

# ARIZONA GOLDEN EAGLE PRODUCTIVITY ASSESSMENT AND NEST SURVEY 2015

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# ARIZONA GOLDEN EAGLE PRODUCTIVITY ASSESSMENT AND NEST SURVEY 2015

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## INTRODUCTION

In 1940, the U.S. Congress passed the Bald Eagle Protection Act to protect declining bald eagle populations (*Haliaeetus leucocephalus*). In 1962, this act was amended to include golden eagles (*Aquila chrysaetos*), becoming the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d, 54 Stat. 250). More recently, the U.S. Fish and Wildlife Service (USFWS) clarified the definition of disturb and finalized regulations providing a mechanism to authorize take (USFWS 2007a, b; USFWS 2009). For implementation of take permits to be compatible with the congressional intent of the Eagle Act (i.e., stable or increasing breeding populations), accurate population estimates and trends are needed (Millsap et al. 2013).

Prior to 2011, information on the status, distribution, and life history of breeding golden eagles in Arizona was limited (Millsap 1981, Eakle and Grubb 1986, Grubb and Eakle 1987, Corman and Wise-Gervais 2005). Observations collected by the Arizona Game and Fish Department (Department) were dated (i.e., 1970s), and no formalized study to document statewide population numbers had ever been implemented. In 2006, the Department conducted a survey effort limited to 85 previously known breeding areas (BAs) and found 14 were occupied by golden eagles (AGFD unpublished data). These observations and other information from partners established a foundation for a more coordinated population assessment effort in Arizona. In 2011, the Southwestern Golden Eagle Management Committee (SWGEMC) was formed by land and wildlife management agencies to enhance coordination, increase communication, and provide oversight for Arizona golden eagle management.

From 2011 to 2014, the Department intensified golden eagle occupancy and nest survey efforts by conducting statewide aerial cliff nest surveys (McCarty and Jacobson 2011, 2012; McCarty et al. 2013, 2014). However, to determine the status of the population, in 2015 the Department also began assessing productivity at a subsample of known BAs statewide. A total of 192 new and 407 potential BAs have been documented since 2011. Currently, there are 246 known, 49 historic, and 423 potential golden eagle BAs outside of Native American lands in Arizona.

## STUDY AREA

The USFWS currently manages golden eagles by Bird Conservation Regions (BCRs) (USFWS 2009). Arizona includes BCR 16 (Southern Rockies/Colorado Plateau), 33 (Sonoran and Mohave Deserts), 34 (Sierra Madre Occidental), and a small portion of BCR 35 (Chihuahuan Desert) (NABCI 2000) (Figure 1).

In 2015, productivity assessments were conducted in all BCRs except 35 and included portions of every county except Yuma in southwest Arizona. Assessments occurred on BLM, U.S. Forest Service (USFS), State Trust, National Park Service (NPS), and private lands. Occupancy and

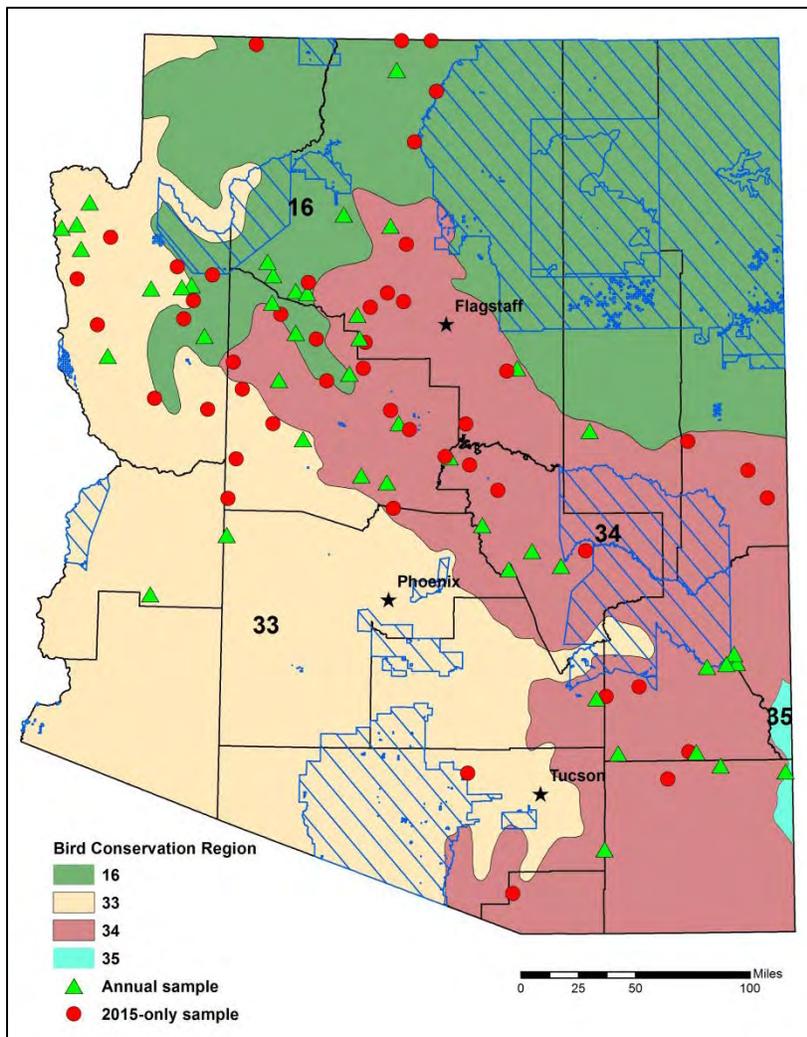


Figure 1. Distribution of golden eagle breeding areas (red circles and green triangles) randomly sampled for productivity in 2015. Native American lands blue shaded. County lines in black.

## METHODS

Productivity assessments were conducted at golden eagle BAs across Arizona using a sampling strategy developed by the Department (Appendix A). Following this strategy, we selected a goal of at least 40% sampling rate. The sample originally included 94 BAs selected randomly from a pool of 230 known BAs. One sample BA was replaced with the next-nearest BA due to ongoing management actions which could influence productivity. Additionally, we removed two annual BAs due to occurrence on tribally-owned private lands, for a final sample size of 92 (Figure 1). Forty-five of these BAs were to be surveyed annually. The other 47 BAs were surveyed in 2015 only and will be replaced by a different random subsample in 2016.

A two to three-person team of biologists conducted cliff-nest surveys by helicopter flown at approximately 60 m (200 ft.) above ground level and at 50-60 knots (approximately 60-70 mph).

nest search activities occurred on federal and state lands north of the Grand Canyon (Arizona Strip) mainly along Kanab Creek, Hurricane Cliffs, Parashant Canyon, Upper Grand Wash Cliffs, and Virgin Mountains.

The surveyed areas included a variety of habitat types, characterized by seven biotic communities including Sonoran Desertscrub (Arizona Upland subdivision and Lower Colorado River Valley subdivision), Mohave Desertscrub, Great Basin Desertscrub, Semidesert Grassland, Plains and Great Basin Grassland, Interior Chaparral, Great Basin Conifer Woodland, and Rocky Mountain (Petran) Montane Conifer Forest (Brown 1994). Elevation ranged from approximately 600 m to 2,438 m (2,050 ft. to 8,000 ft.).

Altitude and speed were influenced by topography, ground-based obstacles (presence of high-tension wires, meteorological towers), and wind. Multiple helicopter passes and/or ground visits were sometimes necessary to accurately document occupancy and productivity.

The minimum data recorded for all surveys included occupancy status, number of adults and their behavior, number of eggs and/or young, nestling age, nest condition, and nest size. Golden eagle nestlings were aged following Hoechlin (1976) and Driscoll (2010). The time and a GPS waypoint were noted using a Garmin GPSMAP 62s or Oregon 450 unit. Digital photos were taken of active nests, as well as most other large nests.

For the productivity assessment, two visits at each BA were initially scheduled at least 30 days apart. The first visit coincided with pre- and early-incubation behavior in late February or early March. The second visit occurred in late March to early April to document occupancy of late-nesting pairs. All known nests were examined at each BA, and additional time was spent surveying for new nests if all the known ones were empty. BAs found to be active after the first two visits were visited again in May and/or June to document the number of young hatched and fledged. At some BAs, observations of final nest status were made via ground visits.

In April, two days of helicopter flights were dedicated to surveys in northern Arizona, examining non-sample BAs (known and potential) and surveying new areas for nests. During these flights some occupancy data was collected but these BAs were not included in the productivity assessment. To focus survey activities, we coarsely identified suitable cliff nest habitat using ArcMap™ (ESRI) to calculate slopes greater than 40 degrees. In addition, we reviewed data on sightings of golden eagles or nests from previous years to identify specific areas of interest.

We followed operational definitions derived from Postupalsky (1974, 1983), Steenhof and Kochert (1982), and Driscoll (2010) to describe breeding status (Appendix B). An area was termed a “breeding area” only if it had been documented as occupied at least once within the last ten years. BAs with no documented occupancy for more than ten years were termed “historic BAs”. However, in many cases a BA designated as historic reflects a lack of occupancy monitoring rather than a ten year period when the site was known to be unoccupied. Areas with one or more “large” nests but not enough observations to designate occupancy status were termed as “potential BAs”. All potential or historic BAs documented as occupied during nest surveys will be reclassified as BAs in future reports. “Large” refers to nests we considered having suitable qualities (e.g., large size and large sticks) for breeding golden eagles as compared to our experience with golden eagle nests in Arizona. “Medium” refers to nests that were not likely to have been large enough for golden eagles.

## RESULTS

The 2015 golden eagle survey effort totaled 102 hours (6,120 minutes) of aerial surveys over 18 days (Appendix C). In addition, ground surveys were conducted for a total of 48.6 hours (2,918 minutes) over 15 days.

*PRODUCTIVITY ASSESSMENT RESULTS*

We surveyed 87 of the 92 selected BAs for an actual sampling rate of 37.8% (87/230). (Appendix D). The remaining five sites were surveyed, but final status was not confirmed so they were not used to determine productivity rates. In total, 45 (51.7%) BAs were occupied, 42 were active, 34 nestlings hatched, and 28 young fledged from 25 BAs. Productivity was 0.63 young fledged per occupied BA and mean brood size was 1.12 nestlings. Productivity was highest within BCR 16 (0.80, n=10 occupied) compared to BCRs 33 (0.60, n=10) and 34 (0.56, n=25) (Table 1).

	All sampled BAs	BCR 16	BCR 33	BCR 34
BAs examined	87	22	21	44
Occupied	45	10	10	25
Active	42	9	10	23
Failed breeding attempts	17	2	4	11
Successful breeding attempts	25	7	6	12
Young hatched	34	8	10	16
Young fledged	28	8	6	14
Nest success	0.56	0.70	0.60	0.48
Mean brood size	1.12	1.14	1.00	1.17
Productivity	0.63	0.80	0.60	0.56

Based on the observation of nestlings (aged by plumage) and fledglings, we estimated incubation and hatch dates for 26 of the active BAs, and fledge dates for 22 of those that were successful. For this purpose, incubation period was considered to be 45 days and age at fledging to be 70 days. Statewide, the estimated start of incubation ranged from January 30 to March 14 (average February 19), while hatching ranged from March 16 to April 28 (average April 5), and fledging ranged from May 28 to July 9 (average June 14).

In BCR 33, the estimated average start of incubation was February 18 (n=6), the average hatching was April 4 (n=6), and the average fledging was June 12 (n=4). Similarly, in BCR 34 the estimated average dates for start of incubation, hatching, and fledging were February 16 (n=14), April 2 (n=14), and June 12 (n=12), respectively. Estimated average dates were five to seven days later in BCR 16 with start of incubation February 23 (n=6), hatching April 9 (n=6), and fledging June 18 (n=6). The smaller sample size in BCR 16 included one of the earliest observed nesting attempts which decreased the average dates by three days. Otherwise the timing in this northern region would be approximately ten days later than the other two BCRs.

*OCCUPANCY AND NEST SURVEY RESULTS*

Results at non-sample BAs in 2015 included documentation of 24 new BAs, 30 new potential BAs (including 57 large nests), and 4 re-occupied historic BAs. Additionally, 152 and 90 new alternate nests were found within BAs and potential BAs discovered prior to 2015, respectively.

Areas worthy of discussion (nest surveys in suitable habitat, potential BAs, historic BAs, BAs, and additional golden eagle sightings) are described below. Nest locations are sensitive data,

considered confidential by the Department, and omitted from this report. Management agencies requiring specific locations should contact the Department's Heritage Data Management System at (623) 236-7618.

*Nest surveys in suitable nesting habitat*

Eight of the 24 new golden eagle BAs were discovered in northern Arizona (north of the Colorado River) on April 8 and 9, 2015 (Table 2). Also, 30 new potential BAs consisting of 57 nests were discovered, primarily in Mohave and Coconino Counties (Appendix E). At two of these new potential BAs, a single golden eagle was observed near at least one large nest indicating possible occupancy, but did not satisfy the criteria for designation as an occupied BA.

*Bar Ten (new BA)*. – On April 8, a golden eagle was incubating in a new cliff nest (#1) (Figure 2).

*Gooseneck (new potential BA)*. – On March 5, one golden eagle was seen soaring. Two nests (#1-2) were found in poor condition.

*Lawson Canyon (new BA)*. – On April 9, a golden eagle was incubating in a new cliff nest (#1), and six alternate large nests were found (#2-7).

*Little Spring (new BA)*. – On April 9, a pair of golden eagles was seen and four large nests were found on cliffs nearby (#1-4).

*Parashant 1 (new BA)*. – On April 8, a golden eagle was incubating in a new cliff nest (#1) (Figure 2), and a second large nest was found (#2).

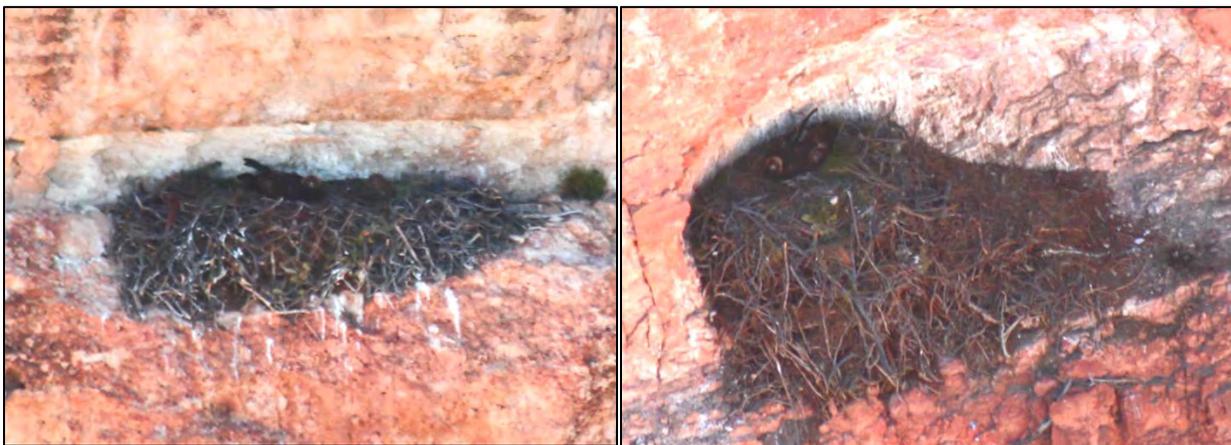


Figure 2. *Bar Ten* (left) and *Parashant 1* (right) breeding areas. Photos by Kurt Licence.

*Scott Canyon (new BA)*. – On April 8, a golden eagle was brooding a small nestling, 2-3 weeks old, in a new cliff nest (#1) (Figure 3). A second large nest was also found (#2).

*Shivwits (new BA)*. – On April 8, a golden eagle was incubating in a new cliff nest (#1), and three alternate large nests were found (#2-4).

*Shivwits 2 (new BA)*. – On April 8, a golden eagle was incubating in a new cliff nest (#1), and three alternate large nests were found (#2-4).

*Sowats Canyon (new BA)*. – On April 9, a golden eagle was incubating in a new cliff nest (#1). Eight alternate large nests were also found (#2-9).

*Upper Grand Wash (new potential BA)*. – On April 8, an adult golden eagles was seen perched near a large nest (#1) which was deep in a hole in the cliff (Figure 3). We were unable to see into the darkness of the hole well enough to determine the contents of the nest. Additional surveys should confirm occupancy in the future. A second large nest (#2) was also found.



Figure 3. Scott Canyon breeding area (left) and Upper Grand Wash potential breeding area (right). Photos by Kurt Licence.

Breeding Area	County	Status <sup>1</sup>	Dates surveyed	Number of nests	Comments
Bar Ten	Mohave	A	4/8	1	Incubating in nest #1.
Lawson Canyon	Coconino	A	4/9	7	Incubating in nest #1.
Little Spring	Coconino	O	4/9	4	Pair of adult golden eagles.
Parashant 1	Mohave	A	4/8	2	Incubating in nest #1.
Scott Canyon	Mohave	A	4/8	2	One nestling, 2-3 weeks old.
Shivwits	Mohave	A	4/8	4	Incubating in nest #1.
Shivwits 2	Mohave	A	4/8	4	Incubating in nest #1.
Sowats Canyon	Coconino	A	4/9	9	Incubating in nest #1.

<sup>1</sup>Breeding area status codes: O=occupied, A=active.

Potential Breeding Areas

Of 62 potential BAs examined, occupancy and activity were confirmed at 16 BAs (Table 3). Because observations were made opportunistically during other surveys, final status was documented at only three BAs (two failed and one successful).

*Aravaipa Canyon 3*. – A golden eagle was incubating in a new nest (#6) on March 30.

*Aquarius Mountains 2*. – A golden eagle was incubating in nest #2 on April 3.

*Cerbats East.* – A golden eagle was incubating in nest #2 on April 1 (Figure 4).

*Chevelon Canyon 6.* – A golden eagle was incubating in nest #1 on February 25.

*Colton Crater.* – A golden eagle was incubating in cliff nest #7 on April 2. SWCA Environmental Consultants (SWCA) reported brooding behavior on April 15.

*Grand Wash 9.* – One 7-week old golden eagle nestling was seen in nest #1 on May 28.

*Grapevine 2.* – A golden eagle was incubating in nest #1 on February 25 and March 31.

*Kaibab 1.* – A golden eagle was incubating in nest #1 on March 4. One 3-week old nestling was seen on May 6.

*Kaibab 2.* – A golden eagle was incubating in nest # 1 on March 4. The nest was empty on April 9.

*Kanab 4.* – A golden eagle was incubating in nest #1 on March 4.

*Martinez.* – A golden eagle was incubating in nest #1 on March 30. One 5-week old nestling was seen on May 21 (Figure 4).



Figure 4. *Cerbats East* (left) and *Martinez* (right) breeding areas. Photos by Kurt Licence.

*Middle Hurricane Cliffs.* – A golden eagle was incubating in nest #2 on March 5.

*Mustang Mountains.* – A golden eagle was brooding at least one small hatchling in nest #1 on March 30.

*Seegmiller.* – A golden eagle was incubating in nest #1 on March 5. One 3-week old nestling was seen on May 4. A juvenile was found out of the nest at 8-9 weeks old on June 8; Department personnel captured the juvenile and attached a satellite transmitter unit before releasing it.

*Sunset Mountain (Horseshoe).* – A pair of eggs was found in a new cliff nest (#15) on March 17, but no eagles were seen. A golden eagle was incubating in this nest on April 15. In the previous two seasons, this BA had been occupied by bald eagles. To synchronize reporting of both species, the BA will be renamed as Horseshoe. Consequently, nest numbers referred to in previous reports will be changed from #1 to #13, and from #2 to #14.

*Winchester Mountains 5.* – A golden eagle was incubating in nest #1 on March 31. The nest was empty on May 21.

Table 3. Summary of potential breeding areas surveyed in 2015 (continued next page).

Location	County	Status <sup>1</sup>	Dates surveyed	Comments
Aquarius Mountains 2*	Mohave	A	2/27, 4/3	Golden eagle incubating in nest #2 on 4/3.
Aquarius Mountains 3	Mohave	U	4/3	All known nests empty. No eagles.
Aravaipa Canyon 3*	Pinal	A	3/30	Golden eagle incubating in new nest #6.
Black Mtns 2	Mohave	U	3/9	All known nests empty. No eagles.
Black Mtns 7	Mohave	U	3/9	All known nests empty. No eagles.
Black Rock 1	Mohave	U	3/5	All known nests empty. No eagles.
Black Rock 2	Mohave	U	3/5	All known nests empty. No eagles.
Black Rock 3	Mohave	U	3/5	All known nests empty. No eagles.
Burro Creek 2	Yavapai	U	4/3	All known nests empty. No eagles.
Cataract Canyon North 1	Coconino	U	2/26, 4/2	All known nests empty. New nests #4-10 found.
Cerbats East*	Mohave	A	4/1	Golden eagle incubating in nest #2.
Chevelon Canyon 4	Navajo	U	3/31	All known nests empty. No eagles.
Chevelon Canyon 6*	Navajo	A	2/25	Golden eagle incubating in nest #1.
Colton Crater*	Coconino	A	4/2	Golden eagle incubating in nest #7 on 4/2.
Gabriel Tank	Yavapai	U	5/29	All known nests empty. No eagles.
Grand Wash 9*	Mohave	A	5/28	One golden eagle nestling 7 weeks old.
Grapevine 2*	Coconino	A	2/25, 3/31	Golden eagle incubating in nest #1 on 2/25 & 3/31.
Hardscrabble Canyon 2	Gila	U	5/28	All known nests empty. New nest #2 found.
Harquahala North	Maricopa	U	2/24	All known nests empty. New nests #3-4 found.
Hualapai Valley 1	Mohave	U	3/9	All known nests empty. No eagles.
Hurricane Cliffs 2	Mohave	U	3/5	All known nests empty. New nests #3-4 found.
Hurricane Cliffs 3	Mohave	U	3/5	All known nests empty. No eagles.
Hurricane Cliffs 4	Mohave	U	3/5	All known nests empty. New nest #2 found.
Hurricane Cliffs 5	Mohave	U	3/5	All known nests empty. New nest #2 found.
Hurricane Cliffs 6	Mohave	U	3/5	All known nests empty. No eagles.
Hurricane Cliffs 7	Mohave	U	3/5	All known nests empty. No eagles.
Hurricane Cliffs 8	Mohave	U	3/5	All known nests empty. New nest #2 found.
Kaibab 1*	Coconino	A	3/4, 5/6	Golden eagle incubating in nest #1 on 3/4. One nestling 3 weeks old on 5/6.
Kaibab 2*	Coconino	F	3/4, 4/9	Golden eagle incubating in nest #1 on 3/4. Nest empty on 4/9.
Kanab 1	Coconino	U	3/4	All known nests empty. No eagles.
Kanab 3	Mohave	U	3/4	All known nests empty. New nest #2 found.
Kanab 4*	Mohave	A	3/4	Golden eagle incubating in nest #1.
Kanab 5	Mohave	U	3/4	All known nests empty. New nest #2 found.
Kanab 7	Mohave			
LCR Becker	Apache	U	2/25	All known nests empty. No eagles.

<sup>1</sup>Breeding area status codes: U=unoccupied, O=occupied, A=active, S=successful, F=failed, -- =undetermined.

\*Indicates a new breeding area was confirmed.

Table 3 continued.				
Location	County	Status <sup>1</sup>	Dates surveyed	Comments
Long Point 1	Coconino	U	2/26, 4/2	All known nests empty. No eagles.
Martinez*	Pima	A	3/30, 5/21	Golden eagle incubating in nest #1 on 3/30. One nestling 5-6 weeks old on 5/21.
Mays Wash	Coconino	U	2/26, 4/2	All known nests empty. One immature golden eagle flying on 4/2.
Middle Hurricane Cliffs*	Mohave	A	3/5	Golden eagle incubating in nest #2.
Mustang Mountains*	Cochise	A	3/30	Golden eagle brooding at least one hatchling in nest #1.
New River Mountains 1	Yavapai	U	2/24	All known nests empty. No eagles.
Pilot Knob	Yavapai	U	4/3	All known nests empty. New nests #3-5 found.
Pinaleno 9	Graham	U	5/21	All known nests empty. No eagles.
Ragged Top	Pima	--	3/30	Nests #1, 3, 4 empty. Nests #2, 5, 6 not seen.
Rawhide 1	Mohave	U	3/9	All known nests empty. No eagles.
Ringbolt Rapids	Mohave	U	3/9	All known nests empty. No eagles.
Seegmiller*	Mohave	S	3/5, 5/4, 6/8	Golden eagle incubating in nest #1 on 3/5. One nestling 2.5-3 weeks old on 5/4. One juvenile 8+ weeks old on 6/8.
Spider Web Ranch	Coconino	U	2/26, 4/2	All known nests empty. No eagles.
Sunset Mountain (Horseshoe)*	Yavapai	A	2/2, 3/17, 4/15	Two unattended eggs on 3/17. Golden eagle incubating in new nest #15 on 4/15.
Trout Creek 3	Mohave	U	3/9	All known nests empty. No eagles.
Trout Creek 4	Yavapai	U	3/9	All known nests empty. No eagles.
Vermillion Cliffs 2	Coconino	U	3/4	All known nests empty. No eagles.
Virgin Mtns 2	Mohave	U	3/5	All known nests empty. No eagles.
Virgin Mtns 3	Mohave	U	3/5	All known nests empty. New nests #2-3 found.
Virgin Mtns 4	Mohave	U	3/5	All known nests empty. No eagles.
Virgin Mtns 5	Mohave	U	3/5	All known nests empty. New nests #2-3 found.
Virgin Mtns 7	Mohave	U	3/5	All known nests empty. No eagles.
Whitlock Mountains 1	Graham	U	5/21	All known nests empty. No eagles.
Whitlock Mountains 2	Graham	U	5/21	All known nests empty. No eagles.
Winchester Mountains 4	Graham	U	5/21	All known nests empty. No eagles.
Winchester Mountains 5*	Graham	F	3/31, 5/21	Golden eagle incubating in nest #1 on 3/31. Nest empty on 5/21.
Yellowstone Canyon	Graham	U	3/30	All known nests empty. New nest #3 found.
Zapata Mountain	Pinal	--	5/21	Nests #1,4,5 empty. Nests #2-3 not seen. New nest #6 found.

<sup>1</sup>Breeding area status codes: U=unoccupied, O=occupied, A=active, S=successful, F=failed, -- =undetermined.

\*Indicates a new breeding area was confirmed.

### Historic Breeding Areas

Of seven historic BAs examined, occupancy was confirmed at four BAs and three were active (Table 4). Because observations were made opportunistically during other surveys, final status was documented at only one BA (successful).

*Black Rock Gulch.* – In 1979, a pair of adults was seen with a juvenile. In 2006, the BA was unoccupied. In June 2011, the timing was too late to determine occupancy. On March 5, 2015, a golden eagle was incubating in nest #2. One 3-week old nestling was seen on May 4, and

Department personnel banded and attached a satellite transmitter unit to the 8-9 week old juvenile on June 9.

*Citadel Wash.* – In 2000, a pair of adults was seen with a fledging. On February 26, 2015, a golden eagle was incubating in nest #1. An adult was seen with one 4-week old nestling on April 2.

*Hidden Canyon.* – In 1979, an adult golden eagle was seen in a nest and noted as unknown incubation status. In 2006, the BA was reported as unoccupied. On March 5, 2015, a pair of golden eagles was seen flying together. Five new large nests (#2-6) were found, several of which were noted as very large.

*Horse Mesa.* – In 2000 and 2002, a pair of golden eagles was observed. In 2006, the BA was reported as unoccupied. On May 22, 2015 two nestlings 8-9 weeks old were seen in nest #1.

Breeding Area	County	Status <sup>1</sup>	Dates surveyed	Comments
Citadel Wash	Coconino	A	2/26, 4/2	Incubating in nest #1 on 2/26. One nestling 4 weeks old on April 2.
Rock Canyon	Coconino	U	4/9	All known nests empty. No eagles.
West Clear Creek	Coconino	U	2/25, 3/31	All known nests empty. New nest #2 found.
Horse Mesa	Maricopa	S	5/22	Two nestlings 8-9 weeks old in nest #1 on May 22.
Black Rock Gulch	Mohave	S	3/5, 5/4, 6/9	Incubating in nest #2 on 3/5. One 3-week old nestling on 5/4. One 8-9 week old nestling on 6/9.
Hidden Canyon	Mohave	O	3/5, 4/8	Pair of golden eagles flying on March 5. Five new nests #2-6 found.
Yellowstone Mesa	Mohave	U	3/5	All known nests empty. No eagles.

<sup>1</sup>Breeding area status codes: O=occupied, A=active, U=unoccupied, -- =undetermined.

### Breeding Areas

In addition to the 87 sample BAs surveyed for productivity, 23 other BAs were opportunistically surveyed. Occupancy and activity were confirmed at 12 of the additional BAs (Table 5). Because observations were made opportunistically, final status was documented at only three BAs (one failed and two successful).

*Aubrey Cliffs 2.* – A golden eagle was incubating in nest #2 on February 26. Two 8-week old nestlings were seen on May 29.

*Aubrey Cliffs 4.* – A golden eagle was incubating in nest #1 on February 26.

*Aubrey Cliffs 5.* – A golden eagle was incubating in nest #1 on February 26.

*Black Mtns 32.* – A bald eagle was incubating in nest #1 on March 9, and a second adult bald eagle was perched above the nest. The nest was empty on April 1. In the future, this breeding

area will also be known as the Nevada Bay breeding area in the Department's bald eagle management program.

*Hess Canyon.* – A golden eagle was incubating in a new nest (#2) on March 18 (Figure 5).

*Johnson Spring.* – A golden eagle was incubating in nest #1 on April 9, and the nest was empty on May 5.

*Loco Point.* – A golden eagle was incubating in a new nest (#5) on March 4.

*Lost Spring 2.* – A golden eagle was incubating in a new nest (#2) on March 5 and April 8. Another new nest (#3) was also found.

*Mesa Butte.* – A golden eagle was incubating in nest #1 on February 26 and April 2 (Figure 5).



Figure 5. Hess Canyon (left) and Mesa Butte (right) breeding areas. Photos by Kurt Licence.

*Rhodes Canyon.* – A golden eagle was in nest #1 with a 3.5-week old nestling May 29.

*Shinarump Cliffs.* – A golden eagle was in a new nest (#5) feeding two small nestlings on April 9. Two nestlings 4-5 weeks old were seen on May 5. Department personnel banded and attached satellite transmitter units to both 8-week old nestlings on May 27.

*The Canal.* – A golden eagle was incubating in a new nest (#3) on March 31.

*Trout Creek.* – A golden eagle was incubating in a new nest (#3) on March 9. New nests #4-6 were also found.

*Wolf Mountain.* – Nest #1 was not seen, buried under snow blanketing the mountain. One golden eagle was seen flying on February 25.

*Ziegler Mountain.* – On February 2, an adult golden eagle was perched near nest #1, which was in good condition. A second, smaller nest was found in a sang nearby.

Breeding Area	County	Status <sup>1</sup>	Dates surveyed	Comments
Aubrey Cliffs 2	Coconino	S	2/26, 5/29	Golden eagle incubating in nest #2 on 2/26. Two nestlings 8+ weeks old on 5/29.
Aubrey Cliffs 4	Coconino	A	2/26	Golden eagle incubating in nest #1 on 2/26.
Aubrey Cliffs 5	Coconino	A	2/26	Golden eagle incubating in nest #1 on 2/26.
Black Mtns 32	Mohave	--	3/9, 4/1	Bald eagle brooding in nest #2 on 3/9. Nest empty on 4/1.
Cochie Canyon	Pima	U	2/23	All known nests empty. No eagles.
Galiuro Mts 11	Graham	U	5/21	All known nests empty. No eagles.
Grapevine 3	Coconino	U	2/25, 3/31	All known nests empty. No eagles.
Hess Canyon	Gila	A	3/18	Golden eagle incubating in new nest #2.
Johnson Spring	Coconino	F	3/4, 4/9, 5/5	Golden eagle incubating in nest #1 on 4/9. Nest empty on 5/5.
Loco Point	Coconino	A	3/4	Golden eagle incubating in new nest #5.
Lost Spring 2	Mohave	A	3/5, 4/8	Golden eagle incubating in new nest #2 on 3/5 and 4/8. New nest #3 also found.
Mesa Butte	Coconino	A	2/26, 4/2	Golden eagle incubating in nest #1 on 2/26 and 4/2.
Mormon Pocket	Yavapai	U	1/5, 2/2, 3/17, 4/15	All known nests empty. No eagles.
Red Mountain	Coconino	--	2/26	Nest #3 appeared empty. Unable to survey due to winds.
Rhodes Canyon	Coconino	A	2/26, 5/29	Adult golden eagle in nest #1 with one nestling 3.5 weeks old on 5/29.
Santa Maria Mountains	Yavapai	U	5/28	All known nests empty. No eagles.
Shinarump Cliffs	Coconino	S	3/4, 4/9, 5/5, 5/27	Two nestlings 1-2 weeks old on 4/9, 4-5 weeks old on 5/5, and 8+ weeks old on 5/27.
The Canal	Navajo	A	3/31	Golden eagle incubating in new nest #3.
Trout Creek	Mohave	A	3/9	Golden eagle incubating in new nest #3. New nests #4-6 found.
Virgin Mtns	Mohave	U	3/5	All known nests empty. No eagles.
Virgin Mtns 6	Mohave	U	3/5	All known nests empty. No eagles.
Wolf Mountain	Apache	U	2/25	Nest #1 buried under snow. One golden eagle flying.
Ziegler Mountain	Apache	U	2/25	One golden eagle perched near nest #1. Second smaller nest found nearby.

<sup>1</sup>Breeding area status codes: O=occupied, A=active, U=unoccupied, -- =undetermined.

### Additional Golden Eagle Sightings

During the 2015 surveys, there were two sightings of golden eagles that were not associated with a breeding area (Table 6).

Location name	County	Date	Number of Eagles	Distance <sup>1</sup>	Comments
Pine Hollow / Kanab Creek	Coconino	3/4	2	3.5	Pair of adults soaring. One eagle performing display flight.
House Rock Valley	Coconino	3/4	1	10	Adult soaring over valley.

<sup>1</sup>Distance to nearest known nest (km).

DISCUSSION

The 2015 results represent the first year of a multi-year assessment of golden eagle productivity in Arizona. This year, productivity of 45 occupied BAs was 0.63, and mean brood size for 25 successful attempts was 1.12 (Table 1). While there are limitations to drawing conclusions based on a single season of data, these values fall within the range (but below the average) compared with other studies (Table 7). In west central Arizona, Millsap (1981) observed high productivity and prey populations during the two-year study were high. Changes in food abundance and weather patterns lead to annual variation and have a significant influence on reproduction (Kochert et al. 2002; McIntyre and Adams 1999; Steenhof et al. 1997; Watson et al. 1992). Northern populations of golden eagles are noted as having smaller broods and fewer young fledged than more temperate populations for a variety of possible reasons, including harsher climate (Kochert et al. 2002). Breeding golden eagles in many parts of Arizona also face extreme climate in the form of heat stress which could lead to lowered productivity. Differences are likely to exist in reproductive output and timing between the diverse assemblage of biological communities that occur in Arizona, as suggested by higher productivity and later timing (by 7-10 days) in BCR 16 this year (Table 1). These differences will be more confidently assessed after additional seasons of data.

Study	State	Years	Annual mean brood size	Brood size range	Mean annual productivity	Productivity range
This study	AZ	1	1.12	--	0.63	--
McIntyre 2002	AK	12	1.45	1.13 - 1.68	0.68	0.16 - 1.16
Phillips et al. 1990	MT/WY	11	1.30	1.1 - 1.8	0.78	0.37 - 1.5
Steenhof et al. 1997	ID	24	1.56	1.0 - 2.0	0.79	0.16 - 1.38
Phillips and Beske 1990	WY	5	1.48	1.33 - 1.65	0.81	0.52 - 1.16
Thompson et al. 1982	OR	16	1.70	1.42 - 2.0	1.08	0.20 - 1.67
Millsap 1981	AZ	2	1.58 <sup>a</sup>	--	1.25	--

<sup>a</sup>Per active nest.

The observed occupancy rate of sampled BAs in 2015 was 51.7% (n=45) of 87 BAs. We observed that 56.0% of 75 BAs were occupied in 2013, and 43.2% of 74 BAs were occupied in 2014, but did not examine the same complement of BAs. Similarly, occupancy averaged 46.8% at three BAs along the upper Verde River for which we have long-term data (16-23 years). By comparison, McIntyre (2002) found an overall occupancy rate of 83.0% (ranging from 69.7% to 93.4%) in a study of golden eagles in Alaska using a combination of foot, dogsled, and helicopter. Arizona's golden eagle occupancy rates may be low, in part, due to reliance on aerial surveys, which are better for locating active nests than finding resident eagles away from nests. Unfortunately, due to the statewide nature of our sampling, ground surveys are extremely time-intensive and often impractical.

We determined age of nestlings by plumage development, which could have led to errors in estimation of incubation and hatch dates. However, the use of digital photographs allowed examination of nestlings in greater detail, improved the accuracy of ageing the young, and provided an archive of images for reference. The first round of aerial surveys were timed well and coincided with the start of incubation in late February to early March for the majority of

BAs, however after the first round of aerial surveys, additional aerial and ground surveys should be conducted in mid-March where occupancy was not detected (Figure 6).

During our surveys in late March to early April, many golden eagles were either still incubating eggs at BAs found active a month earlier or had young hatchlings which were difficult or impossible to see underneath adults. The estimated hatch dates for 2015 suggest that surveys to confirm hatching should occur approximately mid to late April to ensure nestlings are present and large enough to be seen. Surveys to document fledging success should occur in late May to early June, when nestlings are at least 80% of fledging age (Figure 6).

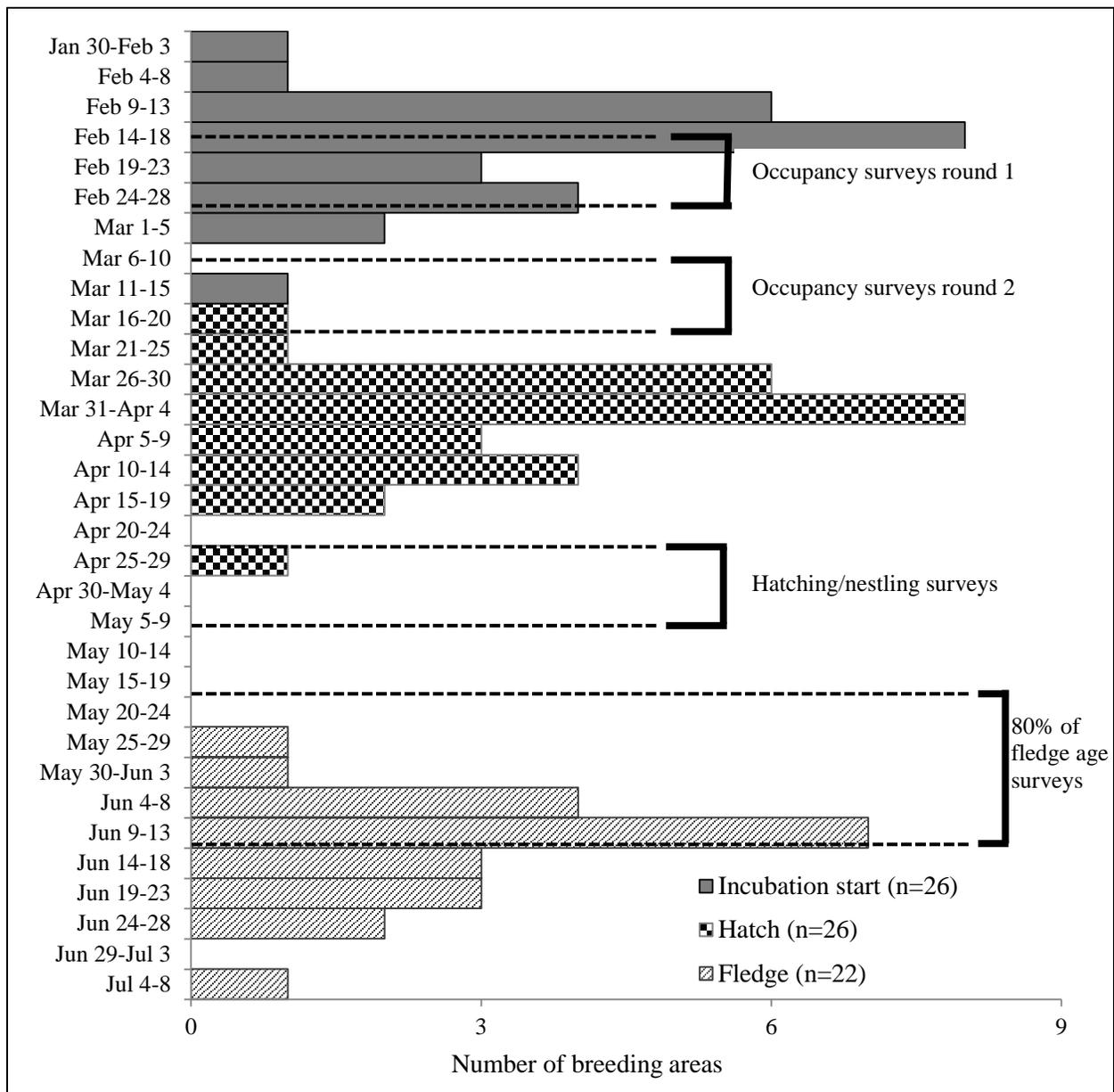


Figure 6. Estimated golden eagle incubation start, hatching, and fledge dates at sampled breeding areas in 2015, including recommended timing for future surveys.

Currently in Arizona, there are 246 known golden eagle BAs, 49 historic BAs, and 423 potential BAs with 763 large nests, excluding those that occur on Native American lands (Table 8, Figure 7).

Table 8. Number of known, historic, and potential golden eagle breeding areas (BAs), and large nests within potential BAs, by Bird Conservation Region (BCR) as of 2015.				
BCR number	BAs	Historic BAs	Potential BAs	Large Nests
16	74	13	83	158
33	55	10	144	283
34	116	25	194	315
35	1	1	2	7
Total	246	49	423	763

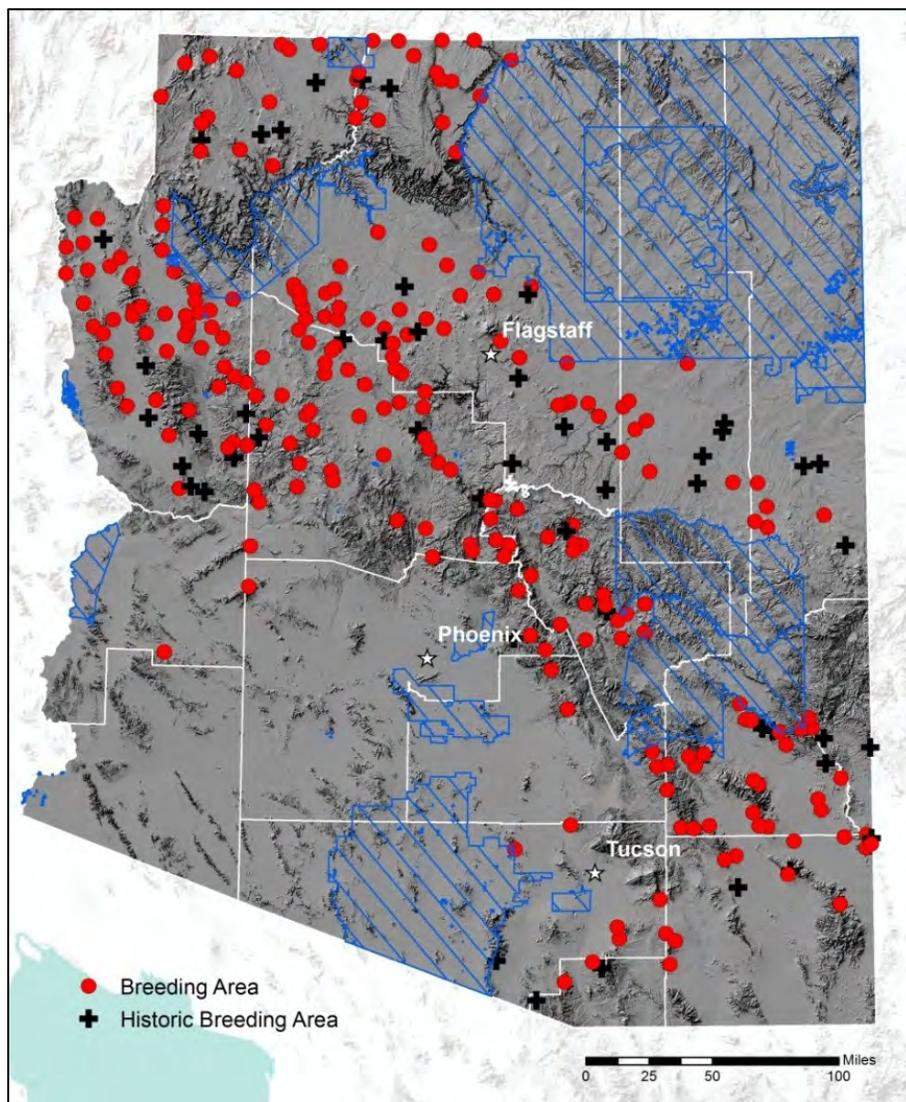


Figure 7. Distribution of current (red circles) and historic (black crosses) golden eagle breeding areas in Arizona, excluding Native American lands (blue shaded). County lines in white.

### MANAGEMENT RECOMMENDATIONS

1. Schedule aerial surveys for the last week of February in BCR 33, BCR 34, and the southern part of BCR 16 to document occupancy and incubation. For the northern part of BCR 16 (north of the Colorado River), schedule surveys for the beginning of March.
2. Schedule aerial surveys mid-March in BCR 33 and 34, and late March in BCR 16 to document occupancy and/or activity at breeding areas that were unoccupied during the first round of surveys.
3. Schedule aerial surveys mid-April in BCR 33 and 34, and late April in BCR 16 to document hatching and count nestlings.
4. Schedule aerial surveys as needed in late May to early June to document success (nestlings at least 80% of fledging age) or failure of each breeding attempt.
5. Incorporate ground surveys into the monitoring plan whenever possible. Ground surveys would be most beneficial in mid-March at BAs where occupancy was not detected after the first round of aerial surveys, and would also be useful to confirm fledging success later in the season. For the sake of efficiency, these surveys should be strategically planned to occur only at BAs with easy access (good roads/tracks nearby and/or short hikes).
6. Revise the occupancy and productivity assessment plan to include the annual adjustment of sampling BAs to maintain an approximate 40% sampling rate and analysis methods for results.
7. Future nest survey efforts should focus on unsurveyed segments of suitable habitat within each of Arizona's three main BCR's.
  - a. In BCR 16, the Grand Wash Cliffs north of Grand Canyon, Andrus Canyon, Kanab Creek and tributaries (Grama and Hack Canyons), Kaibab Plateau, Saddle Mountain Wilderness Area, Marble Canyon, Grand Canyon National Park.
  - b. In BCR 33, portions of Yuma Proving Ground, Barry M. Goldwater Range, Organ Pipe National Monument, Kofa and Cabeza Prieta National Wildlife Refuges.
  - c. In BCR 34, portions of the Superstition Wilderness, southern Tonto National Forest, Mule Mountains, Coronado National Forest (including portions of Atascosa, Chiricahua, Huachuca, Patagonia, Pinaleno, and Santa Catalina, and Santa Rita Mountains), and Apache-Sitgreaves National Forest (San Francisco and Blue Rivers).
8. Through the SWGEMC, partner with tribes (e.g., Gila River Indian Community, San Carlos Apache Tribe, Tohono O'odham Nation, White Mountain Apache Tribe) and Department of Defense whenever possible to conduct nest inventory or occupancy surveys as necessary to fill in gaps of golden eagle distribution.
9. Continue to re-visit potential BAs in order to document occupancy by golden eagles. Highest priority for occupancy surveys include areas where a single golden eagle was found near a large nest, and those areas with multiple large nests in fair to good condition.
10. Investigate additional research methods (including nest cameras) to identify causes of early nesting cycle failures, nest attendance, productivity, provisioning, and diet of Arizona golden eagles.
11. Develop a plan to effectively survey for golden eagle nests in trees.

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APPENDIX A: PROPOSED METHODOLOGY FOR GOLDEN EAGLE BREEDING AREA OCCUPANCY AND  
PRODUCTIVITY ASSESSMENTS

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**Background**

Implementation of the Bald and Golden Eagle Protection Act (BGEPA) has been revised to authorize issuance of permits for the limited take of bald and golden eagles, where take is associated with otherwise lawful activities. Permit thresholds for golden eagles are currently set at the Bird Conservation Regions level and will not exceed one percent of the annual productivity. Few long-term studies of golden eagle populations in North America have been undertaken, and only estimates of abundance are available. Hamerstrom et al. (1975) reported that there were as many as 100,000 individuals in North America, and Olendorff et al. (1981) estimated the wintering population of golden eagles in the western U.S. at 63,242 birds, with a potential 20,500 North American breeding pairs. Watson (1997) estimated the number of breeding pairs at 20,000-25,000 in North America. More recently, WEST, Inc. (Nielson et.al. 2009) estimated the golden eagle population across much of the western United States at 24,734. Due to the limited information on the population status nationally and locally, the United States Fish and Wildlife Service (USFWS) is deferring implementation of new permits until data shows that populations can withstand additional take. State agencies need to collect this information on golden eagle populations so that the USFWS can ultimately allow for golden eagle take associated with otherwise lawful activities.

Compounding the need for current information on golden eagle populations is the increased mandate on renewable energy resource development. This renewable energy development has placed a significant demand on land and wildlife managers to assess these projects and their impacts. These projects, specifically wind and solar, will have long term effects on golden eagles (e.g., mortality through collisions, habitat fragmentation, reductions in prey base). Federal and local permitting agencies will have to address those effects on the local population within approximately 10-miles of each project as well as the project's effect on the regional population within 140 miles, per the BGEPA. Without baseline nest location, occupancy, and productivity data with which to evaluate these effects, permitting agencies are unable to ensure compliance with federal law.

In Arizona, little was known about golden eagle distribution or their status. Surveys were conducted in the 1970s, but fell far short of being comprehensive or statewide. In 2006, the Arizona Game and Fish Department (AZGFD) attempted to assess the golden eagle population by examining from the ground 85 historic nest locations recorded in the Heritage Database Management System (HDMS). Only 14 were found to be occupied. Many of the nest sites had not been visited since the 1970s and because no follow-up surveys were conducted, we were unsure if pairs moved their nest location since originally documented or if the pairs had abandoned the areas altogether. The 2006 effort and results made it clear that any revived ground surveys would be time/cost inefficient, and a helicopter nest survey was needed to establish a new baseline of nest locations statewide. In 2010, the AZGFD acquired funding to conduct a two-year (2011-2012) statewide aerial survey for golden eagle cliff nests. The nest search efforts resulted in the discovery of 328 potential breeding areas with unknown occupancy status and 67 newly discovered occupied breeding areas. Building upon the results of the nest search, the AZGFD began a 2-year (2013-2014) statewide occupancy assessment to determine current occupancy status of all known breeding areas, historic breeding areas, and potential breeding areas (areas with 1 or more eagle sized nests).

**Objectives**

1. Develop methodology that provides estimates on number of golden eagle breeding areas and productivity estimation;
2. Quantify breeding area occupancy and productivity rates for golden eagles in Arizona's 3 Bird Conservation Regions;

3. Update Arizona's Heritage Data Management System with location, occupancy, and productivity data of golden eagles for the use in evaluating proposed project's effects on golden eagles, and;
4. Provide the USFWS with the statewide golden eagle demographic data necessary for issuance of BGEPA take permits.

### **Approach**

The approach for developing golden eagle breeding area abundance, productivity, and occupancy estimates will depend on the availability and extent of current golden eagle information for a given area. For places like Arizona where recent, nearly statewide, nest searches and occupancy assessments have been conducted, a simple stratified random sampling of the known breeding areas, paired with continued nest searches will provide demographic occupancy and productivity estimates that can be extrapolated to the larger population. For areas without an extensive breeding area list, we also designed a stratified random sampling scheme to provide a search grid for identifying new golden eagle territories in conjunction with occupancy and productivity assessments.

In order to determine the sample size necessary to yield productivity estimates representative of the greater population, we used bald eagle productivity data from 2002 to 2013 as a training data set. Although the annual variation of occupancy and reproductive output within the bald and golden eagle populations likely differ, both eagle species have the same reproductive output potential (e.g. 0 to 3 fledglings). When available, use of golden eagle productivity data is recommended. Additionally, this sample size analysis should be repeated once adequate golden eagle productivity data is available.

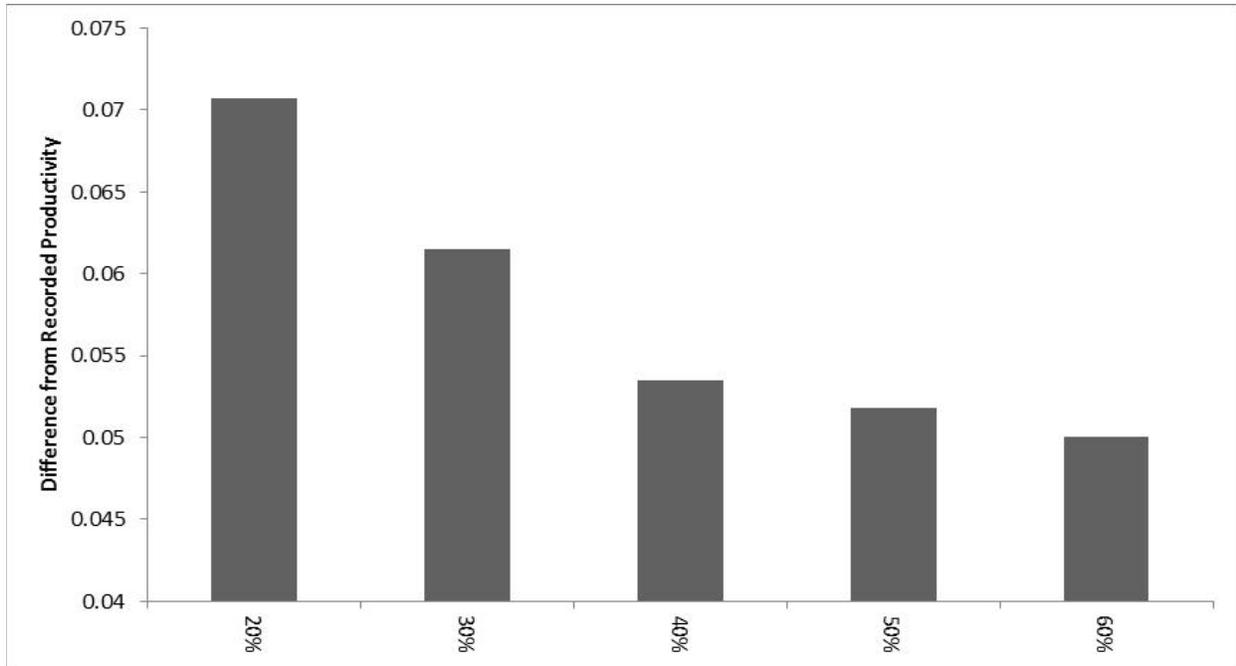
The bald eagle population ranged from 46 (2002) to 68 (2013) breeding areas which is approximately  $\frac{1}{4}$  the number of Arizona's known golden eagle breeding areas. We bootstrapped this productivity and demographic occupancy data at five sampling rates (20, 30, 40, 50 and 60%). We pulled five replicates at each bootstrapping rate and calculated the mean and variance for productivity and demographic occupancy. We then calculated difference between the yearly mean estimates at each sample rate with the actual calculated rate with the 100% yearly sampling rate (*Figures 1 and 2*).

### *Productivity*

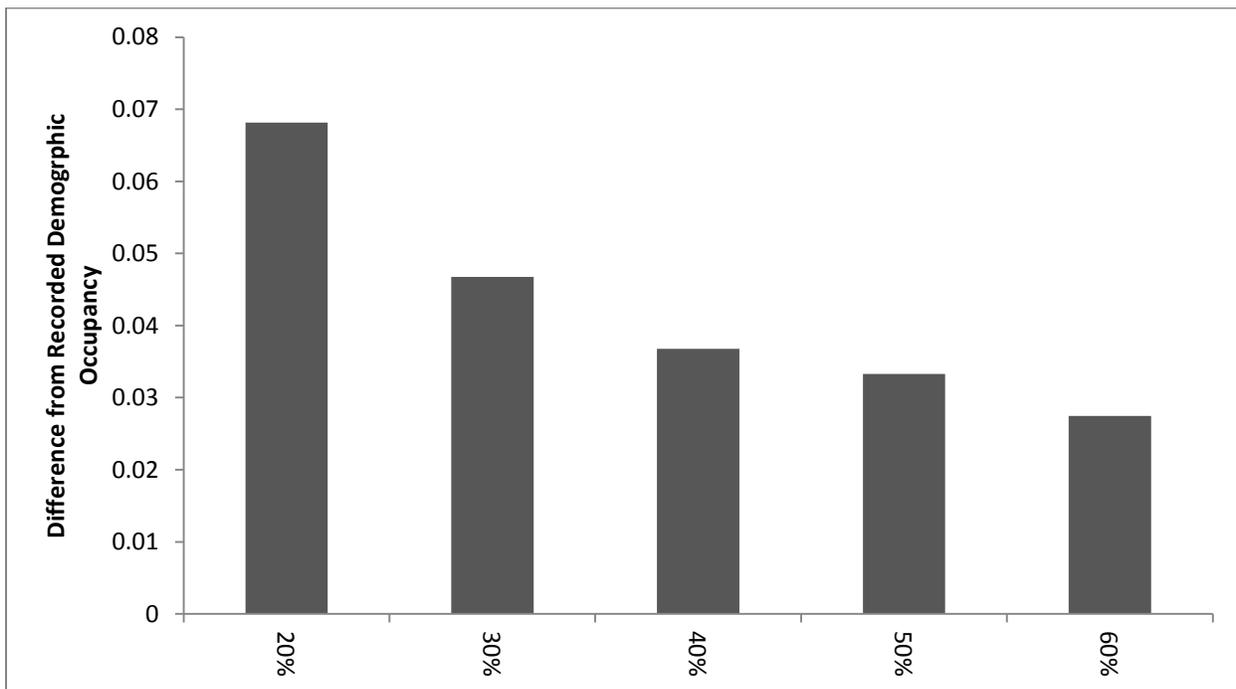
The 20% mean productivity (fledglings/occupied BA) sampling rate differed by  $0.0707 \pm$  and the 30% by  $0.06142 \pm$  from the actual rate, while the 40%, 50% and 60% rates differed by  $0.05354 \pm$ ,  $0.05182 \pm$  and  $0.0500 \pm$  respectively. The 40%, 50% and 60% productivity sampling rates differed from the actual rate at similar levels (5%). Therefore, we recommend the 40% sampling rate as it provides an estimate of productivity indistinguishable from the two higher sampling rates. This sampling rate will provide an estimate of productivity within approximately 0.05 of the actual productivity (100% sampling rate). It is important to note that the 20% and 30% sampling rates varied by only 0.07 and 0.06 from the actual rates. Thus, these lower productivity sampling rates could also be applied if limited resources only allow for a 20% or 30% sample rate.

### *Demographic Occupancy*

As with productivity, demographic occupancy sampling rates provide an estimate of the sample structure needed to represent 100% sampling rates. The difference between sampling rates and the actual demographic occupancy were  $0.06813 \pm$ ,  $0.04672 \pm$ ,  $0.03676 \pm$ ,  $0.03329 \pm$  and  $0.02745 \pm$  at 20, 30, 40, 50 and 60% sampling rates, respectively. Once the sampling rate was increased past 20% they varied at less than 5% from the actual estimated demographic occupancy. Therefore, we recommend sampling rates of at least 30%. We can further reduce the error in demographic occupancy to 4% if a sampling rate of 40% is utilized. As with the productivity estimates we recommend a sampling rate of 40% for the maximum accuracy with the least effort. It is also possible to use the 20% and 30% sampling rates when resources are limited with the assumption that accuracy will be lower.



**Figure 1.** Comparison of sampling based on 20, 30, 40, 50 and 60% sampling rates of Bald Eagle productivity data.



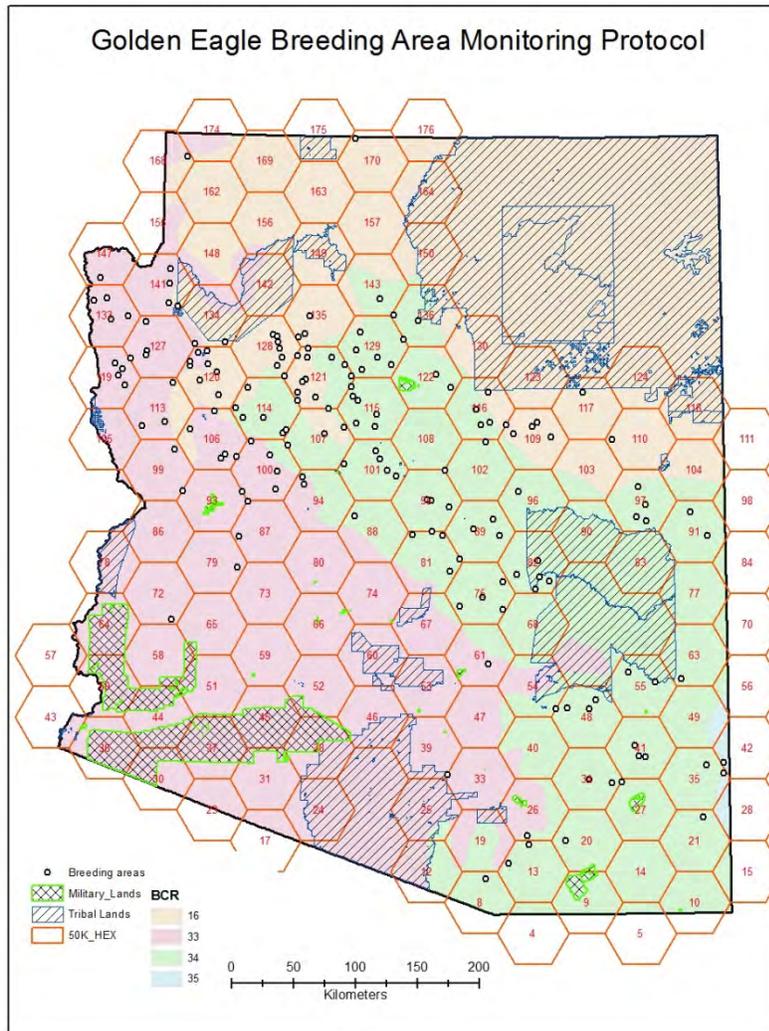
**Figure 2.** Comparison of sampling based on 20, 30, 40, 50 and 60% sampling rates of Bald Eagle demographic occupancy data.

Given these findings for productivity and demographic occupancy, we recommend using this 40% sampling rate as the basis for a stratified random sample of known golden eagle breeding areas. Sampling will be stratified across the three BCRs in Arizona (*Figure 3*). Within each sampling year (not necessarily consecutive), we will randomly select 40% of the known golden eagle breeding areas within each strata. Since golden eagle occupancy and productivity rates are anticipated to have significant annual variation, we need to ensure that any documented variation in

occupancy and productivity rates are actual and not just an artifact of the random sampling approach. As such, we will randomly select 20% of the known golden eagle breeding areas within each strata to be surveyed during each round of monitoring, without replacement. We will then select an additional 20% of known breeding areas to be monitored only in year one, without replacement, for a total of 40% sampling rate. In year 2, we will continue to sample the original 20% sample and select a new 20% sample from the remaining non-surveyed breeding areas. By year 4, the original 20% will have been sampled over 4 monitoring periods and the remaining 80% of the known breeding areas will have been monitored at least once. Newly discovered territories will be added to the random

selection on the year of discovery.

After a full round of monitoring, we will evaluate the necessity of maintaining the original 20% sample as part of the occupancy and productivity rate assessment. If deemed unnecessary, future surveys will be sampled by randomly selecting 40% of the known breeding areas during year one, and without replacing these breeding areas back into the sample, in year two we will continue to sample another 40%. By year three of the sampling, we automatically select the remaining 20% of breeding areas and randomly select an additional 20% from those breeding areas sampled in year one. This staggered sampling pattern will insure that no breeding area is selected in consecutive years. This sampling method will also ensure that after the third sampling year each year's productivity will be based on 20% of the original sample and 20% of a new sample group. The occupancy and productivity assessments will be conducted following the terminology and guidelines outlined in Appendix A. These methods will provide a statistically and biologically defensible golden eagle sampling strategy and provide reliable productivity and demographic occupancy rates across years and BCRs.



**Figure 3.** Golden eagle known breeding areas and the sampling grid for unknown cells within the state of Arizona.

While the above sampling strategy provides a methodology to estimate the productivity and demographic occupancy of known golden eagle breeding areas, it does not allow for the discovery of new breeding areas. For aerial based surveys, potential nest site habitat and historic breeding areas will be surveyed while in transit between the randomly selected breeding areas. For ground based surveys, nest search efforts need to be incorporated. To facilitate these ground and/or aerial based nest search efforts, golden eagle breeding habitat models may be developed to prioritize survey locations. Although not random, this approach provides opportunity for the known breeding area list to grow and maximizes efficiency of aerial survey time.

For areas without an extensive breeding area list, we designed a stratified random sampling scheme to provide a search grid for identifying new golden eagle territories in conjunction with occupancy and productivity assessments. As an example, we developed a 50 km tessellated grid for the entire state of Arizona totaling 133 grid cells (*Figure 3*). We will randomly select 15 grid cells in each BCR stratum (45 total cells per year) for golden eagle breeding area searches. By the third re-sample the entire state will have been searched and we will begin the resampling process anew. The sampling rate may be increased or decreased as dictated by available resources. Once a full round of sampling has occurred, a robust statewide breeding area and potential nest site list will have been compiled and the 40% stratified sampling approach may be implemented. The nest search, occupancy, and productivity assessments will be conducted following the terminology and guidelines outlined in Appendix A with the one exception, that nest searches should be timed during the early pair bonding and early occupancy period of the breeding season. This allows for time to perform a second occupancy visit and a final productivity visit once nestlings reach 80% of fledging age (~8 weeks). Use of this stratified random sampling scheme provides a framework to initiate golden eagle population surveys with data outputs that should be representative of the greater area. Consequently, initial survey results can be used to provide estimates of the greater population.

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#### APPENDIX B: TERMINOLOGY AND RAPTOR REPRODUCTIVE STATUS CRITERIA

**Breeding Area (BA):** An area containing one or more nests within the range of a mated pair of birds displaying occupancy as described below. Operationally, once a BA is established, we consider it a BA whether it is occupied by eagles in a given year or not, until or unless it is designated historical (i.e., ten consecutive years unoccupied).

**Historic BA:** A BA documented as having been unoccupied for ten consecutive years prior to the current year.

**Occupied BA:** An occupied BA must have a nest, which is any nest, where at least one of the following activity patterns was observed during the breeding season:

- a. Young were raised.
- b. Eggs were laid.
- c. One adult sitting low in a nest, presumably incubating.
- d. Two adults present on or near the nest.
- e. One adult and one bird in immature plumage at or near a nest, if mating behavior was observed (display flight, nest repair, copulation).

**Active Nest:** A nest in which eggs have been laid. Activity patterns (a), (b), and (c) above are diagnostic of an active nest.

**Unoccupied BA:** A nest or group of nests at which none of the activity patterns diagnostic of occupancy were observed in a given breeding season. BAs must exist as occupied before they can be recognized and classified as unoccupied.

**Successful nest:** An active nest from which at least one young fledged during the breeding season under consideration. Nests were successful if at least one young was raised past 80% of fledging age.

**Failed nest:** An active nest from which no young fledged regardless of cause.

**Productivity:** The number of young fledged per occupied BA.

APPENDIX C: AREAS SURVEYED IN 2015.

Table 12. Summary of helicopter survey areas and survey time in 2015.

Date	Time (min)	Areas of state surveyed	Sample BAs <sup>1</sup>
2/23	391	Southeast, primarily BCR 34.	15
2/24	162	Central (helicopter fuel pump light ended survey early).	2
2/25	413	Eastern and central, primarily BCR 34.	19
2/26	290	North-central Arizona, BCR 16 and 34.	15
2/27	393	Northwest, primarily BCR 33.	25
3/4	377	Kanab Creek to Page, BCR 16.	6
3/5	370	Kanab Creek to Virgin Mts., BCR 16.	1
3/30	407	Southeast, primarily BCR 34.	16
3/31	341	Eastern and central, primarily BCR 34.	16
4/1	419	West and northwest, BCR 33 and 34.	19
4/2	348	North-central Arizona, BCR 16 and 34.	22
4/3	210	Northwest, BCR 16 and 34.	10
4/8	402	Kanab Creek to Virgin Mts., BCR 16. Primarily searching for new nests.	1
4/9	410	Kanab Creek to Page, BCR 16. Primarily searching for new nests.	4
5/21	271	Southeast, BCR 34.	8
5/22	315	Eastern and central, primarily BCR 34.	13
5/28	341	Northwest, primarily BCR 33 and 16.	15
5/29	260	North-central, BCR 34 and 16.	14
Total	6,120		

<sup>1</sup>Number of productivity sample BAs surveyed.

Table 13. Summary of ground survey time in 2015.

Date	Time (min)	Breeding areas surveyed
5/4	67	Black Rock Gulch; Seegmiller
5/5	215	Shinarump Cliffs; Johnson Spring; Top Rock
5/6	194	Two Mile; Kaibab 1
5/20	48	Tumacacori 2
5/27	300	Banding at Shinarump Cliffs
6/8	133	Banding at Seegmiller.
6/9	355	Banding at Black Rock Gulch; Top Rock.
6/16	270	Black Mtns 9; Black Mtns 3; Alchesay Canyon; Parker Creek.
6/17	320	Young Mountain; Black Mtns 24; Austin Peak; Jumpoff; Pine Creek 2
6/18	357	Boquillas; Round Mountain; Mesa Redonda; LCR Lyman Lake
6/22	200	Poland Creek
6/23	150	Agua Fria 1
6/24	115	Square Mountain
6/25	164	Tumacacori 2
7/6	30	Boquillas
Total	2,918	

APPENDIX D: 2015 GOLDEN EAGLE PRODUCTIVITY

Table 14. Golden eagle breeding area summary at sampled BAs, 2015 (continued next page).								
Breeding Area <sup>1</sup>	ID <sup>2</sup>	Status <sup>3</sup>	Nest	Eggs <sup>4</sup> / Young / Fledged	Incubation Date	Hatch Date	Fledge Date	
<b>Bird Conservation Region 16</b>								
Aubrey Cliffs 1	3NE063	F	3	1 -- --	<4/2	--	--	
Aubrey Cliffs 3	3GE044	U	--	-- -- --	--	--	--	
Austin Peak	3NE001	S	3	1 1 1	<2/27	4/3-5/28	>6/17	
Big Chino	3GE037	S	3	2 2 2	<2/26	2/26-5/29	>5/29	
Boquillas	3GE040	S	3	1 1 1	2/26-4/2	4/2-5/29	6/18-7/16	
Cataract Canyon North 2	2NE069	U	--	-- -- --	--	--	--	
Cherokee Point	3NE073	U	--	-- -- --	--	--	--	
Cottonwood Cliffs North	3GE050	U	--	-- -- --	--	--	--	
Granite	2GE049	S	6	1 1 1	<4/15	<4/15	>5/29	
House Rock Valley	1GE049	U	--	-- -- --				
Juniper Mountains 1	3NE059	S	2	1 1 1	<2/26	2/26-4/2	>5/29	
Juniper Mountains 3	3GE071	O	--	-- -- --	--	--	--	
Lost Spring	2NE018	U	--	-- -- --	--	--	--	
Mount Floyd	3GE041	U	--	-- -- --	--	--	--	
Paria River	2NE021	U	--	-- -- --	--	--	--	
Red Tanks	3GE047	U	--	-- -- --	--	--	--	
Round Mountain	3GE042	S	1	1 1 1	<4/2	4/2-6/18	4/2-6/18	
Saddle Canyon	2GE078	U	--	-- -- --	--	--	--	
South Butte	3GE038	U	--	-- -- --	--	--	--	
Sullivan Buttes	3NE095	F	1	1 1 1	<2/26	--	--	
Top Rock	2GE010	S	4	1 1 1	3/4-4/9	4/9-5/5	>6/9	
Two Mile	2GE077	U	--	-- -- --	--	--	--	
<b>Bird Conservation Region 33</b>								
Black Mtns 24	3NE022	S	7	2 2 1	<2/27	4/1-5/28	5/28-6/17	
Black Mtns 28	3NE026	U	--	-- -- --	--	--	--	
Black Mtns 3	3NE028	S	5	1 1 1	<5/28	<5/28	5/28-6/16	
Black Mtns 9	3NE036	F	3	1 1 --	<2/27	4/1-5/28	--	
Black Mtns North	3GE032	U	--	-- -- --	--	--	--	
Black Mtns West	3GE026	S	12	1 1 1	<2/27	2/27-4/1	>5/28	
Burro Cliffs	3GE057	F	4	1 1 --	<2/27	2/27-4/1	--	
Burro Mesa	3GE007	U	--	-- -- --	--	--	--	
Grand Wash 5	3NE067	S	2	1 1 1	<2/27	4/3-5/28	>5/28	
Harcuvar North	4GE003	U	--	-- -- --	--	--	--	
Harquahala	4GE001	U	--	-- -- --	--	--	--	
Hualapai South	3GE030	F	2	1 1 --	<2/27	2/27-4/1	--	
Kirkland Peak	3NE099	S	2	1 1 1	2/27-4/1	4/1-5/28	>5/28	
Kofa	4GE002	U	--	-- -- --	--	--	--	
Long Mountain	3NE049	U	--	-- -- --	--	--	--	
Poachie	4GE004	U	--	-- -- --	--	--	--	
Sycamore	3GE058	U	--	-- -- --	--	--	--	
Table Mountain Plateau	3GE069	F	5	1 -- --	<2/27	--	--	

<sup>1</sup>Shaded BAs are to be monitored annually.

<sup>2</sup>Breeding area identification number.

<sup>3</sup>F=failed; S=successful; O=occupied; U=unoccupied.

<sup>4</sup>Represents minimum number of eggs laid.

<sup>5</sup>Estimated incubation date based on nestling plumage.

Table 14. (continued).							
Breeding Area <sup>1</sup>	ID <sup>2</sup>	Status <sup>3</sup>	Nest	Eggs <sup>4</sup> / Young / Fledged	Incubation Date	Hatch Date	Fledge Date
Waterman Mountains	5GE023	U	--	-- -- --	--	--	--
Wright Canyon	3GE052	U	--	-- -- --	--	--	--
Young Mountain	3GE073	S	3	1 1 1	2/27-4/1	4/1-5/28	5/28-6/17
<b>Bird Conservation Region 34</b>							
Alchেসay Canyon	6GE002	S	6	2 1 1	<3/31	3/31-5/11	>6/16
Ash Mountain	6GE040	F	1	1 1 --	<2/25	2/25-3/31	--
Bear Canyon	5GE010	U	--	-- -- --	--	--	--
Black Canyon	1NE004	F	3	1 -- --	2/25-3/31	--	--
Bryce Mountain	5GE019	U	--	-- -- --	--	--	--
Camp Wood	3GE060	U	--	-- -- --	--	--	--
Cedar Mountain	2GE036	S	1	1 1 1	<3/18	4/2-5/29	>6/11
Cherry Creek	3GE062	F	1	1 -- --	2/25-4/2	--	--
Copper Creek	6GE029	F	3	1 -- --	2/25-4/2	--	--
Deadman Mesa	6NE019	F	1	1 -- --	2/25-3/31	--	--
Double Knobs	2GE072	S	1	1 1 1	<2/26	2/26-4/15	>5/29
Eagle Rock	2GE037	U	--	-- -- --	--	--	--
Fisher	5GE036	S	3	1 1 1	<2/23	2/23-3/30	>5/21
Garden Spring Canyon	5GE026	F	7	1 -- --	<2/23	--	--
Grapevine	2GE074	F	2	1 -- --	<2/25	--	--
Grapevine 3	2NE075	U	--	-- -- --	--	--	--
Grindstone Wash	2GE073	U	--	-- -- --	--	--	--
Hardscrabble Canyon 1	6GE031	U	--	-- -- --	--	--	--
Hell Point	3GE017	U	--	-- -- --	--	--	--
Houston Creek	6GE034	U	--	-- -- --	--	--	--
Johnson Canyon	2NE034	U	--	-- -- --	--	--	--
Jumpoff	6GE045	S	2	1 1 1	1/6-2/25	3/31-4/16	5/22-6/17
LCR Lyman Lake	1GE019	S	4	1 1 1	<2/25	3/31-5/22	5/22-6/18
Mesa Redonda	1GE052	S	1	1 1 1	<2/25	3/31-5/22	5/22-6/18
Mohon Mountains	3GE055	U	--	-- -- --	--	--	--
Muleshoe	2GE041	O	--	-- -- --	--	--	--
New River Mountains 2	6NE028	F	1	1 -- --	2/18-4/1	--	--
Nutriosio Creek	1GE015	U	--	-- -- --	--	--	--
Oak Spring Canyon	6GE018	U	--	-- -- --	--	--	--
O-Bar-O	5GE020	S	1	2 1 1	<2/23	2/23-3/30	>5/21
Parker Creek	6GE025	S	6	2 2 2	<2/25	2/25-3/31	5/22-6/16
Peloncillo Mountains	5GE018	U	--	-- -- --	--	--	--
Pinaleno 2	5GE033	F	1	1 -- --	<2/23	--	--
Pine Creek 2	6GE032	S	2	2 2 2	<2/25	3/31-5/28	>6/17
Rattlesnake Wash 1	2NE070	F	3	1 -- --	2/26-4/2	--	--
Red Butte	2GE005	U	--	-- -- --	--	--	--
Santa Teresa	5GE025	U	--	-- -- --	--	--	--
Square Mountain	5GE021	S	2	1 1 1	<3/30	3/30-5/21	5/21-6/24
Table Mountain	5NE077	O	--	-- -- --	--	--	--
Tumacacori 2	5GE034	S	4	1 1 1	<2/23	3/30-5/20	5/20-6/25
Turtle Mountain 1	5NE038	U	--	-- -- --	--	--	--

<sup>1</sup>Shaded BAs are to be monitored annually.

<sup>2</sup>Breeding area identification number.

<sup>3</sup>F=failed; S=successful; O=occupied; U=unoccupied.

<sup>4</sup>Represents minimum number of eggs laid.

Table 14. (continued).

Breeding Area <sup>1</sup>	ID <sup>2</sup>	Status <sup>3</sup>	Nest	Eggs <sup>4</sup> / Young / Fledged	Incubation Date	Hatch Date	Fledge Date
Ward Pocket	3NE103	U	--	-- -- --	--	--	--
West Clear Creek	2GE070	U	--	-- -- --	--	--	--
Whetstone Mountains 3	5GE035	F	2	1 1 --	<2/23	2/23-30	--

<sup>1</sup>Shaded BAs are to be monitored annually.

<sup>2</sup>Breeding area identification number.

<sup>3</sup>F=failed; S=successful; O=occupied; U=unoccupied.

<sup>4</sup>Represents minimum number of eggs laid.

APPENDIX E: NEW POTENTIAL BREEDING AREAS DOCUMENTED IN 2015

Table 15. Summary of new potential breeding areas with large nests documented in 2015.		
Area Name	Number of nests	Comments
<b>Coconino County</b>		
Buster	1	Large nest, fair condition reported by SWCA.
East Cedar	1	Large nest, fair condition reported by SWCA.
Kanab 6	2	Nests in poor condition.
<b>Graham County</b>		
Tripp Canyon	1	Large, eagle-sized nest, fair condition.
<b>Mohave County</b>		
Cottonwood Point	1	Large nest, poor condition.
Gooseneck	2	Large nests, poor condition. One golden eagle soaring.
Hidden Canyon 2	1	Large nest, poor condition.
Hodges	2	At least two nests potentially large enough for eagles.
Hurricane Cliffs 9	1	Large nest, fair condition.
Jump Canyon	3	Two large nests, poor-fair condition. One medium to large nest, poor condition.
Kanab 8	4	Three nests, poor to fair condition. Fourth nest with red-tailed hawk incubating.
Kanab 9	1	Large nest, poor to fair condition.
Kanab 10	1	Large nest, poor to fair condition.
Link Point	1	Large nest, very poor condition.
Parashant 2	1	Large nest, fair condition.
Parashant 3	1	Large nest, poor condition.
Parashant 4	1	Large nest, fair condition.
Parashant 5	1	Large nest, very poor condition.
Parashant 6	4	Three nests grouped together, poor condition. Fourth nest also poor.
Parashant 7	2	Two large nests, fair condition.
Pigeon Canyon	3	One large, eagle-sized nest, fair condition. Two other nests poor.
Pymn	3	Three large nests, poor condition.
Shivwits 3	3	Two large, eagle-sized nests, fair condition. Third nest very poor.
Shivwits 4	5	Three large nests, fair condition. Two medium to large nests also fair, with a common raven incubating in one of them.
Shivwits 5	2	Two large nests, poor condition, with a peregrine falcon incubating in one of them.
Slide Canyon	1	Large nest, poor condition.
Sowats Point	5	One large nest, fair to good condition. Four other nests poor.
Toroweap	1	Large nest, poor condition. Active common raven nest nearby.
Upper Grand Wash	2	Two large nests, fair condition. One adult golden eagle perched.
Virgin Mtns 8	2	Two large nests, poor to fair condition.