MANAGEMENT AND STATUS OF BREEDING BALD EAGLES IN ARIZONA IN 2017

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ABSTRACT: In the 1970s research, management, and recovery projects were initiated in Arizona and across the contiguous United States to address population declines and losses of Bald Eagles (*Haliaeetus leucocephalus*) (Figure 1). The species has recovered nationally and was removed from the Endangered Species List in 2007. In Arizona, the Bald Eagle population is currently increasing with the potential to continue growing. Productivity has been relatively high for more than a decade, and breeding areas are being discovered in new areas and habitats.

In 2017 there were 85 known Bald Eagle breeding areas (nesting territories) in Arizona, and 65 were occupied by eagle pairs. By comparison, Florida alone has approximately 1,500 breeding pairs (Bald Eagle general information 2017). Bald Eagles breeding in Arizona are relatively isolated from neighboring populations due to long distances separating them, short natal dispersal distances, and little evidence of immigration or emigration. The small number of breeding pairs and relative isolation have made it necessary to continue intensive monitoring and management of the species in Arizona.

Figure 1. Bald Eagle at the Lake Pleasant breeding area, Maricopa County, AZ. Photo by George Andrejko

DISTRIBUTION IN ARIZONA AND THE SOUTHWEST

The known population of breeding Bald Eagles in Arizona has changed in size and distribution since intensive monitoring began in the 1970s. Rubink and Podborny (1976) described Bald Eagles in 1975 occurring along the Salt and Verde rivers, the lower Black River, a portion of Eagle Creek (a tributary of the Gila River), and 1 nest site on the Colorado River at the Havasu National Wildlife Refuge. Hunt et al. (1992) reported Bald Eagle breeding areas on 3 additional river systems by 1990, including the main stream of the Agua Fria, Bill Williams, and Gila rivers, and 4 creeks (Ash, Burro, Canyon, and Tonto creeks), but considered the Black River and Eagle Creek nests as either potential or unknown historic breeding areas. Nesting Bald Eagles were not detected above the Mogollon Rim in these studies; however, breeding was reported near Stoneman Lake prior to 1890 (Mearns 1890), on the Little Colorado River near Grand Falls in 1951 (Hunt et al. 1992), and possibly at Lower and Upper Lake Mary in the 1970s (Hunt et al. 1992).

In 2017, 85 breeding areas were located along the Agua Fria, Bill Williams, Colorado, Little Colorado, Gila, Salt, San Carlos, San Francisco, and Verde rivers; Burro, Chevelon Canyon, Cibecue, Lynx, Oak, Pinal, Show Low, Silver, Tonto, and Walnut creeks; and Ashurst, Crescent, Dogtown, Tremaine, White Horse, and Woods Canyon lakes or reservoirs (Figure 2, McCarty et al. 2017). Elevation of breeding areas ranged from 142 m to 2822 m, including 58% at elevations lower than 915 m, 21% between 915 m and 1830 m, and 21% above 1830 m. The highest concentrations of breeding activity occur along the lower Verde River from Horseshoe Dam downstream to the Salt River, and the lower Salt River from Roosevelt Dam to the Granite Reef Diversion Dam, where the average for each system is 1 breeding area for every 6.7 km of river. On the middle and upper portions of both of these rivers (upstream of Horseshoe and Roosevelt dams) the average is 22.7 km.

Bald Eagle breeding areas occur in smaller numbers in areas immediately surrounding Arizona, with the exception of Colorado where known pairs increased from 14 to 148 between 1987 and 2011 (Bald Eagle 2017). Approximately 7 territories exist in southern California. However, 2 are considered "sporadic" (USFWS 2012). Approximately 5 breeding areas were recently known in Nevada, 11 in Utah, 4-7 in New Mexico, and 1 in western Texas (USFWS 2012). Bald Eagles were discovered nesting in northern Sonora, Mexico in 1986 and 4 territories were recently occupied there, but production of young has been poor (Brown 1988, USFWS 2012). Historically, the dearth of known Bald Eagle breeding pairs in the southwestern part of their range outside of Arizona, and the large distances between them, was part of the evidence supporting the idea that the Arizona population was isolated. In recent years breeding populations have increased and distribution has expanded, and the degree of isolation may be diminishing.

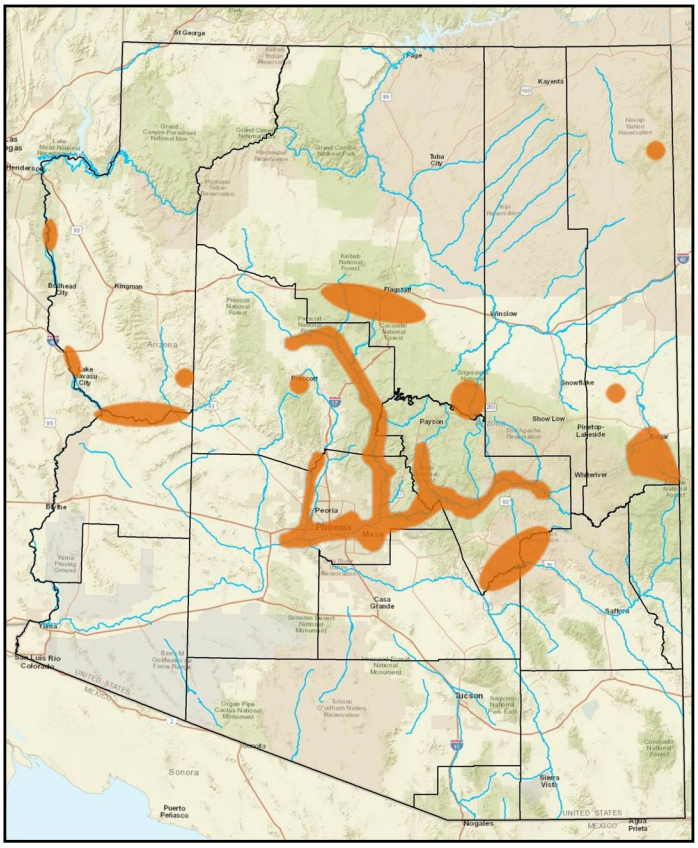

Figure 2. Known distribution of breeding Bald Eagles in Arizona as of 2017 (shaded orange). County outlines in black and major rivers in blue lines.

One of the most notable changes in Bald Eagle distribution in Arizona since the 1990s has been the expansion of known breeding areas to higher elevations north of the Mogollon Rim. A new territory was pioneered at Luna Lake (2400 m) near Alpine in 1994, and 3 more were discovered at high elevations in the following decade. From 2005 to 2017, 15 more breeding areas were established at higher elevations (1700-2520 m), mainly stretching southeast from Williams in Coconino County to the White Mountains in Apache County. These 15 territories accounted for more than a third of all new breeding areas discovered during that time, and represent a significant addition to the overall distribution of the species in Arizona. One of these new sites, near Canyon de Chelly in northern Apache County, is over 200 km from the nearest known breeding area in Arizona. The nesting Bald Eagles at Canyon de Chelly are not banded and their origin is unknown. It is possible they arrived from more proximate areas in southwestern Colorado, but they could have originated within Arizona. Either way, the Canyon de Chelly territory is an example of a potential avenue of exchange between Arizona and more northern populations.

The Colorado River has also experienced changes in the status of nesting Bald Eagles, although historic information is scarce. The pair of eagles observed building a nest in a tree on Topock Marsh at the Havasu National Wildlife Refuge in 1975 occupied the area through 1979, but egg laying was never observed (Rubink and Podborny 1976, Hunt et al. 1992). Several nests and an adult Bald Eagle were found at Gene Wash Reservoir in 1996 on the California side of the Colorado River, but breeding was not confirmed until 2006 at nearby Copper Basin Reservoir (Jacobson et al. 2006). One of the breeding eagles at Copper Basin was noted with a blue band, indicating an Arizona-hatched bird. Between 2010 and 2015, 3 breeding areas were discovered in Arizona and 1 in Nevada along or near the Colorado River from Hoover Dam to the Bill Williams River. The band status of resident birds at these Colorado River territories is either unknown or unconfirmed, however at 2 of the sites the eagles are reportedly not banded (Arizona Game and Fish Department (AZGFD) (unpub. data). Offspring dispersing from these breeding areas could continue to populate the Colorado River or move deeper into southern California and Nevada. The Grand Canyon portion of the Colorado River is not included in annual nest surveys, and no nesting Bald Eagles are currently known in Arizona upstream of Hoover Dam.

Bald Eagles have also established territories in urban environments in Arizona, primarily within the greater Phoenix area. These urban territories do not always include natural riparian communities, and instead may contain artificial water formations such as recharge basins, urban ponds and lakes, canals, or ephemeral pools in flood-controlled washes. Since 2009 six pairs of Bald Eagles have built nests at golf courses or housing developments, in industrial settings, or near busy roads, and at least 2 other pairs have been nesting on the fringes of the urban-rural interface. The establishment of territories in the Phoenix area may represent eagles taking advantage of unexploited resources or could be a signal that traditional habitats nearby on the Salt and Verde rivers are filling up. The number of known breeding areas associated with the regulated portion of the Salt River (from Roosevelt Lake to Granite Reef Dam) grew from 4 to 15 between 2002 and 2015, and includes the closest nesting pairs in the state, separated by only 300 m. At Saguaro Lake, one of the oldest Bald Eagle territories on the lower Salt River, 3 more pairs began nesting in 2003 to 2009. By contrast, no new breeding areas have been found on the unregulated Salt River since 1984. Along the regulated part of the Verde River, known breeding areas increased from 5 to 12 between 1996 and 2015. The unregulated Verde River grew from 6 to 10 breeding areas between 2006 and 2017.

BREEDING CHRONOLOGY

At the lowest elevations, Bald Eagles return to territories in Arizona as early as September; the majority of pairs, however, initiate courtship behavior between October and December. The first eggs are laid in late December at a few of these sites, while most egg laying occurs in January or February. The young fledge at 10 to 12 weeks of age with the first ones leaving the nest in early April and most of them out by the end of May. At the highest elevations, eggs are laid in March or (rarely) in early April and the young fledge in June and July or (rarely) early August. Juveniles remain in their natal area for about 6 weeks after fledging before migrating north for the summer (see Movement Studies under the management projects below).

LISTING HISTORY AND INCEPTION OF MANAGEMENT PROGRAMS IN ARIZONA

Throughout much of the 20th century, Bald Eagle populations declined due to direct persecution, habitat loss, and the negative impact of environmental contaminants, specifically DDT, to reproduction (Ratcliffe 1970; Wiemeyer et al. 1984, Wiemeyer et al. 1993; Bildstein 2008). Congress passed the Bald Eagle Protection Act in 1940, amended to include Golden Eagles in 1962, which makes take of eagles illegal except for limited purposes requiring a permit.

In the 1950s and 1960s the pesticide DDT, which caused decreases in eggshell thickness and disrupted reproduction (Wiemeyer et al. 1984, 1993), led to declines of local and regional Bald Eagle populations. By 1963 the number of breeding pairs of Bald Eagles in the contiguous United States was estimated below 500 (USFWS 2007), and the use of DDT was banned in 1972. The size and distribution of the Bald Eagle population in Arizona prior to the 1970s and the extent to which it was affected by anthropogenic factors remains unknown. DDE (a metabolite of DDT) and other contaminants were detected in eggs in the state in the 1980s, as was moderate eggshell thinning, but negative effects to productivity were not demonstrated (Grubb et al. 1990, Hunt et al. 1992, Driscoll et al. 1999).

The Bald Eagle was listed under the federal Endangered Species Act (ESA) in 1978 and additional recovery efforts were launched. That year, 11 breeding areas were known in Arizona and the U.S. Forest Service (USFS) and Maricopa Audubon Society teamed up to monitor 1 of the nesting attempts, an effort that expanded into the Arizona Bald Eagle Nestwatch Program (ABENWP) (Forbis et al. 1985). A 1982 recovery plan for Bald Eagles in the Southwest specified goals to increase the breeding population, restore eagles to additional river systems, and maintain important wintering areas (USFWS 1982). Although propagation and reintroduction programs were enacted in many parts of the country to reestablish populations, that technique was not used in Arizona. Instead, the management focus was on protecting existing nest areas, conducting nest searches and productivity assessments, and maximizing productivity so that growth could occur naturally.

Throughout the 1970s and 1980s the USFWS, U.S. Bureau of Reclamation (USBR), AZGFD, USFS, and others initiated research, monitoring, management, and conservation projects to protect Bald Eagles in the state (Hildebrandt and Ohmart 1978, Ohmart and Sell 1980, Haywood and Ohmart 1983, Grubb 1986, Hunt et al. 1992). These projects examined population dynamics, foraging ecology, habitat selection, and juvenile dispersal and laid the foundation for management programs in place today. Some of the early collaborators in Arizona formed the Southwestern Bald Eagle Management Committee (SWBEMC) in 1984 to coordinate and align research, recovery, and management efforts. Later studies on Bald Eagles in Arizona included food habits, contaminant levels in eggs, and winter ecology (e.g., Grubb et al. 1990, Brown 1993, Grubb 1995, Grubb and Lopez 1997).

By 1995, there were 32 known breeding areas in Arizona, and Bald Eagle populations had recovered nationally to the point that the USFWS downlisted the species to "threatened" on the ESA across all recovery regions. The species was removed from the ESA in 2007. At the time of delisting Arizona had 54 known breeding areas, and the USFWS estimated nearly 10,000 breeding pairs in the contiguous United States and tens of thousands more in Alaska, where Bald Eagles were never listed (USFWS 2007). In 2004, the Center for Biological Diversity, Maricopa Audubon Society, and Arizona Audubon Council submitted a petition to the USFWS to classify Bald Eagles breeding in the Sonoran Desert Area of central Arizona as a Distinct Population Segment (DPS). The USFWS announced a negative finding in 2006. However, due to a legal challenge and subsequent court order, Bald Eagles in central Arizona were temporarily designated as a DPS in 2008 and listed as threatened, while the USFWS conducted a 12-month status review of the Sonoran Desert Area population (USFWS 2008). In the status review, the USFWS determined the population did not satisfy the definition of a DPS and therefore was not eligible for listing (USFWS 2010). Bald Eagles in the Sonoran Desert Area were then removed from the list of endangered and threatened species in 2011 (USFWS 2011). Further legal challenges resulted in another 12-month finding that supported the previous conclusions (USFWS 2012). The 2012 finding was upheld by a U.S. District Court in 2014, and that decision was affirmed by an appellate court in 2017.

BALD EAGLE MANAGEMENT PROJECTS IN ARIZONA

AZGFD has continued many of the Bald Eagle projects that were started or expanded during the recovery phase because they are vital for determining the status of the breeding and wintering populations and protecting breeding areas and nesting attempts. Some of the projects are described below, including the ABENWP, nest surveys and productivity monitoring, banding and resighting, movement studies, artificial platforms and nests, and winter counts.

Figure 3. The 2017 Arizona Bald Eagle Nestwatch Program crew, 2 February 2017. Photo by David Majure

The Arizona Bald Eagle Nestwatch Program

The ABENWP celebrated its 40th season in 2017, and over 450 people have participated as Nestwatchers since the program's inception (Forbis et al. 1985). Each year, teams of biologists (Figure 3) are contracted to monitor some of the state's Bald Eagle breeding areas, typically where human recreation and the potential for nest disturbance is high. Reducing nest failures, leading to increased productivity, is one of the core purposes of the ABENWP. To safeguard eagle nesting attempts, Nestwatchers monitor nest closure areas, educate the public about the possible impacts of human-caused disturbances, and contact state and federal agencies to intervene when eagles encounter life-threatening situations. Through their efforts, Nestwatchers have directly contributed to the rescue of over 100 Bald Eagles facing potentially fatal scenarios, including nestlings that fell from nests or became entangled in monofilament fishing line, and have indirectly saved an unknown number of others. Nestwatchers also collect data on important eagle foraging and roosting locations, and provide recommendations that help land managers make informed decisions on how to best protect valuable eagle habitat.

Nest surveys and productivity monitoring

Biologists conduct surveys of Bald Eagle breeding areas in Arizona from January to June. The USFWS started evaluating the status of the population, searching the main river systems, and monitoring productivity in 1972 (Rubink and Podborny 1976). Currently, AZGFD surveys Bald Eagle nests from the ground and from helicopters provided by the Salt River Project, Arizona Public Service, and USBR. Nest surveys are the main tool for documenting productivity, searching for new alternate nest locations and new breeding areas, tracking population growth, and confirming re-occupancy at historic areas, and can help identify potential management issues.

The known population of breeding Bald Eagles in Arizona has increased since the first surveys occurred in the1970s, rising from 2 breeding areas in 1970 to 85 in 2017 (Figure 4). However, increases in the earlier years were most likely due to intensified survey effort leading to discovery of nests that had existed long before they were found. Growth of the population likely started in the 1990s and has continued to the present. As more Bald Eagles reach breeding age and establish territories, the expectation is that growth will slow and the population will become self-limiting as competition for resources escalates and all viable nesting habitat is occupied.

In addition to the documentation of new breeding areas and nests, productivity of all known breeding areas is determined annually from survey data. Productivity (the number of young fledged per occupied breeding area) fluctuated in the 1970s and 1980s due to the smaller number of known territories and may not have been representative of the actual population because the success or failure of a few nesting attempts had a larger influence overall (Figure 4). Previous studies on the status and demography of Bald Eagles in Arizona reported productivity of 0.69 in 1987 to 1993 (Driscoll et al. 1999), and 0.75 in 1991 to 2003 (Allison et al. 2008). Since then (2004-2017) productivity has been higher, averaging 0.99 (Table 1).

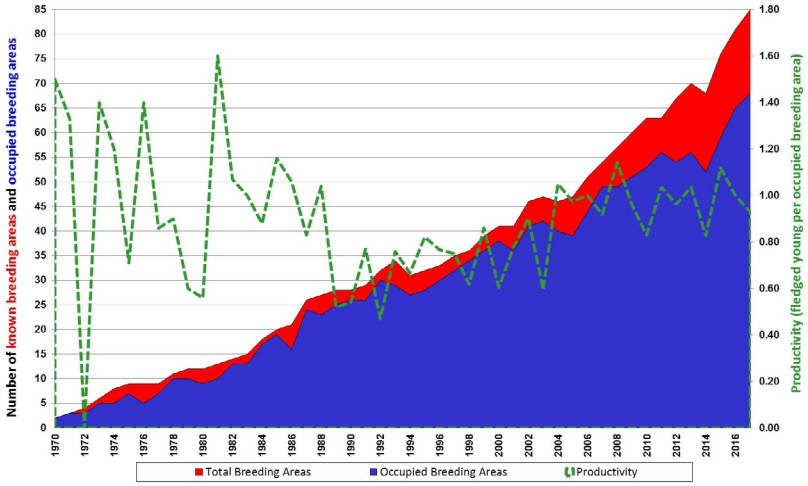

Figure 4. Number of known Bald Eagle breeding areas, occupied breeding areas, and productivity in Arizona, 1970-2017.

Table 1. Productivity at Bald Eagle breeding areas in Arizona, 2004-2017.

Year	Known Breeding Areas	Occupied Breeding Areas	Successful Nesting Attempts	Young Fledged	% Nest Success	% Occupied	Mean Brood Size	Productivity
2004	46	40	27	42	67.5	87.0	1.6	1.05
2005	47	39	25	38	64.1	83.0	1.5	0.97
2006	50	43	28	42	65.1	86.0	1.5	1.00
2007	53	48	25	42	52.1	90.6	1.7	0.92
2008	56	48	30	53	62.5	85.7	1.8	1.14
2009	59	50	29	47	58.0	84.7	1.6	0.96
2010	62	52	27	44	51.9	83.9	1.6	0.83
2011	62	55	34	56	61.8	88.7	1.6	1.04
2012	66	54	31	52	57.4	81.8	1.7	0.96
2013	68	54	35	58	64.8	79.4	1.7	1.04
2014	68	52	30	43	57.7	76.5	1.4	0.83
2015	76	59	39	66	66.1	77.6	1.7	1.12
2016	81	65	41	65	63.1	80.2	1.6	1.00
2017	85	68	35	63	51.5	80.0	1.8	0.93
Average	--	--	--	--	**60.3**	**83.2**	**1.6**	**0.99**

Banding and resighting projects

Banding efforts in Arizona were started in the late 1970s, but it was not until 1987 that a more comprehensive banding and resighting project was started and has continued to the present (e.g., Hildebrandt 1981, Hunt et al. 1992, Haywood and Ohmart 1983, Beatty and Driscoll 1996). In addition to the standard USFWS band, blue anodized aluminum bands are placed on nestlings in Arizona (Figure 5). Prior to 1990, some other colors were used on nestlings (red, purple, and green). The color bands have a unique alphanumeric code which is more easily resighted from a distance with a powerful spotting scope and enables identification of individual eagles. The majority of resighting occurs at known territories after banded birds have entered the breeding population starting at 4-6 years old. Since 1987 over 650 Bald Eagle nestlings have been banded in Arizona.

Figure 5. A color-banded Bald Eagle nestling in Arizona. 28 March 2017. Photo by Kyle McCarty

Banding and resighting provides the basis for demographic analysis and description of the population, including breeding tenure, site fidelity, and dispersal distance. It also provides the main evidence that the Arizona Bald Eagle population currently does not rely upon immigration and appears to be isolated from other populations. Out of 102 eagles identified by their bands at Arizona breeding areas through 2017, all were confirmed as hatched in Arizona except 1 individual. In 1994, AZGFD confirmed that the male breeding at Luna Lake had been marked with a patagial tag and banded as a nestling in Matagorda County, Texas, in 1988, a dispersal distance (natal area to breeding area) of over 1300 km (Beatty and Driscoll 1996, Mabie et al. 1994). This bird was captured by AZGFD and additionally marked with a black band, and is still the only Bald Eagle known to have entered the Arizona breeding population from outside of the state. Long-distance dispersal and immigration to Arizona is therefore possible, but documented cases are rare.

Known dispersal distances differ for males and females hatched in Arizona, averaging 45.1 km and 109.7 km respectively (Allison et al. 2008). Millsap et al. (2014) estimated slightly longer dispersal distances for Bald Eagles in the coterminous United States, 59.8 km for males and 138.2 km for females. These distances indicate that emigration from Arizona to other breeding populations is likely to be minimal. There is 1 instance of an Arizona-hatched Bald Eagle unsuccessfully attempting to nest in southern California (Allison et al. 2008, USFWS 2012). However, if no one is banding Bald Eagles or attempting to resight them in neighboring populations, then some immigration and emigration would go undetected, and dispersal distances would appear shorter.

Allison et al. (2008) found the median duration of a breeding pair was 4.9 years, and median breeding tenure for individuals was 9.8 years, meaning a typical adult will have about 2 mates over the course of its breeding life. The longest-lasting pair, and currently oldest Bald Eagles in Arizona, includes the breeders at Luna Lake in eastern Arizona who have remained together since 1994. The Luna male was known to be 28 years old in 2017, and the female was at least 28 years old.

Deductions regarding the apparent isolation of the Bald Eagle population in Arizona are tempered by the fact that not all banded breeders are identified, not all breeders have bands, and not all nestlings are banded each year. In 2004-2016, a total of 168 individuals were detected as breeders in Arizona, and 87 (52%) were positively identified as Arizona-hatched birds or had blue bands that were not read but were consistent with an Arizona origin. There were at least 79 (47%) unidentified breeding individuals, including 75 with no bands and 4 that were single-banded (USFWS band only, no color band). The prevalence of unbanded breeders (approximately 45%) is due in part to the banding rate of nestlings. From 2004 to 2017, a total of 710 juvenile Bald Eagles fledged in Arizona. Of these, 39.7% were banded as nestlings and the remaining 60.3% were not banded (Table 2).

Table 2. Number of young hatched, fledged, and fledglings banded at Arizona Bald Eagle breeding areas 2004-2017.

Number of young:				
Year	**Hatched**	**Fledged**	**Fledged, banded (%)**	**Fledged, Not banded (%)**
2004	50	42	24 (57.1)	18 (42.9)
2005	48	38	15 (39.5)	23 (60.5)
2006	57	42	21 (50.0)	21 (50.0)
2007	64	42	23 (54.8)	19 (45.2)
2008	68	53	24 (45.3)	29 (54.7)
2009	71	47	14 (29.8)	33 (70.2)
2010	57	44	21 (47.7)	23 (52.3)
2011	68	56	20 (35.7)	36 (64.3)
2012	66	52	13 (25.0)	39 (75.0)
2013	75	58	15 (25.9)	43 (74.1)
2014	57	43	12 (27.9)	31 (72.1)
2015	75	66	29 (43.9)	37 (56.1)
2016	79	65	25 (38.5)	40 (61.5)
2017	83	62	26 (41.9)	36 (58.1)
Totals	**918**	**710**	**282 (39.7)**	**428 (60.3)**

Movement studies

Radio and satellite telemetry have been an essential part of Bald Eagle movement studies in Arizona. Six very high frequency (VHF) radio transmitters were attached to juvenile Bald Eagles in the state from 1977 to 1979 (Hildebrandt 1981, Sell 1982). From 1987 to 1990, researchers also used VHF radio telemetry to track 11 juvenile Bald Eagles (up to a year old), 8 nonbreeding immatures (1-4 years old), and 9 breeding adults, focusing on studies of home range, foraging behavior, habitat preferences, and migratory movements (Hunt et al. 1992, 2009). In the 1990s, small but expensive solar-powered satellite transmitters were developed for use on wildlife, enabling location data to be sent from a tagged animal and relayed to an office computer. AZGFD and USBR attached 17 battery- or solar-powered satellite transmitters to juvenile Bald Eagles in 2002-2004, and 8 more between 2014 and 2017. The Salt River Project contributed 6 additional transmitters in 2017, 4 of which were used on Bald Eagles. Transmitters are placed on eagles using a backpack harness, with the unit resting on the upper part of the back (Figure 6).

Figure 6. Bald Eagle nestling with solar-powered backpack satellite transmitter. 2 June 2014. Photo by Kyle McCarty

The tracking data show that most juvenile Bald Eagles in Arizona remain in their natal areas for 44-51 days postfledging, and then depart on a northward migration in June or July (Hunt et al. 2009, AZGFD unpubl. data). At higher elevations, the young move north later in July or August. After leaving the natal area, a typical juvenile heads to northern Arizona where 3 distinct migration routes emerge. One route continues straight north to summer areas in Utah, Wyoming, and Montana. A second route turns northwest for destinations in Oregon, Washington, Idaho, and northern California. The third route passes through Colorado and Wyoming on a northeastern track toward North Dakota and South Dakota, and as far east as Minnesota. While most of Arizona's first-time migrants remain in the United States, some of them find their way deep into Canada.

Juvenile Bald Eagles return to Arizona around the end of September or October and spend the fall and winter months at reservoirs and other places throughout the state where waterfowl and other prey are available. Limited data on the second spring migration of 5 tagged birds revealed that 4 of them moved north earlier (in April and May), and they used summer areas geographically similar to those used on their first migration, while 1 bird did not migrate north in its second year (AZGFD unpubl. data). It is unknown whether the general migration pattern of northbound in April-May and southbound in September-October is typical beyond their second year, and learning more about older immature and adult Bald Eagles is one of the current goals of transmitter deployment. Transmitter life expectancy continues to improve, and tagged birds that survive to adulthood will help identify areas in Arizona both within and outside of breeding territories that are important for Bald Eagles.

Artificial platforms and nests

In Arizona, artificial platforms and nests have been used infrequently to replace fallen nests in areas with limited substrate or to provide eagles with a safe alternative nest location. An artificial nest for Bald Eagles was built at the Havasu National Wildlife Refuge in 1976 by the USFWS to replace a fallen nest, using the original materials to build a new nest in an adjacent tree (Hunt et al. 1992). An artificial tripod structure was built in 1977 to replace a natural nest tree that had fallen at Horseshoe Reservoir (Grubb 1980, 1983) (Figure 7). The tripod was used in 1979, but the nesting attempt failed after inundation by floodwaters. In the 1980s, multiple artificial structures and nests were built at Horseshoe but were either swept away by flooding or were not utilized by eagles. Artificial nests were placed in trees or cliffs at 7 additional territories in the1980s, and Bald Eagles eventually fledged young from at least 5 of these artificial nests (Hunt et al. 1992).

Figure 7. Tripod structure for a Bald Eagle nest (left, photo from Grubb 1980), and installation of an artificial nest in a snag (center) and the completed nest (right),18 November 2015. Photos by Arizona Game and Fish Department

Construction of artificial nests and platforms is a relatively inexpensive and potentially effective method for preserving productivity at Bald Eagle breeding areas. In 2011 two artificial nests were placed in trees at a Verde River breeding area that had experienced a severe tick infestation (*Argas* spp.). The larval ticks feeding on eagle nestlings caused dehydration, partial paralysis, and increased susceptibility to disease by weakening the immune response, which resulted in the death of 8 nestlings over 3 years (Justice-Allen et al. 2016). The goal of building artificial nests at this site was to provide a parasite-free nest option for the eagles. One of the nests was utilized by the breeding pair in 2012 and they successfully fledged 2 nestlings. The pair laid eggs in the second artificial nest in 2016, but the nesting attempt failed (McCarty et al. 2016). At another breeding area on Tonto Creek, an artificial nest was placed in a tree in 2012. The objective was to lure the resident eagle pair away from the creek bed which was busy with Off Highway Vehicle activity and toward a quieter parcel of private land nearby (with the owner's permission) where they had previously been successful. For 3 years this pair produced no young at the natural nest in the creek bed. They finally moved to the artificial nest and have fledged young each year from 2015 to 2017.

Bald Eagle winter count

Winter counts of Bald Eagles have been conducted in Arizona since the 1970s (e.g., Todd 1981). The state contributes annually to a nationwide midwinter Bald Eagle survey effort initiated in 1979 by the National Wildlife Federation and now overseen by the U.S. Army Corps of Engineers (Steenhof et al. 2002, 2008). Surveys in Arizona initially occurred on a limited geographic basis until a more intensive statewide winter count was established in 1992 (Beatty 1992). AZGFD presently coordinates 102 survey routes that are completed during a 2-week period in early January with help from volunteers and federal, state, and tribal partners.

Winter counts in Arizona averaged 240 Bald Eagles each year from 2008 to 2017 (Table 3, McCarty et al. 2017). Eakle et al. (2015) analyzed count trends and estimated that wintering eagles in Arizona declined significantly at the rate of -2.2% per year in 1992-2010, and declined at the same rate in the southwestern United States in 1986-2010. At the same time, Bald Eagles have significantly increased on winter counts in 12 northern and eastern states, suggesting the distribution of wintering eagles could be affected by climate change such that milder conditions allow eagles to stay farther north than in previous years (Eakle et al. 2015). The winter count remains a useful measure of Bald Eagle populations and will continue to provide postdelisting data on national population trends. Wintering habitat is also an important factor to consider when evaluating the impact of development projects.

Table 3. Bald Eagle winter counts in Arizona, 2008-2017.

Year	Adults	Immatures	Unknown Age	Total
2008	152 (82%)	29 (16%)	4 (2%)	185
2009	139 (68%)	62 (30%)	3 (2%)	204
2010	159 (63%)	81 (32%)	12 (5%)	252
2011	157 (71%)	57 (26%)	8 (4%)	222
2012	189 (63%)	94 (32%)	15 (5%)	298
2013	169 (66%)	76 (30%)	10 (4%)	255
2014	188 (71%)	77 (29%)	1 (0.4%)	266
2015	141 (69%)	53 (26%)	10 (5%)	204
2016	161 (65%)	71 (29%)	17 (7%)	249
2017	169 (65%)	84 (32%)	8 (3%)	261
Average	**170 (69%)**	**69 (28%)**	**9 (4%)**	**240**

SUMMARY

The Bald Eagle population in Arizona is increasing and has the potential to continue growing. Productivity has been relatively high and stable for more than a decade, and breeding areas are being discovered in new areas and habitats. Available habitat includes, but is not limited to, many other high-elevation lakes and rivers currently occupied only by nesting Ospreys, portions of the Colorado River and the many creeks that drain into it, and urban areas. Additionally, a few other pairs of Bald Eagles in Arizona have adopted a relatively new behavior that could open up more possible breeding habitat. Normally their diet is mostly fish (76%) and mammals (18%), with birds, reptiles, amphibians, and carrion rounding out the rest of the food items (Grubb 1995). Most mammals taken are either rabbits or ground squirrels; however, at a few breeding areas the eagles prey on Gunnison's prairie dogs (*Cynomys gunnisoni*). The prairie dogs appear to be a significant food source for these pairs. Similarly, a nesting pair of Bald Eagles subsisted in large part on black-tailed prairie dogs (*Cynomys ludovicianus*) in Texas (Boal et al. 2006).

Although more Bald Eagles are known breeding in Arizona now than at any time before, the management projects outlined above are still required because the population in the state is still small and relatively isolated from other Bald Eagle population centers. Arizona's human population has also expanded from 1.75 million people in 1970 to nearly 7 million in 2016, bringing more development of housing, agriculture, roads, and recreation areas, and additional demand for water storage and flood control. All of these activities have the potential to create conflicts with breeding Bald Eagles. Under the Bald and Golden Eagle Protection Act, land managers and owners have responsibilities to protect nesting eagles from disturbances that could affect productivity. The current management program in Arizona ensures that the potential impacts to eagles of development projects can be evaluated and responded to appropriately.

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