Peregrine Falcon Monitoring in Clark County, 2009-2010
2005-NDOW-549-P Final Project Report

Nevada Department of Wildlife
Wildlife Diversity Division

Final Project Report

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EXECUTIVE SUMMARY

- Known peregrine falcon breeding territories were monitored Clark County in 2009 and 2010 for occupancy, success and productivity.
- In 2009 and 2010 combined, over 146 hours were spent driving nearly 5,000 miles, followed by 186 miles hiked in order to conduct 167 hours of peregrine survey observation.
- Exploratory surveys were conducted in 2010 using a recently developed Call-broadcast survey technique in order to locate and document new territories.
- The Call-broadcast efforts were used in conjunction with a predictive habitat suitability model. 143 call-broadcast surveys were conducted, across 151 miles, resulting in 6 potential new peregrine falcon territories.
- A minimum of 16 breeding territories are known to exist, and nine pairs were successful in producing 19 successful young in 2010.
- All breeding indices (occupancy, success and productivity) were within the USFWS recommended ranges.
- Peregrine falcons appear to be expanding in Clark County, and increased survey effort has also contributed to a recent steep increase in known territories.

BACKGROUND

The American Peregrine falcon (*Falco peregrines anatum*) is a wide-ranging, cliff-dwelling species that exhibits a high degree of territoriality and breeding site fidelity. Strong attachment to nest site may be a main reason mates remain paired from year to year, rather than attachment to each other as individuals (White *et al*, 2002). Additionally, recruited young exhibit nesting site fidelity, often returning to breed in similar habitat (e.g. natural cliffs vs. urban structures) (Cade *et al* 1996). Pairs often use the same cliff, and frequently the same eyrie from year to year, but occasionally have alternate nesting sites, usually on the same cliff or within a few kilometers. Peregrines utilize a variety of habitats containing cliffs that generally overlook broad, expansive landscapes, and regional populations are sometimes highly associated with dendritic or large bodies of water (Grebence and White 1989). Increasingly, peregrines will also take advantage of urban structures with high-rise buildings serving as cliff surrogates. Peregrines utilize habitat on three levels: nesting site, territory, and home range. The specific nesting location is known as an eyrie, and an individual territory may contain more than one eyrie, used in different years. Peregrines do not construct nests, stick or otherwise, instead laying eggs directly on the ground substrate at the nesting site, such as a ledge or hole in the cliff face. Occasionally peregrines will utilize old existing stick nests, usually constructed by red-tailed hawks or golden eagles. A nesting territory is an area that contains an eyrie(s) that has been occupied by a breeding pair, and is defended by the pair. The territory is usually not less than 1 km^2 (Cade 1960) and will contain the eyrie, and adjacent perching sites and foraging areas. Home range is the hunting area beyond the defended territory boundary. Peregrines feed mainly on other avian species, and occasionally small mammals, especially bats.

The historical distribution of the peregrine in Nevada is somewhat sketchy. Prior to 1985 the last known active eyrie in Nevada was observed in 1959 and in the years following peregrines were thought to have been possibly extirpated as a breeding species in the State. Following dramatic declines over much of their range in North America, the species was listed as endangered in 1970 under the precursor to the Endangered Species Act of 1973 (as amended) (ESA). A subsequent ban on DDT (dichlorodiphenyltrichloroethane) and other eggshell-thinning chlorinated hydrocarbons, along with nationwide artificial hacking efforts involving the managed release of young into the wild, allowed the species to begin to recover. The Nevada Department of Wildlife (NDOW) contributed to this effort beginning in 1984 by conducting a series of juvenile peregrine falcon releases in Ruby Valley in Elko County as well as a hacking project on urban structures in Clark County. In 1985 an active breeding pair was documented on Lake Mead, and over the next few years additional territories were discovered. The U.S. Fish and Wildlife Service (FWS) delisted the peregrine in 1999, and in 2003 the "Monitoring Plan for the American Peregrine Falcon, A species recovered under the Endangered Species Act" was published. This post-delisting monitoring plan is the culmination of the final process of species recovery, as mandated in section 4(g) (1) of the ESA, which requires that the FWS "implement a system in cooperation with the States to monitor effectively for not less than five years, the status of all species which have recovered to the point at which the measures provided pursuant to this Act are no longer necessary" (USFWS 2003). Three known territories in Nevada were randomly selected to be monitored every three years through 2015, with the resulting data incorporated into the FWS regional and nationwide triennial population status analysis. Although only data from the three sites are required, partners throughout Nevada have endeavored to monitor all known sites and provide annual data to FWS, per their request. The plan is designed to detect a significant decline in territory occupancy, nest success, or productivity in numerous monitoring regions across the United States (Green *et al* 2006). The document also provides recommended survey and monitoring standards and protocols.

Following re-discovery of peregrines in Nevada in 1985, State and federal partners increased survey efforts which resulted in a sustained increase in discovered territories, most of which were located on the Lake Mead National Recreation Area (LMNRA). While peregrines will nest in cliff habitat associated with open gulfs of air and overlooking generally open, exposed landscape with adequate prey base, they usually prefer cliffs adjacent to water; therefore, most attention and effort was focused on LMNRA due to the concentration of high-quality cliff habitat and prey availability along the lake shores. Currently the steep cliffs adjacent to the shorelines of Lakes Mead and Mojave may contain the core breeding population of peregrine falcons in Nevada, and contribute substantially to a broader distribution of regional breeding peregrines (Barnes and Jaeger, 2010). The relatively recent increase in breeding numbers of peregrines in southern Nevada may also be attributable to birds expanding west and north out of the canyon lands of northern Arizona along the Colorado River. By the mid-2000's, the National Park Service (NPS) began intensively monitoring and searching for new territories, allowing (NDOW) to redirect survey and search efforts to areas outside of the LMNRA. In 2001, only two non-LMNRA peregrine breeding territories were known in Clark County; however, by 2010, there were 14 positively identified sites in non-NPS areas of Clark County, several additional suspected sites, as well as nine territories in Lincoln County to the north (Figure 1).

This project only covers portions of Clark County and reports on data from 2009 and 2010. Results from monitoring efforts in preceding years, other Nevada counties, and data collected on LMNRA are reported elsewhere. This report, associated data, and habitat suitability model and map represent the final products and deliverables for NDOW contract 2005-NDOW-549-P and 2005-NDOW-609D-P (see deliverables for that modeling project). Funding for this project was provided by the Clark County Multiple Species Habitat Conservation Plan (MSHCP) and the Nevada Department of Wildlife and FWS State Wildlife Grant.

PROJECT GOALS AND OBJECTIVES

The primary goal of this project was to collect additional data in 2009 and 2010 on known nesting territories in order to better elucidate the current status of peregrines in Clark County. Project objectives included: the documentation of the number of territorial adult birds and nesting territories; whether reproduction was occurring; and whether each breeding effort was successful. In addition, effort was put forth to search for and document new, previously unknown peregrine territories. Collected data was also used to develop and test a habitat suitability model and map developed under associated project 2005-NDOW-609C-P. This new information, combined with survey data from previous years and LMNRA, will contribute to the overall understanding of peregrine breeding population trends in southern Nevada.

METHODS

Passive Surveys

Since 2005 the standardized survey methodology prescribed by the FWS post-delisting monitoring plan (USFWS 2003) has been followed during annual survey and monitoring efforts. Prior to 2005 NDOW surveys were short in duration and mainly focused on determining site occupancy by known breeding pairs. The FWS protocols call for three or more visits, up to 4-hours in duration, to known historical nesting territories. The first visit should occur during late courtship, egg laying or early incubation to determine territory occupancy. The second visit should occur during the early nestling stage to determine age of the nestlings or to check the 'unoccupied' status of territories still in question, and the third (or more) visit should be made to occupied territories during the late nestling stage to determine nest success and productivity. Timing of breeding activity can vary significantly from territory to territory, often requiring multiple visits to obtain the necessary information (Figure 2). Nest phenology was calculated based on seven days for clutch completion, 33 days for incubation (beginning after the third egg, if determined), and 40 days from hatching to fledging. Nestling age was estimated during site visits using photographs of peregrines of known ages (Cade *et al*. 1996). Occupancy is defined as a territory where either a pair of peregrines is present (2 adults or adult/subadult mixed pair), or there is evidence of reproduction (e.g. one adult observed sitting low in the nest, eggs or young are seen, or food is delivered into the eyrie). Occupancy for a territory must be established for at least one of two 4-hour site visits. Occupancy rate within a region is the number of occupied territories divided by the number of territories that were checked for occupancy within that predefined area or region. Nest success is the proportion of occupied territories in a monitoring region in which one or more young $\geq$ 28 days old is observed. Productivity is calculated as the number of young $\geq$ 28 days old per occupied territory, averaged across the monitoring region. The definition of nest success was set forth by the FWS (2003), which considers a breeding attempt to be successful if at least one nestling reached the age of 28 days, or 65% of average age of fledgling (Steenhof 1987).

Nest monitoring was conducted by observers familiar with peregrine identification and breeding behavior. Surveys were conducted during favorable weather, and days with high winds and/or heavy precipitation were avoided. To minimize stress to peregrines and avoid causing sustained territorial defensive behavior from the birds, observation posts were a minimum of 150 meters from the eyrie, and observers took care to avoid eliciting a territorial response and/or flushing incubating peregrines (Pagel 1992). Whenever possible, surveys were conducted during time periods when peregrines are most active; four hours post-sunrise, and four hours pre-sunset (Fuller and Mosher 1987). Observers used appropriate equipment, including high-quality binoculars and spotting scopes.

Call-broadcast/Rapid Assessment Surveys

Researchers at UNLV began developing a call-broadcast survey technique in 2008 in order to reduce the time necessary to confirm presence of territorial breeding peregrines and more efficiently conduct exploratory surveys. Broadcasting pre-recorded conspecific vocalizations as a survey technique has been shown effective for a variety of species, especially owls, woodland raptors, and other birds (Kennedy and Stahlecker 1993,

Johnson *et al*. 1981). Effective range, response rates, and peregrine detection rates resulting from the broadcasted calls throughout the breeding season were established through research within LMNRA in recent years.

The call-broadcast survey protocol consisted of a 10 minute survey session at each point of interest. The 10 minutes consisted of 3 min. of passive listening and observation, followed by a 30 second broadcast, followed by a 1 min. listen/observation period, a second 30 sec. broadcast, and concluding with a 5 min listen/observation period. Upon detection of a peregrine, the broadcast cycle was terminated to minimize disturbance to the bird(s). The conspecific vocalization audio files were taken from Stokes Field Guide to Bird Songs: Western Region (Time Warner Trade publishing, New York, NY), and were broadcast using a handheld FoxPro digital game caller (FoxPro FX3 or similar model, FoxPro Inc., Lewiston, PA). During each 30 sec. broadcast, the observer slowly rotated 360º to uniformly project the calls in the surrounding area. Similar to passive survey protocols, call-broadcasts were conducted during morning and early evening hours, precipitation and excessively windy days were avoided, and observers were familiar with peregrine identification and breeding behavior. If determinable, data recorded included: distance from observer to detected peregrine, time to respond, duration and type of response, sex and age of the individuals, and nesting stage of the discovered territory, if applicable.

A peregrine falcon habitat suitability model and map of Clark County were developed by researchers at UNLV for use by LMNRA and NDOW personnel. The model, based on known eyrie locations, slope, slope vs. flat areas and solar radiation (watt hours/m^2), was generated using a maximum entropy approach in the program Maxent (Phillips *et al*. 2006), and was visualized in a Geographic Information System (GIS). Detailed information regarding the model and map is contained in a separate, but associated report for contract 2005-NDOW-609C-P. Resultant maps, output by the model, were then used to prioritize and direct exploratory survey efforts in Clark County in order to locate new, previously undocumented peregrine breeding territories. By utilizing the habitat suitability maps in conjunction with the call-broadcast survey method described above, a sort of 'rapid assessment' of potential high quality habitat can be conducted with relative time savings compared to the FWS passive survey approach.

Other Survey Approaches

Additional survey methods and techniques were occasionally employed, usually in conjunction with discovery or exploratory efforts. Releasing domestic rock doves (*Columba livia*) near eyries, suspected eyries or high quality suitable habitat is a method that has been used to elicit responses from potential peregrines in an area, and quickly determine occupancy in the vicinity of known historic territories. Peregrines may not always respond to released pigeons, especially later in the breeding cycle, and this method is more reliable when used in proximity to a large body of water, thereby limiting its usefulness. Aerial cliff nesting raptor surveys have also been conducted by NDOW in southern Nevada. Using helicopters to conduct raptor surveys is more efficient than attempting to cover the same area on the ground via vehicle or on foot, however aerial surveys still have their limitations which may result in missed detections. Exploratory surveys using a variety of survey methods were conducted at specific sites based on one or more of the following criteria: 1) previous peregrine activity documented in the past consisting of one adult, but not meeting the official occupied definition; 2) observation of a peregrine during NDOW aerial survey (either cliff-nesting raptor survey or other big game survey); 3) follow-up of historic peregrine sight record or report of an observation by a skilled birder; or 4) the presence of suitable high-quality habitat.

Data Management

All data collected during surveys, as well as historic data utilized for this project, were collected and incorporated in accordance with the Data Management Plan, previously developed, submitted and approved as Deliverable D2 for the contract 2005-NDOW-549-P. Quality assurance and control measures were used in

verifying the accuracy of historic and recent data. Standardized datasheets were used for data collection in the field; data were double checked and entered in a timely manner into associated databases including a check for transcription errors, and spatial data was mapped and screened for errors and outliers.

The peregrine falcon, although delisted from the ESA, is still considered a sensitive species by the FWS and the State of Nevada. As a result, all spatial data, including coordinates for eyries and site descriptions should be safeguarded due to the risk and magnitude of loss or harm which would result from inadvertent or deliberate disclosure. While data contained herein may be used for various analyses required for programmatic planning and the adaptive management science process, specific locality data may not be transferred to another party, released to the public or made available in any format without the express written consent of NDOW.

RESULTS

Occupancy and Breeding Success

All results reported here reflect data collected in Clark County, but exclusive of NPS LMNRA lands, which are discussed in a separate report/contract 2005-NPS-475-P. Any reference to data collected, numbers of birds, territories, or eyries in Clark County refer only to those outside of LMNRA.

In 1994 only a single known peregrine territory was known to exist in Clark County (outside of LMNRA), incidentally the result of a hacking project at the Las Vegas Hilton (Figure 3). At the start of this project in 2009, only seven territories were documented; however, by the conclusion of data collection in 2010, that number had more than doubled to 16 known breeding territories (Figure 4) (Table 1). At least 24 different eyrie locations were noted among the known territories during the project timeframe.

Ten of the 13 known territories were occupied in 2009, resulting in an occupancy rate of 76.9%, while in 2010, 11 of the 15 known territories were occupied for a rate of 73.3%. One known territory was documented as occupied early in 2009, but follow-up visits that year and in 2010 were not completed due to inaccessibility issues (Department of Defense lands) which resulted in unknown status, therefore this site was not included in any analysis. Two other sites were discovered occupied late in 2010, but, due to remoteness and other constraints, follow-up surveys could not be completed to determine success or productivity and thus these were not included in those respective analyses. Five of the 9 occupied territories (55.5%) with known outcomes were successful in 2009, and 100% of occupied territories were successful in 2010. Eleven young were documented in 2009 and 19 in 2010. Productivity was 1.21 and 2.11 successful young/occupied territory in 2009 and 2010 respectively. Successful young/successful territory was calculated to be 2.20 in 2009 and 2.11 in 2020 (Table 2). Three historic sites in 2009 and four sites in 2010 were not occupied during this project. Three of these sites had been consistently occupied and successful up through the mid-2000's. Adults were initially present at a historic territory in 2009, but mid-way through the breeding season the adult activity completely ceased at the site. Unsuccessful efforts were made to locate a possible alternate eyrie nearby. This site is frequented by people, a popular place to dump trash, and is always strewn with evidence of recreational firearm shooting, perhaps resulting in disturbance causing abandonment or possible persecution of the birds.

Call-broadcast and Rapid Assessment

Rapid site assessments using the call-broadcast survey method was employed with earnest in 2010. In total, 143 call-broadcast surveys were conducted within 10 different mountain ranges in Clark County (Figures 5 and 6). Areas selected for rapid assessment exploratory surveys were selected based on the draft peregrine falcon habitat suitability model and map (Figures 7 and 8) (Detailed information on this model and map will be available via deliverables for associated project 2005-NDOW-609), which predicted the most likely peregrine breeding habitat in the County. Peregrines were detected at six of the 143 survey points (4.19% detection rate), consisting of 3 newly discovered active territories and three detections of single peregrines. Follow-up

surveys should be conducted at and near the locations of the single detections. In addition, seven new, previously unknown prairie falcon territories were located, along with one new American kestrel nesting territory.

DISCUSSION

Over the past 25 years since the peregrine was re-discovered breeding in Nevada, the number of known and officially occupied sites have continued to increase, especially in recent years. In 2009 and 2010 the peregrine occupancy rates for known historic sites were well above the FWS regional threshold value of 71%, which might trigger an agency management action or response, but below the ideal target value of 84% (USFWS 2003). Nest success values were at or above the FWS recommended threshold of 55%; however nest success in 2009 was below the ideal target value of 68% (all FWS values are 90% CI=$\pm$2%) (FWS 2003). Productivity was 1.21 and 2.11 young per occupied territory in 2009 and 2010, respectively; both values are above the FWS ideal 1.0 nestling/occupied territory. Determining exact eyrie location for some sites has been difficult in the past which can affect the ability to assign a known outcome to the site and calculate peregrine breeding success. Many peregrine territory locations in southern Nevada consist of extremely wide and high cliff faces, surrounded by a profusion of additional suitable cliffs/habitat that may serve as alternate sites, and under these circumstances it is often very difficult to locate the actual eyrie even if a pair of adults is located, especially if limited time is spent at each site. This, in turn may affect ability to locate and observe nestlings and/or fledglings. If time permits, additional site visits can be conducted in hopes of observing fledged young, however, this requires additional time and mileage and may not be possible or practical given the number and spacing of other sites.

The relatively high occupancy rates observed and increasing number of discovered occupied territories, in both optimal and marginal habitat, in recent years may indicate an expanding peregrine population in southern Nevada, however, increased monitoring efforts and the adoption of standardized surveys required by the FWS post-delisting monitoring plan have no doubt contributed to the steady increase in newly discovered territories. Historically, survey objectives focused more on determining territory occupancy (which, under previous definitions only required the observation of a single bird), and also focused on higher quality habitat within the LMNRA. By increasing the number of visits and the time spent at each known territory, we have been able to more accurately determine occupancy, eyrie location, nest success and productivity. While this approach results in enhanced data collection, it is time consuming, especially as the number of known territories continues to increase. For example, in 2009 and 2010 combined, the project biologist conducted 83 passive surveys requiring 167 hours of observations. In order to achieve this, 145 hours were spent driving nearly 5,000 miles and 186 miles were hiked to access the peregrine territories (Table 3). Ultimately, it's difficult to determine whether there has actually been a recent increase and/or expansion in the species population in southern Nevada, or if these territories have been occupied, yet undiscovered until recently, since during that same time period survey effort also increased substantially. Peregrine falcons are somewhat charismatic and often when someone (e.g. biologist, skilled birder, etc) encounters a territorial pair they tend to talk about it and that information usually gets back to the those persons interested in and/or responsible for their conservation (i.e., me); so, anecdotally, yet not scientifically, it would seem that the species is likely expanding. The last intensive, comprehensive aerial raptor survey in southern Nevada was completed over 30 years ago. As a result, it's still plausible that many recently discovered territories may have been occupied but overlooked in recent years, and there may be many additional territories yet to be located.

Peregrine density is limited first by the number and distribution of suitable eyrie locations, and then by territorial pair spacing. Territory size is in turn influenced by prey availability and ampleness. As food abundance increases, territory boundary defense relaxes (White *et al* 2002). Nevada's basin and range geology and topography provides desired peregrine habitat consisting of cliffs and adjacent open areas for foraging, and it would appear that the availability of suitable nesting locations in Clark County is not a major limiting factor.

Clark County is approximately 5 million acres, with nearly 313,400 ac of those classified as cliff-associated habitat. The predictive habitat suitability model has further refined this, and while not all cliff faces will include the physical attributes peregrines select for in choosing a nesting location (i.e. aspect, ledge or pothole, degree of overhang or shading, cliff height, distance to water, etc), there is still a relatively immense quantity of habitat yet to be surveyed, resulting in a high potential for additional nesting pairs.

It is currently unknown how important the 'distance to water' component is in regard to peregrine occupancy and breeding success and to what extent it may be limiting peregrine density and distribution in southern Nevada. Peregrine falcons will forage in any open area, but wetlands, riparian areas and other areas adjacent to bodies of water or rivers are preferred as these water-associated areas are usually highly productive in terms of concentrated, superabundant prey resources (White *et al* 2002). Research conducted at LMNRA (Barnes and Jaeger 2009) determined average distance to permanent water from peregrine breeding sites to be approximately 1.08 km, while an analysis of sites outside LMNRA and away from the lakes showed breeding territories were an average of 11.45 km to the nearest reliable source of water. Some literature (Cade and Bird, 1990) suggests peregrines usually nest within 400-800 meters of water. Prey availability and abundance may be the more important limiting factor, rather than available nesting sites, when it comes to peregrine density in southern Nevada and in areas away from LMNRA. Adequate prey resources influence territory size, and territorial boundary defense and spacing, referred to as 'nearest neighbor distance' (NND), often decreases as food abundance increases. Work by Barnes and Jaeger (2009) have demonstrated this to be case at LMNRA. Interestingly, the Mojave Desert habitat of southern Nevada contains a relatively large lake/river system (i.e. Colorado River and Lake's Mead and Mojave), and once adequate data are collected, better comparisons can be made in regard to density and distribution of peregrine populations within xeric desert habitat compared to LMNRA populations, with its abundant food sources and proximity to water.

Prairie falcons (*Falco mexicanus*) also utilize and select similar nesting sites; therefore competition with prairie falcons may be a possible factor influencing peregrine population density (Bond 1946). In fact, NDOW has documented peregrines apparently displacing prairies at several historic prairie falcon nesting territories. Interspecific competition with golden eagles (*Aquila chrysaetos*), great horned owls (*Bubo virginianus*) and some common ravens (*Corvus corax*) can also affect peregrine density and success. For example, in 2009 a pair of peregrines and golden eagles nested within 200m of each other in a small box canyon. While both pairs were eventually successful, the peregrine breeding success was low (one fledged young) and came very late in the season. Throughout the nesting season the adult peregrines were consumed with defending their territory against the eagles, and expended an enormous amount of energy in doing so.

In 2010 the addition of the rapid assessment call-broadcast surveys further increased our knowledge of occupied territories while reducing some time spent surveying potential habitat, but not necessarily reducing required effort. Prior to implementing the call-broadcast methods the accepted discovery strategy was the passive survey approach, consisting of a minimum of four hours viewing of potential breeding sites along cliff faces. The task of a complete survey of Clark County would be daunting, if not impractical, to survey every site by this method. Using the habitat suitability model to stratify and high-grade the remaining habitat, while concurrently implementing the rapid assessment call-broadcast approach resulted in more efficient use of survey time; instead of spending four passive hours at a single cliff face, those four hours spent hiking along suitable habitat with the rapid assessment approach could yield up to five or more linear miles of surveyed habitat. The needed time and effort to survey all predicted habitat is still great; in 2010, more than 151 miles were hiked in order to conduct 143 exploratory call-broadcast surveys in areas predicted by the model (Table 3).

CONCLUSIONS AND RECOMMENDATIONS

This monitoring project made possible the initiation of a hopefully ongoing comprehensive assessment of peregrine falcon occupancy and reproductive success in Clark County, focused on areas excluding LMNRA and therefore by default excluding perceived high-quality shoreline cliff habitat. The first known re-discovered breeding peregrine falcon territory in Clark County (excluding LMNRA) was documented 16 years ago. Today there are more than 18 known territories in that same area, more than 61 known territories combined when LMNRA and Lincoln County sites are included, and this number is reasonably expected to rise each year. This specific monitoring project covers only Clark County, yet in order to elucidate the current status of peregrines in southern Nevada, it is important to consider all known territories. Numbers of peregrines in southern Nevada have steeply increased in recent years, but so has the amount of survey effort, and this is not without cost. Even with the implementation of new survey methods and approaches and the development of a draft habitat suitability model, peregrine surveys continue to be time and resource consuming, and large areas of predicted suitable habitat in Clark County still need to be assessed. Regardless, data from this monitoring project, when combined with data and knowledge of additional peregrine territories in southern Nevada indicate a healthy, expanding population compared to even a decade ago. Actual historical and current population estimates are difficult as many sites are remote, not monitored regularly, and due to the vast ruggedness of available habitat many sites may still be undetected.

Observed increase in the peregrine falcon population is likely attributable to a combination of factors, including nationwide recovery efforts such as elimination of organochlorine pesticides, and artificial hacking programs. Specifically in southern Nevada, increase in peregrines may be attributable to the proximity to and possible expansion north and west from the Colorado Plateau and the canyon lands of northern Arizona along the Colorado River. This is plausible when you consider that peregrine populations in Arizona appeared to be less impacted during the range wide declines that prompted ESA listing (White *et al.* 2002). It has been suggested that the habitat within LMNRA may contain the core breeding population of peregrine falcons in Nevada, and further, peregrines numbers may have reached carrying capacity in the high quality habitat of the recreation area (Barnes and Jaeger 2009). As a result, LMNRA may be an important transition area contributing to the expansion of peregrines throughout other portions of southern Nevada.

It is recommended that monitoring known territories, or a subset of territories, and continued incorporation of the rapid assessment call-broadcast surveys be implemented, as funds and resources allow. Continued monitoring and exploratory surveys, combined with data from other areas, will allow us to continue to track and monitor the progress and expansion of peregrines throughout Nevada, and aid in determining population trends. Data from this project suggest territory occupancy and reproductive success is well within the FWS recommended thresholds and targets limits. Additional research goals may include comparing reproductive success, nearest neighbor distance, prey preference and other variables of LMNRA peregrines (associated with high-quality traditional habitat), to pairs breeding in more xeric habitats, further from large bodies of water, and with less abundant prey sources. Molecular phylogenetic and phylogeographical studies could help answer questions regarding the source of peregrine populations and expansion in the desert southwest, and banding projects could reveal important information about survival, recruitment, natal dispersal and use of habitat in Nevada.

LITERATURE CITED

Barnes, J. 2006. Report on Peregrine Falcon (*Falco peregrinus*) Monitoring (2004-2005) within Lake Mead National Recreation Area. Unpublished final report submitted to the Clark County Multiple Species Habitat Conservation Plan (MSHCP project no. 2003-NPS-229-P-2004-07) by the National Park Service, Lake Mead National Recreation Area, Boulder City, Nevada. 18 pp.

Barnes, J. 2007. Peregrine falcon monitoring and evaluation: 2007 annual report. Unpublished cooperative report prepared by Public Lands Institute, University of Nevada, Las Vegas and Resource Management, Lake Mead National Recreation Area, National Park Service. 24 pp.

Barnes, J. and Jef Jaeger. 2009. Peregrine falcon monitoring within Lake Mead National Recreational Area, 2008-2009, Final project report. 2009.

Bond, Richard M. 1946. The peregrine population of western North America. Condor 48:101-116.

Cade, T.J., J.H. Enderson, C.G. Thelander, and C.M. White 1988. Peregrine Falcon populations; their management and recovery. The Peregrine Fund, Inc., Boise, ID.

Cade, T.J., Enderson, J.H., J.L. Linthicum. 1996. Guide to Management of Peregrine Falcons at the Eyrie. The Peregrine Fund. Boise, ID.

Grebence, B. L. and C. M. White. 1989. Physiographic characteristics of Peregrine Falcon nesting habitat along the Colorado River system in Utah. Great Basin Nat. 49:408-418.

Green, M.G., T. Swem, M. Morin, R. Mesta, M. Klee, K. Hollar, R. Hazelwood, P. Delphey, R. Currie, and M. Amaral. 2006. Monitoring results for breeding American Peregrine Falcon (*Falco peregrinus anatum*), 2003. U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-R1005-2006, Washington DC.

Fuller, M.R. and J.A. Mosher. 1987. Raptor survey techniques. Pp. 37-66 *in* Raptor management techniques manual. B.G. Pendleton, B.A. Millsp, K.W. Cline, and D.W. Bird, eds. Natl.Wildl. Fed., Washington, D.C.

Hargis, C. D. and B. Woodbridge. In press. A design for monitoring northern goshawks (*Accipiter gentilis*) at the bioregional scale. *In* M. L. Morrison, editor. The northern goshawk: a technical assessment of its status, ecology, and management. Studies in Avian Biology.

Herron, G.B., C.A. Mortimore, and M.S. Rawlings. 1985. Nevada raptors, their biology and management. Nevada Department of Wildlife Rept.

Johnson, R.R., B.T. Brown, L.T Haight, and J.M. Simpson. 1981. Playback recordings as a special avian censusing technique. Studies in Avian Biology 6:68-75.

Kennedy, P.L. and D.W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcasts of three conspecific calls. J. Wildl. Manage. 57:249-257.

Pagel, J.E. 1992. Protocol for observing known and potential peregrine falcon eyries in the Pacific Northwest. Pp. 83-96 *in* Proceedings: Symposium on peregrine falcons in the Pacific Northwest. J.E. Pagel, ed. Rogue River National Forest, Medford, OR 97501

Steenhof, K. 1987. Assessing raptor reproductive success and productivity. P.157-170 *In* Raptor management techniques manual. B.A.G. Pendleton, B.A. Millsap, D.W. Clinge, and D.W. Bird, eds. Natl. Wildl. Fed., Washington, D.C.

U.S. Fish and Wildlife Service. 2003. Monitoring Plan for the American Peregrine Falcon, A Species Recovered Under the Endangered Species Act. U.S. Fish and Wildlife Service, Divisions of Endangered Species and Migratory Birds and State Programs, Pacific Region, Portland, OR. 53 pp.

White, C. M., N. J. Clum, T. J. Cade, and W. G. Hunt. (2002). Peregrine Falcon (*Falco peregrinus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database

Wildlife Action Plan Team. 2006. Nevada Wildlife Action Plan. Nevada Department of Wildlife, Reno.

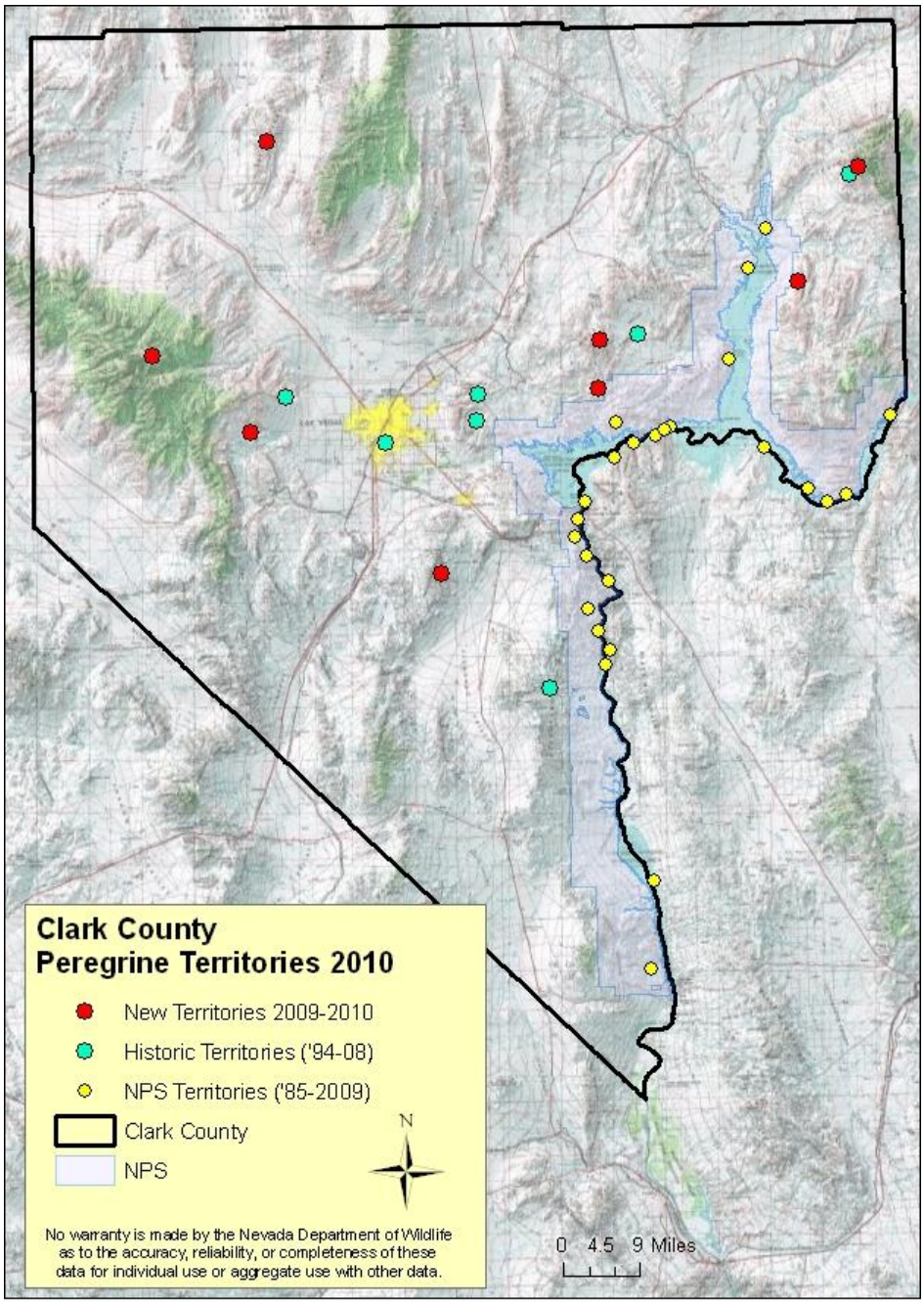

FIGURE 1. Distribution of all known peregrine falcon territories in Clark County as of 2010. LMNRA sites are included for reference. Not all known territories are occupied in any given year. Territories indicated in 'red' where discovered during the course of this project (2009-2010).

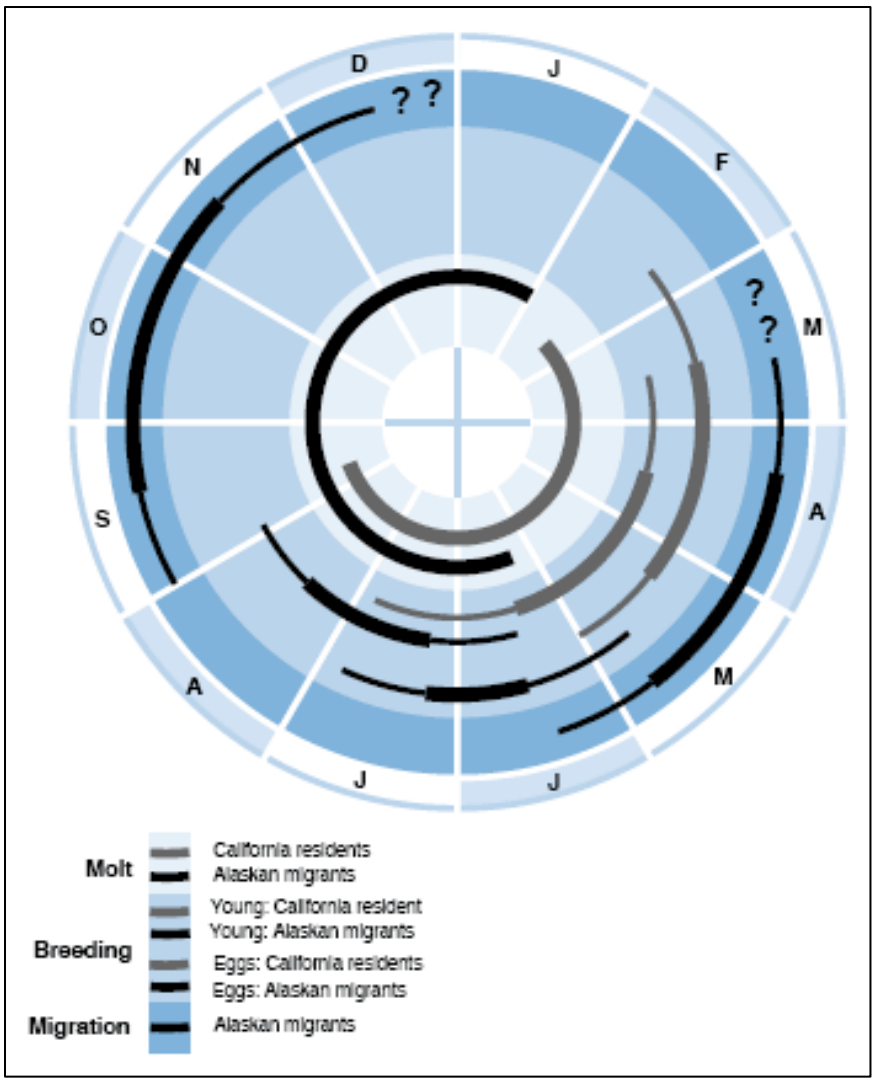

FIGURE 2. Annual cycle of breeding, migration, and molt in the Peregrine Falcon (from White *et al*, 2002). Nevada resident birds follow similar timeline as the indicated California residents.

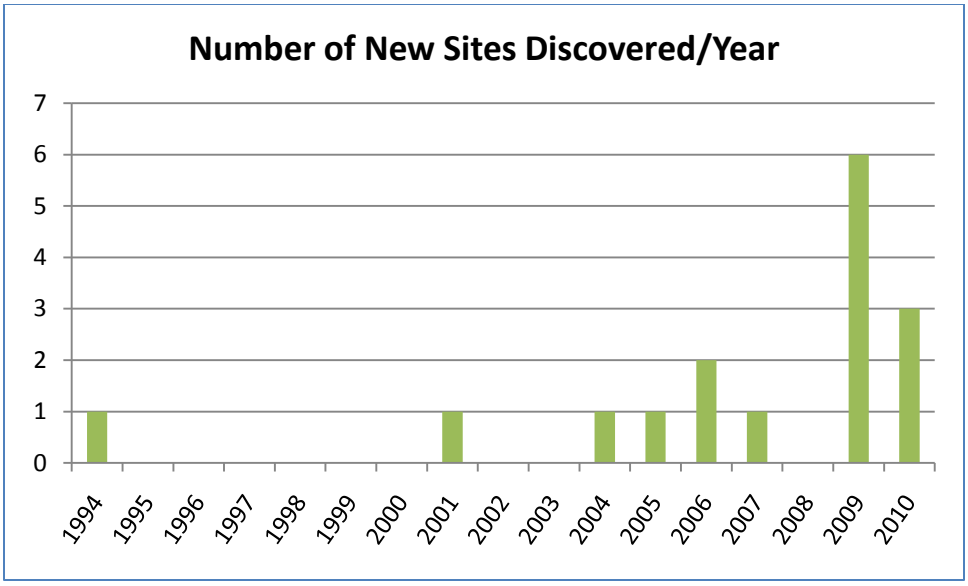

FIGURE 3. Number of new peregrine falcon breeding territories discovered each year, 1994-2010.

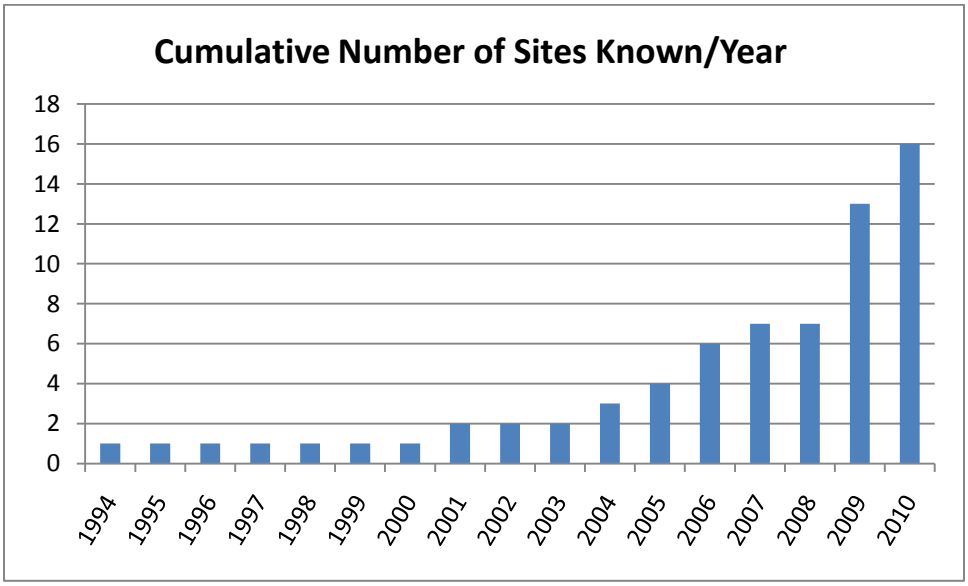

FIGURE 4. Cumulative number of known peregrine falcon territories per year, 1994-2010.

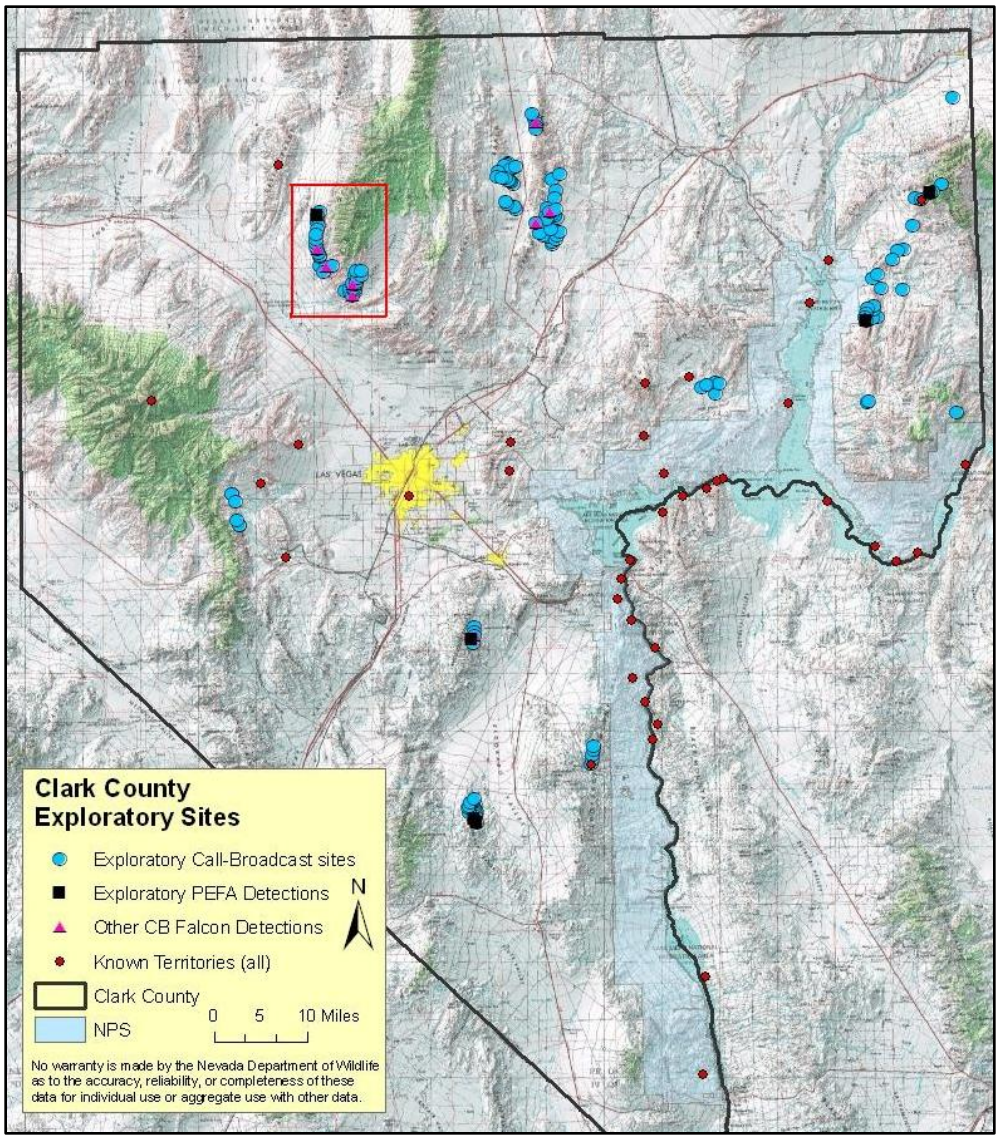

FIGURE 5. Rapid assessment exploratory survey locations. Blue dots represent single or cluster of rapid assessment call-broadcast survey points within 10 different mountain ranges in Clark County. Black squares indicate location of peregrine detections.

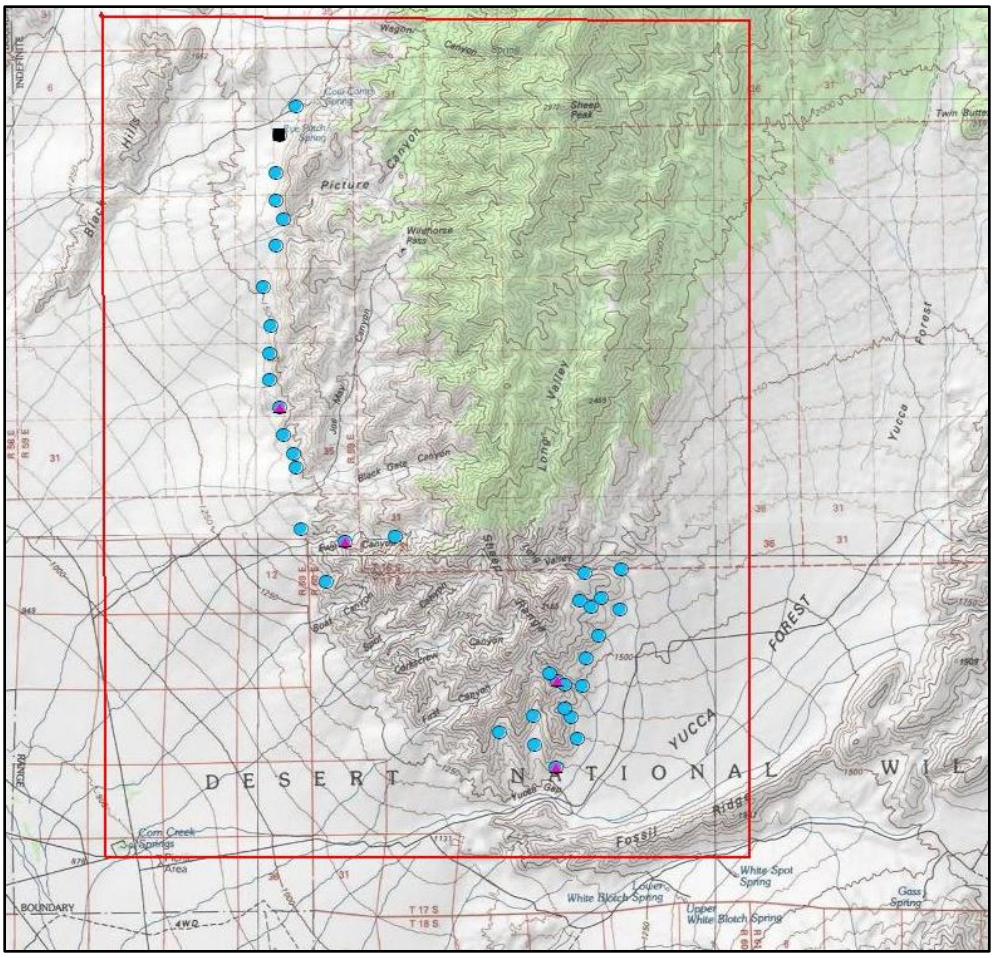

FIGURE 6. Close-up example of rapid assessment exploratory survey locations and results for the Sheep Range, Clark County. This area is represented in the red box in Figure 5. Blue dots are survey locations, black square indicates peregrine falcon detection, and pink triangles are detections of other falcon species.

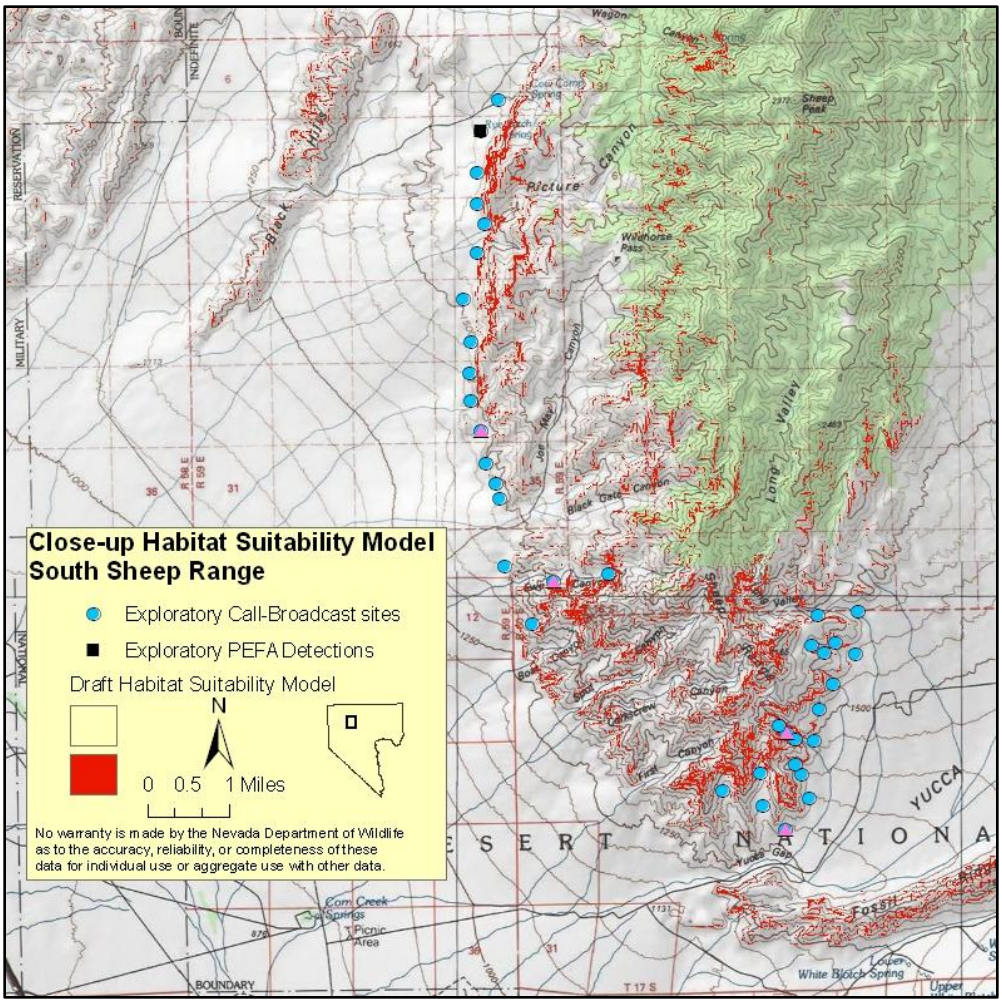

FIGURE 7. Close-up of the Sheep Range rapid assessment call-broadcast survey locations overlain with the draft habitat suitability model. Predicted high-quality breeding habitat is shown in red. Pink triangles represent discovered prairie falcon territories.

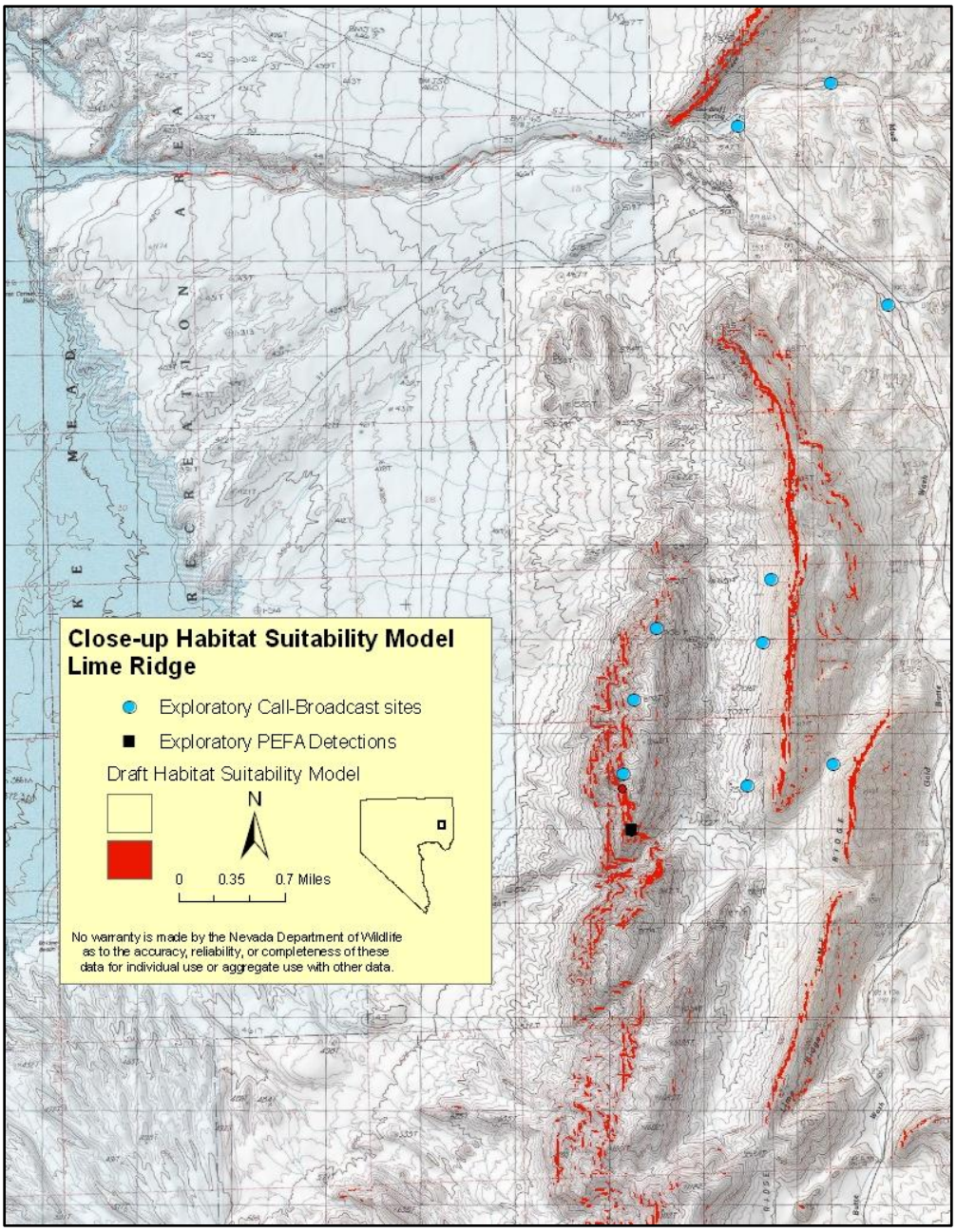

FIGURE 8. Additional example of a rapid assessment call-broadcast survey cluster in the Lime Ridge area of the Gold Butte Mountains, Clark County.

TABLE 1. Summary of occupancy and reproductive success status for known territories in 2009 and 2010. Territory names have been abbreviated or re-named due to data sensitivity concerns; the territory names have no bearing on this table.

Territory	*2009*				*2010*			
	Occ	*Succ*	*#Young*	*#Adults*	*Occ*	*Succ*	*#Young*	*#Adults*
AnnNar	Yes	Yes	2	2	Yes	Yes	3	2
BR	Yes	No	--	3	Yes	Yes	3	2
BDia	Yes	No	--	2	Yes	Yes	2	2
Desert Range S	Yes	Unk	--	2	Unk	--	--	--
Rainbow	Yes	Yes	2	2	Yes	Yes	1	2
LAM-Chey	Yes	Yes	2	2	Yes	Yes	4	2
LV Hil	No	--	--	--	No	--	--	--
Mud	Yes	Yes	4	2	Yes	Yes	3	2
Up Chuck	Yes	Yes	1	2	Yes	Yes	1	2
Nelson	No	--	--	--	No	--	--	--
Sun	Yes	No	--	2	No	--	--	--
V Guzzler	No	--	--	--	No	--	--	--
TH Cal	Yes	No	--	2	Yes	Yes	1	2
Penny	n/a				Yes	Yes	1	2
Lime	n/a				Yes	Unk	Unk	2
V North	n/a				Yes	Unk	Unk	2

TABLE 2. Peregrine falcon summary statistics for known territories in Clark County, 2009-2010. Success rate is the proportion of successful pairs per occupied territory. Only occupied territories with known outcomes are included in the calculations.

Variable	*2009*	*2010*
Known potential territories	13	16
Occupied territories (Occ terr. w/ known outcomes)	10 (9)	11 (9)
Occupancy rate of known territories	76.9%	73.3%
Total # adults	20	22
Successful territories (pairs)	5	9
Total # young	11	19
Success rate	55.5% [1]	100% [1]
Productivity (Successful young/occupied territory)	1.21	2.11
Successful young/Successful territory	2.20	2.11

1—Success and productivity calculated based on occupied territories with known outcomes. In 2009 one occupied Territory had an unknown outcome, and in 2010, two occupied territories had unknown outcomes.

TABLE 3. Survey effort statistics for 2009 and 2010.

Variable	*2009*	*2010*
Number of sites surveyed	13	15
Total # of passive survey site visits	47	36
Hours of passive observation	105 hrs	62 hrs
Hours of driving (est.)	86	60
Miles driven (est.)	2,932	2,011
Miles hiked (actual)	98 mi	88 mi
Exploratory Call-broadcast surveys	n/a	143
Exploratory miles hiked (actual)	n/a	151 mi