2019

Eagle Nest and Roost Monitoring within Exelon Lands: Muddy Run Pumped Storage Project (FERC No. 2355) and Conowingo Hydroelectric Project (FERC No. 405)

B. D. Watts
The Center for Conservation Biology, bdwatt@wm.edu

B. J. Paxton
The Center for Conservation Biology, bjpaxt@wm.edu

Recommended Citation

Watts, B. D. and B. J. Paxton. 2019. Eagle Nest and Roost Monitoring within Exelon Lands: Muddy Run Pumped Storage Project (FERC No. 2355) and Conowingo Hydroelectric Project (FERC No. 405). Center for Conservation Biology Technical Report Series, CCBTR-19-02. College of William & Mary and Virginia Commonwealth University, Williamsburg, VA. 44 pp.

EAGLE NEST AND ROOST MONITORING WITHIN EXELON LANDS: MUDDY RUN PUMPED STORAGE PROJECT (FERC NO. 2355) AND CONOWINGO HYDROELECTRIC PROJECT (FERC NO. 405)

Prepared for Exelon Generation Company, LLC and Gomez and Sullivan Engineers, DPC.

CENTER FOR CONSERVATION BIOLOGY
COLLEGE OF WILLIAM AND MARY
VIRGINIA COMMONWEALTH UNIVERSITY

Eagle Nest and Roost Monitoring within Exelon Lands

Muddy Run Pumped Storage Project (FERC No. 2355) and Conowingo Hydroelectric Project (FERC No. 405)

Final report submitted to Exelon Generation Company, LLC, January 2019

Bryan D. Watts, PhD
Barton J. Paxton
The Center for Conservation Biology
College of William and Mary & Virginia Commonwealth University

Recommended Citation:

Watts, B. D. and B. J. Paxton. 2019. Eagle Nest and Roost Monitoring within Exelon Lands: Muddy Run Pumped Storage Project (FERC No. 2355) and Conowingo Hydroelectric Project (FERC No. 405). Center for Conservation Biology Technical Report Series, CCBTR-19-02. College of William & Mary and Virginia Commonwealth University, Williamsburg, VA. 44 pp.

Project Partners:

Exelon Corporation
Gomez & Sullivan Engineers
The Center for Conservation Biology
College of William and Mary
Virginia Commonwealth University

Front Cover: An incubating bald eagle sleeps in the shadows on a transmission tower. One of several nests built on towers along the lower Susquehanna River. Photo by Bryan Watts.

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

Table of Contents

Contents

EXECUTIVE SUMMARY

The lower Susquehanna River including Exelon hydroelectric facilities falls within the Upper Chesapeake Bay Bald Eagle Concentration Area. The area supports a large and growing breeding population of bald eagles and is a convergence area for resident non-breeding eagles and migratory eagles from populations along the entire Atlantic Coast. The area represents one of the highest-use eagle areas in eastern North America and a network of communal roosts. In consideration of this significance, Exelon has developed a bald eagle management plan for the area that includes periodic monitoring. The objectives of this project were 1) to survey the area for pairs of breeding bald eagles,2) to determine the occupancy status of known communal roosts, and 3) to estimate the overall abundance of eagles

Biologists from The Center for Conservation Biology surveyed the study area for bald eagle nests using a standard two-flight approach and examined 51 bald eagle nests. We located 35 occupied breeding territories and documented 29 breeding attempts. Breeding success was 86.2% and pairs produced at least 46 young. Average reproductive rate was 1.31/pair and 1.59/breeding attempt. This rate is above that required for population maintenance and is consistent with recent rates documented throughout the broader Chesapeake Bay. The breeding population has increased 290% since the survey conducted in 2010 representing an average doubling time of 5.2 years. This rate of growth is higher than that for the broader Bay population.

We counted 230 bald eagles during 43 surveys of 19 communal roosts within the study area. More than twice (159 winter vs 71 summer) as many birds used the set of roosts during the winter compared to the summer period. Considering known-age birds, an identical ratio of juveniles to adults (44.8 juveniles: 55.2% adults) was documented for both the winter and summer periods. We found eagles within all communal roosts (N = 19) included in the survey during at least one season. Fifteen roosts were used during both winter and summer. The number of eagles associated with roosts ranged from 1 to 78 during the winter survey and from 1 to 14 during the summer survey. We discovered a new roost (Roost #20) during the summer survey period.

BACKGROUND

The Chesapeake Bay supports significant resident and migratory populations of bald eagles including an estimated 30,000 individuals during the course of the annual cycle (Watts et al. 2007). The resident breeding population has grown exponentially since the 1970s and is now the largest population in eastern North America with an estimated 2,000+ breeding pairs (Watts et al. 2008). In addition to being an important breeding area, the Bay is a convergence area for populations throughout New England and the Canadian Maritimes that migrate south and spend the winter months and for populations throughout the Southeast that migrate north and spend the summer months (Watts et al. 2007). Both breeding and migratory eagles congregate within lower saline waters and form eagle concentration areas (Watts et al. 2006, 2007). One of six concentration areas recognized throughout the Chesapeake is the Upper Chesapeake Bay-Susquehanna Bald Eagle Concentration Area. Concentration areas support high breeding densities, dense foraging areas and networks of communal roosts (Watts 2007, Watts and Mojica 2012).

The waters of the lower Susquehanna River support several power generating stations including Exelon Corporation's Muddy Run Hydroelectric Station, Peach Bottom Atomic Power Plant, and Conowingo Hydroelectric Station. These facilities fall within the Upper Chesapeake Bay-Susquehanna Bald Eagle Concentration Area. An investigation in 2011 of the lower Susquehanna River including project lands identified 12 occupied bald eagle breeding territories and 19 active communal roosts (Mojica et al. 2011). In accordance with the Bald Eagle Management Plan for Exelon Lands, monitoring of bald eagle nests and roosts on Exelon lands should be carried out every five years.

OBJECTIVES

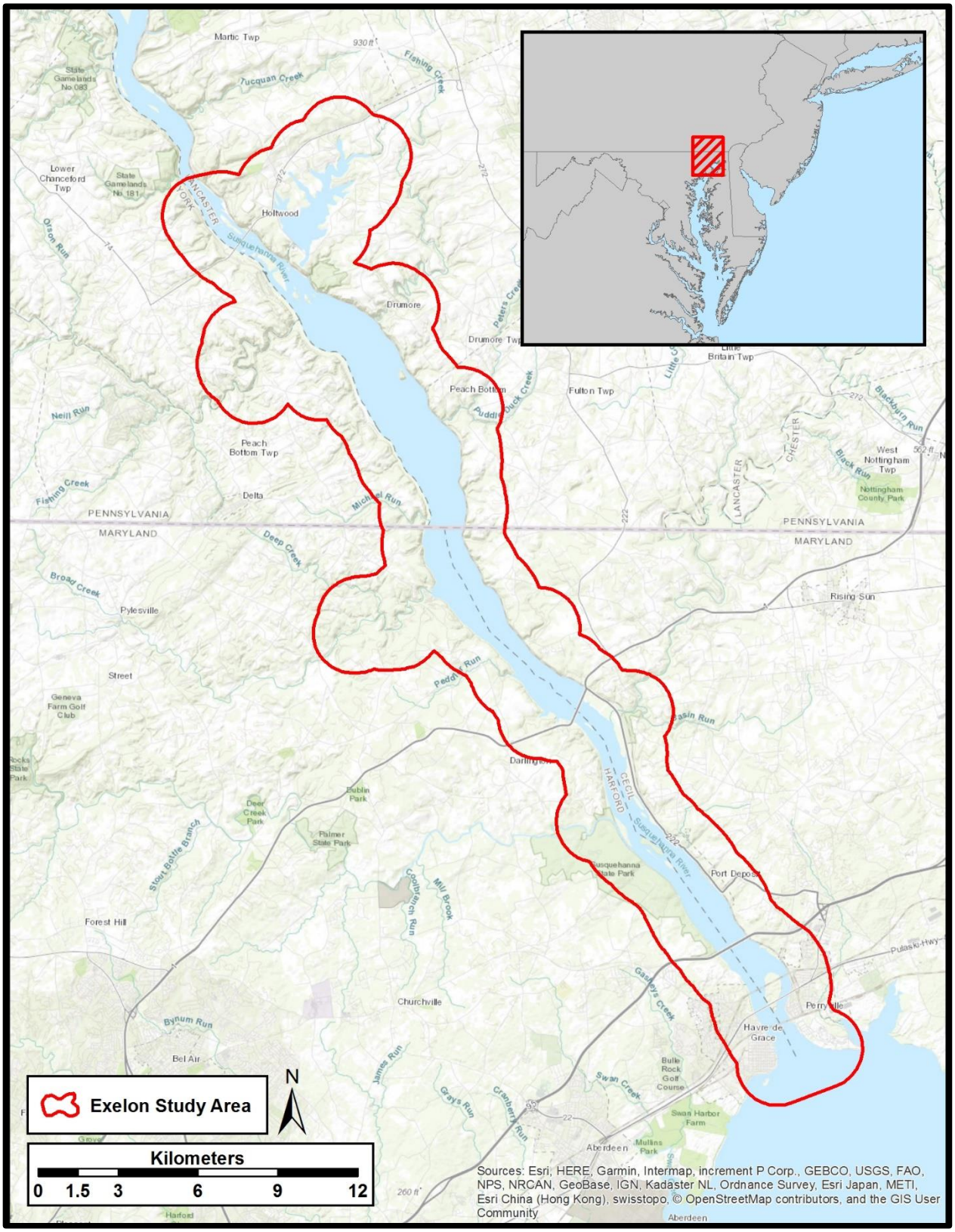
In accordance with the Bald Eagle Management Plan for Exelon Lands, the objectives of this project were:

1) To document the status, distribution and productivity of nesting bald eagles along the lower Susquehanna River study area using standard aerial survey techniques.
2) To determine the occupancy status of known bald eagle communal roosts within the lower Susquehanna River study area during the winter and summer seasons.

STUDY AREA

The study area included all lands within 1.5 kilometes of the shorelines of Conowingo Pond, Muddy Run Reservoir and Recreation Lake and the Susquehanna River out to its mouth where it enters the Chesapeake Bay (Figure 1). This includes all shoreline from US Route 40 near the mouth of the Susquehanna to Pennsylvania Route 372 near the north end of the Conowingo and Muddy Run reservoirs (approximately 80 kilometers of shoreline).

Figure 1. Map of the lower Susquehanna River indicating the landward extent of the study area used for bald eagle nest surveys.



METHODS

Nesting and Productivity Surveys

We surveyed all major waterways and tributaries within the study area for breeding bald eagles during the 2018 breeding season using a standard two-flight approach (Fraser et al. 1983). On 19 March, 2018 we used a high-wing Cessna 172 aircraft to systematically overfly the land surface, at an altitude of approximately 100 m above tree canopy, to detect eagle nests. Flights were flown to systematically move between the shoreline and a distance of approximately 1.5 km inland to cover the most probable breeding locations for bald eagles. We plotted all nests detected on a GPS-enabled tablet computer using recent aerial imagery to plot nest location based on landscape features. In areas with insufficient features to allow for accurate plotting of the nest position, we made two passes directly over the nest using bearings that differed by approximately 90 degrees. We then used the intersection of the resulting GPS bread crumb trail to accurately plot the nest position. All nests were assigned a unique alpha-numeric code. We examined each nest to determine its structural condition, the type and condition of nest tree, and the condition of the surrounding landscape. We rechecked all occupied territories on 23 April, 2018 for productivity. We maneuvered a Cessna 172 aircraft low over the nest to allow observers to view the nest contents. We counted all eaglets and aged them by sight. Active bald eagle nests were rechecked between mid-April and late-May for productivity. A Cessna 172 aircraft was used to fly low over nests, allowing observers to examine nest contents. All eaglets were counted and aged by sight. Following national conventions (USFWS 2009), a breeding territory was considered "occupied" if a pair of birds was observed in association with the nest and there was evidence of recent nest maintenance (e.g., well-formed cup, fresh lining, and structural maintenance). Nests were considered "active" if a bird was observed in an incubating posture or if eggs or young were detected in the nest.

Communal Roost Surveys

We conducted exit and/or entry surveys of 19 bald eagle communal roosts during winter (1 January – 31 March, 2018) and summer (1 June – 31 August, 2018) periods to determine occupancy status. Roosts had been previously delineated within the study area using night locations of eagles tracked with satellite transmitters (Mojica et al. 2011). We positioned experienced observers in locations where birds could be observed within roosts, entering roosts or leaving roosts. Exit (dawn) surveys were conducted from 30 minutes before sunrise to 30 minutes after sunrise. Entry (dusk) surveys were conducted from one hour before civil twilight to civil twilight. Dawn and/or dusk surveys were conducted to determine occupancy. If we detected bald eagles were using a roost during the initial survey visit of the season (positive occupancy), we conducted no additional surveys for that season. If we did not detect eagles during the initial survey of the season (negative occupancy), a follow up survey was conducted on a different day and time.

We used spotting scopes and binoculars to detect eagles and to classify them according to plumage. Birds in adult, definitive plumage (typically attained at 5.5 years) were classified as adults. Birds in basic I-IV plumage were considered juveniles (McCollough 1989). During surveys we recorded date, time, weather conditions, observer (s), number of juvenile, adult and unaged eagles observed.

RESULTS

Bald Eagle Nest Survey

We surveyed 51 bald eagle nests within the study area that were either known before the survey (N = 24) or found during (N = 27) the survey (Table 1, Figure 2, see Appendices 1 and 2 for details). New nests included 24 (88.9%) that were in good condition and three (11.1%) that were in fair condition. Twenty-four of these nests were within occupied territories and supported 19 documented breeding attempts. Of the 24 nests that were known previously, nine (37.5%) were absent, one (4.2%) was in poor condition, three (12.5%) were in fair condition and 11 (45.8%) were in good condition and supported 10 documented breeding attempts.

We located 35 occupied bald eagle territories within the study area during the 2018 breeding season (Table 1, see Appendices 1 and 2 for details). This result represents a 290% increase since the survey conducted in 2010 (35 vs 12 occupied territories) of the same study area using the same survey approach and observer. Average population doubling time for this increase would be 5.2 years. Within occupied territories we documented 29 breeding attempts that produced at least 46 young. Average reproductive rate per pair was 1.31 and per nesting attempt was 1.59. For territories with documented nesting attempts, breeding success was 86.2%. Average brood size for successful pairs was 1.84.

Table 1. Bald eagle nests surveyed on the lower Susquehanna River in 2018. See methods for definitions of "occupied territory" and "active nest." Survey observations, conditions and coordinates for nests are listed in appendices.

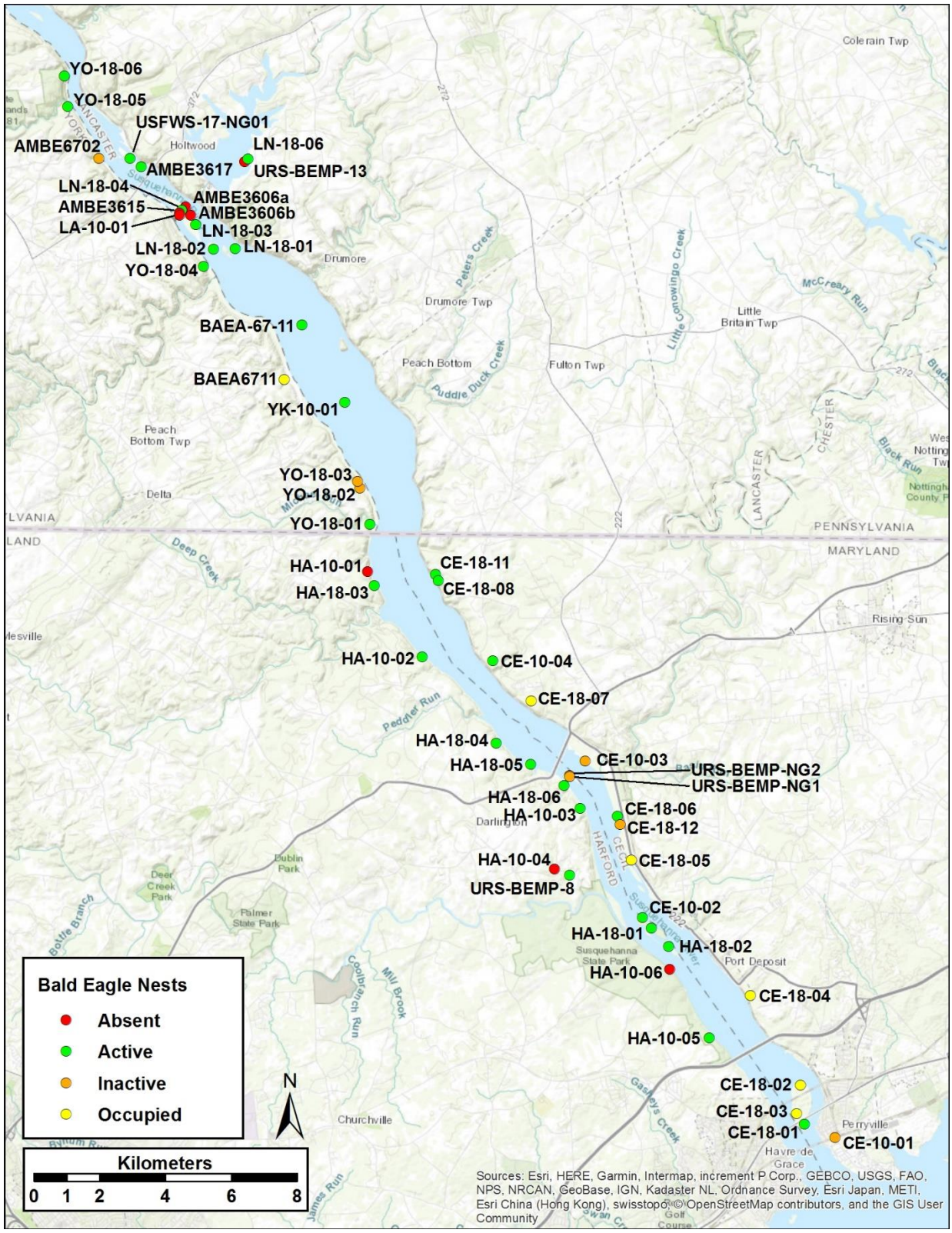
Nest Code	Nest Substrate	Nest Status	Occupied Territory?	Active Nest?	Productivity
AMBE3606a	Unknown	Absent	N	N	-----
AMBE3606b	Unknown	Absent	N	N	-----
AMBE3615	Unknown	Absent	N	N	-----
AMBE3617	Sycamore Tree	Good	Y	Y	2
AMBE6702	Red Maple Tree	Fair	N	N	-----
BAEA6711	Transmission Tower	Good	Y	N	-----
BAEA-67-11	Transmission Tower	Good	Y	Y	2

Nest Code	Nest Substrate	Nest Status	Occupied Territory?	Active Nest?	Productivity
CE-10-01	Cell Tower	Poor	N	N	-----
CE-10-02	Oak Tree	Good	Y	Y	3
CE-10-03	Transmission Tower	Absent	N	N	-----
CE-10-04	Oak Tree	Good	Y	Y	1
CE-18-01	Oak Tree	Good	Y	Y	0
CE-18-02	Oak Tree	Good	Y	N	-----
CE-18-03	Oak Tree	Blown Out	Y	N	-----
CE-18-04	Oak Tree	Good	Y	N	-----
CE-18-05	Sycamore Tree	Good	Y	N	-----
CE-18-06	Poplar Tree	Good	Y	Y	2
CE-18-07	Hardwood Tree	Good	Y	N	-----
CE-18-08	Oak Tree	Good	Y	Y	1
CE-18-11	Poplar Tree	Good	Y	Y	2
CE-18-12	Sycamore Tree	Fair	N	N	-----
HA-10-01	Oak Tree	Absent	N	N	-----
HA-10-02	American Beech	Good	Y	Y	2
HA-10-03	Oak Tree	Good	Y	Y	2
HA-10-04	Oak Tree	Absent	N	N	-----
HA-10-05	Oak Tree	Good	Y	Y	2
HA-10-06	Sycamore Tree	Absent	N	N	-----

Nest Code	Nest Substrate	Nest Status	Occupied Territory?	Active Nest?	Productivity
HA-18-01	Oak Tree	Good	Y	Y	3
HA-18-02	Red Oak Tree	Good	Y	Y	1
HA-18-03	Oak Tree	Good	Y	Y	≥1
HA-18-04	Oak Tree	Good	Y	Y	2
HA-18-05	Oak Tree	Good	Y	Y	2
HA-18-06	Oak Tree	Good	Y	Y	0
LA-10-01	Hardwood Tree	Absent	N	N	-----
LN-18-01	Oak Tree	Good	Y	Y	1
LN-18-02	Oak Tree	Good	Y	Y	2
LN-18-03	Transmission Tower	Good	Y	Y	1
LN-18-04	White Pine	Good	Y	Y	2
LN-18-06	Transmission Tower	Good	Y	Y	0
URS-BEMP-13	Hardwood Tree	Absent	N	N	-----
URS-BEMP-8	Oak Tree	Good	Y	Y	2
URS-BEMP-NG1	Transmission Tower	Fair	N	N	-----
URS-BEMP-NG2	Transmission Tower	Fair	N	N	-----
USFWS-17-NG01	Oak Tree	Good	Y	Y	2
YK-10-01	Transmission Tower	Good	Y	Y	0
YO-18-01	American Beech	Good	Y	Y	2
YO-18-02	Poplar Tree	Fair	N	N	-----

Nest Code	Nest Substrate	Nest Status	Occupied Territory?	Active Nest?	Productivity
YO-18-03	Oak Tree	Fair	N	N	-----
YO-18-04	Oak Tree	Good	Y	Y	2
YO-18-05	Oak Tree	Good	Y	Y	2
YO-18-06	Hardwood Tree	Good	Y	Y	2

Figure 2. Map of bald eagle nests or nest locations that were checked by aerial surveys during the 2018 nesting season.



Bald Eagle Roost Monitoring

We counted 230 bald eagles during 43 surveys of 19 communal roosts within the study area (Tables 2 and 3, Appendix 3). More than twice (159 winter vs 71 summer) as many birds used the set of roosts during the winter compared to the summer period. Overall age distribution was 111 (48.3%) adults, 90 (39.1%) subadults, and 29 (12.6%) birds where age could not be determined. Considering known-age birds, an identical ratio of juveniles to adults (44.8 juveniles: 55.2% adults) was documented for both the winter and summer periods.

Table 2. The number of eagles observed during surveys of communal roosts conducted during the winter period (2018). Refer to Figure 3 for the location of roosts.

Roost Code	Date	Period	Season	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles	Total
1	3/27/2018	PM	Winter	42	36	0	78
2	3/27/2018	PM	Winter	4	3	0	7
3	3/28/2018	PM	Winter	0	1	2	3
4	3/28/2018	PM	Winter	3	7	5	15
5	3/28/2018	AM	Winter	1	2	0	3
6	3/27/2018	PM	Winter	2	6	0	8
7	3/27/2018	PM	Winter	1	4	0	5
8	3/27/2018	PM	Winter	4	1	0	5
9	3/27/2018	PM	Winter	0	4	5	9
10	3/28/2018	PM	Winter	2	2	0	4
11	3/27/2018	PM	Winter	2	5	0	7
12	3/28/2018	PM	Winter	2	3	0	5
13	3/29/2018	AM	Winter	0	0	2	2
14	3/29/2018	AM	Winter	0	2	2	4

Roost Code	Date	Period	Season	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles	Total
15	3/28/2018	AM	Winter	0	0	0	0
15	3/29/2018	PM	Winter	0	0	0	0
16	3/28/2018	AM	Winter	0	0	0	0
16	3/29/2018	PM	Winter	0	0	0	0
17	3/28/2018	AM	Winter	0	1	0	1
18	3/28/2018	AM	Winter	1	1	0	2
19	3/28/2018	PM	Winter	0	1	0	1

Table 3. The number of eagles observed during surveys of communal roosts conducted during the summer period (2018). Refer to Figure 3 for the location of roosts.

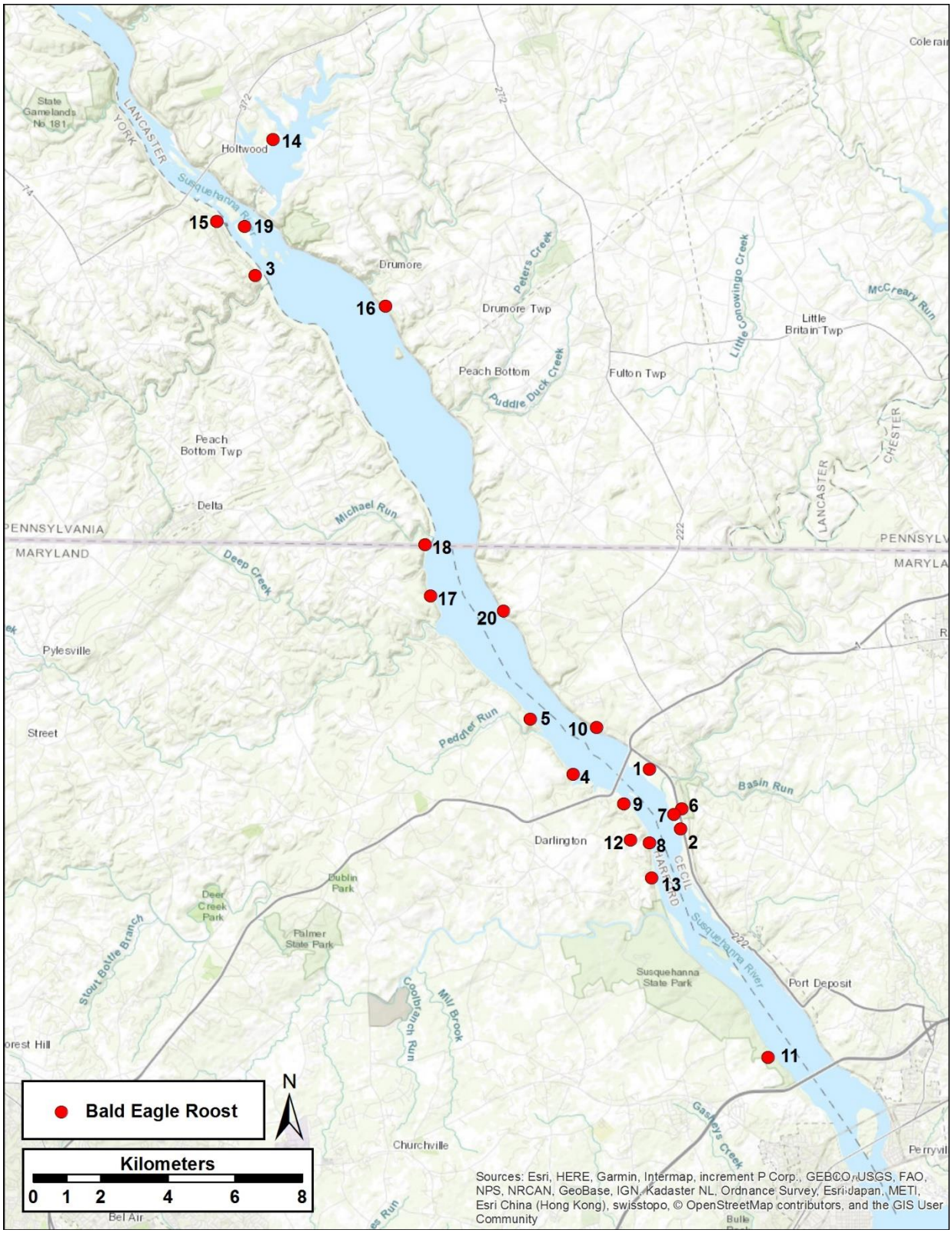
Roost Code	Date	Period	Season	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles	Total
1	8/14/2018	PM	Summer	12	4	0	16
2	8/14/2018	PM	Summer	1	2	0	3
3	8/16/2018	PM	Summer	1	2	0	3
4	8/15/2018	PM	Summer	0	2	0	2
5	8/16/2018	AM	Summer	1	2	0	3
6	8/14/2018	PM	Summer	0	2	0	2
7	8/14/2018	PM	Summer	1	0	0	1
8	8/14/2018	PM	Summer	0	0	0	0
8	8/15/2018	AM	Summer	0	0	0	0

Roost Code	Date	Period	Season	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles	Total
9	8/14/2018	PM	Summer	0	0	0	0
9	8/15/2018	AM	Summer	0	0	0	0
10	8/15/2018	PM	Summer	3	1	0	4
11	8/14/2018	PM	Summer	0	5	0	5
12	8/15/2018	PM	Summer	0	1	0	1
13	8/15/2018	AM	Summer	0	0	2	2
14	8/15/2018	AM	Summer	5	2	7	14
15	8/16/2018	AM	Summer	0	0	2	2
16	8/15/2018	PM	Summer	0	2	0	2
17	8/16/2018	AM	Summer	0	2	0	2
18	8/16/2018	AM	Summer	0	0	1	1
19	8/16/2018	PM	Summer	0	2	0	2
20	8/16/2018	AM	Summer	2	3	1	6

We found eagles within all communal roosts (N = 19) included in the survey during at least one season (Tables 2 and 3). Fifteen roosts were used during both winter and summer, roosts 15 and 16 were used during the summer only and roosts 8 and 9 were used during the winter only. The number of eagles associated with roosts ranged from 1 to 78 during the winter survey and from 1 to 14 during the summer survey.

We discovered a new roost during the summer survey period. On 16 August 2018, during the morning survey of roost 17, multiple birds were heard vocalizing on the hillside above the observation point for roost 17. As morning light increased, 2 juvenile, 3 Adult, and 1 unaged bald eagle were observed exiting this roost. The new site is located on the steep forested hillside on the north shore of the Susquehanna River, 2 KM ENE of the mouth of Broad Creek at 39.70404N, 76.21466W (Figure 3).

Figure 3. Map of bald eagle communal roosts surveyed for occupancy status during the winter and summer seasons (2018).



DISCUSSION

The study site within the lower Susquehanna River is a significant bald eagle breeding area. The forested shoreline, low disturbance and apparent high prey availability within the Conowingo Reservoir, Muddy Run Reservoir, and the lower Susquehanna River combine to support high breeding density. Breeding density around the outfalls of dams is particularly high. The population growth rate with an average doubling time of only 5.2 years is higher than that reported for the broader Chesapeake Bay as a whole (Watts et al. 2008). The site now supports 35 occupied breeding territories and ranks among some of the highest nest densities within the Bay.

Reproductive rates recorded during the 2018 breeding season were high and consistent with those reported for the Chesapeake Bay in recent years (Watts et al. 2007, 2008). Nesting success was on the high end of recent reports and reproductive rates are above those believed to be needed for population maintenance (Watts et al. 2008). The lower Susquehanna River sits within the tidal-fresh reach of the upper Bay. This low salinity zone has been shown to have the highest bald eagle growth rates, breeding densities and reproductive rates of any throughout the estuary (Watts et al. 2006).

The lower Susquehanna study site sits within the Upper Chesapeake Bay Bald Eagle Concentration Area and supports thousands of non-breeding eagles throughout the year from breeding populations along the entire Atlantic Coast (Watts et al. 2007). These birds assemble within communal roosts to rest at night and loaf during the day. All of the 19 roost sites delineated in 2010 (Mojica et al. 2011) were still being used in 2018 and a new site was discovered while conducting fieldwork. Bald eagles are highly social and communal roosts play a significant role in their life cycle (Watts and Mojica 2012, Watts and Turrin 2017). Roost density along the lower Susquehanna is particularly high and the major roost just below the Conowingo Dam is the dominant roost within the upper Chesapeake Bay (Watts and Mojica 2012). This roost was found to support the highest number of roost nights and the largest number of individual birds of any roosts studied within the upper Chesapeake Bay (Watts and Mojica 2012, Watts and Turrin 2017). Roosts within the upper Bay are interconnected like a complex network and this roost is the largest central hub within the network (Watts and Dyer 2018).

Bald eagle nests and communal roosts are protected under the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d) under the working definition of the “disturb” clause. Alternatives should be sought for actions that may either alter the physical structure of nest or roost trees or cause disturbances that impact the ability of individuals to use these features or associated foraging areas. Introduction of new disturbances like boat ramps, aircraft corridors, and explosives should be avoided in consultation with the U.S. Fish and Wildlife Service and state wildlife agency (USFWS 2007).

ACKNOWLEDGMENTS

Many individuals contributed to the success of this project. David Frazier, Dan Gonzalez, and Erin Redding provided insight and support. Laura Duval, Chance Hines, Marie Pitts, and Fletcher Smith assisted with roost surveys. Staff at Susquehanna State Park permitted off-hour access for roost observations. Norfolk Southern allowed access for roost observations. Jim Reed piloted the plane for the nest surveys. Marie Pitts assisted with report production. We also thank Erica Lawler and Jane Lopez of the Sponsored Programs Office at the College of William and Mary for their administrative assistance.

LITERATURE CITED

Fraser, J. D., L. D. Frenzel, J. E. Mathisen, F. Martin, and M. E. Shough. 1983. Scheduling Bald Eagle reproductive surveys. Wildlife Society Bulletin 11:13-16.

McCollough, M. A. 1989. Molting sequence and aging of bald eagles. Wilson Bulletin 101:1-10.

Mojica, E. K., B. J. Paxton, and B. D. Watts. 2011. Eagle Nest, Roost and Foraging Area Monitoring at Exelon's Conowingo and Muddy Run Reservoirs. Final Report. Center for Conservation Biology Technical Report Series, CCBTR-11-15. College of William and Mary & Virginia Commonwealth University, Williamsburg, VA. 16 pp.

U.S. Fish and Wildlife Service. 2007. National Bald Eagle Management Guidelines.

U.S. Fish and Wildlife Service. 2009. Post-delisting Monitoring Plan for the Bald Eagle (Haliaeetus leucocephalus) in the Contiguous 48 States. U.S. Fish and Wildlife Service, Divisions of Endangered Species and Migratory Birds and State Programs, Midwest Regional Office, Twin Cities, Minnesota. 75 pp.

Watts, B. D., A. C. Markham, and M. A. Byrd. 2006. Salinity and population parameters of Bald Eagles (Haliaeetus leucocephalus) in the lower Chesapeake Bay. Auk 123:393-404.

Watts, B. D., G. D. Therres, and M. A. Byrd. 2007. Status, distribution and the future of Bald Eagles in the Chesapeake Bay. Waterbirds 30:25-38.

Watts, B. D., G. D. Therres, and M. A. Byrd. 2008. Recovery of the Chesapeake Bay bald eagle nesting population. Journal of Wildlife Management 72:152-158.

Watts, B. D. and E. K. Mojica. 2012. Management implications of bald eagle roost proliferation within the Chesapeake Bay. Journal of Raptor Research 46:120-127.

Watts, B. D. and C. Turrin. 2017. Mapping bald eagle activity shadows around communal roosts: Implications for management guidelines. Journal of Wildlife Management 81:1-10.

Watts, B. D. and R. J. Dyer. 2018. Structure and resilience of bald eagle roost networks. Wildlife Society Bulletin 42:195-203.

APPENDICES

Appendix I. Descriptions, substrates and locations of bald eagle nests included in aerial surveys of the study area (2018).

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
AMBE3606a	Unknown		Nest absent	No change in tree or surrounding landscape	387953	4407469
AMBE3606b	Unknown		Nest absent	No change in tree or surrounding landscape	388121	4407220
AMBE3615	Unknown		Nest absent	No change in tree or surrounding landscape	387779	4407286
AMBE3617	Sycamore Tree	Live	Nest positioned in top crotch, nest in good condition with well-formed cup and fresh lining	Nest is on long forested island just upstream of bridge, this nest is the eastern nest on the island, nest tree is supercanopy and is along the northern edge of the island, site is protected by forest buffer and isolation	386601	4408680
AMBE6702	Red Maple Tree	Live	Nest positioned in a top crotch, nest large and in good structural condition, nest does not have a cup and no fresh lining, this nest has not been worked on this season and appears abandoned	Nest tree is on steep embankment overlooking the river along the south shoreline, nest is visible from the water during leafoff but has extensive forest buffer and would be difficult to access due to grade and isolation	385321	4408946

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
BAEA6711	Transmission Tower	NA	Nest is positioned on a small catwalk on the crossarm of transmisson tower, nest is in good condition, has a well-formed cup and fresh lining.	Transmission tower is along the south shoreline and associated with a substation, nest is easily accessible from road system within substation, completely exposed to human activity	390961	4402226
BAEA-67-11	Transmission Tower	NA	Nest is positioned on 3rd level catwalk on tower above water, nest is wide and pancake shaped, well-formed cup and fresh lining	Transmission tower is over water and nest is high enough on tower that there is little access by boat, no real disturbance issue at this nest	391499	4403894
CE-10-01	Cell Tower	NA	Nest built within top crows nest of cell tower	Cell tower is located along a railroad track in the middle of city setting	407694	4379226
CE-10-02	Oak Tree	Live	Nest positioned in top crotch, nest in good condition with well-formed cup and recent lining	Nest tree on isolated island in river next to a great blue heron colony, nest may be visible from shoreline but no access except by water	401843	4385892
CE-10-03	Transmission Tower	NA	Nest was positioned on catwalk of tower, no change in tower but nest absent	Tower has good forest buffer and is surrounded by great blue heron colony, no change in surrounding landscape	400104	4390646

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
CE-10-04	Oak Tree	Live	Nest positioned within a triple-pronged top crotch but down under crown, well-formed cup and fresh lining	Nest tree along north shorelin near mouth of creek, tree is about 20 m from edge of pasture, nest is protected by forest buffer on the upland side and extensive forest buffer and railroad tracks on the river side	397292	4393695
CE-18-01	Oak Tree	Live	Nest is built in top crotch of tree but placed down below forest canopy, nest is moderate in size with a well-formed cup and fresh lining.	Nest tree is positioned on a Garrett Island surrounded by good forest buffer, no access except by water	406757	4379626
CE-18-02	Oak Tree	Live	Nest is built in a top crotch of tree, has a well-formed cup and partial lining.	Nest tree is positioned on Garrett Island very near a 10-pair great blue heron colony, good forest buffer, no access to nest except by water.	406645	4380813
CE-18-03	Oak Tree	Live (recent storm damage)	Nest was in a top crotch of a huge isolated oak tree, top of tree snapped off and nest on ground	Nest tree is on topographic high on Garrett Island and towered above the surrounding landscape, nest was visible from railroad tracks and possibly roadway but no access except by boat, site appears to be an old home site with open areas around nest tree	406518	4379952

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
CE-18-04	Oak Tree	Live	Nest in a lateral crotch along periphery of crown, nest is shallow and possibly first-year nest, nest has well-formed cup and has recent lining	Nest tree on high bluff overlooking the river, situated within a forested embankment, may be visible from below during leafoff, well protected from human activity.	405117	4383530
CE-18-05	Sycamore Tree	Live	Nest is positioned down in a deep top crotch well below crown, nest has well-formed cup and recent lining	Nest tree positioned along the north shoreline,along a creek, tree is about 50 meters off a paved road and not far from a house, nest is accessible from ground	401499	4387640
CE-18-06	Poplar Tree	Live	Nest positioned within a flimsy top crotch high on the tree, nest is moderate size with well-formed cup and recent lining	Nest tree is positioned along the north shoreline along a creek, house within 200 m, nest has good forest buffer but is not too far from paved road, nest is accessible from roadway	401082	4388977
CE-18-07	Hardwood Tree	Live	Nest positioned in a high top crotch, nest tree quite spindly and small, nest is small with well-formed cup and fresh lining, shallow nest that appears to be a first-year construction	Nest tree isolated within a recently thinned hardwood stand set back from bluff along the north shoreline, house fairly close and nest is accessible from logging road	398467	4392471

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
CE-18-08	Oak Tree	Live	Nest positioned in a crotch of lateral limb, nest is moderate in size and relatively shallow, nest has well-formed cup and fresh lining	Nest tree extending out over steep embankment along north shoreline, nest is protected by extensive forest buffer and steep grade	395628	4396127
CE-18-11	Poplar Tree	Live	Nest is positioned within a deep top crotch well below crown, nest in good condition with well-formed cup and fresh lining	Nest tree is positioned along the north shoreline and just above a small pond, nest is protected by extensive forest buffer and topography	395553	4396308
CE-18-12	Sycamore Tree	Live	Nest is in deep top crotch, nest did not have cup or recent lining	Nest tree in good condition, tree positioned with forest buffer down in floodplain below dam, nest well protected with little access	401167	4388726
HA-10-01	Oak Tree	Live	Nest absent	No change in tree or surrounding landscape	393485	4396393
HA-10-02	American Beech Tree	Live	Nest is positioned in a small top crotch in the crown, nest is in good condition, well-formed cup with fresh lining	Nest tree is on embankment along the south shoreline overlooking the river, nest tree is along a power right of way with a gravel road almost under nest, nest tree is downslope of a housing development	395144	4393809

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
HA-10-03	Oak Tree	Live	Nest is in solid top crotch below crown, good structural condition, well-formed cup with fresh lining	Nest is on embankment between pasture and river, nest tree is positioned along edge of ravine, nest tree has good forest buffer and is well protected, foot path below but good distance from nest	399952	4389215
HA-10-04	Oak Tree	Live	Nest absent, no adults present	No change in tree or surrounding landscape	399163	4387363
HA-10-05	Oak Tree	Live	Nest positioned in deep top crotch, large nest in good structural condition, well-formed cup and fresh lining	Nest tree positioned on bluff over embankment nest to a ravine, good forest buffer and well protected from disturbance	403864	4382248
HA-10-06	Sycamore Tree	Live	Nest absent	Nest tree is positioned down on the floodplain and has good forest buffer, no change in surrounding landscape	402667	4384321
HA-18-01	Oak Tree	Live	Nest positioned in a triple-prong top crotch, nest in good condition with well-formed cup and recent lining	Nest tree on isolated island in river, south of CE-10-02 but on same island, may be visible from shoreline but no access except by water	402106	4385577

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
HA-18-02	Red Oak Tree	Live	Nest positioned in top crotch, nest in good condition with well-formed cup and recent lining	Nest tree on isolated island in river, island just downriver of island with CE-10-02, may be visible from shoreline but no access except by water	402642	4385025
HA-18-03	Oak Tree	Live	Nest is positioned in a solid top crotch, nest is large and in good structural condition, well-formed cup and fresh lining	Nest tree is on steep embankment overlooking river along south shoreline, tree is supercanopy over extensive forest buffer, tree is well protected with low chance of disturbance	393697	4395981
HA-18-04	Oak Tree	Live	Nest is positioned in a top crotch under the crown, nest is in good condition, well-formed cup with fresh lining	Nest tree is positioned along a bluff with pasture on the upland side, nest tree has good forest buffer	397401	4391190
HA-18-05	Oak Tree	Live	Nest is in top crotch, good structural condition, well-formed cup with fresh lining	Nest tree is positioned on embankment along the south shoreline, nest tree has good forest buffer but is not far away from a building complex	398448	4390543

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
HA-18-06	Oak Tree	Live	Nest is in top crotch, good structural condition, well-formed cup but does not have fresh lining	Nest tree is on embankment above parking lot below Conowingo Dam, nest has good forest buffer but is very close to human activity associated with parking lot	399459	4389902
LA-10-01	Hardwood Tree		Nest absent	No change in tree or surrounding landscape	387773	4407220
LN-18-01	Oak Tree	Live	Nest positioned in good top crotch, nest in good condition with well-formed cup and fresh lining	Nest tree on rocky island, surrounded by scattered trees, house on the island within about 30 m of nest, house appears to be occupied, boat at dock	389469	4406200
LN-18-02	Oak Tree	Live	Nest positioned in a triple-prong top crotch, nest in good condition with well-formed cup and fresh lining	Nest tree on a rocky island with good forest buffer, tree is upslope and 100 m from house along shoreline, house does not appear to be currently occupied	388798	4406187
LN-18-03	Transmission Tower	NA	Nest positioned on cross arm of small transmission tower, nest in good condition with well-formed cup and fresh lining	Transmission tower is on rocky island with forest buffer on the upland side, tower is positioned near shoreline so nest is visible and accessible from the water side	388260	4406927

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
LN-18-04	White Pine	Live	Nest positioned within a top crotch, nest in good condition with well-formed cup and fresh lining	Nest tree is isolated within forested island and is supercanopy towering over surrounding forest, no houses near nest and nest is protected with good forest buffer and isolation of island	387847	4407368
LN-18-06	Transmission Tower	NA	Nest is built on transmission tower on a juncture of the trusses, nest is small and appears to be first year construction, well-formed cup and fresh lining	Nest is surrounded by a mix of young forest and fields and is very visible from paved road nearby	389857	4408919
URS-BEMP-13	Hardwood Tree	Live	Nest is absent	Nest tree in good condition and no change to surrounding forest or landscape	389747	4408847
URS-BEMP-8	Oak Tree	Live	Nest is out on an extreme lateral limb in huge tree, nest is in good structural condition, well-formed cup and fresh lining	Nest tree is in pasture near a farm pond, paved road passes within 100 m of nest but nest appears to be well isolated from disturbance	399624	4387188

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
URS-BEMP-NG1	Transmission Tower	NA	Nest is on catwalk of transmission tower, pancake-shaped nest, nest does not have formed cup or recent lining, nest has not been worked this season	Transmission line below Conowingo Dam across from parking lot, site is protected from disturbance by isolation from shoreline but is close to activity along shoreline	399618	4390217
URS-BEMP-NG2	Transmission Tower	NA	Nest is on catwalk of transmission tower, pancake-shaped nest, nest does not have formed cup or recent lining, nest has not been worked this season	Transmission line below Conowingo Dam across from parking lot, site is protected from disturbance by isolation from shoreline but is close to activity along shoreline	399620	4390173
USFWS-17-NG01	Oak Tree	Live	Nest positioned in top crotch, nest in good condition with well-formed cup and fresh lining	Nest is the second and to the west of the first nest on long forested island upriver from bridge, nest is surrounded by extensive forest buffer and is protected by isolation on island	386263	4408946
YK-10-01	Transmission Tower	NA	Nest is positioned on a low catwalk on the tower over water, nest is very wide and sprawling with well-formed cup and fresh lining	Transmission tower is over water and nest is high enough on tower that there is little access by boat, no real disturbance issue at this nest	392787	4401545

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
YO-18-01	American Beech Tree	Live	Nest is positioned in a solid top crotch, nest is large and in good structural condition, well-formed cup and fresh lining	Nest tree is on steep embankment overlooking river along the south shoreline, tree is supercanopy over extensive forest buffer at the mouth of a creek, tree is well protected with low chance of disturbance	393551	4397825
YO-18-02	Poplar Tree	Live	Nest is positioned in nice top crotch, nest is in fair structural condition but does not have formed cup and no fresh lining, nest does not appear to have been worked on this season	Nest tree is on steep embankment overlooking the river along the south shoreline, nest tree is supercanopy with good forest buffer, nest tree is somewhat isolated with low chance of disturbance	393260	4398931
YO-18-03	Oak Tree	Live	Nest is positioned in nice top crotch, nest is in fair structural condition but does not have formed cup and no fresh lining, nest does not appear to have been worked on this season	Nest tree is on steep embankment overlooking the river along the south shoreline, nest tree is supercanopy with good forest buffer, nest tree is on bank below a house on the bluff	393183	4399131

Nest Code	Nest Substrate	Substrate Condition	Nest Position	Surrounding Landscape	NAD83UTMz 18X	NAD83UTMz 18Y
YO-18-04	Oak Tree	Live	Nest positioned in top crotch, nest large and in good condition, well-formed cup and fresh lining	Nest tree is supercanopy out over surrounding forest and on a steep embankment along the south shoreline, nest is likely visible from water during leafoff but would be difficult to access due to grade and isolation	388502	4405668
YO-18-05	Oak Tree	Live	Nest positioned in top crotch, nest large and in good condition, well-formed cup and fresh lining	Nest tree is on steep embankment overlooking the river along the south shoreline, nest is visible from the water during leafoff but has extensive forest buffer and would be difficult to access due to grade and isolation	384382	4410518
YO-18-06	Hardwood Tree	Live	Nest positioned in top crotch, nest large and in good condition, well-formed cup and fresh lining	Nest tree is on steep embankment overlooking the river along the south shoreline, nest is visible from the water during leafoff but has extensive forest buffer and would be difficult to access due to grade and isolation	384269	4411438

Appendix II. Observations made of bald eagle nests during aerial surveys conducted within the study area (2018).

Nest Code	FL 1 Date:Time	FL 1 Comments	FL 2 Date:Time	FL Comments
AMBE3606a	3/19/2018:1114	Nest absent, no adults present	4/23/2018:1028	Nest absent, no adults present
AMBE3606b	3/19/2018:1115	Nest absent, no adults present	4/23/2018:1028	Nest absent, no adults present
AMBE3615	3/19/2018:1117	Nest absent, no adults present	4/23/2018:1029	Nest absent, no adults present
AMBE3617	3/19/2018:1140	Both adults on nest brooding small chicks (<10 d)	4/23/2018:1032	2 chicks, no adults present
AMBE6702	3/19/2018:1130	Nest empty, no birds present, does not appear to be active	4/23/2018:1031	Nest empty, no birds present, does not appear to be active
BAEA6711	3/19/2018:1340	Nest empty, no birds present, nest in good structural condition with cup and fresh lining, may have failed early	4/23/2018:1047	Nest empty, no adults present
BAEA-67-11	3/19/2018:1042	Adult incubating, second adult perched on next level above nest	4/23/2018:1021	Adult brooding small chicks (<20 d), at least 2 chicks, could not get close enough to resolve
CE-10-01	3/19/2018:0926	Nest in poor condition, cup is mostly gone and no lining, no evidence of use, no adults observed	4/23/2018:0948	Nest in poor condition, no adults present
CE-10-02	3/19/2018:0943	Adult incubating, second adult perched along adjacent shoreline	4/23/2018:1002	3 chicks (30 d), adult perched in adjacent tree, second adult not seen

Nest Code	FL 1 Date:Time	FL 1 Comments	FL 2 Date:Time	FL Comments
CE-10-03	3/19/2018:1003	Nest absent, no adults present at nest site	4/23/2018:1007	Nest absent, no adults present
CE-10-04	3/19/2018:1014	Adult incubating, second adult not seen	4/23/2018:1010	Adult feeding 1 chick (42 d), second adult not seen
CE-18-01	3/19/2018:0929	Adult incubating, second adult perched along adjacent shoreline	4/23/2018:0949	Adult incubating, second adult not seen
CE-18-02	3/19/2018:0931	Nest Empty, lined, appears to have had use, adult about 10 m away on shoreline	4/23/2018:0952	Nest empty, no adults present
CE-18-03	3/19/2018:0930	Nest on ground, was observed intact earlier in season, nest limbs recently snapped off, adult present in tree	4/23/2018:0951	Nest has been completely rebuilt, no adults present
CE-18-04	3/19/2018:0935	Nest empty, lined and appears to have been used, no adults present at nest, adults below along shoreline	4/23/2018:0956	Nest has been blown out in storm and partially reconstructed, no adults present
CE-18-05	3/19/2018:0951	Nest empty, adult standing in nest, second adult perched 10 m away	4/23/2018:1003	Nest empty, no adults present
CE-18-06	3/19/2018:0956	Adult feeding 2 chicks (16 d), second adult not seen	4/23/2018:1004	2 chicks, no adults present
CE-18-07	3/19/2018:1009	Nest empty but freshly built, no adults on nest but single adult along shoreline below bluff	4/23/2018:1009	Nest empty, adult standing on nest, second adult not seen

Nest Code	FL 1 Date:Time	FL 1 Comments	FL 2 Date:Time	FL Comments
CE-18-08	3/19/2018:1019	2 chicks (20 d), adult flew into nest from down river, second adult not seen	4/23/2018:1017	Adult feeding 1 chick, second adult not seen
CE-18-11	3/19/2018:1017	Adult incubating, second adult not seen	4/23/2018:1014	2 chicks (20 d), adult brooding, second adult not seen
CE-18-12	3/19/2018:0958	Nest empty, not used, no adults present	4/23/2018:1005	Nest empty, not used, no adults present
HA-10-01	3/19/2018:1352	Nest absent, no adults present	4/23/2018:1053	Nest absent, no adults present
HA-10-02	3/19/2018:1405	Adult incubating, second bird perched along shoreline within 50 m	4/23/2018:1055	2 chicks (34 d), adult attending, second adult not seen
HA-10-03	3/19/2018:1444	Adult incubating, second adult not seen	4/23/2018:1102	2 chicks (42 d), no adults present
HA-10-04	3/19/2018:1506	Nest absent, no adults present	4/23/2018:1107	
HA-10-05	3/19/2018:1509	Adult incubating, second adult not seen	4/23/2018:1110	2 chicks (28 d), adult attending, second adult not seen
HA-10-06	3/19/2018:1505	Nest absent, no adults present	4/23/2018:1107	Nest absent, no adults present
HA-18-01	3/19/2018:0944	1 egg, at least 1 chick (<5 d) in nest, adult feeding chick	4/23/2018:1002	3 chicks (6-7 wks), both adults perched in adjacent tree
HA-18-02	3/19/2018:0941	Adult incubating, second adult not seen	4/23/2018:0957	Adult feeding 1 chick (18 d), second adult not seen

Nest Code	FL 1 Date:Time	FL 1 Comments	FL 2 Date:Time	FL Comments
HA-18-03	3/19/2018:1358	Adult incubating, second adult not seen	4/23/2018:1054	Adult brooding small chicks (<15 d), second adult not seen
HA-18-04	3/19/2018:1410	Adult standing on nest feeding 2 chicks (12 d), second adult not seen	4/23/2018:1057	2 chicks, adult on nest, second adult not seen
HA-18-05	3/19/2018:1418	Adult on nest brooding 2 chicks (<10 d), second adult perched along shoreline about 60 m away	4/23/2018:1059	2 chicks, no adults present
HA-18-06	3/19/2018:1429	Adult incubating, other adults in area.	4/23/2018:1101	Nest empty, no adults present
LA-10-01	3/19/2018:1118	Nest absent, no adults present	4/23/2018:1029	Nest absent, no adults present
LN-18-01	3/19/2018:1051	Adult incubating, second adult not seen	4/23/2018:1024	1 chick (28 d), adult on nest, second adult not seen
LN-18-02	3/19/2018:1100	Adult incubating, second adult not seen	4/23/2018:1024	2 chicks (30 d), adult attending, second adult not seen
LN-18-03	3/19/2018:1105	Adult incubating, second adult not seen	4/23/2018:1026	1 chick (15 d), adult attending, second adult not seen
LN-18-04	3/19/2018:1116	Adult incubating, second adult not seen	4/23/2018:1028	2 chicks (22 d), no adults present
LN-18-06	3/19/2018:1120	Adult incubating, second adult not seen	4/23/2018:1030	Nest empty, no adults present
URS-BEMP-13	3/19/2018:1119	Nest absent, no adults present, see replacement nest on transmission tower	4/23/2018:1030	Nest absent

Nest Code	FL 1 Date:Time	FL 1 Comments	FL 2 Date:Time	FL Comments
URS-BEMP-8	3/19/2018:1452	Adult incubating, second adult not seen	4/23/2018:1106	2 chicks (18 d), adult attending, second adult not seen
URS-BEMP-NG1	3/19/2018:1426	Nest empty, birds roosting on tower but no adults associated with nest, this nest has not been worked this breeding season	4/23/2018:1100	Nest empty, birds roosting on tower but no adults associated with nest, this nest has not been worked this breeding season
URS-BEMP-NG2	3/19/2018:1426	Nest empty, birds roosting on adjacent tower but no adults associated with nest, this nest has not been worked this breeding season	4/23/2018:1100	Nest empty, birds roosting on tower but no adults associated with nest, this nest has not been worked this breeding season
USFWS-17-NG01	3/19/2018:1141	Adult incubating, second adult not seen	4/23/2018:1033	2 chicks (22 d), adult standing on nest, second adult not seen
YK-10-01	3/19/2018:1029	Adult incubating, second adult not seen	4/23/2018:1019	Nest empty, no adults present
YO-18-01	3/19/2018:1347	Adult incubating, second adult not seen	4/23/2018:1051	2 chicks (18 d), no adults present
YO-18-02	3/19/2018:1345	Nest empty, no birds present, does not appear to be active	4/23/2018:1050	Nest empty, no birds present, does not appear to be active
YO-18-03	3/19/2018:1346	Nest empty, no birds present, does not appear to be active	4/23/2018:1050	Nest empty, no birds present, does not appear to be active

Nest Code	FL 1 Date:Time	FL 1 Comments	FL 2 Date:Time	FL Comments
YO-18-04	3/19/2018:1411	Adult incubating, second adult not seen	4/23/2018:1057	2 chicks (18 d), adult attending, second adult not seen
YO-18-05	3/19/2018:1305	Adult incubating, second adult not seen	4/23/2018:1027	2 chicks (30 d), adult attending, second adult not seen
YO-18-06	3/19/2018:1330	Adult incubating, second adult not seen	4/23/2018:1038	2 chicks (35 d), adult attending, second adult not seen

Appendix III. Description and location of communal roosts (N=20) included in monitoring program within the study area (2018).

Roost ID	Latitude	Longitude	Description of roost and surrounding landscape
1	39.66217	-76.1634	Large roost encompassing power lines and wooded hillside and bottom on the north side of the Susquehanna, just downstream from the Conowingo Dam.
2	39.64643	-76.1523	Small roost on the southeast side of a wooded island on the north shore of the Susquehanna River, 2.5 KM downstream from the Conowingo Dam.
3	39.79283	-76.3024	Medium roost on the forested hillside of the south shore of the Susquehanna River SSE of Big Chestnut Island
4	*39.66064*	*-76.1898*	*Large roost on the forested hillside of the south shore of the Susquehanna River 1 KM upstream of the Conowingo Dam*
5	39.67518	-76.2048	Small roost on the forested hillside of the south shore of the Susquehanna River directly across from the mouth of Conowingo Creek
6	39.65178	-76.1521	Small roost in a forested wetland east of the rail road tracks 0.75 KM SE of mouth of Octoraro Creek
7	39.65023	-76.1548	Small roost on the northern side of a wooded island on the north shore of the Susquehanna River, 0.75 KM SSE of the mouth of Octoraro Creek
8	39.64256	-76.1632	Small roost on the forested hillside of the south shore of the Susquehanna River 1.9 KM downstream of

Roost ID	Latitude	Longitude	Description of roost and surrounding landscape
			the Conowingo Dam
9	39.65288	-76.1722	Medium roost on the forested hillside of the south shore of the Susquehanna directly above the parking lot for Conowingo Dam and Fisherman Park
10	39.67328	-76.1819	Medium roost on the forested hillside of the north shore of the Susquehanna 1.2 miles upstream of the Conowingo Dam
11	39.58558	-76.121	Medium roost on the forested hillside of the south shore across from the town of Port Deposit and 1.2 KM upstream of the I-95 bridge.
12	39.64316	-76.1698	Small roost on the forested edge of a pasture on top of a ridge 1.3 KM south of Rowland Island
13	39.63322	-76.1622	Small roost on the forested hillside of the south shore of the Susquehanna River 1 KM north of Stafford Bridge
14	39.82925	-76.297	Large roost on a forested point of west shore of Muddy Run Reservoir encompassing power line towers, 2 KM south of Bethesda
15	39.80718	-76.316	Small roost on the forested hillside of the south shore of the Susquehanna River, across from upper bear island, river road bisects this roost.
16	39.78512	-76.2572	Small roost on the forested hillside of the north shore of the Susquehanna River, 1.5 KM NNW of Mt Johnson Island

Roost ID	Latitude	Longitude	Description of roost and surrounding landscape
17	39.70784	-76.2401	Large roost on the forested hillside of the south shore of the Susquehanna River, just upstream from the mouth of Broad Creek
18	39.72146	-76.2423	Small roost on the forested hillside of the south shore of the Susquehanna River, just downstream from the mouth of Michael Run
19	39.80587	-76.3064	Small roost on the forested north end of Lower Bear Island, roost encompasses the power line towers on the north side of the island
20	39.70404	-76.2147	New suspected roost identified while observing roost 17. Roost is on the forested hillside on the north shore of the Susquehanna River, 2 KM ENE of the mouth of Broad Creek

Appendix IV. Circumstances and observations of communal roosts made during the winter and summer seasons within the study area (2018).

Roost ID	Date	Period	Season	Arrival Time	Departure Time	Observer	Affiliation	Weather	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles
1	3/27/18	PM	Winter	1845	1955	Laura Duval	CCB	40 F, winds S at 5-10, cloudy with some mist	42	36	0
2	3/27/18	PM	Winter	1845	1955	Bryan Watts	CCB	40 F, winds S at 5-10, cloudy with some mist	4	3	0
3	3/28/18	PM	Winter	1845	1955	Fletcher Smith	CCB	45 F, Calm/Light winds from the S, cloudy with some light rain	0	1	2
4	3/28/18	PM	Winter	1845	1955	Bart Paxton	CCB	45 F, Calm/Light winds from the S, cloudy with some light rain	3	7	5
5	3/28/18	AM	Winter	528	730	Bart Paxton	CCB	40 F, Light winds from the S, cloudy	1	2	0
6	3/27/18	PM	Winter	1845	1955	Bryan Watts	CCB	40 F, winds S at 5-10, cloudy with some mist	2	6	0
7	3/27/18	PM	Winter	1845	1955	Bryan Watts	CCB	40 F, winds S at 5-10, cloudy with some mist	1	4	0

Roost ID	Date	Period	Season	Arrival Time	Departure Time	Observer	Affiliation	Weather	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles
8	3/27/18	PM	Winter	1845	1955	Bart Paxton	CCB	40 F, winds S at 5-10, cloudy with some mist	4	1	0
9	3/27/18	PM	Winter	1845	1955	Marie Pitts	CCB	40 F, winds S at 5-10, cloudy with some mist	0	4	5
10	3/28/18	PM	Winter	1845	1955	Marie Pitts	CCB	45 F, Calm/Light winds from the S, cloudy with some light rain	2	2	0
11	3/27/18	PM	Winter	1845	1955	Fletcher Smith	CCB	40 F, winds S at 5-10, cloudy with some mist	2	5	0
12	3/28/18	PM	Winter	1845	1955	Bryan Watts	CCB	45 F, Calm/Light winds from the S, cloudy with some light rain	2	3	0
13	3/29/18	AM	Winter	558	730	Bart Paxton	CCB	45 F, Light winds from the NE, cloudy and foggy	0	0	2
14	3/29/18	AM	Winter	558	730	Bryan Watts	CCB	45 F, Light winds from the NE, cloudy and foggy	0	2	2

Roost ID	Date	Period	Season	Arrival Time	Departure Time	Observer	Affiliation	Weather	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles
15	3/28/18	AM	Winter	528	730	Bryan Watts	CCB	40 F, Light winds from the S, cloudy	0	0	0
15	3/29/18	PM	Winter	1845	1955	Laura Duval	CCB	65 F, wind E at 5-10, partly cloudy	0	0	0
16	3/28/18	AM	Winter	528	730	Marie Pitts	CCB	40 F, Light winds from the S, cloudy	0	0	0
16	3/29/18	PM	Winter	1845	1955	Bart Paxton	CCB	65 F, wind E at 5-10, partly cloudy	0	0	0
17	3/28/18	AM	Winter	528	730	Fletcher Smith	CCB	40 F, Light winds from the S, cloudy	0	1	0
18	3/28/18	AM	Winter	528	730	Laura Duval	CCB	40 F, Light winds from the S, cloudy	1	1	0
19	3/28/18	PM	Winter	1845	1955	Laura Duval	CCB	45 F, Calm/Light winds from the S, cloudy with some light rain	0	1	0
1	8/14/18	PM	Summer	1915	2035	Laura Duval	CCB	75 F, calm winds, mostly cloudy	12	4	0

Roost ID	Date	Period	Season	Arrival Time	Departure Time	Observer	Affiliation	Weather	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles
2	8/14/18	PM	Summer	1915	2035	Bart Paxton	CCB	75 F, calm winds, mostly cloudy	1	2	0
3	8/16/18	PM	Summer	1830	2030	Bart Paxton	CCB	80F, winds calm, partly cloudy	1	2	0
4	8/15/18	PM	Summer	1900	2035	Chance Hines	CCB	75-80F, wind West at 0-5, partly cloudy	0	2	0
5	8/16/18	AM	Summer	530	700	Bart Paxton	CCB	70F, winds calm, partly cloudy	1	2	0
6	8/14/18	PM	Summer	1915	2035	Bart Paxton	CCB	75 F, calm winds, mostly cloudy	0	2	0
7	8/14/18	PM	Summer	1915	2035	Bart Paxton	CCB	75 F, calm winds, mostly cloudy	1	0	0
8	8/14/18	PM	Summer	1915	2035	Chance Hines	CCB	75 F, calm winds, mostly cloudy	0	0	0
8	8/15/18	AM	Summer	530	700	Chance Hines	CCB	70F, wind West at 0-5, mostly clear	0	0	0

Roost ID	Date	Period	Season	Arrival Time	Departure Time	Observer	Affiliation	Weather	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles
9	8/14/18	PM	Summer	1915	2035	Laura Duval/Bart Paxton	CCB	75 F, calm winds, mostly cloudy	0	0	0
9	8/15/18	AM	Summer	530	700	Laura Duval	CCB	70F, wind West at 0-5, mostly clear	0	0	0
10	8/15/18	PM	Summer	1900	2035	Laura Duval	CCB	75-80F, wind West at 0-5, partly cloudy	3	1	0
11	8/14/18	PM	Summer	1915	2035	Fletcher Smith	CCB	75 F, calm winds, mostly cloudy	0	5	0
12	8/15/18	PM	Summer	1900	2035	Bart Paxton	CCB	75-80F, wind West at 0-5, partly cloudy	0	1	0
13	8/15/18	AM	Summer	530	700	Bart Paxton	CCB	70F, wind West at 0-5, mostly clear	0	0	2
14	8/15/18	AM	Summer	530	700	Fletcher Smith	CCB	70F, wind West at 0-5, mostly clear	5	2	7
15	8/16/18	AM	Summer	530	700	Chance Hines	CCB	70F, winds calm, partly cloudy	0	0	2

Roost ID	Date	Period	Season	Arrival Time	Departure Time	Observer	Affiliation	Weather	#Juvenile Bald Eagles	#Adult Bald Eagles	#Unaged Bald Eagles
16	8/15/18	PM	Summer	1900	2035	Fletcher Smith	CCB	75-80F, wind West at 0-5, partly cloudy	0	2	0
17	8/16/18	AM	Summer	530	700	Fletcher Smith	CCB	70F, winds calm, partly cloudy	0	2	0
18	8/16/18	AM	Summer	530	700	Laura Duval	CCB	70F, winds calm, partly cloudy	0	0	1
19	8/16/18	PM	Summer	1830	2030	Chance Hines/Laura Duval	CCB	80F, winds calm, partly cloudy	0	2	0
20	8/16/18	AM	Summer	530	700	Fletcher Smith	CCB	70F, winds calm, partly cloudy	2	3	1