COLORADO WILDLIFE SCIENCE
Ecological Research, Management & Consulting

TECHNICAL MEMORANDUM

To: Gary Tennenbaum, Director, Pitkin County Open Space & Trails
Lindsey Utter, Planning and Outreach Manager, Pitkin County Open Space & Trails

From: Jonathan Lowsky, Principal Biologist

Date: November 3, 2018

Re: Great Blue Heron Colony Assessment

North Star Nature Preserve (North Star) has supported an active colony of great blue herons since at least the early 1980s (Joy Smith, pers. comm.). Until 2006, it was located on the west side of the river in spruce trees (Photo 1). Following the removal of a barn across the river to the northeast, the herons established a new location in the narrowleaf cottonwoods and spruce in the current location (Photos 2, 3; Fig. 1). The North Star heronry has been inconsistently monitored by Pitkin County Open Space & Trails (OST) staff or by concerned citizens (e.g., Charlie Hopton) in cooperation with Bird Conservancy of the Rockies'[1] (BCR) Colony Watch program[2] since 2000 (Table 1).

Table 1. Great blue heron activity at North Star

Year	Nests	Active nests	Adults	Juveniles
2000	NA	4	4	4
2001	NA	7	7	7
2002	NA	7	14	24
2003	NA	8	16	19
2004	11	11	22	30
2005	13	11	22	20
2006	NA	NA	NA	NA
2007	15	6	9	6
2008	NA	6	12	8
2009	NA	4	6	0
2010	NA	8	NA	11
2011	NA	6	NA	NA
2012	7	5	10	6
2013	NA	3	NA	5
2014	7	4	8	7
2017	3	0	6	0
2018	2	0	4	0

The major parameters of interest for long term monitoring of great blue herons are colony size (i.e., the number of active nests), nesting success (i.e., the proportion of nests successful in fledging young,

[1] Formerly Rocky Mountain Bird Observatory
[2] For more information see http://rmbo.org/v3/avian/CitizenScience/ColonyWatch.aspx.

or conversely the level of abandonment) and nesting productivity (i.e., the number of young fledged per successful and per active nests). The heron monitoring at North Star has been conducted for many years by volunteers in the absence of a formal protocol. As such, the existing database must be considered to be somewhat fuzzy regarding nesting productivity and success.

That being said, the monitoring data from 2000 to 2018 indicates a substantial decrease in occupancy and production at the North Star heronry. A sharp drop in active nests, adults and juveniles coincided with the change in location and a substantial increase in river-based recreation at North Star. In 2014 it was determined that further study is necessary to determine whether this is part of a natural fluctuation or if management actions have contributed to this decline. Adoption of the 2015 North Star Management Plan included action items as first steps to reverse the trajectory of heron production at North Star. Such measures included a 200 meter Quiet Zone buffer around the existing colony, closure of the section of the JH Smith Interpretive Trail that's within 200 meters of the nest stand during the nesting season, and closer monitoring of recreational use by OST Rangers.

In 2018, Colorado Wildlife Science, LLC (CWS) initiated a dual effort to: (1) more accurately monitor the success of the heronry and, (2) investigate the proximate cause of the apparent heronry decline. The monitoring protocol that was to be used is based on the one established by Vennesland and Norman (2006). Under this protocol, the heronry would be visited by a CWS biologist at least every other week during the breeding season beginning with arrival at the heronry in late March or early April. Data collected would include location, species, and number of nest trees; total number of nests; number of active nests; activity at nest; failed nests; number of young; age of young; number of young fledged; number of successful nests; and evidence of predation. An important part of the protocol is an assessment of the heronry in terms of nest stand health, potential replacement stands, existing and potential threats to the persistence of the heronry, and recommendations to improve conditions for herons in the North Star area. In addition, CWS planned to observe interactions between river-based recreationists and nesting and foraging herons. Data collected was to include type of recreation (e.g., paddle board, kayak, etc.), number in the party, and noise level (e.g., playing music, talking quietly or loud, etc.).

I. 2018 SURVEYS

The herons began their return to the heronry before April 13 and by April 24 there were four herons actively engaging in courtship, pair bonding, and nest building on two nests. On May 2, two birds were observed standing on the nests. Both of the occupied nests were on the east side of the Roaring Fork River in spruce trees near the former site of the Smith barn (Fig. 1). By May 23, however, only one nest was occupied; a single female was observed sitting on the nest in a manner typical of incubation. Nine days later, on June 1, however, that nest was no longer occupied and the entire heronry appeared to be unoccupied as well. A lengthy search of all nest structures was conducted and none were occupied. The river reach from just south of North Star north to the Preserve Subdivision was searched for heron nests but none were discovered. A ground search was conducted beneath the nests on both the east and west sides of the river in an attempt to determine whether any young were hatched but no shell remnants, evidence of predation, guano, or carcasses were found. We conducted nest searches again on June 13 and June 28. Although herons were observed

flying or hunting, none were observed roosting, incubating, or conducting nest maintenance in either the east or west nest stands. As a result, we ceased the monitoring effort.

II. NEST STAND HEALTH & POTENTIAL REPLACEMENT STANDS

We evaluated the two nest stands recently occupied by great blue herons as well as potential replacement stands at North Star. The nest stands at North Star that the herons have been using are in good condition despite occupancy of the western heronry for over 15 years and the eastern for more than 7 years. This is likely due to the relatively small numbers of active nests each year. Great blue heron colonies often damage host trees over time, which may influence colony relocation (Julin 1986). They damage trees by removing leaves, twigs and other foliage for nesting, and by depositing guano, which can reduce light absorption, burn leaves, cause defoliation, and alter soil chemistry (Julin 1986). Herons keep their nests clean by defecating over the side of the nests. The likely purpose is to reduce the chance of chicks being exposed to pathogens such as fungi and bacteria, and to avoid attracting insects while chicks are young and defenseless (Quinney 1982, Butler 1991, Watts and Bradshaw 1994, Carlson 1995, Vennesland 2000). The white guano coats everything underneath the nests: branches, trunks, foliage, and the ground, giving all a somewhat whitewashed appearance. Although the bird droppings can act as a natural fertilizer as they contain large quantities of nitrogen, phosphorus, and potassium, the amount deposited may lead to overfertilization, especially if it is released rapidly during rainfall. When this happens, those trees that support nests lose most of their foliage; they appear diseased and soon die.

Although some heronries are used for many years, most smaller colonies, especially those under 50 nests, relocate more frequently (Gebauer and Moul 2001). As such, heronries should be considered dynamic rather than static. For example, the heronry at Cattle Creek which is the largest in the Roaring Fork Watershed, has moved above and below the Cattle Creek – Roaring Fork River confluence within a 3-mile reach over the last 20 years. After a few years, the ponderosa pines and narrowleaf cottonwoods in which the herons nested begin to seriously decline, and the herons move, over a few seasons, to a new stand. The heronry persists but in a new location.

Given the dynamic nature of heronries, alternate nesting sites should be conserved to replace those that decline because of occupancy (see Kernes and Howe 1967). These should be selected primarily for their proximity to the existing colony and within proximity to known foraging habitat. Gibbs and Kinkel (1997), as well as others, concluded that relative height and suitable limb structure was more important than species, although Kelsall and Simpson (1980) showed fidelity to certain tree species by certain heronries. We identified five replacement stands on North Star that currently contain trees that are in close proximity to important foraging areas identified by Golder in 2014 (Golder Associates 2014). These stands are composed of mature narrowleaf cottonwoods and/or Engelmann spruce or of younger trees that will, over time, provide the height and limb structure preferred by herons in the upper Roaring Fork Valley. These replacement stands are shown in Fig. 1. It should be noted that although suitable nest stands occur south of North Star on private land and conservation land held by other organizations, only potential replacement stands on North Star were evaluated.

III. SPECIES BACKGROUND & CONSERVATION STATUS

Great blue herons breed across the entire North American continent (Palmer 1962). The largest heron species in North America is common and widespread with a distribution that covers most of the North American continent (Butler 1992). This highly adaptable species thrives in a wide variety of habitats. Early in the 20th century, great blue herons suffered from unrestricted hunting, but today, with legal protection and greater awareness about conservation, they are among the most abundant wading birds in North America (Audubon Society 2007). Great blue heron populations are stable or increasing throughout most of its entire range and are ranked globally secure and rare to uncommon in Colorado (G5/S3B1) by NatureServe and the Colorado Natural Heritage Program (CNHP) (NatureServe 2018). The World Conservation Union (IUCN) red list category for the great blue heron is "LC" (Least Concern) and the Audubon Watchlist Status is "Green"2 (Audubon Society 2007). As with all migratory birds from western tanagers (*Piranga ludoviciana*) to American robins (*Turdus migratorius*), the great blue heron is protected under the federal Migratory Bird Treaty Act of 1918.

Great blue heron nesting in Colorado has been documented since the late 19th century (Bailey and Niedrach 1965) and heron populations are generally stable or increasing throughout most of its range (Rocky Mountain Bird Observatory 2005). The earliest extensive surveys, which were conducted in 1965 and 1973, noted 23 and 18 colonies respectively, mostly in the northeast quarter of the state (Ryder et al. 1979). In 2002, Levad and Leukering reported 127 active great blue heron colonies in Colorado. According to Bird Conservancy of the Rockies (formerly Rocky Mountain Bird Observatory), statewide bird monitoring program data were submitted for 174 sites, including many inactive sites which are monitored because of this species' habit of reestablishing sites after many years of inactivity. One hundred twenty four sites were active from 1999 through 2004 (Rocky Mountain Bird Observatory 2005).

As with most bird species, nesting areas represent an integral component of breeding and the lack of acceptable sites may limit population numbers. Habitat characteristics that influence the location of heronries vary considerably depending on physiographic factors. Human activity within or near active heronries has been associated with reduced productivity and site abandonment (Bjorkland 1975, Wershkul et al. 1976). As with other wading birds, response to disturbance is influenced by a variety of factors including breeding stage and distance (Vos et al. 1985).

IV. RESPONSE TO HUMANS

A. Literature

Human disturbance is a major factor influencing nesting and foraging activities of the great blue heron. Though herons may become habituated to some human activities (Grubb 1979, Kelsall and Simpson 1980, Vennesland 2000), human recreation can cause herons to temporarily abandon their breeding attempts, allowing predators to take eggs (Moul 1990), or permanently abandon a colony (Markham and Brechtel 1979). Colonies are typically located in areas with abundant natural buffers (forest and wetland) and low road density (Watts and Bradshaw 1994, Gibbs and Kinkel 1997). Major threats to great blue herons include housing and industrial development, water recreation, road construction, and any other activities that result in habitat degradation (Simpson et al. 1987, Popotnik

and Giuliano 2000). High levels of human activity near breeding colonies have also been linked with increased disturbance from bald eagles (Vennesland 2000). According to the Heron Working Group[3],

> *"As a rule, general day-to-day activity by humans that reside near colonies does not interfere with heron nesting activities. It is novel sounds that frighten herons from nests and lead to abandonment. Sudden blasts of horns or dynamite and starting of chain saws are known to frighten herons from nests. Colonies will sometimes abandon if these activities persist."*

B. Distance & Timing

Vennesland (2000) was among the first to experimentally show that herons habituate to non-threatening presence of people near colonies. He measured the response of herons to his approach (on foot) through the nesting season. He found that colonies in rural areas that seldom experienced people departed their nests sooner than colonies in urban areas. He also established recommendations for the nesting season (February to August) in British Columbia. His study revealed that heron breeding productivity was significantly and negatively predicted by the frequency of pedestrian traffic within 250m of colonies. The low productivity documented at colonies with high levels of pedestrian activity, however, was more directly due to bald eagle disturbance. Hence, there may be an interaction between human and eagle disturbances at heron colonies. Vennesland concluded that "(t)otal human activity (including pedestrians, cars, planes and land clearing equipment) had no relationship to heron breeding" (Vennesland 2000).

Klein (1993) reported that great blue heron responses to humans in vehicles and afoot varied from no response to flying away, and that they reacted more to humans on foot than in vehicles. Rodgers and Smith (1995) reported that great blue herons flushed at a mean distance of 32.0 ± 12.3 m in response to persons approaching on foot. Skagen et al. (2001) found a reduction in the number of great blue heron nests when they were exposed to humans on foot. Vennesland (2000) found that herons at isolated colonies in southwestern British Columbia reacted more strongly to human disturbance than at colonies in urban settings, and that response varied as the season advanced. Herons at the isolated Canadian Forces Base and Hatzic colonies reacted strongly to the approach of Vennesland at 100 m and 90 m, respectively, whereas urban colonies at Beacon Hill Park, Victoria, and Stanley Park, Vancouver, never responded, indicating a relatively strong degree of habituation.

Great blue heron colonies are most sensitive to human disturbance during the early stages of nest selection, nest building, pair formation and egg-laying (Fig 2; Quinney 1982, Vos et al. 1985, Butler 1992). Once eggs are laid, adults flush reluctantly, and once chicks are in the nest few adults will flush.

As the chicks grow, there appears to be a growing commitment by the adult herons and they are much less likely to abandon a nest when disturbed. Vos et al. (1985) determined that the distance in which herons responded to experimental human intrusion averaged around 150 m early in the breeding season, dropping to 60 m late in the breeding period. Vos et al. (1985) studied a heronry at Fossil Creek Reservoir in Larimer County, Colorado. They found that heron response to human activity changed as the breeding season progressed each year. Herons were most responsive to human

[3] A consortium of individuals from university, government and conservation organizations interested in the conservation of the Pacific Great Blue Heron (*Ardea herodias fannini*).

intrusions early in the breeding season (March), flushing from the nest at the slightest disturbance

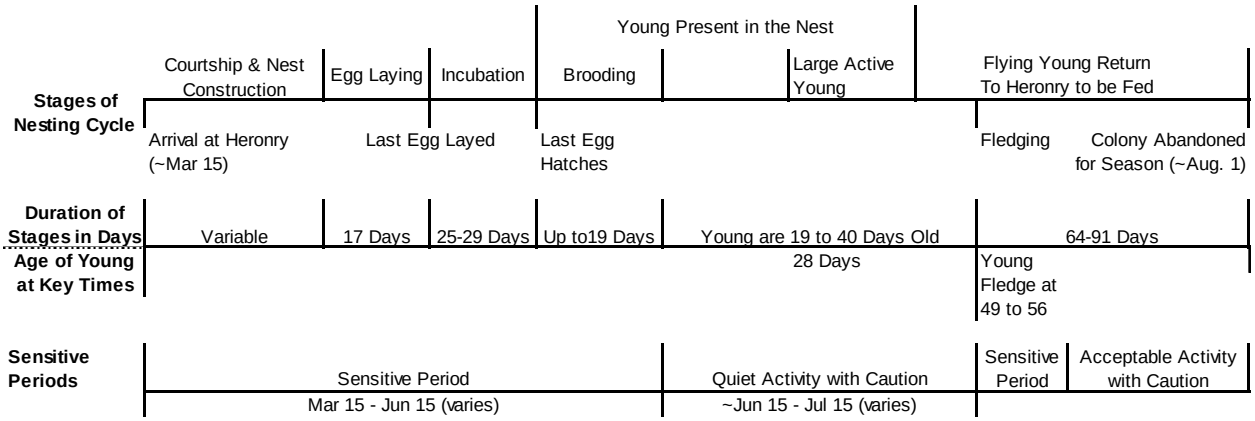

Figure 2. Nesting cycle sensitivity

and not returning until the cause was no longer present. During egg laying and incubation (mid-April), herons were less willing to abandon nests and returned more readily. Attachment further strengthened in late-May to early-June when young were present. At nine colonies in southwestern British Columbia, Vennesland found that the average distance at which herons responded to the first approach of a colony in the season was 49 m, whereas response distance to the last approach averaged 15 m, suggesting that herons habituate to observers over the season.

i. Buffer Distances

To protect heronries from human disturbance, most studies reviewed by Butler (1991) recommended a minimum 300 m (984 ft) buffer zone from the periphery of colonies in which no human activity occurs during the courtship and nesting season (15 February to 31 July). Following experimental work on the disturbance of nesting great blue herons in Larimer County, Colorado and Ontario, Canada, Vos et al. (1985) recommended that a 250 m buffer zone (their greatest flushing distance) plus 50 m for a total of 300 m would be suitable to minimize disturbance to nesting great blue herons. In a similar study on flushing distance in Florida, Rodgers and Smith (1995) recommended a distance of 100 m to avoid disturbance to nesting great blue herons from motor boats and humans on foot. For great blue herons in Colorado, Colorado State Parks (1998) recommends a 200 m buffer based on an unpublished literature review in 1994 by Clint Miller, Boulder Open Space (See Table 2). Vennesland (2000) suggested that a quiet zone and a limited activity zone be considered for all colonies. Each colony responds slightly differently to the presence of people and specific rules should be adopted for each situation. The quiet zone extends 165 meters away from the outer edge of a colony. In remote uninhabited areas, the quiet zone is out of bounds to people. In inhabited areas, the quiet zone allows people to carry on with their normal activity but restricts any sudden, loud activity. The limited activity zone extends 165 to 300 meters from a colony in which no sudden, loud activity should be allowed. These recommendations only apply while herons are nesting.

Table 2. Recommended buffer zones for great blue herons

Author(S)	Year	Location	Buffer (M)	Timing
BC Ministry of Environment[4]	2004	British Columbia	300 (undeveloped) 200 (Rural) 60 (Urban)	January 15 - September 15
Bowman and Siderius	1984	Ontario	300	March 15 – Aug. 1
Buckley & Buckley	1978	New York	300	Through pair-formation, nest construction, & early egg laying
Butler	1992	British Columbia	300	February 15 - July 31
Carlson & McLean	1996	Ohio, W Penn	300	NA
Colorado State Parks	1998	Lit Review	200	NA
Gebauer & Moul	2001	British Columbia	250-300	February 15 - July 31
Erwin	1989	Virginia, N Carolina	100	NA
Mackintosh et al.	2006	Vancouver, BC	300	Varied – See Appendix A
Parker	1980	Montana	200	NA
Quinn & Milner	1999	Washington	250-300	February 15 - July 31
Rodgers & Smith	1995	Florida	100	NA
Vennesland	2000	British Columbia	165	February - August
Vos et al.	1985	Colorado	250	Mid-February - Early August
Werschkul	1976	Oregon	250	NA

C. Habituation

In a 2001 Wildlife Working Report, Gebauer & Moul (2001) reported several studies have provided evidence that some heron colonies can become habituated to non-threatening human disturbance (Anderson 1978, Webb and Forbes 1982, Vos et al. 1985, Butler 1992, Gebauer 1995, Gebauer and Moul 2001). In fact, many heronries have been established or continue to persist within 300 m (984 ft) of human disturbance (Photo A). In British Columbia, a colony at Stanley Park is located in a highly disturbed area (Otter 1991) but has reproduced successfully in most years (i.e., 1977-1997), and another colony was established in a cedar hedge between a busy parking lot and an access road to Vancouver International Airport between 1981 and 1992 (Webb & Forbes 1982). Butler (1991) described established colony sites in highly

Photo A. Great blue herons can habituate to humans recreating in close proximity. Photo courtesy of the City of Vancouver.

[4]From Heron Working Group/Ross Vennesland

disturbed areas at an industrial site near Parksville, and in in residential areas of Victoria and Vancouver.

If dense vegetation obscures human activity, herons appear less likely to react. At the Canadian Forces Base colony, Gebauer (1995) speculated that a natural 50 m buffer of cottonwoods on one side and a 5 m wide dugout waterway between the colony and dike on the other side, may have contributed to a colony's lack of response to activities. A 100 m cottonwood buffer may have sheltered a colony near a major highway bypass in Port Coquitlam, B.C., Bowman and Siderius (1984) and Vos et al. (1985) also suggested that a dense buffer of trees or shrubs might reduce the impact of potential disturbances.

D. Abandonment & Longevity of Heronries

Heronries may be very stable and can exist for 20 to 50 years (Moseley 1936, Bjorkland 1975, Sullivan and Payne 1988), but the average lifespan of heronries in Ontario is only about 9 years (Collier et al. 1992). Heronries may be temporarily unoccupied for a year and then subsequently reoccupied; heronries unoccupied for two or more consecutive years are generally considered to be abandoned (Dunn et al. 1985, Collier et al. 1992). Herons can habituate to everyday human activities that don't threaten their survival, but may abandon colonies if a threat is perceived; they may abandon even with apparently benign stimuli. What constitutes a threat is not known: it may be damage to habitat in a defined radius, e.g., as would happen with removal of nearby trees; or, it may be encroachment of human activities, such as people or objects moving around a nesting area, or construction taking place in the nesting or foraging areas.

Great blue herons began to abandon a large heronry (> 700 nests) in Minnesota in 2000 and by 2005 had dwindled to 25 nests (Von Duyke 2006). Researchers used time-lapse video cameras to investigate the abandonment. They found that for all of the remaining nests, raccoons were observed entering, attacking, killing, and eating heron chicks. Video data suggested that adults, when present, were very reluctant to defend chicks from raccoons. Raccoon raids occurred at various times throughout the day and night. Nests were raided multiple times, either the same day or on consecutive days. Verification that multiple raccoons actively hunted within the colony occurred when two cameras simultaneously recorded raccoon raids in the same tree. Despite the video, researchers were careful not to conclude that raccoons were the only cause of the abandonment. Thunderstorms, avian predators (e.g., eagles, great horned owls [*Bubo virginianus*]; American crows [*Corvus brachyrynchos*]; gulls), and stochastic weather events were factors as well. Rather, they concluded that the raccoon predation was part of a cascade of events that ultimately led to the abandonment (Von Duyke 2006).

In a long-term study of heron and egret colonies around San Francisco Bay, Kelly et al. (2006) found that colonies tended to become inactive within five years unless nest abundance reached a threshold of increasing persistence. Great blue heron colonies that remained smaller than six nests generally became inactive within five years, but colonies persisted, on average, for 12 years or more if maximum abundance was greater than 20 nests (Kelly et al., 2006). In the San Francisco Bay area persistence of heronries began to increase substantially only after reaching an abundance of 20-30 nests. Heronry sites with less than ten nests of all species combined tended to become inactive, on

average, within approximately eight years (Figure 2) (Kelly et al. 2006).

The following are factors and/or observations regarding heronry longevity:

1. Great blue heron colonies may damage host trees over time, which may influence colony relocation (Julin 1986).
2. Heron breeding sites can be relocated rapidly because nests can be built in 3 days and eggs can be laid within about 1 week (Butler 1997).
3. Heronries are dynamic, especially in areas of high disturbance (Butler 1992, Vennesland 2000).
4. Some colonies are used for many years but most colonies, especially those under 50 nests, are relocated more frequently (Gebauer and Moul 2001).
5. Heronry sites with less than ten nests tended to become inactive, on average, within approximately eight years (Kelly et al. 2006).
6. Once a colony has been abandoned for more than 1 year, recolonization occurs infrequently (Gebauer and Moul 2001).

E. Mitigation

Carlson and McLean (1996) showed that barriers that reduced human occurrence below heronries had a stronger effect on the number of herons fledged than buffer zones around colonies. Barriers such as fences, ditches, other watercourses, and dense forests may be effective in reducing human intrusion. Summers (1996), cited in Gebauer & Moul (2001), recommended that vegetation screening be required between heronries and all development activities occurring within 100 m or less from a heronry. Screening vegetation should be at least two meters high at a distance of 100 m from the edge of the colony. At distances closer than 100 m, the vegetation height will depend on its distance from the colony and the height of the nests at the nearest edge of the colony. Summers (1996) also makes specific recommendations for spacing and species composition of vegetation utilized in screening. Rodgers & Smith (1995) advised that mitigation may be possible to shorten buffer distances when physical barriers prevent direct visual contact. Ikutaa and Blumstein (2003) concluded that "…by reducing the number of humans and providing areas of refuge within highly visited habitats, protective barriers allow birds to behave as they would in an undisturbed environment." Van Duyke (2006) used metal flashing to prevent mammalian predators from climbing the nest trees. Carlson and McLean (1996) showed that barriers that reduced human occurrence below colonies had a stronger effect on the number of herons fledged than buffer zones around colonies. Barriers such as fences, ditches, other watercourses, and dense forests may be effective in reducing human intrusion.

In 2014, Golder Associates (2014) recommended a number of mitigation measures to promote the integrity and persistence of the heronry at North Star. All of those recommendations remain valid and should be implemented or continued. In addition, the following measures would further promote recolonization:

1. Rangers should aggressively patrol the river reach at the heronry from March 15 until June 15 to enforce the "Quiet Zone" and minimize disturbance during the pair bonding, mating, and laying periods.
2. A dense area of narrowleaf cottonwoods, spruce, and tall willow species should be planted or protected where young trees are already growing between the river and the east and west nesting areas to screen recreational activity from the herons.
    a. Plantings and protection of existing trees should be completed as close to the area of disturbance as possible (i.e., the river).
    b. This should also be implemented at alternate nesting stands at North Star (Fig. 1).
    c. Where possible, the trees/shrubs planted should be a mixture of deciduous and coniferous, and half should be of the same species currently used for nesting.
3. Maintain perch trees adjacent to major foraging areas (Fig. 1).

V. DISCUSSION[5]

The decline and abandonment of the heronry coincided with both a significant increase in river-based recreation in the river reach adjacent to the nest stands and serious decline in the nest stands themselves. Unfortunately, due to the abandonment in 2018 we were unable to observe behavior of the nesting herons in response to recreationists. We were able, however, to observe (fourteen observations from May through July) that when herons were hunting within the river itself, they flushed 100% of the time upon sighting a paddle board, kayak, or canoe approaching them. This has certainly led to a significant reduction in the value of the river from Wildwood to North Star as a foraging area. On eight occasions, however, we observed herons hunting in the other off-river foraging sites identified by Golder when recreationists were present on the river. In all eight instances the foraging heron did not appear to react to the human activity.

We can conclude that, overall, great blue heron habitat conditions have declined at North Star over the past few years due to both the increased recreation and natural processes. OST, however, has taken steps to reduce the potential impact of the river activity on herons through the new management plan. The impact could be further reduced by implementing the mitigation measures above. In addition, OST's efforts to maintain the fen, protect foraging areas on the west side of the river, and protecting and enhancing the alternate nest stands combine to make it feasible that great blue herons will return to North Star in 2019 and beyond.

[5] Since the 2017 update provides an in-depth look into heronry abandonments, I will not duplicate it here.

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BACKGROUND & QUALIFICATIONS

Colorado Wildlife Science, LLC (CWS) is a small wildlife and ecological consulting firm based in Basalt, Colorado, specializing in wildlife research, management, and monitoring, ecological assessments, wetland & riparian delineations, conservation easement baseline inventories, ecological planning, habitat management, and ecological restoration. CWS applies a scientifically sound approach to biological resource studies and management. Our work combines professional integrity and strong academic training with extensive experience working for government, private, and non-profit clients. With an extensive network of professional collaborators that includes plant ecologists, foresters, hydrologists, and soil scientists, CWS leverages the collective knowledge of experienced professionals working toward practical, effective and cost saving solutions.

CWS provides expert services to a diverse array of clients. Since we are a small company, personal attention is ensured. We combine full in-house GIS (ArcGIS) with real-time, sub-meter GPS to provide state-of-the-art spatial data, analyses, maps, and presentations. We have prepared Biological Assessments and Biological Evaluations, and contributed to EAs and EISs. CWS has worked with large private firms such as Jacobs; Carter & Burgess; Mead & Hunt; Parsons; Amec Foster Wheeler; SE Group; and SAIC as well as city, county, state, and federal agencies such as City of Aspen, City of Glenwood Springs, Pitkin County, Town of Basalt, Colorado Department of Transportation, and Roaring Fork Transportation Agency. CWS has prepared over 70 conservation easement baseline and Present condition reports for 8 different conservation organizations in 5 western Colorado counties.

Owner and Wildlife Biologist Jonathan Lowsky, M.S. Wildlife Biology, Colorado State University, has a broad range of knowledge. With more than 26 years of professional experience with federal (US Forest Service), state (Colorado Division of Wildlife), and county agencies as well as two major universities (Colorado State University and University of Washington), Jonathan's career has focused on a diverse array of wildlife from bighorn sheep, elk, and songbirds to northern goshawks, flying squirrels, small mammals, and spotted bats. Mr. Lowsky's experience includes biological assessments and evaluations for NEPA compliance, conservation planning, GIS mapping and modeling, wildlife research, and ecological monitoring design and implementation, as well as wetland and riparian delineations, evaluations, and restoration. He has authored management plans and conservation easement baseline inventory reports and published scientific papers. An expert birder, experienced tracker, certified wetlands delineator, trained fluvial geomorphologist, and passionate observer of wildlife, Jonathan has spent countless hours studying and appreciating Colorado's diverse ecological communities. A detailed description of Mr. Lowsky's professional experience and references are available. For additional information, please visit our website at www.coloradowildlifescience.com.

VII. FIGURES

106°48'15"W 106°48'0"W 106°47'45"W 106°47'30"W 106°47'15"W

39°10'24"N

39°10'12"N

39°10'0"N

39°9'48"N

A B C D E F

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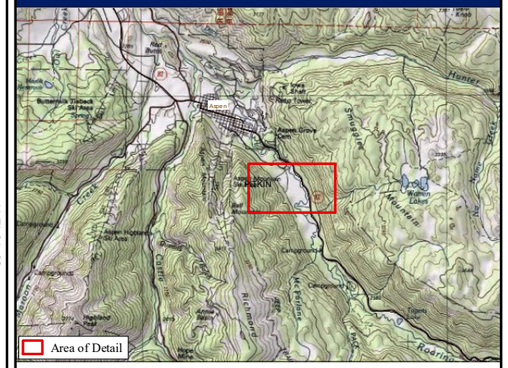
Pitkin County Open Space & Trails
Great Blue Heron Colony Assessment

North Star Nature Preserve

Figure 1. Great Blue Heron Habitat with 200 m Buffer & Alternate Nest Stands



N

Legend:

- North Star Boundary
- Great Blue Heron Colony - Western Nest Stand
- Great Blue Heron Colony - Eastern Nest Stand
- Alternate Nest Stand
- Important Foraging Area
- 200 m Buffer from Heron Nest Stands
- Trail

0 250 500 1,000 Feet

1 inch = 417 feet

Coordinate System: NAD83 State Plane Colorado Central	Basemap Sources: Pitkin County GIS 2014 Orthophotos
Project No 1400717	
Date Prepared: 2018-10-11	

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VIII. PHOTOS

Photo 1. Western nest stand when still active in 2009 (Photo taken 6/23/2009)

Photo 2. Western nest stand in 2018 (Photo taken 10/17/2018)

Photo 3. Heron observed on nest in the eastern nest stand in 2018 (Photo taken 5/31/2018)

Photo 4. Eastern nest stand in 2018 (Photo taken 10/17/2018)

Photo 5. Alternate nest stand C (Fig. 1) (Photo taken 10/17/2018)

Photo 6. Alternate nest stand D (Fig. 1) (Photo taken 10/17/2018)

Photo 7. A portion of alternate nest stand F (Fig. 1) (Photo taken 10/17/2018)