date	Fledge Date	Abandon Date	Failed Date	# of Eggs	# of Nestlings	Known Fledglings	Possible Fledglings	Occup. Status
PRFA	Ball Pinnacle	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Cyn N of Willow Spgs	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Central High Peaks	—	<1/26	—	—	—	—	—	—	—	—	—	Occupied
PRFA	Citadel	CI-1	<1/7	<4/1	—	—	—	<5/31	—	—	0	0	Failed
PRFA	Crowley Drainage	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Crowley Towers	CT-1	<1/10	<3/29	4/21–23	6/2–3	—	—	—	2	2	2	2
PRFA	D. Soto Canyon	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Deserted Valley	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Discovery Wall	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Drywall	DRY-2	<2/8	<3/31	5/7–9	6/17–20	—	—	4	4	4	4	4
PRFA	Egg	—	<2/28	—	—	—	—	—	—	—	—	—	Occupied
PRFA	Frog Canyon	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Frog / Hand	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	General Balconies	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Goat Rock	*RW-2	<1/14	—	—	—	—	—	—	—	—	—	Occupied
PRFA	Guard Rock	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Hanging Valley	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Hawkins	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	High Pks W of CPA	—	—	—	—	—	—	—	—	—	—	—	Not Occ.

Note: for the “Occup. Status” column, numbers refer to possible fledglings, “Occupied” = territorial occupation, “Not Occ.” = no occupation, “Failed” = failed nest. For the “Nest Code” column, * refers to territorial links for raptor pairs occupying more than 1 territory.

Table APP B.1 (continued). 2021 Pinnacles nest phenology and success for prairie and peregrine falcons.

Nest Species	Territory Occupied	Nest Code	Arrival Date	Begin Incub	Hatch Date	Fledge Date	Abandon Date	Failed Date	# of Eggs	# of Nestlings	Known Fledglings	Possible Fledglings	Occup. Status
PRFA	Little Pinnacles	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Machete	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Marion Canyon	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Mating Rocks	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Narrows	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	NE Sec 15	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Neglected Valley	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	North Balconies	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	North Chalone	NC-1	<1/21	<3/22	4/25–5/1	6/2–5	—	—	5	5	5	5	5
PRFA	North Wilderness Rock	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Pig Canyon	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Pipsqueak Pinnacles	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Prescribed Burn Cliffs	PB-3	<1/25	<4/6	4/27–30	6/7–11	—	—	5	5	5	5	5
PRFA	Resurrection Wall	RW-2	<1/14	<3/24	4/19–23	6/1–3	—	—	4	4	4	4	4
PRFA	Scout Peak	*RW-2	<1/14	—	—	—	—	—	—	—	—	—	Occupied
PRFA	South Balconies	SGB-23	<1/26	<4/1	5/2–4	6/15–16	—	—	—	3	3	3	3
PRFA	South Chalone	SC-14	<2/15	<4/13	4/13–15	5/27–28	—	—	—	4	4	4	4
PRFA	S. Wilderness Rock	—	<2/4	—	—	—	—	—	—	—	—	—	Occupied
PRFA	Teapot Dome	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Tugboat	—	—	—	—	—	—	—	—	—	—	—	Not Occ.

Note: for the "Occup. Status" column, numbers refer to possible fledglings, "Occupied" = territorial occupation, "Not Occ." = no occupation, "Failed" = failed nest. For the "Nest Code" column, * refers to territorial links for raptor pairs occupying more than 1 territory.

Table APP B.1 (continued). 2021 Pinnacles nest phenology and success for prairie and peregrine falcons.

Nest Species	Territory Occupied	Nest Code	Arrival Date	Begin Incub	Hatch Date	Fledge Date	Abandon Date	Failed Date	# of Eggs	# of Nestlings	Known Fledglings	Possible Fledglings	Occup. Status
PRFA	Tunnel	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Upper Bear Gulch	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Upper Condor Gulch	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Western Front	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PRFA	Willow Spring Slide	WSS-2	<1/19	<4/13	5/1–4	6/6–8	—	—	—	4	4	4	4
PEFA	Hawkins Peak	HP-5	<1/7	<3/24	4/28–5/1	5/31–6/1	—	—	—	1	1	1	1
PEFA	Pig Canyon	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PEFA	Upper Condor Gulch	*HP-5	<1/7	—	—	—	—	—	—	—	—	—	Occupied
PEFA	Lower Condor Gulch	*HP-5	<1/7	—	—	—	—	—	—	—	—	—	Occupied
PEFA	Central High Peaks	*HP-5	<1/7	—	—	—	—	—	—	—	—	—	Occupied
PEFA	Goat Rock	*HP-5	<1/7	—	—	—	—	—	—	—	—	—	Occupied
PEFA	General Balconies	SGB-6	<1/7	<5/19	5/19–23	6/28–7/1	—	—	3	3	3	3	3
PEFA	Machete	*SGB-6	<1/7	—	—	—	—	—	—	—	—	—	Occupied
PEFA	South Balconies	—	—	—	—	—	—	—	—	—	—	—	Not Occ.
PEFA	South Chalone	SC-11	<2/15	<4/23	4/26–28	6/7–9	—	—	—	3	3	3	3
PEFA	Frog / Hand	*LP-2	<1/5	—	—	—	—	—	—	—	—	—	Occupied
PEFA	Little Pinnacles	LP-2	<1/5	<4/26	4/26–5/1	6/4–6	—	—	—	2	2	2	2
PEFA	Hanging Valley	*LP-2	<1/5	—	—	—	—	—	—	—	—	—	Occupied
PEFA	Willow Spring Slide	—	<2/7	—	—	—	—	—	—	—	—	—	Occupied

Note: for the “Occup. Status” column, numbers refer to possible fledglings, “Occupied” = territorial occupation, “Not Occ.” = no occupation, “Failed” = failed nest. For the “Nest Code” column, * refers to territorial links for raptor pairs occupying more than 1 territory.

Appendix C. 2021 Results and Discussion for Peregrine Falcon Occupancy and Productivity

Results: Peregrine Falcons

Four peregrine falcon pairs occupied territories and nested at Pinnacles in 2021—at Little Pinnacles, Hawkins Peak, General Balconies, and South Chalone Peak (Table APP C.1). This marked the 17th consecutive year that at least one peregrine falcon pair has nested at Pinnacles. Prior to 2004, peregrine falcon occupancy or nesting had not been confirmed at Pinnacles for 49 years. All four of the nesting pairs successfully hatched and fledged a combined nine young (Figure APP C.1), compared to our 16-year (since 2005) means (SD) of 1.6 (1.5) nesting pairs, 1.4 (1.3) successful nests, 3.9 (5.3) nestlings, and 3.8 (5.1) fledglings (Table APP C.2).

Table APP C.1. 2021 Pinnacles peregrine falcon breeding summary.

Territory	Nest Used/ Last Year Used	# Eggs Laid	# Young Hatched	# Young Fledged
Hawkins Peak *	HP-5/ 2019	—	1	1/1
Little Pinnacles *	LP-2/ NEW	—	2	2/2
General Balconies *	SGB-6/ 2017	3	3	3/3
South Chalone Peak	SC-11/ 2020	—	3	3/3

* Nests within the core areas.



Figure APP C.1. Peregrine falcon fledgling at Hawkins Peak (NPS/GAVIN EMMONS, 2012).

Table APP C.2. 1984 to 2021 Pinnacles peregrine falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
1984	0	0	0	0	0	0 (0)
1987	0	0	0	0	0	0 (0)
1988	0	0	0	0	0	0 (0)
1989	0	0	0	0	0	0 (0)
1990	0	0	0	0	0	0 (0)
1991	0	0	0	0	0	0 (0)
1992	0	0	0	0	0	0 (0)
1993	0	0	0	0	0	0 (0)
1994	0	0	0	0	0	0 (0)
1995	0	0	0	0	0	0 (0)
1996	0	0	0	0	0	0 (0)
1997	0	0	0	0	0	0 (0)
1998	0	0	0	0	0	0 (0)
1999	0	0	0	0	0	0 (0)
2000	0	0	0	0	0	0 (0)
2001	0	0	0	0	0	0 (0)
2002	0	0	0	0	0	0 (0)
2003	0	0	0	0	0	0 (0)
2004	1	0	0	0	0	0 (0)
2005	1	1	1	3	3	3.0 (0)
2006	1	1	1	3	3	3.0 (0)
2007	1	1	1	3	3	3.0 (0)
2008	1	1	1	3	3	3.0 (0)
2009	1	1	1	3	3	3.0 (0)
2010	1	1	1	1	1	1.0 (0)
2011	1	1	0	0	0	0 (0)
2012	1	1	1	4	4	4.0 (0)
2013	2	1	1	4	3	3.0 (0)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP C.2 (continued). 1984 to 2021 Pinnacles peregrine falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2014	2	2	2	3	3	1.5 (0.7)
2015	2	2	2	6	6	3.0 (1.4)
2016	2	2	1	3	3	3.0 (0)
2017	2	2	2	7	7	3.5 (0.7)
2018	2	2	2	4	4	2.0 (1.4)
2019	4	3	2	7	6	3.0 (0)
2020	4	4	3	8	8	2.7 (1.2)
2021	4	4	4	9	9	2.3 (1.0)
Mean (SD) Total (2004 to 2020)*	1.8 (1.5)	1.6 (1.5)	1.4 (1.3)	3.9 (5.3)	3.8 (5.1)	2.6 (1.2)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Occupied Territories

Core Areas: In 2021, there were three territorial peregrine falcon pairs within the core areas.

Non-Core Areas: In 2021, there was one peregrine falcon pair within the non-core areas.

Phenology and Productivity

We first observed the peregrine falcon pair at Little Pinnacles on 5 January 2021 (Appendix B), and we first observed incubation by the Hawkins peregrine falcon pair on 24 March. We first observed hatching of young at the Hawkins Peak nest between 28 April and 1 May. We confirmed fledging of young at the Hawkins nest between 31 May and 1 June, at the Little Pinnacles nest between 4 and 6 June, at the South Chalone Peak nest between 7 and 9 June, and at the General Balconies nest between 28 June and 1 July.

Discussion: Combined Prairie and Peregrine Falcon Occupancy and Productivity

Given the small sample size and brief period that peregrine falcon pairs have occupied and produced young at breeding territories at Pinnacles, we cannot currently ascertain any statistical relevance or trends specifically to peregrine falcon breeding results at the park. However, we combined prairie and peregrine falcon results over the 36 years of monitoring efforts (Table APP C.3 and Figure APP C.2) to represent overall falcon occupancy and productivity numbers at Pinnacles. Combined falcon occupancy and productivity rates across both species in core and non-core areas this year were higher than the 35-year running averages. Thirteen falcon pairs attempted to nest this year and twelve nest successfully produced 40 fledglings, compared to our 35-year means (SD) of 10.3 (2.2) nesting pairs, 8.0 (2.3) successful nests, and 27.3 (8.7) fledglings (Table APP C.3).

Table APP C.3. 1984 to 2021 Pinnacles prairie and peregrine falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
1984	10	9	8	30	27	3.4 (0.9)
1987	6	4	4	13	10	2.5 (1.7)
1988	12	9	8	24	24	3.0 (1.2)
1989	12	12	9	24	21	2.3 (1.1)
1990	14	10	8	31	29	3.6 (0.9)
1991	14	11	10	34	34	3.4 (1.3)
1992	13	11	10	38	34	3.4 (1.5)
1993	13	12	10	39	35	3.5 (1.1)
1994	13	13	12	45	42	3.5 (0.9)
1995	13	11	8	24	24	3.0 (0.5)
1996	12	10	9	35	34	3.8 (1.0)
1997	12	8	6	26	26	4.3 (0.8)
1998	10	7	0	0	0	0 (0)
1999	10	8	6	25	25	4.2 (0.8)
2000	8	8	7	22	22	3.1 (1.2)
2001	10	10	7	24	24	3.4 (1.1)
2002	11	9	7	26	22	3.1 (1.1)
2003	12	9	8	33	32	4.0 (1.1)
2004	13	11	9	36	33	3.7 (1.4)
2005	14	11	10	32	27	2.7 (1.1)
2006	16	15	11	38	33	3.0 (0.8)
2007	15	13	10	38	36	3.6 (1.3)
2008	13	6	5	15	15	3.0 (1.0)
2009	13	12	11	44	40	3.6 (1.4)
2010	14	12	8	28	28	3.5 (1.2)
2011	14	13	8	33	33	4.1 (0.6)
2012	13	12	9	32	31	3.4 (1.1)
2013	14	12	11	51	46	4.2 (0.8)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

Table APP C.3 (continued). 1984 to 2021 Pinnacles prairie and peregrine falcon nesting productivity—core and non-core areas combined.

Year	Territorial Pairs	Nesting Pairs	Successful Nests	# Total Nestlings	# Total Fledglings	# Fledglings / Nest Mean (SD)
2014	14	12	9	33	30	3.3 (1.5)
2015	14	10	7	27	27	3.9 (1.1)
2016	13	8	6	22	22	3.7 (0.8)
2017	12	11	6	34	22	3.7 (0.5)
2018	12	12	8	30	26	3.3 (1.3)
2019	15	10	7	22	21	3.0 (1.0)
2020	13	11	7	26	22	3.1 (0.9)
2021	13	13	12	40	40	3.3 (1.2)
Mean (SD) Total (1984 to 2020)*	12.5 (2.1)	10.3 (2.2)	8.0 (2.3)	29.5 (9.5)	27.3 (8.7)	3.3 (0.7)

* Mean total for 1984 to 2020 excludes the two years, 1985 and 1986, where monitoring was not conducted.

In comparing prairie falcon results (Table APP A.1 and Figure 3) with combined prairie and peregrine falcon results (Table APP C.3 and Figure APP C.2), peregrine falcon breeding efforts appear to be supplementing overall large falcon productivity. Overall falcon fecundity has remained generally consistent with the 35-year averages, but prairie falcon fecundity generally appears to be cyclic while peregrine falcon fecundity is increasing. At Hawkins Peak, since 1984, a prairie falcon pair consistently nested in the territory until a peregrine pair began occupying the territory 17 years ago; since 2004 no prairie falcons have nested at Hawkins Peak. In 2020 and 2021, a peregrine falcon pair occupied territories at Little Pinnacles and Frog/Hand, ultimately nesting and fledging young successfully at Frog/Hand in 2020 and at Little Pinnacles in 2021 for the first time since the Pinnacles falcon monitoring program began. These territories were also used consistently in previous years by prairie falcon pairs, but not during the 2020 and 2021 breeding seasons. These observations suggest that—in certain instances—prairie and peregrine falcons may compete for territorial occupancy of limited cliff-nest habitat at Pinnacles. Agonistic interactions between the two species—leading to peregrine falcon pairs evicting prairie falcons from territories and to lower prairie falcon nesting productivity in the presence of peregrine falcons—have been documented in other locations where the ranges of these falcon species overlap (Porter and White 1973; Walton 1973; Dekker and Corrigan 2006).

From 2014 to 2021 we have documented mixed observations of prairie falcons apparently abandoning certain historic territories due to peregrine falcon presence—as detailed above—but tolerating peregrine falcon nesting pairs in other territories. We observed both prairie and peregrine falcon pairs in relatively close proximity—at South and General Balconies—nesting and fledging young. In 2021 the prairie and peregrine falcon pairs at Balconies defended the cliff areas, and we

observed few confrontations between the falcon pairs. Similarly, at South Chalone Peak in 2020 and 2021, prairie and peregrine falcon pairs both nested, selecting cliff nest locations within close proximity that were separated from each other by visual barriers of cliff walls. During the 2021 season, the South Chalone Peak prairie and peregrine falcon nests both successfully fledged young. General literature references are lacking regarding prairie and peregrine falcon pairs tolerating and successfully nesting in close proximity. At present, due to limited peregrine nesting efforts at Pinnacles, data specific to the park remain scarce and therefore are inconclusive regarding competition for cliff-nest habitat between the two species.

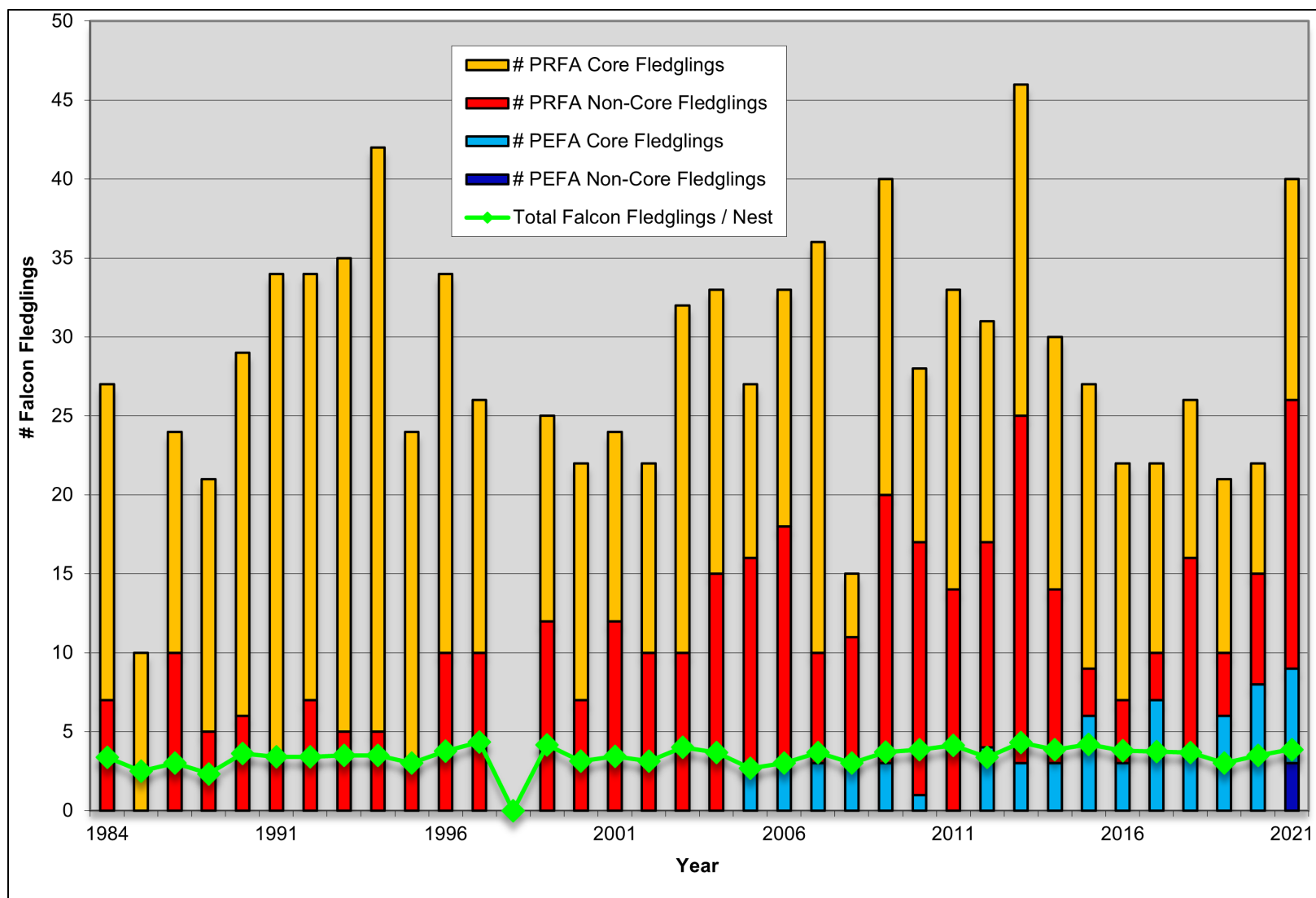


Figure APP C.2. Combined core and non-core Pinnacles prairie falcon and peregrine falcon fledgling productivity, 1984–2021. Data for 1998 reflects total nest failure and no successful fledging of young due to extreme flooding throughout Park. No monitoring conducted in 1985 and 1986.

Appendix D. Documentation of Changes in Data Collection Methods

No changes were made to data collection methods for the Pinnacles raptor monitoring program through the course of the 2021 season.

In October 2020, contractors in the Central I&M Office completed updates to the Pinnacles Raptor Monitoring database with guidance from S. Wakamiya and G. Emmons. The updated database incorporated a refactored schema to implement Inventory and Monitoring Division standards and allow for *ad hoc* data while maintaining data integrity, as well as a new user interface. The updated database allows for tracking of data-processing levels, protected records, protocol configuration, and taxon reference authority identification, as well as ensuring data quality. The updates also streamline and improve efficiencies in creating annual breeding status records. G. Emmons tested functionality by entering and validating data in the new system while S. Wakamiya tested functionality during the data-certification phase.

Following the end of the 2017 to 2019 field seasons, the Raptor Monitoring Access database was reviewed by G. Emmons, S. Wakamiya, and regional Inventory & Monitoring database managers. The database review was part of a greater effort to confirm consistency of I&M databases according to national standards. G. Emmons reviewed quality assurance / quality control (QA / QC) tools and offered recommendations on building more efficiencies into database design, and S. Wakamiya worked with the regional database managers to address inconsistencies in circular references, table relationships, and foreign key lengths.

Following the end of the 2016 field season, the front end of the Raptor Monitoring Access database was updated with an improved Data Entry Form interface and several redundant fields were removed. The back end of the database was updated with additional Data Summary Tools including improved QA queries for duplicate and missing records, and for checking errors in survey locations and falcon-occupancy determinations. The Breeding Raptors table was also updated for improved and more consistent terminology in occupancy status fields.

Following the end of the 2015 field season, legacy data were revised to account for negative data (i.e., no birds observed) for all prairie and peregrine falcon observations for the years of 2003 to 2015. Legacy data were also revised to account for missing data in records including observer location, weather, and falcon territories observed.

Following the end of the 2014 field season, the Raptor Monitoring Access database was updated from .mdb to .accdb format. Terminology and data entry fields in the Data Entry Form were updated to more clearly reflect raptor observations pertaining to the I&M Protocol versus observations of other raptor species in the park, to distinguish more efficiently between occupancy and fecundity results, and to provide easier access to territory tables. Data summary tools were also added as queries to allow for more comprehensive review and revision of breeding-summary and raptor-observation information in spreadsheet format.

Appendix E. Public Interest Highlights.

The 2021 breeding season was the 36th year of raptor monitoring at Pinnacles. Field observations began 1 January 2021 and ended 10 July 2021, with a total of greater than 150 possible and active nest sites monitored during 850 observation hours. Climbing advisories were put into effect in January to reduce nest disturbance by visitors, updated to reflect unoccupied territories in March, and lifted in July at the end of the raptor breeding season.

- Pinnacles falcon-monitoring surveys proceeded fully throughout the 2021 season despite challenges associated with the COVID-19 pandemic. The NPS raptor biologist and three long-term volunteers adhered to strict protocols of social distancing, use of face masks, and remote survey guidelines to mitigate for any coronavirus exposure risks.
- During the 2021 season, Pinnacles staff conducted prairie falcon nest entries to collect data on genetics and rodenticide exposure at two nest sites—the North Chalone Peak and South Balconies nests. Blood samples were taken from eight falcon nestlings; blood serum samples have been frozen pending additional funding to test for rodenticide exposure. Test results from 20 prairie falcon nest entries conducted in 2014 to 2019 indicated positive exposure for nestlings from two nest entries and negative exposure for all nestlings from the other 18 nest entries. During the 2014 season, all four falcon nestlings at the South Balconies nest tested positive for trace amounts of Diphacinone. During the 2017 season, one of the two nestlings at the Egg nest tested positive for measurable amounts of Diphacinone, and the other nestling tested negative for rodenticide exposure. These results represented the first confirmation of rodenticide exposure in the Pinnacles prairie falcon population. Additionally, banding and blood sample information collected in 2009 to 2021 will be used in regional efforts to ascertain genetic insularity and pair fidelity in the Pinnacles prairie falcon population.
- In 2021, the Pinnacles raptor biologist co-authored two presentations for the prairie falcon symposium organized for the annual Raptor Research Foundation conference. The presentations focused on sequencing of the prairie falcon genome and related management implications, and the general state of prairie falcon populations in California. The Pinnacles raptor biologist also participated in the prairie falcon symposium to discuss future strategies for documenting prairie falcon population health and status across regional landscapes and throughout the known prairie falcon breeding range.
- During the 2021 season, four territorial pairs of peregrine falcons successfully fledged a total of eight young, representing the 17th consecutive year that a pair of peregrine falcons has successfully nested at the park during the history of the raptor monitoring program. The four breeding peregrine falcon pairs confirmed at Pinnacles in 2021, and the successful fledging of nine young from four nests, represent the highest numbers of peregrine falcon breeding pairs and total fledglings confirmed at the park in over 60 years. Prior to 2004, the last previously confirmed peregrine falcon territorial occupancy or nest effort at Pinnacles was documented at the Drywall territory in 1957.

- As noted in Appendix C, falcon productivity was notably higher than in recent years. The data suggest an apparent cyclic population pattern for prairie falcons, with peregrine falcon breeding efforts appearing to be supplement overall falcon productivity to yield fecundity rates that are generally consistent with Pinnacles' 35-year average.
- Incoming Pinnacles interpretive staff and volunteers received the two PowerPoint presentations described above that focused on raptor monitoring and falcon nesting, and we circulated monthly raptor-monitoring updates and associated photos to NPS staff and associating organizations throughout the 2021 breeding season via email.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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