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Current Status of Falcon Populations in Saudi Arabia

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CURRENT STATUS OF FALCON POPULATIONS IN SAUDI ARABIA

BY

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CURRENT STATUS OF FALCON POPULATIONS IN SAUDI ARABIA

This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science in Wildlife and Fisheries Sciences degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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الملخص

حالة مجموعات صقور الصيد في المملكة العربية السعودية

البراء بن محمد بن عثمان

2016

تسخدم الصقور الكبيرة بشكل واسع في الصقارة في الجزيرة العربية، مما أدى إلى تناقص أعدادها في كثير من مناطق إنتشارها، وعليه فقد قمنا في موسم التزاوج لعام 2015 بمسح لأعشاش الصقور النشطة والغير نشطة للشاهين الجبلي (*Falco pelegrinoides pelegrinoides*) Barbary والصقر الوكري (*F. biarmicus*) Lanner في المملكة العربية السعودية لتحديد الحالة للمجموعات الصقور البرية خلال السنوات العشرون الماضية وذلك عن طريق استبيان تم توزيعه وتعبئته من قبل الصقاقير وكذلك من خلال المقابلات الشخصية والزيارات الميدانية لأعشاش الصقور، بالإضافة لذلك فقد شملت الدراسة التعرف على وضع الصقور المهاجرة والصقور المهجنه كما تضمنت أهداف الدراسة التعرف على أعداد وأسعار الصقور التي تستخدم في الصقارة والتي منها: الصقر الحر (*F. cherrug*) Saker Falcons, الشاهين البحري المهاجر (*F. peregrinus sp*) Peregrine Falcons، الصقر السنقر (*F. rusticolus*) Gyrfalcons , والصقر المهجن Hybrid في المملكة العربية السعودية. بالنسبة للصقور المعششة بالمملكة قمنا بتقسيم منطقة الدراسة إلى ثلاثة مناطق المنطقة الغربية والشمالية, المنطقة الجنوبية الغربية, والمنطقة الوسطى. قمنا بزيارة 1,255 عش للصقر الوكري والشاهين الجبلي. ومن خلال هذه المسوحات لم يسجل أية عش نشط للصقر الوكري في جميع المناطق. أما بالنسبة للشاهين الجبلي فقد بلغت عدد الأعشاش التي تم زيارتها 725 عشاً بلغ نسبة الأعشاش النشطة منها 14.7% ، 4% من الأعشاش كان يوجد بها ذكر بلا أنثى (26 عش)، كما بلغت نسبة إنتاج العش 1.33 فرخ/زوج. أما نسبة نجاح التعشيش كانت 28.7% (n =35, SE = 4.37, CI = 20.12-37.26). كما تبين وجود إنخفاض في أعداد الأعشاش في المنطقة الغربية الشمالية بمعدل 7.69% من عام 2004 في عام 2015. أما فيما يتعلق بأعداد الصقور المملوكة لدى الصيادين بالمملكة فقد قدرت بحوالي 9,092 صقراً.

وللتعرف على حالة الصقور الصحية بالأسر فقد تم أخذعينات عشوائية لعدد 119 صقر وتبين أن 36.1% من الصقور كان مريضاً، ونسبة 95.5% من الصقور تموت قبل عمر 6 سنوات عند الصقارين بمتوسط عمر يصل لحوالي 3 سنوات. كما قدرت عدد الصقور الوكرية والشاهين الجبلية التي تم شبكها وتهريبها إلى الشرق الأوسط في عام 2015 بحوالي 2,544. أما في عام 2014 فقد قدرت عدد الصقور التي تم شبكها بلغ حوالي 4,027 صقراً منها (ليبيا 35.0%, الخليج العربي 15.5%, إيران 11.1%, تركيا 9.9%, مصر 8.6%, اليمن 8.1%, السودان 7.9%, والأردن 3.4%). أما متوسط سعر بيع الصقر الوحش في مزاد ارتفع بما يقارب 723% ما بين عام 2005-2014 كان متوسط السعر 2,755$ وأصبح 19,928 دولار أمريكي. ومتوسط سعر صقر مصقور(مدرب) 5,741$. وكانت قيمة عدد 1,042 صقر 6,105,193 $ في عام 2014 وهذا ربما يرجع لزيادة عدد الصقارين مما أدى لزاد عدد الصقور التي يتم شبكها، مما أدى إلى ارتفاع أسعار الصقور وبالتالي زيادة أعداد الصقور في الأسر. ويؤيد 93% من الصقارين بوجوب فرض قوانين لهواية الصقارة ودعمها، كما أن بقاء الصقر عند الصقار لمدة طويلة وقلة المعرفة لغذاء الصقر، كما أن عدم وجود تطبيق للأنظمة بشكل صارم خاصة في عملية استيراد الصقور، كل هذه العوامل ربما أدت إلى قلة أعداد الصقور في البرية، وعليه فإن هذه النتائج تأكد أهمية إدارة وحماية الصقور في المملكة العربية السعودية، بالإضافة لعمل المزيد من الدراسات البيلوجية للصقور في الشرق الأوسط والتعرف على دورها في التنوع الأحيائي بالمنطقة.

ABSTRACT

CURRENT STATUS OF FALCON POPULATIONS IN SAUDI ARABIA

ALBARA M. BINOTHMAN

2016

Falcons (*Falco* spp.) are widely used for falconry in the countries of the Middle East. During the 2015 breeding season, we surveyed historic and active nest sites of Barbary (*Falco pelegrinoides pelegrinoides*) and Lanner (*F. biarmicus)* Falcons in Saudi Arabia. Field and questionnaire surveys were conducted and personal contact with falconers was made to document the current distribution and price changes for Lanner Falcons, Barbary Falcons, Saker Falcons (*F. cherrug*), Peregrine Falcons (*F. peregrinus*), Gyrfalcons (*F. rusticolus*), and Hybrid Falcons in Saudi Arabia. We categorized our survey into three geographic groups; southwest (A), northwest (B), and central (C) regions of the country. We visited 1,255 historic nest sites of Lanner Falcons and Barbary Falcons. No active Lanner Falcon nests were recorded in any of the survey sites. Approximately 14.7% (n = 111) of 725 Barbary Falcon nests were active. In 2015, 4% (n = 26) of inactive nests were occupied by an unpaired male. Productivity was 1.33 young fledged/pair, and nest success was 28.7% (n = 35, SE = 4.37, CI = 20.12–37.26). Nesting in the northwest

declined approximately 7.69% from 2004. In 2015, we documented 9,092 falcons in captivity in Saudi Arabia. We sub-sampled 119 falcons to determine health; 36.1% were considered unhealthy while 63.9% were considered healthy. Approximately 95.5% of captive falcons died before the age of 6 and the average lifespan was 3 years (SE = 0.22, *n* = 169). At least 2,544 adult and juvenile Lanner and Peregrine Falcons were trapped and smuggled to the Middle East in the 2015 harvest season. In 2014, there were approximately 4,027 falcons trapped in the Middle East (Libya 35.0%, Arabian Gulf 15.5%, Iran 11.1%, Turkey 9.9%, Egypt 8.6%, Yemen 8.1%, Sudan 7.9%, and Jordan 3.4%). Average auction price of wild captured falcons increased between 2005−2014 by approximately 723% ($2,755 vs. $19,928 [USD]). The average value of a trained falcon in 2014 was $5,741 and the total value of captive falcons (*n* = 1,042) was $6,105,193. We identified an increase in falconry awareness; more than 93% of falconers agreed to the need for regulations and supported a release program. An increase in the number of falconers has led to increased trapping pressure as a consequence of rising falcon prices, an increase in the number of captive falcons, long-term and poor captive management, and strict enforcement of government regulation on falcon imports. All of these factors are contributing to falcon population declines. Our results indicate that falcons require protection and management in Saudi Arabia and more information on the present status of falcon populations in the countries of the Middle East is crucial for their conservation.

CHAPTER 1: Falconry and Falcon Trends in the Middle East

This chapter was prepared for submission to Acta Ornithologica and was coauthored by Shubham Datta, Jonathan A. Jenks, Mohammed Y. Shobrak, Kent C. Jensen, and Troy W. Grovenburg

Falconry and Falcon Trends in the Middle East

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ABSTRACT

During 2015, we surveyed falcon (*Falco* spp.) boarding facilities in Saudi Arabia and Middle East falconers to document current falcon populations, health of falcons, number of falcons trapped, and price changes of falcons sold in Saudi Arabia and the Middle East. We documented 9,092 falcons in captivity in Saudi Arabia. We sub-sampled 119 falcons to determine health; 36.1% were considered unhealthy while 63.9% were considered healthy. Approximately 95.5% of captive falcons died before the age of 6and the average lifespan was 3 years (SE = 0.22, n = 169). In 2014, there were approximately 4,027 falcons trapped in the Middle East (Libya 35.0%, Arabian Gulf 15.5%, Iran 11.1%, Turkey 9.9%, Egypt 8.6%, Yemen 8.1%, Sudan 7.9%, and Jordan 3.4%). Average auction price of wild captured falcons increased between 2005−2014 by approximately 723% ($2,755 vs. $19,928.87 [USD]). The average value of a trained falcon in 2014 was $5,741 and the total value of captive falcons (n = 1,042) was $6,105,193. We identified an increase in falconry awareness; more than 93% of falconers agreed to the need for regulations and supported a release program. An increase in the number of falconers has led to: increased trapping pressure as a consequence of rising falcon prices, an increase in the number of captive falcons, long-term and poor captive management, and strict enforcement of government regulation on falcon imports. All of these factors are contributing to falcon population declines. Our results suggest that falcons require protection and management in Saudi Arabia and more information on present status of falcon populations in the countries of the Middle East is crucial for their conservation.

INTRODUCTION

Falcons (*Falco* spp.) are widely used for falconry in the countries of the Middle East. In Arabian culture, falcons have been respected and widely used from the time of Pre-Islamic Arabia (Ali 2011). The number of falcons used for falconry in the Middle East has increased over the past five years (Shobrak 2014). Between the years 1998–2001, 6,838 falcons of various species visited the Fahad bin Sultan Falcon Center (Naldo and Samour 2004). Middle East falconers prefer to hunt using falcons rather than other raptors (i.e., *Buteos*). Moreover, they prefer specific types/sex and subspecies of falcons, such as Saker Falcon (SF) *F. cherrug*, Peregrine Falcon (PF) *F. peregrinus*, Lanner Falcon (LF) *F. biarmicus*, GyrFalcon (GF) *F. rusticolus*, as well as Hybrid Falcons HF (Eastham et al. 2002, AlRashidi 2004a, Dixon 2009, Shobrak 2014). For example, Arabian falconers prefer certain morphological colors and shapes of SF for their appearance and hunting ability (Eastham et al. 2002).

Information concerning falcons and falconry in the Middle East is limited. For instance, the number of captive and trapped falcons in the Middle East is not well known (Dixon;2009, Shobrak 2014). Moreover, falcon prices can be expensive. The most expensive falcon sold in 2002 was $35,000 [USD] (AlRashidi 2004a). More recently, a falcon sold in Kuwait during the 2013-2014 hunting season for $716,000 (Alsulaili Hashem, Alsulaili Falcon Research and Trade, personal communication; Figure 1). Additionally, there is limited information about populations and health of falcons in captivity and changes in auction prices over the last few years.

Our first objective was to document the current number of trapped falcons and their prices in the Middle East and determine if the preference of falcon species used has

changed over time. Our second objective was to document the current number of falcons in captivity and their health in Saudi Arabia. Our third objective was to measure falconry awareness among falconers. We hypothesized the number of trapped falcons would increase corresponding to an expected increase in prices as well as competition for desired falcon species. This information will contribute to the knowledge of falcons and falconry in the Middle East and serve as foundation information for species conservation efforts.

MATERIALS AND METHODS

The Middle East is a transcontinental region centered on Western Asia and Egypt. Falcons are trapped during their migration, which typically occurs from mid-September through April. We focused on a group of countries that had information concerning trapped falcons available through social media such as Twitter and Instagram. These countries included: Bahrain, Egypt, Iran, Jordan, Kuwait, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, and Yemen. Other African countries reported were Sudan and Libya. Saudi Arabia is located in the southwest side of the Asian continent, and we categorized our study in Saudi Arabia by region: east, central, north, west, and south. Trapping falcons occurred in all regions, but there were popular locations in each region (Jennings 1993, Shobrak 2014)

Arabian Falconry Classification and Trapped Documentation

Arabian falconry has a specific classification for each morphological color and shape of SF, PF, and LF. We documented the Arabian falconry classification and compared it with

the identified subspecies (Pfeffer and Karyakin 2010, Karyakin 2011, White et al. 2013, Kovács et al. 2014, Zhan et al. 2015). We documented the number of falcons trapped and their sale prices during 2014. We used questionnaires, personal communication, and social media to survey 590 falconers. Additionally, we gathered unpublished data from researchers from different countries and regions, including Arabian Gulf Abdurrahman Alghamdi from King Abdulaziz University, Mohammad Qasban Almehdawe, Naif Ibrahim Alrefae from the Alaradi Falcon Conservation Center (AFCC), and Abo-Aowad from Alshalan Makeed from Saudi Arabia, and Hashem Alsulaili from Alsulaili Falcon Research & Trade (AFR&T) from Kuwait. To avoid any data overlap, we compared the number of trapped falcons with other falconers and falcon markets.

Captive Falcon

We collected data on the number of captive falcons from makeed/marbat. Makeed are places where falconers keep their falcons after the hunting season, from April to September (AlRashidi 2004a). One of the challenges of our study was searching for falcon makeed locations in each city we visited, as there was no documented list of locations. We created survey questions and interviewed each makeed owner (Appendix 1). We documented the number of makeed in each region, the number of falcons, and current falcon prices.

We visited makeeds, interviewed falconers, and physically examined a subset of falcons and collected fecal samples when possible. We followed the standards of avian medicine procedures (Redig 1993, Del Hoyo and Elliot 1994, Wernery et al. 2004, Tully et al. 2009). We mixed fecal samples with distilled water and examined them for internal

parasites using a microscope (Motic BA210, Xiamen, China). We gave falcons a positive (+) diagnosis if they had an abnormality in one of the following: general appearance and attitude, eyes, nares and cere, beak/mouth/oral, ears, pectoral musculature, sternum, feathers, skin, abdomen palpation, heart/lungs/air Sacs, cloaca and vent, wings, feet and legs, tail and uropygial gland, nervous system, dropping color, and fecal sample test. If we did not document any abnormality, we gave the falcon a negative (-) diagnosis. We saved the (+) fecal samples, oral and anal swabs, and feather samples from wild birds (SF, PF, LF) and stored them at Taif University (TU), Tilad Veterinary Center (TVC), AFCC, and AFR&T for additional analyses. Additionally, we documented captive falcon diets by using Makeed food data and falconer questionnaires.

RESULTS

Arabian Falconry Classification and Trapped Documentation

Arabian falconry has a unique falcon classification. From our study we determined that Peregrine Falcons were classified into two groups: Shahin bahre and Shahin Jablay. Shahin bahre was a PF that was larger in size, stronger, and molted later than Shahin Jablay, such as *F. peregrinus tundrius, F. peregrinus calidus,* and *F. peregrinus anatum.* Shahin Jablay were smaller and had a reddish color, such as the following: *F. p. pelegrinoides, F. peregrinus babylonicus, F. peregrinus nesiotes* and *F. peregrinus brookei* (Figure 2). Prices varied considerably; the Shahin Jablay was less expensive than the Shahin Bahre. For example, in 2014, the average auction prices of Shahin Jablay and Shahin Bahre were $1,800 and $18,096, respectively. Other terms that we documented

included: LF named Wakre harar (Lanner Saker Arabian falconry definition) in the eastern side of Arabian Gulf, Laggar Falcon *Falco jugger* was named LF or Wakre harar (Lanner Saker Arabian falconry definition), and the subspecies of SF *F. cherrug cyanopus* was named Wakre harar (Figure 3).

The trapping season for LF and Shahin Jablay in Saudi Arabia began 8 April 2015 and trapping reports were collected until 13 August 2015. Trapping continued throughout the year, but trapped data was not collected after the last chicks had fledged. There were more than 200 trappers in Libya, trapping falcons from locations along the borders of Sudan and Niger. In Sudan, there were a few tourism companies offering hunting licenses. Trapping locations in Sudan usually occurred in Kassala and Dongol regions. In Iraq, there were approximately 500 trappers and 50 falconers. Trapping occurred throughout the county, but some areas were heavily trapped (i.e., Al Anbar, Basra, Najaf, and Maysan governorate). In Turkey, there were approximately 100 trappers and few falconers (≤ 5). Trapping locations typically occurred near the Armenian and Georgian borders.

In 2014, 4,027 falcons were trapped/smuggled in the Middle East (Libya 35.0%, Arabian Gulf 15.5%, Iran 11.1%, Turkey 9.9%, Egypt 8.6%, Yemen 8.1%, Sudan 7.9%, and Jordan 3.4%). The species most trapped were PF (2,096 birds) and SF (489 birds; Table 1).

Price change

Total season prices between 2002 and 2013 increased by 505%, and the total season prices between the years of 2013-2014 increased by 158% (Table 2). In 2002-2003 the

cost of a male (M) LF and M Shahin Jablay was $0 (lack of interest in males due to small size), and the most expensive falcons were female (F) SF with an average price of $6,370 (Table 3). During 2009-2013 the average cost of M LF was $245 and M Shahin Jablay was $124. The most expensive falcons were again F SF with an average price of $22,984 (Table 3). In 2014, the average cost of M LF was $461 and M Shahin Jablay was $256. The most expensive falcons were F SF with an average price of $34,670 (Table 3). Survey results indicated the total prices of 1,042 falcons owned by 540 falconers was $6,105,193 and the average price of one falcon was $5,741. Falcon species in captivity consisted of PF 51%, LF 32.7%, SF 10.1%, GF wild 0.67%, HF 2.6%, and GF 2%. The most expensive falcons were wild GF with prices starting at $24,000 (Table 4). There were some famous auction locations (i.e., Mjeramh) located in western Saudi Arabia and Al Shalan located in northwestern Saudi Arabia. During the 2013-2014 trapping season, AFR&T, located in Kuwait, sold the most expensive recorded falcon (*F c. cherug*) for $716,000 (Figure 1).

Falcon Market Inflation

Our results show that there were two new types of falcon competitions: racing of falcons and beauty contests of SF. There were price increases for all falcon species (type/sex) used for falconry and specific morphological shapes and sizes were more expensive than others (e.g., female falcons were more expensive than males) and specific types of SF such as: *F. c. cherug, F. c. hendersoni,* and *F. c. alticus* for their appearance, and *F. c. milvipes* for their larger size.

Captive Falcons and Their Health

We documented 9,092 falcons in captivity in Saudi Arabia located in 335 private and 74 public makeed. Falcons were dispersed throughout Saudi Arabia. Approximately 54% of captive falcons were in the eastern region, 27.4% in the central, 12.8% in the north, 3.3% in the west region, and 1.6% in the south region. After hunting season ended, 16.1% of falconers sold their falcons, 22.7% released their falcons, and 61.1% sent their falcons to the makeed. There were two types of makeed; private and public makeed (Figure 4) and two types of makeed style: free flight and limited movement (Figure 5). Limited movement makeeds were used for aggressive falcons and were easier to monitor the health of birds. Prices differed among makeeds but ranged from $500 to $2,000 for a six month period. Food types differed among makeed; typically private makeeds fed there falcons wild prey (i.e., rats, mice, dipodidae, small birds, pigeons, doves, and lizards), whereas public makeeds fed their falcons frozen food (Brown quail [*Synoicus ypsilophorus*] and chicken). Of 779 identified falcons located in makeeds, the most common falcon in captivity was SF (41.9%) and the least common was wild GF (5.1%; Table 5). There were three falcon hospitals in the central region of Saudi Arabia and no professional clinics were documented in other regions. However, there was a private clinic in the north region, 2 to 5 unprofessional falcon clinics in the east, and one in the west (Table 6).

We diagnosed 36.1% of 119 falcons (-) and 63.9% (+). In captive raptors, we documented coccidiosis (9 cases), trematodes (9 cases), cestodes (tapeworms; 1 case), digestive infection (3 cases), bumblefoot (2 cases), respiratory infection (1 case), nutrition deficiency (13 cases), blindness (1 case), dehydration (3 cases), trichomonas (4 cases), and Poxvirus (1 case). Approximately 95.5% of captive falcons died before the

age of 6. Cause-specific mortality included: disease (45.7%), hunting accidents (30.9%), poor management such as unhealthy diet and poor husbandry (21.0%), and hospital error (2.5%). The oldest falcons in captivity were a LF (24 years), Shahin Jablay (14 years), SF (25 years), Shahin bahre (12 years), GF (10 years), and HF (8 years). Average current age of 169 falcons was 3 years (SE = 0.22 years).

Awareness

Approximately 26% of falconers had less than 5 years falconry experience and 6.2% had more than 30 years of experience. Surveyed falconers trapped 1,064 falcons, lost 534 birds, and currently owned 438 falcons. Furthermore, 447 indicated they had released 562 falcons. Falcons were released for rehabilitation (72.1%) and because of difficulties with caring for the falcons (9.5%). Ninety six percent of 457 participants indicated that falconry awareness had increased in the last 10 years and 50% of 473 participants agreed that falconry had increased more than 50%. Reasons for increased awareness included culture, hobby, money, media, competitions, fashion, and luxury. Ninety four percent of falconers surveyed indicated a need for increased falcon regulations such as trapping, hunting regulation and a falconry ID system. Ninety-six percent of falconers agreed that not enough is currently being done to protect falcons.

DISCUSSION

Arabian Falconry Classification and Trapped Documentation:

It was difficult to identify the species and subspecies of falcons as Arabian falconry has their own falcon classification. People specializing in falcon classification will be needed for future efforts to identify the species/subspecies of falcons and determine which populations are threatened. Our results indicated a large number of trapped falcons were not documented and limited information currently exists documenting the number of trapped falcons in the Middle East (AlRashidi 2004a, Dixon 2012, Shobrak 2014). Our result indicated that most falcons smuggled or brought into the Arabian Gulf countries are transported without CITES documentation (Convention on International Trade in Endangered Species of Wild Fauna and Flora 2016). However, the number of SF and PF that were trapped in the Arabian Gulf in 2014 was more than the number of falcons that had been trapped in 2013 (525 VS. 242; Shobrak 2014). Our trapping data may be biased as those falcons trapped in Egypt, Jordan, Iran, Libya, Sudan, Turkey, and Yemen may have been previously trapped elsewhere and were smuggled outside of their homeland using a different route. Additionally, some falcons are trapped and sold without being reported or entering the market. However, we are confident in the accuracy of the trapped (number/species) falcons in the Arabian Gulf (Saudi Arabia, Bahrain, Kuwait, Qatar, and United Arab Emirate) as our technicians and volunteers were present in the field. Peregrine Falcons were the most trapped species in the Middle East, though classification issues with PF subspecies may confound numbers reported. Arabian falconers classify PF into two types, Shahen Bahre (946 falcons) and Shahen Jablay (1,150 falcons). Falconers trap LF and BF and send the larger falcons to the markets and use smaller falcons as Trads (trained falcon used to trap other larger falcons such as SF and PF). Trappers

typically release Trads after trapping season but many of the falcons die, suffering from injuries and starvation. Lanner Falcons were the second most trapped falcon.

An additional factor in the increase in falcon prices may have been strict enforcement from Arabian Gulf wildlife authorities supported by CITES regulations. Strict enforcement of the importation of wild falcons may not have considered falcon market demand. Moreover, when Arabian Gulf wildlife authorities and CITES began strict enforcement, they may not have taken into consideration the growth of falconry, which lead to more falcons being trapped/smuggled. Falconry is a respected hobby in the Arabian culture and culturally there is no shame in trapping or smuggling a falcon into the country. When the wildlife authorities of the Arabian Gulf regions enacted regulations to make it illegal to trap or import falcon, falcon smuggling continued nonetheless (Figure 6). Moreover, many falcons smuggled into the Middle East were injured or died due to various illnesses and stress along the smuggling route. Falcon species in general are threatened and their numbers will continue to decline as falconry is still being used in the Middle East without an active conservation plan (Figure 6).

Falcon Market Inflation

Our results indicated that the prices of all falcon species (type/sex) used for falconry in the Middle East have increased. Reasons for this increase included social media; for example, more television shows began to live-broadcast falconry competitions and auction prices that exposed the general public to falconry. Thus, social media is a critical component in the increase in falconers and the increase in the awareness of the sport of

falconry. Likewise, owning many expensive falcons indicates the importance and prominence of a family.

Wild falcon auctions sell the most expensive falcons in the world. Our price data were significantly higher than previously reported data (AlRashidi 2004). Prices for all falcon species increased, but specific morphological forms were more expensive than others. Previously published literature reported six existing subspecies of SF; *F. c. cherrug, F. c. korelovi* (old name *F. c. aralocaspius*), *F. c. coatsi, F. c. milvipes, F. c. hendersoni, F. c. cyanopus* and *F. c. danubialis*. There are potentially two additional subspecies; however, scientists have not agreed because *F. c. saceroides* and *F. c. alticus,* are hybrids between the subspecies previously listed above (Karyakin 2011). A more recent study stated that *F. c. cherrug,* and *F. c. milvipes* are the only two recognized subspecies of SF based on genetic evidence but can occur in numerous polymorphic forms (Eastham et al. 2002, Kovács et al. 2014). Arabian falconers have been found to favor three specific morphological characteristics of SF, which are referred to locally as Ashgar, Jarudi, and Sinjari (Eastham et al. 2002). We found several falcons at auctions that were advertised as subspecies; *F. c. cherug*, *F. c. hendersoni*, *F. c. alticus*, and *F. c. milvipes* and appeared to have the morphological traits of Ashgar, Jarudi, and Sinjari, which would suggest these falcons may not be a different subspecies.

There are many large falcon competitions in the Arabian Gulf and falconers from all over the world come to compete. There are two kinds of competitions: racing falcons and beauty competition. Beauty competitions held within the country select SF based on color and size. However, this competition may affect specific subspecies (morphological color

and shape) of SF such as: *F. c. cherug*, *F. c. hendersoni*, and *F. c. alticus* for their appearance, and *F. c. milvipes* for their large size.

Arabian falconers prefer female SF (Cade and Digby 1982, Remple and Gross 1993, Barton 2000), which are the highest priced SF. This preference may result in a decrease in the genetic diversity of Saker Falcons and falcon species in general. Trappers generally only trap the largest and most morphologically appealing females. Selecting for these females may decrease size and limit morphological variation among wild populations. Additionally, smaller females from the same species may decrease nest survival in the future. For example, cultch size, fledging success, feeding and health of chicks were different between small and large females. Smaller females from the same species have the potential to produce a smaller clutch, and chicks relative to a larger female (Parker and Begon 1986, Newton 2010, Korpimäki and Hakkarainen 2012). Additionally, the prices of all species have increased steadily over the past 10+ years. For sustainable use, the number, sex, and age of trapped falcons should be managed.

Captive Falcons and Their Health

Our results also indicated the number of captive falcons in Saudi Arabia was higher than previously documented (Del Hoyo and Elliot 1994, Ferguson-Lees and Christie 2001, AlRashidi 2004, Shobrak 2014). While direct comparisons among studies are limited, between 1998-2001 there were 6,838 falcons of various species that visited Fahad bin Sultan Falcon Center, Riyadh, Kingdom of Saudi Arabia (Naldo and Samour 2004). Additionally, other researchers observed that there were more than 3,000 SF in captivity (Del Hoyo and Elliot 1994, Ferguson-Lees and Christie 2001, AlRashidi 2004a, Shobrak

2014). The majority of captive falcons were located in the east, central, and northern regions of Saudi Arabia. Falconers from all of the Arabian Gulf countries hunt in these areas within the Saudi Arabian desert. Falconers can then leave their falcons in makeeds that are located in these same regions after hunting season is over. Moreover, favored prey targeted by falconers include the Asian Houbara Bustard *Chlamydotis macqueenii* and Stone Curlew *Burhinus oedicnemus* whose migration corridors occur in the Middle East region (Remple and Gross 1993, Riou et al. 2011). Also, desert characteristics are preferred by falconers over other landscapes (i.e., mountains) because it is open and provides free movement. Falconers risk losing their falcons in mountainous regions due to limited vision. Finally, the migration route of SF and PF is located near the Red Sea and trappers use this area to trap falcons (Shobrak 2014). Therefore, the majority of falconers were in the east, central, and north regions of the country, and more trappers were located in the western areas of Saudi Arabia.

Scientists have indicated that SF were commonly used in Arabian falconry (Allen and Critchley-Salmonson 1980, AlRashidi 2004a, Shobrak 2014). However, Middle East falconers recently have preferred hybrid falcons more than other species (Dixon;2012). In 2005, falcon preference in Saudi Arabia was SF, PF, LF and BF (AlRashidi 2004a). However, our results from our makeed surveys indicated that HF and SF are the most highly used for falconry. This suggests there may be new falcon species preferred by falconers, such as HF, SF, PF, LF, and Shahin Jablay. This may aid in future conservation by decreasing the pressure on trapped wild falcons. However, hybrids may escape captivity and breed with the native population, possibly affecting the genetic diversity of native wild falcons. There is already some evidence of hybridization of

falcons in the wild (Dixon 2009). Additionally, we documented historical information about hybridization between LF and SF and during our field work we documented breeding sites of escaped *F. p. brookei* in Taif city with anklet still attached. Anklet are short straps fastened around the leg of a falconry falcon or a hawk to limit their movement (Figure 2).

Our survey results indicate that only 4.5% of captive falcons survive beyond their 6th year. However, historically captive falcons live longer than wild falcons (Dewey and Potter 2002, White et al. 2002). The typical lifespan of a SF in captivity was 15 to 20 years and 5 to 7 years in the wild (Naldo and Samour 2004, Hekman 2005). The range lifespan of a PF in captivity was 25 (high) years and 13 (high) years in the wild (Dewey and Potter 2002, White et al. 2002). Our results indicate that a variety of health issues have contributed to a decrease in the lifespan of captive falcons in Saudi Arabia.

Our results support that less of Naldo and Samour (2004) who observed the largest number of falcon infections in Saudi Arabia were parasitism, aspergillosis and other respiratory diseases, bacterial and viral diseases, and bumblefoot. Additionally, falcon hunting injuries were similar to greyhound racing injuries (Prole 1976, Sicard et al. 1999) in the Middle East. Neither public nor private makeed provide any vaccinations, vitamins, or healthy meal plans. Furthermore, there were only three falcon hospitals available that provide basic health services in Saudi Arabia, and falconers were often quite a distance away. This makes it difficult to care for falcons in cases of emergency or even for routine health maintenance. This may have contributed to the increased mortality rate of falcons in Saudi Arabia. This lack of information and poor management had led to an increase in the mortality rate of captive falcons. Many of the cases that we

reported were easy to treat, such as dehydration and lack of vitamins and minerals. Increased availability of health care, acute and chronic, for falcons may result in longer lived falcons in captivity and less demand on fragile, wild populations.

Awareness

The number of falconers has increased and more beginning falconers are joining falconry. Our results contradicted AlRashidi (2004) who reported that 45% of falconers had at least 20 years of falconry experience. Reasons for this increase may include social media, competitions, fashion, and luxury. Our result concerning regulations supported those of AlRashidi (2004); the majority of falconers supported implementing hunting and falconry regulations. However, some falconers still disagreed with prohibiting the removal of chicks from nests in future falconry regulation. In Arabian falconry culture, some falconers prefer young chicks, and trapping is still a traditional way to generate income. More falconers are joining falconry and the prices and trapping of falcons have increased, resulting in an increased number of falcons in captivity. However, the lifespan of a captive falcon has decreased. Falconers overwhelmingly agreed that current organizations have not done enough work to protect falcons or to develop the falconry industry.

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Figure 1: This falcon of the subspecies *F. c. cherrug* (female; weight 1,123 g) was the most expensive bird ($716,000) sold at auction in 2013-2014 (Alsulaili from Alsulaili Falcon Research & Trade).

Figure 2: The two *F. peregrinus* subspecies that were documented nesting in Saudi Arabia, *F. p. pelegrinoides* and *F. p. brookei*. The female *F. p. brookei* below had anklet on but was seen in the wild.

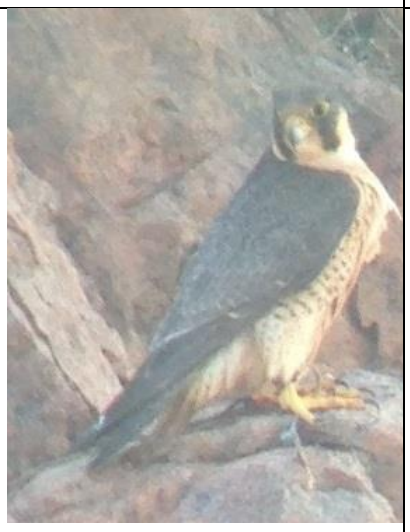
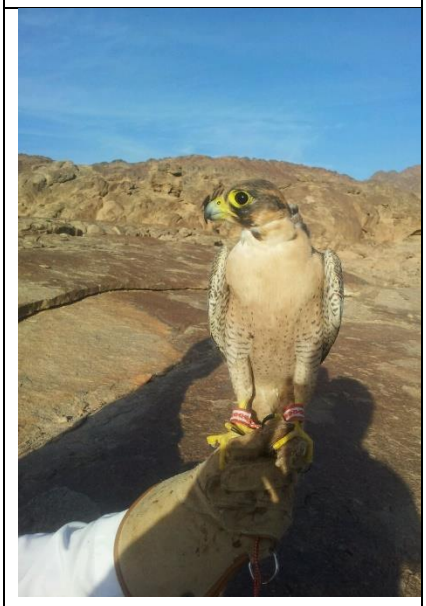
F. p. brookei (juvenile)	*F. p. brookei* (female)	*F. p. brookei* (male)
		
F. p. pelegrinoides (female)		
		

Figure 3: These falcons (left) *F. biarmicus,* (center) *F. jugger*, (right) *F. c. cyanopus* are collectively referred to as wakre or wakre harar in eastern Middle-Eastern countries.

Figure 4: Private makeed (upper) and public makeed (lower) in the west of Saudi Arabia.

Figure 5: Limited flying makeed (upper) and free flying makeed (lower) west of Saudi Arabia.

Figure 6: Approximately 142 illegally trapped adult and juvenile *F. biarmicus* and Shahin Jablay falcons (top) were confiscated by Egyption Authorities in 2008. Seven illegally wild trapped *F. rusticolus* (bottom) that died during transport in 2015 (Alaradi Falcon Conservation Center).

Table 1: The number of trapped falcons by country in 2014.

Country	*F. cherrug*	*F. peregrinus*	*F. biarmicus*	Shahin Jablay	Total
Arabian Gulf	79	446	2	100	627
Yemen	50	50	30	200	330
Iran	150	150	*	150	450
Turkey	150	150	*	100	400
Jordan	50	50	10	30	140
Libya	10	100	800	500	1,410
Sudan	*	*	300	20	320
Egypt	*	*	300	50	350
Total	489	946	1,442	1,150	4,027

* denotes unknown number of falcons.

Table 2: Reported prices (*F. cherrug & F. peregrinus*) from 2002-2014 at Arabian gulf falcon auction.

Content	AlRashidi (2004) 2002/2003	From our study 2009 – 2013	From our study 2014
Number of falcons	125	130	138
Lowest	$93	$266	$533
Highest	$35,995	$184,894	$138,661
Average price	$2,755	$13,271	$19,928
Total price	$344,314	$1,738,620	$2,750,184

Table 3: The average and range of prices for male (M) and female (F) falcons from 2002-2014.

Species	Number of falcons 2002/2003	Average 2002/2003	Range 2002/2003
M *F. cherrug*	*	$733	$533 - $1,066
F *F. cherrug*	*	$6,370	$1,333 - $3,5995
M *F. peregrinus*	*	$223	$93 - $600
F *F. peregrinus*	*	$3,219	$800 - $10,666
M *F. biarmicus*	*	$94	No profit
F *F. biarmicus*	*	$399	$150 - $500
M Shahin Jablay	*	$70	No profit
F Shahin Jablay	*	$400	$100 - $400
Species	Number of falcons 2009/2013	Average 2009/2013	Range 2009/2013
M *F. cherrug*	11	$3,581	$1,408 - $6,933
F *F. cherrug*	43	$22,984	$2,000 - $184,894
M *F. peregrinus*	27	$1,185	$266 - $3,302
F *F. peregrinus*	49	$13,583	$2,971 – $49,598
M *F. biarmicus*	*	$245	*
F *F. biarmicus*	*	$800	$400 - $1,500
M Shahin Jablay	*	$124	*
F Shahin Jablay	*	$800	$300 - $700
Species	Number of falcons 2014	Average 2014	Range 2014
M *F. cherrug*	9	$6,226	$2,133 - $13,332
F *F. cherrug*	34	$34,670	$3,636 - $138,661
M *F. peregrinus*	13	$2,419	$533 - $13,332
F *F. peregrinus*	82	$18,096	$3,967 - $72,263
M *F. biarmicus*	*	$461	*
F *F. biarmicus*	*	$1,800	$700 - $2,500
M Shahin Jablay	*	$256	*
F Shahin Jablay	*	$1,800	$600 - $1,500

* denotes unknown number of falcons.

Table 4: The reported prices of 1,042 falcons owned by 540 falconers with total value of $6,105,193.

Prices	*F.biarmicus*	Shahin Jablay	*F.cherrug*	*F. peregrinus*	*F. rusticolus* (wild)	Hybrids	*F. rusticolus* (captive)
$533	84	66	0	0	0	0	0
$1,066	135	130	0	0	0	0	0
$1,599	77	100	0	2	0	0	0
$2,133	24	41	0	1	0	0	0
$2,666	13	35	20	6	0	7	0
$4,000	8	39	15	11	0	6	0
$5,333	0	0	14	15	0	5	0
$8,000	0	0	4	17	0	4	6
$10,667	0	0	11	24	0	3	5
$13,334	0	0	4	10	0	2	4
$16,000	0	0	2	6	0	1	3
$18,666	0	0	2	6	0	0	2
$24,001	0	0	12	6	2	0	1
$26,664	0	0	7	9	1	0	0
$53,329	0	0	11	12	1	0	0
$79,994	0	0	1	3	1	0	0
$106,659	0	0	1	0	1	0	0
$133,324	0	0	2	0	1	0	0
Total	341	411	106	128	7	28	21

Table 5: The reported composition of captive falcon species.

Number of falcons	779
F. cherrug	41.97%
Hybrid Falcons	24.13%
F. peregrinus	12.58%
F. biarmicus	9.75%
Shahin Jablay	6.41%
F. rusticolus (wild)	5.13%

Table 6: The number of falcons by region in Saudi Arabia, 2015.

Saudi Arabia regions	South	West	North	Central	East	Total
Number of falcon in each region	149	305	1,171	2,493	4,974	9,092
Number of public makeed in each region	1	4	15	19	35	74
Number of private makeed in each region	106	2	78	126	23	335
Number of hospital	0	0	0	3	0	3
Percentage	1.6%	3.4%	12.9%	27.4%	54.7%	

Appendix 1: Interview falconer sheet:

1. Are you a falconer - Yes. - No.
2. Falconry experience:

   - Less than 5 years. - Less than 10 years. - Less than 20 years.

   - Less than 30 years. - More than 30 years.
3. Are you a:

   - Falconer. - Trapper. - Both.
4. How did you get your falcon:

   - Market. - Trapped it. - Both.
5. Do you have:

   - A native Lanner Falcon (from Saudi Arabia).

   - A native Barbary Falcon (from Saudi Arabia).

   - I don't have.
6. What was its age?
7. When was the last time you saw a Lanner or a Barbary Falcon in the wild? Please list the City*
8. How many falcons do you have?
9. Have you lost a falcon?
10. Do you trap native falcons in Saudi Arabia - Yes. - No.
11. How many falcons have you trap in your falconry experience:

    - Less than 5 falcons. -Less than 10 falcons. - Less than 15 falcons.

    - Less than 20 falcons. - More than 20. – More, list please.
12. Have you released a falcon: - Yes. - No.

13. Reason for release:

    - Falcon was sick. -For rehabilitation.

    - Hard to keep them. - Other reasons, list please.

14. Do you think falconry has increased in the past 10 years: - Yes. - No

15. What do think the increasing rate is 25% 50% 100%

16. What do you think the reason for falconry increase might be?

17. Do you think the number of Barbary and Lanner Falcons are in decline in your city:

    -Yes. - No.

18. Reason of the decline:

    - Trapping adults. - Increase in their prices. - Gunshot. - Urban sprawl.

19. Do you agree or disagree with the following:

    - Falconry license.

    - Falcon Passport / ID.

    - Falconry club in your city/country.

    - Releasing adult falcons.

    - Support local breeding farm.

    - Stop trapping adult falcons.

    - Stop trapping male falcons.

    - A penalty for trapping male and adult falcons.

    - Taking falcon chicks from the nest.

    - Trapping regulations.

    - Support releasing falcons.

20. How much does your falcon cost:

    - Less than $ 533. - Less than $1066. - Less than $1,599.

    - Less than $2,133. - Less than $ 2,666. – More, list please.

21. What do you do to your falcon after falconry season ends:

    - Send it to a falcon makeed. -keep him at your house.

    - Sell the bird. -Release the falcon. -Comments:

22. What's the oldest falcon you have/had:

23. Do you know if there is any Barbary and Lanner Falcon organizations in the Middle East:

    - Yes. - No. - I don't know.

24. Does the wildlife organization in the Middle East do enough to protect Barbary and Lanner Falcons?

    - Yes. - No.

25. What type of makeed do you have?

26. How many falcons in the makeed?

27. What type of food and supplement do you feed them?

28. What type of species and subspecies of falcons in your makeed?

CHAPTER 2: Saudi Arabia Lanner and Barbary Falcon Population Status

This chapter was prepared for submission to Acta Ornithologica and was coauthored by Shubham Datta, Neal Martorelli, Jonathan A. Jenks, Mohammed Y. Shobrak, Kent C. Jensen, and Troy W. Grovenburg

Saudi Arabia Lanner and Barbary Falcon Population Status

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ABSTRACT

During the breeding season of 2015, we surveyed 1,255 historic and active nest sites of Lanner Falcon *Falco biarmicus* and Barbary Falcon *Falco peregrinus pelegrinoides* in Saudi Arabia. We categorized our survey into three geographic regions: northwestern, central, and western. No active Lanner Falcon nests were recorded in any of the survey sites. Approximately 14.7% (*n* = 111) of 725 of Barbary Falcon nests were active in 2015; 4% (*n* = 26) of inactive nests were occupied by an unpaired male. Productivity was 1.33 young fledged/pair and nest success was 28.69% (SE = 4.37, CI = 20.12, 37.26). Nesting in the northwest declined approximately 7.69% from 2004. At least 2,544 adult and juvenile Lanner Falcon and Peregrine Falcons *Falco peregrinus* were trapped during the 2015 harvest season. Increased trapping and habitat deterioration are contributing factors in population decline of falcons in Saudi Arabia. Our results suggest that populations of breeding Lanner Falcon and Barbary Falcon may be at risk in Saudi Arabia and more focused research on their status and occupancy in the Middle East is crucial for their conservation.

INTRODUCTION

Lanner Falcon (LF) *Falco biarmicus* and Barbary Falcon (BF) *Falco peregrinus pelegrinoides* are both listed as least concern according to the IUCN Red-list of Threatened Species (Birdlife International 2013, IUCN 2015). Both species have large ranges. Lanner Falcon are found in Africa, some parts of Asia, and Europe. Barbary Falcons have larger ranges, living on most continents (e.g., Africa, Europe, and Asia; Birdlife International 2013; IUCN 2015). The LF is found at elevations ranging from 700 to 1,000 m utilizing open areas. Barbary Falcon is found from 1,000 to 1,500 m in seasonally wet ravines with trees and shrubs (hereafter referred to as *wadi*; a valley that is dry except in the rain season). Both species are found in mountain sites with sharp rocky cliffs and chose mountain caves for nesting in Saudi Arabia (Jennings 1981, AlRashidi 2004b).

The most common diet for BF are medium size birds (e.g., Rock Pigeon *Colomba livia* , Barn Swallow *Hirundo rustica*, White-crowned Wheatear *Oenanthe leucopyga*, House Martin *Delichon urbica*), and Grasshoppers (Orthaptera); (AlRashidi 2004, Birdlife International 2013, Shafaeipour 2014, IUCN 2015). The most common diet for LF in Italy were small birds such as European Starling *Sturnusv Ulgaris*, Green Woodpecker *Picusv iridis*, and Eurasian Jay *Garrulus glandarius* (Goodman and Haynes 1992). Few studies have documented nest survival for BF and LF. Barbary Falcon nest survival was 81.1% in Tenerife, Canary Island (Rodríguez et al. 2007).

Lanner Falcons numbers in Europe have declined (Sarà 2014). Numbers also are declining in Israel, and southern Africa (Birdlife International 2013, IUCN 2015). The

number of BF also are declining in the United Kingdom. These declines are primarily due to shooting, poisoning, and trapping for falconry (Birdlife International 2013, IUCN 2015). Lanner Falcons are locally threatened in Europe and Saudi Arabia and their population status should be addressed at small and large scales (Jennings 1995, Vittorio et al. 2015). From the early 1990s there were less than 100 pairs of LF and 1,300 pairs of BF in all of the Middle East (Jennings 1995). Lanner Falcon may be vulnerable to extinction in the near future (Jennings 1995, AlRashidi 2004b).

Our main goals in this study were to document the current distribution of LF and BF, evaluate reproductive parameters, and estimate numbers of trapped, imported, and smuggled LF and BF in Saudi Arabia and the middle-east in general. This study will help in better understanding the status of LF and BF in the Middle East, and will aid in future conservation recommendations.

MATERIALS AND METHODS

Study Area

Saudi Arabia is in the southwest side of the Asian Continent. In Saudi Arabia, Lanner Falcons and Barbary Falcons are found in high mountains with extreme gradients. Nests are usually found in rocky cliffs (Jennings 1981, AlRashidi 2004b, Shafaeipour 2014). Lanner Falcon nests are typically found in open areas at elevations ranging from 700 to 1,000 m. Barbary Falcon nests are typically found around trees and shrubs at elevations of 1,000 to 15,000 m (Jennings 1981;1995, AlRashidi 2004b). We separate our study area

into three regions based on geographic location and habitat characteristics; southwest (A), northwest (B), and central (C), with a total area of 6,725.3 km² (Figure 1).

Southwest (A). Region A included approximately 1,442.4 km² and ranged from Jizan City in the southwest of Saudi Arabia to Taif City in the northwest; 17.63973°N 43.25195°E to 21.77573°N 40.43945°E. The climate is moderate and it rains throughout the year with more rain occurring during the summer. The average low temperature is 20º C and the average high is 25º C (Jennings 1995, Vincent 2008). This region includes two primary mountain ranges, Sarawat and Tihamah. The Tihamah Mountains are located on the coastal plain that separates the Red Sea from the western bordering mountains of Saudi Arabia; from the Gulf of Aqaba south to the Bab el Mandeb Strait. This range on average has less rain and a more moderate climate in winter than the rest of the region. The Sarawat Mountains extend from northern tip of Yemen north to Taif City, Saudi Arabia. This range is characterized by steep slopes in the west with small open areas between peaks (Jennings 1995, Vincent 2008). The highest peak is located in region A is Souda Mountains at 3,015 m. Agricultural practices in the area rely on seasonal precipitation. Crops include bananas, mangos, oranges, apples, coffee, corn, and wheat. The Sarawat Mountains are rich in wildlife, and many unique wildlife species occur in the area including the South Arabian Leopard *Panthera pardus nimr,* Arabian red-legged partridge *Alectoris melanocephala*, and the Cape hare *Lepus capensis*. Plant communities in the Sarawat Mountains transition with elevation, with the juniper woodlands at highest elevations followed by olive woodlands and arid woodlands at the lowest elevations such as *Acacia-Commiphora, A. hamulosa, Olea europaea subsp. africana, Juniperus*

phoenicea, A. totilis, A. ehrenbergiana, and Commiphora spp. (Jennings 1995, Vincent 2008).

Northwest (B). Region B includes approximately 3,009.6 km² and extends from Mecca City, Saudi Arabia in the south to the border of Jordan in the north; 21.73700 ° N 40.54443 ° E to 29.22496 ° N 36.19873 ° E and 27.60168 ° N to 41.47217 ° E. The largest mountain range is the Al Hijaz Mountains, which are located at latitude 28 to 26 north, to the north of Al wajh City. The highest peak is Rwaggn Mountain (2,393 m) in Al Madinah City. The average low and high temperatures are from 28º C to 42º C in summer, and 8º C to 22º C in winter. Almedina Mountain extends south of latitude 28 north to the border of Jordan and the highest mountain peak is Alloz Mountain 2,549 m in Tabuk City. Average high and low temperatures in summer are between 25º C to 40º C and from 5º C to 25º C in winter (Jennings 1995, Vincent 2008). Hasma Hill is located in the north west of Saudi Arabia to the east of Madina Mountain and from west and northwest of Tabuk City. The mountain ranges from 800 to 1,700 m (Vincent 2008) in elevation below mean sea level. In the central hills of Najd Plateau, the average altitude is between 500 to 1,000 meters, characterized by igneous and metamorphic rocks. The highest mountain is Aja Mountain (1,544 m) in Hail City. The average low and high temperatures are from 30º C to 40º C in summer and in winter between 5º C to 15º C. Plant communities in the Al Hijaz Mountains transition with elevation and were similar to the Sarawat Mountains (Jennings 1995, Vincent 2008).

Central (C). Region C is approximately 2,273.3 km² and ranges from Wadi al-Dawasir City north to Al-Qassim City, Saudi Arabia;19.92993°N 45.13672°E to 26.64545°N 43.98315°E. The area consists of small discontinuous mountains and hills. The average

mountain range is from 500 to 1,700 m and the highest point is 1,196 m in Tuwaiq Riyadh City. The average high and low temperatures in summer are 50º C and 5 º C in winter. Plant communities in this region are difficult to classify; in general, there are xeromorphic dwarf shrublands and meadow which often develop after rains and contain *Acacia spp., Lychium shawii, Tamarix spp., Astragalus spp., Fagonia spp., and Plantago spp.* (Jennings 1995, Vincent 2008)

Nest Monitoring

Field work began on 3 March 2015, by collaborating with Alaradi Falcon Conservation Center (AFCC). Alaradi Falcon Conservation Center provided nest locations and assisted with coordination of 73 professional falconer volunteers from all study areas. With this aid we gathered the locations of all active and inactive (historical) nests before we began field work. We documented species, date last observed, and mountain elevation for each site visited.

We used three methods for detecting falcons at nest sites when they were not initially observed. We would first play a recording of a BF pair, followed by flying a trained falcon, and lastly releasing a pigeon (if the other methods failed to detect falcon). A recording of a breeding pair of BF was played for five-minute-intervals until a falcon was observed. If this first step failed, a trained BF juvenile female was flown within the vicinity of the nest. If the first two methods failed, a pigeon was released within the vicinity of the nest during the peak feeding times, at sunrise and sunset.

All active and inactive nest site locations visited were recorded using a handheld Garmin GPSMAP 62 Global Positioning System (GPS; Garmin Ltd.), ArcGIS apps on IPhone

5+, and then entered into ArcGIS 10.2.2 (Environmental Systems Research Institute, Redlands, CA, USA). We used binoculars (Binocular Nikon 10*42 5.5), spotting scopes Swarovski Optik 20x 30x 40x 60, Tripod (Swarovski), and Canon EOS 700D Digital SLR Camera and 18-55mm EF-S IS STM Lens at every site we visited to document and observe behavior.

If we located an active nest, we would try, if possible, to access it on foot and record observations of nest activity (e.g., feeding, incubation, defending the nest). At each nest we recorded the date and time of observation, took pictures, and note pair behavior such as incubation and fledgling. We considered the nest successful if at least one chick successfully fledged.

All animal handling procedures followed guidelines approved by The Ornithological Council (Fair et al. 2010) and were approved by the Institutional Animal Care and Use Committee at South Dakota State University (Approval No. 13-002A) and Taif University. Lanner Falcon and BF are not endangered or threatened species and both are listed as least concern according to the IUCN Red-list of Threatened Species (Birdlife International 2013, IUCN 2015).

Statistical Analysis

Habitat Measurements. We used ArcGIs to record the elevation and location of all active and inactive nests of Lanner Falcons and Barbary Falcons.

Reproductive Parameters

Predicted Nest Survival Analysis. Nest survival was estimated with a modified logistic regression in Program R (R Core Team 2014), which accounted for the number of exposure days using a log-link function (Shaffer and Burger 2004). Survival was used as the binary response (1 = survived, 0 = failed). We initially explored the relationship between the response and the predictors "nest date" which represented the median date between visits. The quadratic form of "nest date" and "incubation status" which defined if the nest was incubating or hatched in both interactive and fixed effect models. Using an AIC framework for model selection (Posada and Buckley 2004), "incubation status" and the linear form of "nest date" were chosen in the form of an interactive model to predict survival. The output from this model produced a value for daily nest survival (DSR). Daily nest survival was transformed to a relevant metric of nest success using the known average incubation and fledging periods of BF, 30.5 and 37.5 days respectively (AlRashidi 2004b). The mean DSR for incubating nests was raised to the power of 30.5 and multiplied by the mean DSR for hatched nests raised to the 37.5 power which output a survival prediction for the combined 68 days of incubating and fledging (Steenhof et al. 2007). Standard errors for the transformed nest success value were calculated using the delta method in Program R (Powell 2007, Steenhof et al. 2007).

Apparent Nest Survival Analysis and Productivity

Apparent nest survival was calculated (successful nest/total nest) where the nest fledged at least one chick. Productivity was calculated (total chicks/total nests). Chick sex ratio was determined by the number of identified chicks by gender/total fledging from the same identified nest. Fecundity was determined as number of females produced per female.

Trapping History

Unpublished harvesting data for the years of 2010, 2011, 2012, 2013, and 2014 were collected by Abdurrahman Alghamdi, a graduate research assistant at King Saud University, and other falconers that were interviewed at AFCC. We also gathered information from Instagram and other social media. We documented the number of adult and juvenile LF and BF trapped each year.

RESULTS

Nest Monitoring

The three methods we used for detecting falcons at nest sites were effective in finding unobserved falcons. For the recording method, on one occasion, the nestlings responded to the recorded sound. On another, the pair flew and made a defensive sound. When a trained falcon was flown, most of the time another falcon would come to defend their nest territory. Lone males would try to court with our female falcon and females would try to force our falcon out of their territory. None of the falcons were injured or came in contact with each other. When pigeons were released, falcon pairs usually would chase the pigeon, especially at feeding time.

Nest Status and Locations

We documented several subspecies of Peregrine Falcon (PF) *Falco peregrinus* that breed in Saudi Arabia, including: *F. p. nesiotes, F. p. brookei, and F. p. pelegrinoides*. *Falco p. nesiotes and F. p. brookei* are not native to Saudi Arabia and are thought to be products

of cross breeding of native and introduced falcons (Figure 2). These cross breeds are referred to region as Shahin Jablay and will be hereafter referred to this way. There were 1,255 historic nests reported within the study area. Of these 1,255 nests, only 111 (8.6%) were active and all were Shahin Jablay (Table 1 and Figure 3). In 2015, we located a total of 530 LF nests (12 nests in region A, 485 nests in region B and 33 nests in region C). None of the LF nests found in 2015 were active. We located a total of 725 Shahin Jablay nests (614 inactive nests and 111 active nests). In region A, there were 53 active nests and 122 inactive nests. In region B, we found 51 active nests and 424 inactive nests. In region C, we found 7 active nests and 95 inactive nests.

In 2015, there were 28 inactive nests that were occupied by males (6 nests in region A, 19 nests in region B, and 3 nests in region C). Forty falcons (both male and female) were purchased from trappers and released by falconers. Two of the females from the 111 nests had escaped from their owners, two pairs were new wild couples, and 6 were bought from the market and released by a falconer. Twenty nine pairs were trapped in the 2015 harvest season. Three pairs, 2 Shahin Jablay and 1 LF, abandoned their nests due to construction.

Nest Elevation

Our result documented differences in the elevation between the active and non-active nests. Inactive LF nests elevation (mean) was 1,127.6 m (SE = 36.7, CI = 1055.7, 1199.42). For Shahin Jablay, mean elevation of non-active nests was 1,547.4 m (SE = 62.8 m, CI = 1424.26, 1670.6) and active nests was 1,942.4 m (SE = 65.9 m, CI = 1813.24, 2071.52).

Reproductive parameters

Nest Survival Analysis and Productivity. Nest survival for breeding nests was 0.50% (*n* = 69). Productivity for all nests was 1.33 fledge/nest (*n* = 69). Individually, productivity for region A was 1.47 fledge/nest (*n* = 32), region B was 1.27 fledge/nest (*n* = 26), and region C was 1.09 fledge/nest (*n* = 11).

The apparent nest survival for all nests was 50.7% (*n* = 69). Apparent nest survival for region A, region B, and region C was 56.2% (*n* = 32), 50% (*n* = 26), and 36.3% (*n* = 11) respectively. In all regions, all fledglings that left the nest were trapped. The average brood size was 2.6 (range = 1-4). The distribution of nests with 1, 2, 3, and 4 fledglings per nest was 5.7% (*n* = 2), 37% (*n* = 13), 45.7% (*n* = 16), and 11.43% (*n* = 4), respectively. The sex ratio was 68.4% female and 31.6% male in 15 nests with 38 chicks where sex was determined; fecundity was 1.73.

Trapping History

Harvest season started on 8 April 2015 and ended on 7 August 2015. Typically, trappers trap migratory falcons (e.g., Saker Falcon (SF) *Falco cherrug* and PF). Native falcons are trapped between mountains and migratory falcons are trapped near the Red Sea (See Shobrak 2014). Approximately 1,171 pairs of falcons were trapped 1999-2015: 472 pairs from 1999 to 2000, 229 pairs from 2000 to 2005, 220 pairs from 2005 to 2010, and 250 pairs from 2010 to 2015 (Table 2 and Figure 4).

Most falcon nests were known to trappers so they waited near the nest until the chicks fledged. According to our survey the total number of native LF and Shahin Jablay trapped in 2015 was 216 falcons (204 Shahin Jablay and 12 LF), 17 of which were adults

(3 LF and 14 Shahin Jablay). Nestlings (*n* = 17) also were taken from nests (Table 3 & 4). There was a sharp decline of trapped native LF and BF and a high number of LF and Shahin Jablay that were imported and smuggled to the Middle East from other countries.

DISCUSSION

Population Status and Trapping History.

Our result suggests that BF may become extirpated in the near future from the Middle East. Morphological features suggest some nesting BF may have belonged to various subspecies. AlRashidi (2004) documented the population status of BF in some parts of region B had declined and did not document any nesting pairs of LF. Only 2.27% of BF nests documented active by AlRashidi in 2004 were active during our study. Only one active nest did not succeed in fledgling because trappers captured all their chicks in every season and the pair may now be too old to produce chicks. A trapper reported a nest where he had trapped the female and the chicks and left the male for 7 consecutive years. The male brought a new female every year. In 2015, the male was with a migratory female Peregrine Falcon *F. peregrinus*, no chicks were documented, and the PF female left the area on 20 May 2015.

More than one thousand juvenile and adult Shahin Jablays were imported or smuggled to the Middle East. This indicates the native BF population may be threatened globally. Moreover, 2004 and 2005 were the two years with the highest number of trapped pairs cumulatively (Table 2). We believe this was because Saudi Wildlife authority put a ban on trade of falcons because of avian influenza virus (H5N1), which increased the pressure

for trapping native falcons (Saudi Arabia Stop Importing Birds 2004, Marjuki et al. 2008).

Our result suggests that free ranging LF maybe close to be extirpated from Saudi Arabia with less than 14 chicks and adult trapped in the entire country. Jennings (1995) maintained that LF might become extinct as a breeding species in Arabia in the near future. Lanner Falcons are threatened in Europe (Vittorio et al. 2015), due to high harvesting and no protection. Our results indicate that nests persist where falconers protect pairs; when the pair gets trapped, the falconers will buy them and release them back into the wild. In the harvest season of 2015, trappers protected nests by trapping the pair and keeping them in a safe place until the trapping season was over.

Barbary Falcon used to be the only subspecies of PF native to Saudi Arabia. An Arabian falconer named all small size subspecies of PF as Shahin Jablay. Moreover, we documented different colors that breed in Saudi Arabia and many import small size subspecies of PF as BF. Further research may help identify all subspecies of BF in Saudi Arabia.

Nest Elevation

Jennings (1981) and Alrashidi (2004) documented that LF was found at elevations ranging from 700 to 1,000 m utilizing open areas. Barbary Falcons are found from 1,000 to 1,500 m in seasonally wet ravines with trees and shrubs. Both species were found in mountain sites with sharp rocky cliffs and selected mountain caves for nesting in Saudi Arabia (Baldwin and Meadows 1988, Bundy et al. 1989, Jennings 1995, AlRashidi 2004b). Our data indicate that nests at high elevation and with difficult access were found

active in 2015. This may indicate there are active nests at higher elevation and therefore hard to access which we might not have documented. However, the total number of trapped chicks from unknown nest locations was 98. Using nest productivity data from our results, there may be an additional 73 undocumented nests.

Reproductive Parameters

The three methods we used for detecting falcons at nest sites were effective in finding unobserved falcons and improved our efficiency in finding nesting pairs. Nest survival of Shahin Jablay was lower than BF in the Tenerife, Canary Island, which was 81.1% in the Rodríguez (2007) study and 89.2% in the Siverio (2011) study. During our study brood size was higher than compared to Siverio (2011). During the breeding season we documented trappers releasing domestic pigeons every week to feed falcons at various locations. Moreover, the nests we documented were not all BF; some of them were other subspecies of PF. This might have influenced our productivity and nest success counts. Barbary Falcon are facing the same threat as well. There were only 111 nests documented from our study, and the number of Shahin Jablay trapped was 191 (177 chicks and 14 adult). Due to this heavy harvesting, the population of Shahin Jablay may not be able to recover.

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Figure 1: Falcon study regions A, B, and C in Saudi Arabia.

Figure 2: Several morphological forms or subspecies of breeding *F. peregrines* in Saudi Arabia, which are all collectively referred to as *F. p. pelegrinoides* or Shahin Jablay.

Figure 3: The distribution of *F. p. pelegrinoides* /Shahin Jablay & *F. biarmicus* in Saudi Arabia. Active nest density (top left) and inactive nest density (top right) for *F. p. pelegrinoides/* Shahin Jablay. Inactive nest density for *F. biarmicus*.

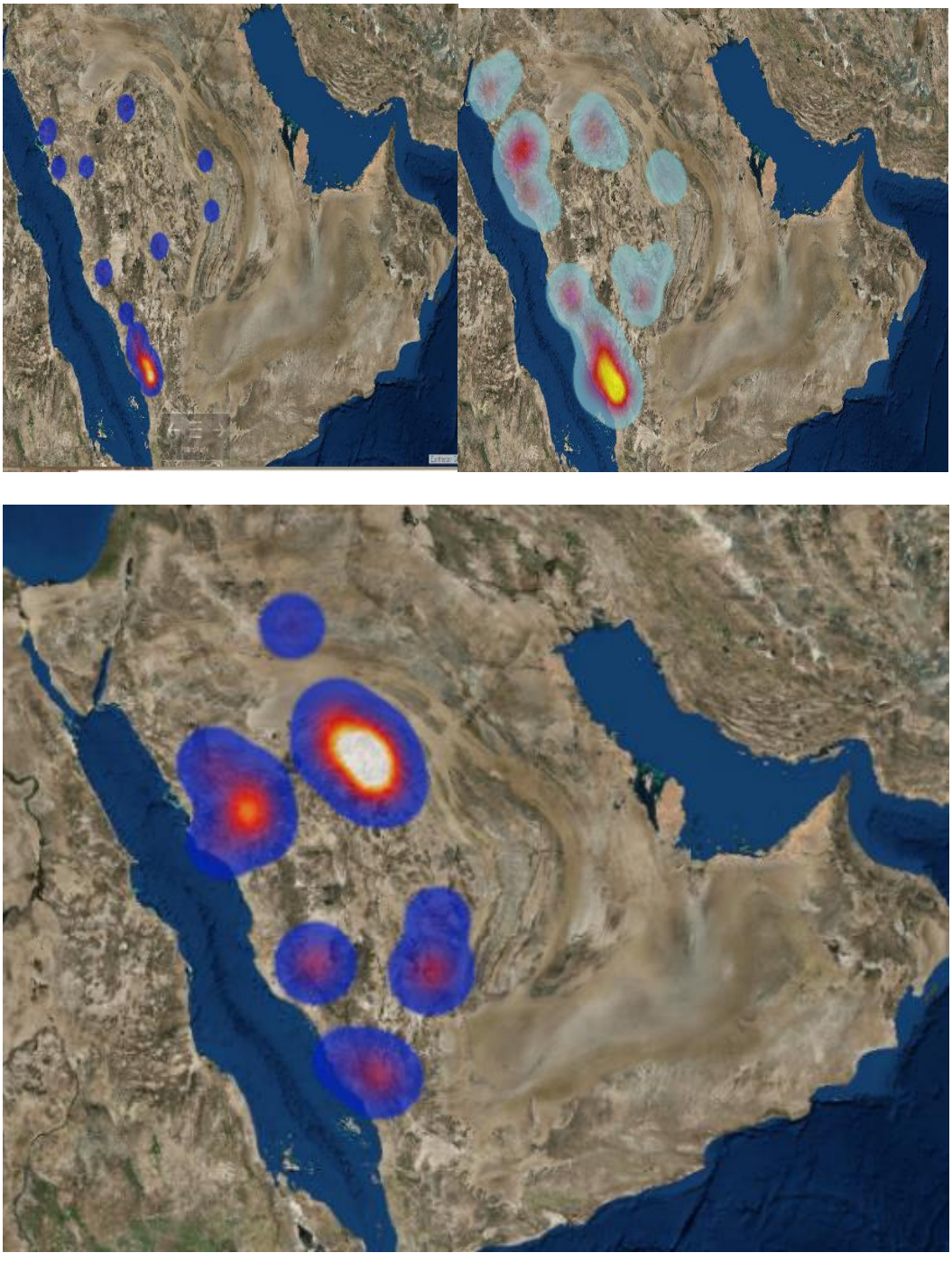

Figure 4: Locations of trapped *F. p. pelegrinoides* (blue) and *F. biarmicus* (red).

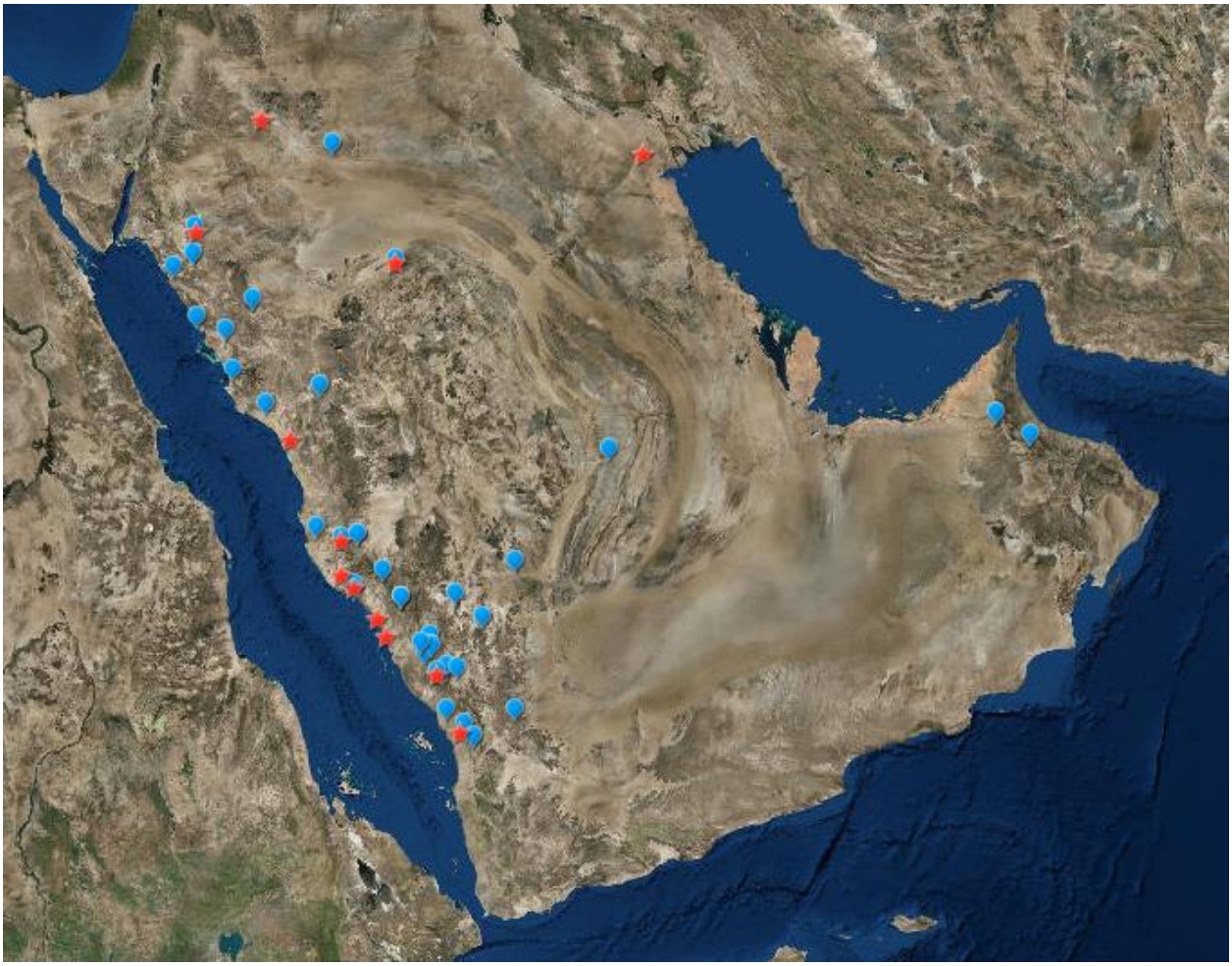

Figure 5: Nest locations of *F. p. pelegrinoides* (* - Al Rashidi 2004, # - Jennings 1995).

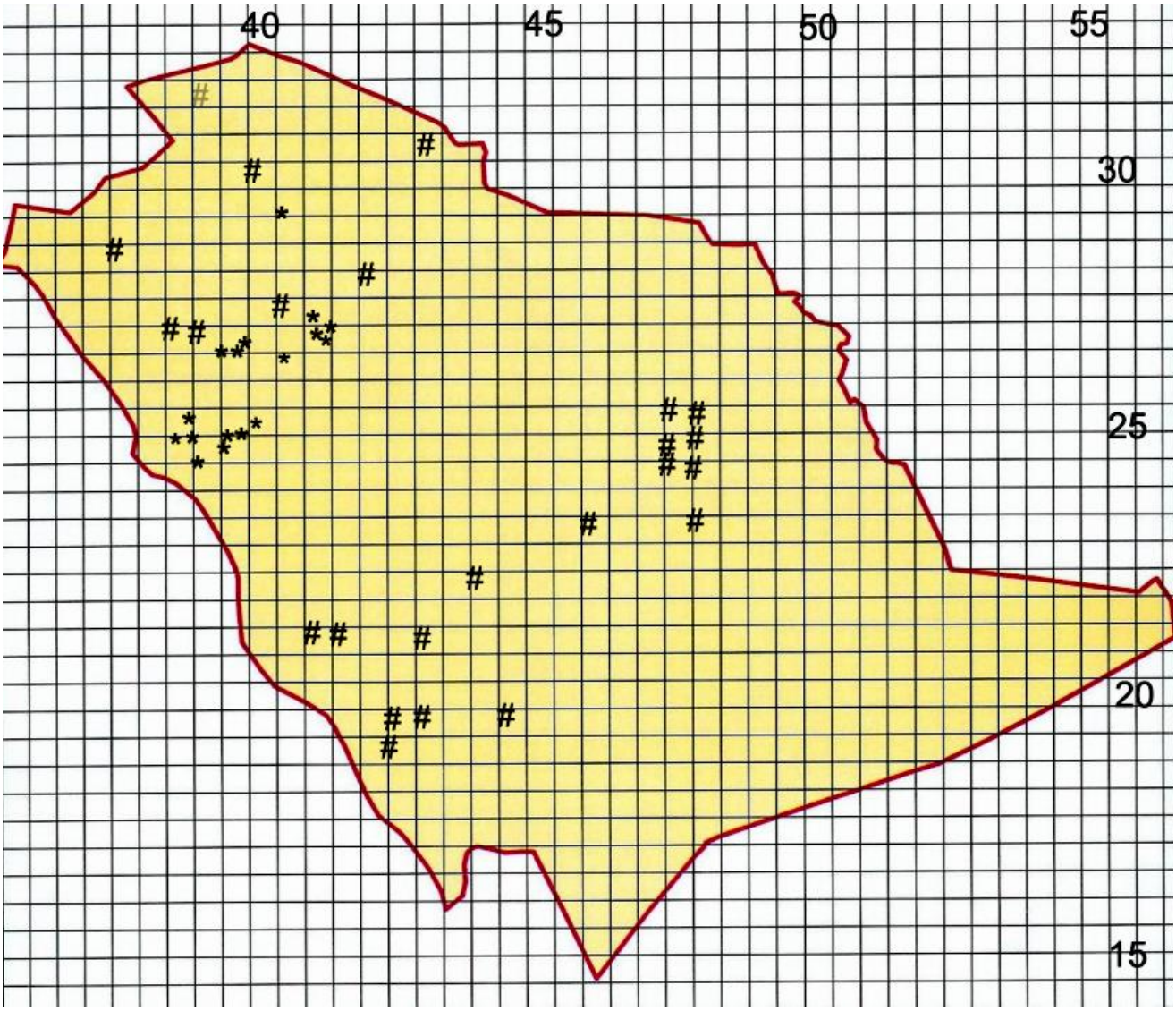

Table 1: Composition of all nests reported in Saudi Arabia.

Species	Number of nests	Active nests	Inactive nests	Percentage active
Shahin Jablay	725	111	641	14.76%
F. biarmicus	530	0	530	0%
Total number for both species	1,255	111	1,171	8.66%

Table 2: Pairs of *F. biarmicus* and *F. p. pelegrinoides* or Shahin Jablay trapped by from 1999-2015 in Saudi Arabia.

Year	Inactive nests	Year	Inactive nests	Year	Inactive nests
1999	306	2005	103	2011	64
2000	166	2006	27	2012	56
2001	36	2007	30	2013	41
2002	30	2008	47	2014	60
2003	29	2009	24	2015	29
2004	31	2010	92	Total	1171

Table 3: The number of reported *F. biarmicus* and *F. p. pelegrinoides* or Shahin Jablay illegally trapped from 2010-2014 in and out the Middle East.

Locations	2010	2011	2012	2013	2014
F. biarmicus in KSA	*	19	18	24	2
Shahin Jablay in KSA	84	144	97	166	100
F. biarmicus from outside KSA	559	518	427	620	1440
"Shahin Jablay" from outside KSA	225	265	229	165	1050

* denotes unknown number of falcons.

Table 4: The number of falcons trapped by country during 2014.

Country	*F. biarmicus*	Shahin Jablay
Iran	0	150
Yemen	30	200
Turkey	0	100
Libya	800	500
Sudan	300	20
Egypt	300	50
Jordan	10	30
Total	1440	1050

Table 5: Composition of reported nests in part of region B from 2004-2015 (AlRashidi 2004).

F. p. pelegrinoides	2004	2015	Percentage
Active nests	13	1	2.27%
Inactive nests	26	44	
Male with no females	6	1	

Summary of Falcon Conservation in Saudi Arabia and Recommendations for Sustainable Use

Albara M. Binothman

INTRODUCATION

Biodiversity can be defined as the variety of life found in an ecosystem or habitat (Sodhi and Ehrlich 2010). The manifestation of different species and apparent life forms in small or large environments exemplify the meaning of biodiversity. Conservation biology is the understanding that protecting species from various conflicts that affect these species and their ecosystems in general are important as well as looking for the best way to apply conservation methods. The importance is in understanding all of the variables that are causing problems in order to solve them (Sodhi and Ehrlich 2010).

The art of falconry hunting is active in more than sixty countries. The Chinese used falcons for hunting as early as 700 BC and falconry in Japan began in the 3rd century AD (Kenward 2009). People who lived in central Saudi Arabia were using falcons more than 9,000 years ago (The Roots of Purebred Arabian Horses 2016). Falcons are one of the most respected animals in Arabian culture, and an honorable hobby or pastime in other nations. Falconry awareness has increased tremendously over the last few years, as there is an apparent love and respect for these fascinating animals.

Our research indicates there are significant numbers of falcons in captivity, and as a result, falconry technology and techniques have advanced significantly. Some of the reasons for the increase in numbers in captivity include: culture, hobby, money, media, competitions, and fashion. This in turn has created an increase in the consumption and

prices of falcons. Historic evidence of a preference for unique morphology and shapes of Lanner Falcons (LF) *Falco biarmicus*, Peregrine Falcons (PF) *Falco peregrinus* and Saker Falcons (SF) *Falco cherrug* indicates they might become extirpated as migrant or resident falcons in the Middle East. A lack of regulations may contribute to extinction of sub-species. We discuss potential solutions for this problem and separate them into five stages: Understanding the History and the Need for Falcon Consumption, Control and Eliminate Any Current Damage, Releasing Native and Migrant Falcons, Long-Term Damage Control and Monitoring, and Additional Research.

UNDERSTANDING FALCONRY HISTORY

Historically, Middle Eastern falconers used various raptor sub-species. Kashm 968, mentioned that Arabian falconry used eagles, falcons, and hawks. Over time, Arabian falconers came to prefer falcon species more than other raptors. Arabian falconers observed that falcons hunt different kinds of prey, are typically faster, and are easier to train. Arabian falconers stopped using other raptors, and very few falconers today have other species. Today, hunting with falcons has increased and falconry has changed from being a way of life to a hobby.

In the past, Arabian falconers released their falcons after the hunting season was over (Allen 1980, Upton 2002), which helped sustainability. Today, we have approximately 9,000 falcons in captivity in Saudi Arabia. This high number of falcons in captivity as well as the large number of falconers creates environmental and social constraints on the ecosystem in the Middle East (i.e., falcons and prey species). The government has begun

to shift falconers from hunting prey species in the wild to promoting falcon competitions. Today, there are many competitions all around the Arabian Gulf. There are currently two main types of competition: speed and beauty. These competitions affect the subspecies of SF as the competitions are focused on appearance and size. The size and color of falcon preferences may affect the subspecies genetic diversity in the future and lead to selective breeding.

CONTROLLING AND ELIMINATING THE DAMAGE

Many falconers agree that wildlife organizations and projects do not do enough to protect LF and Barbary Falcon (BF) *Falco peregrinus pelegrinoides*, nor other game species. Education and legal protection are the most effective tools to protect and save raptors (Richardson and Miller 1997). However, falcon conservation awareness and education may have limited success because most of the information about these falcons is found in different languages such as English. The majority of Middle Eastern falconers speak Arabic. There are limited documentaries, small clips, brochures, and books that speak of or highlight falcon ecology, husbandry, and problems that a falconer might encounter. We need to make the problem clear and support projects that provide information about falconry challenges with different aspects, opinions, and angles such as over trapping, and trapping females and adult falcons. It is important to support projects that highlight the status of falcons, which will help to change human attitudes and behavior towards the issue. Education is the most effective tool to increase environmental sustainable use awareness (Europa 2002).. Highlighting the problems and providing the

solutions to all parts involved will require a great deal of effort. The forming of falconer institutions will bring us closer to solving this conflict.

RELASING NATIVE AND MIGRANT FALCONS

Providing insight into release methods and support for release projects will help falconers release their falcons safely. Projects that aid in freeing captured falcons could be a beneficial tool that could help bolster falcon populations in the Middle East. It will not only increase the current falcon population, but it will allow falconers to be a part of the conservation process. Additionally, such a release project will help to increase the wild population of falcons, and aid in further research such as migration routes and nest success. We have to produce a permitting regulatory regime to stop the trapping and selling of adult falcons, and trapping and selling male falcons, because there is little to no demand for them. Perhaps a fine will be necessary for trapping male or adult falcons and taking chicks from the nest. Juvenile SF and PF can sustainably withstand a harvest with a conservation fee (trapping and buying the falcons) imposed. This agrees with Cade (1979) that trapping and releasing juvenile falcons in the late winter may increase their winter successes.

Other regulations need further study. We have to make something perfectly clear: the only reason that 111 nests of BF are still active is because falconers were present to protect the nests. We need falconers from all regions to become involved in every aspect of falcon conservation strategies. We have to support falconers that want to protect falcon nests by employing and giving them ID’s to promote communication with other falconers

and make them feel that they are a part of the solution. The more falconers are involved, the higher the impact.

LONG TERM DAMAGE CONTROL AND MONITRING

Falcon Clinics and Research Facilities

Falcon clinics and research facilities are a critical part of the solution in saving falcon species in the Middle East. Many falconers would like to have a falcon club with a small clinic in their region. This could make a difference in a falcon's lifespan. There are only 3 falcon hospitals, which are located in the center of Saudi Arabia. They serve 9,000 falcons, and it is very hard for falconers to travel great distances to treat their falcons. As we know, birds of prey cannot withstand diseases for a long time. Typically, these falcons die within a few days of catching a disease (Doneley 2010).

Wildlife Refuges

Wildlife refuges are simple concepts that are needed in all parts of the Middle East to help protect wildlife. We have to protect the habitats for LF and BF, along with providing protection outside the refuges. One of the most important things that affect native LF and BF in Saudi Arabia was that most of their habitats found were outside the Saudi wildlife authority refuges. For example, Al Khar Mountain which is located in the south of Saudi Arabia, has the highest number of BF nests. There were more than 46 historic nests, and today there are only 15-25 active BF nests because the area is not protected.

Falcon refuges may benefit other species. Introducing extirpated local species and protecting them from hunting or any disturbance may subsequently increase their numbers. This also may work towards increasing genetic diversity of many threatened species. These areas may provide needed refuge for threatened species such as: Lappet-faced Vulture *Torgos tracheliotos*, Egyptian Eagle *Neophron percnopterus*, Bearded Vulture *Gypaetus barbatus* , Arabian Magpie *Pica asirensis*, Greater spotted eagle *Clanga clanga*, Sociable Plover *Vanellus gregarious*, Slender-billed Curlew *Numenius tenuirostris*, and White-headed Duck *Oxyura leucocephala*. Moreover, falcon refuges may provide area for other endangered species such as: Arabian leopard *Panthera pardus nimr*, Kori bustard *Ardeotis kori*, and the Arabian woodpecker *Dendropicos dorae* that have been near or extirpated from the Middle East.

Developed Captive Breeding

Captive breeding is one of the key actions we can take to save falcons and the falconry culture. The consumption and prices of wild falcons have increased, and more falcons will be trapped in the future. The total price of 198 falcons in 2014, wild SF and PF, was $2,750,184.62. There are many good markets for captive breeding and information about captive breeding has become easier to find. We have many examples of how captive breeding has helped and saved species such as the California condor *Gymnogyps californianus* and PF in North America (Cade et al. 1996, Meretsky et al. 2000). Captive breeding can be a tool for reintroduction research, education purposes, and falconer consumption (Platt 1977). With more than 4,500 wild falcons trapped and imported (legal and illegal) to the Middle East in 2014, we need to increase captive breeding knowledge and then support falconers and breeders to breed their falcons instead of trapping wild

falcons each year. Captive breeding also may help threatened falcon species through reintroductions. There have been no active nest sites documented for resident LF in Saudi Arabia. Currently, Alaradi Falcon Conservation Center AFCC has two pairs of native LF, which they have tried to breed and release. The Conservation Breeding Specialist Group (CBSG) might offer its help in this circumstance. The Conservation Breeding Specialist Group is the oldest and largest global environmental organization. Their mission is providing effective conservation plans to save threatened species.

International Falconry Regulation

Falconry has been used all around the world. Different nations have different ways of hunting and different prey and raptor species. It commenced more than 9,000 years ago. The need for international falconry regulation with effective enforcement is crucial in saving falcon species and falconry culture all around the world for the next generation. The regulation has to be standard like any other type of hunting. With international regulations we might create a sustainable use of these wild falcons.

Falconry Exchange

It may be beneficial for falconers from different countries to visit other countries and encounter a cultural exchange between falconers. It is important to increase awareness and conservation knowledge, and this can be done in many different ways. One of the solutions is having falconers visit other refugees. This way they can see wildlife in other countries and be exposed to different kinds of regulations and knowledge. That may help them to understand different aspects of falconry. Falconry is about enjoying one's time in the wild and seeing the same activity that has been experienced for more than 9,000

years. Falconry is not like any other method of hunting game and this needs a unique method of regulation. Opening the door for hunting, trapping falcons, and communicating with other falconers with different cultures might increase the awareness process.

ADDITIONAL RESEARCH

During this study, we documented different colors and shapes Lanner Falcons and Barbary Falcons; white and red/black. These falcons require additional research. It just might be that they are hybrid falcons or these colors are from different subspecies mixing with native species. Moreover, the size of Lanner Falcons in the north appears to be larger than those of the south of Saudi Arabia. What is behind this diversity in a small area? Do hybrids affect resident Lanner Falcons and Barbary Falcons? Or Fst values, which means that falcons have been breeding in closed areas due to overharvesting which make the colors and size different. Falconry has been used for centuries and the Middle East is the falconry capital of the world, where there are more falconers and falcons in captivity than any other place in the world. Many falcons have been lost or released during and after hunting season. These falcons may have cross-bred with the native falcons, and this was apparent in their color pattern. Further studies are needed to understand the issue and save the original species if there is an effect on the population.

Understanding Other Conflicts and Challenges

It is important to protect the ecosystem and evaluate falcon sites before announcing release projects. Many nesting locations have been previously occupied by other raptors such as the Lesser kestrel *Falco naumanni*, and some hawks. Moreover, the majority of

falcon nests are located in close proximity to human activity. That makes them an easy target. Human activity such as physically harming or killing eggs, young, or adults, and altering habitats and disrupting normal behavior, are all known to impact raptors (Postovit and Postovit 1987). During the 2015 harvesting season, approximately 18 juvenile Barbary Falcons were taken from their nest; three adult female Barbary Falcons were trapped and sold during the breeding season (chicks died at the nest and one male found by itself); and 3 historic falcon nests (1 = LF, 2= BF) were abandoned due to construction.

Releasing falcons should be done at the same time as promoting falconer awareness and apply regulations to avoid human disruption. Furthermore, research concerning prey species are critical. As many as 1,255 nests have been abandoned and limited information exists concerning the prey species in proximity to nest sites. Information that applies: isotopes to known delivery items; DNA feather blood sampling to know where migrant routes are located; and classification. This is an important strategy for falcon conservation.

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