U.S. Fish & Wildlife Service

Recovery Plan for the Ocelot *(Leopardus pardalis)*
First Revision

July 2016

RECOVERY PLAN FOR THE OCELOT
(*Leopardus pardalis*)

FIRST REVISION

JULY 2016

Original Plan Approved: August 22, 1990

Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

Approved: Benj N. Tuggle

Regional Director, U.S. Fish and Wildlife Service, Southwest Region

Date: 7/28/2016

DISCLAIMER

The Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*), requires the development of recovery plans for listed species, unless such a plan would not promote the conservation of a particular species. In accordance with section 4(f)(1) of the Act and to the maximum extent practicable, recovery plans delineate actions which the best available science indicates are required to recover and protect listed species. Plans are published by the U.S. Fish and Wildlife Service (USFWS), and may be prepared with the assistance of recovery teams, contractors, state agencies, and others. Recovery objectives will be implemented and any necessary funds made available, subject to budgetary and other constraints affecting the parties involved in ocelot conservation, and objectives may be adjusted as new and pertinent information is made available. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Recovery plans do not necessarily represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than the USFWS. They represent the official position of USFWS only after they have been signed by the Regional Director. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions. Please check for updates or revisions at the website on the next page before using the plan. Throughout the plan, the use of the term "we" refers to the Ocelot Recovery Team, and not necessarily just the USFWS.

The ocelot (*Leopardus pardalis*) is listed throughout its range including 22 countries. The United States (U.S.) contains only a small portion of the ocelot's range and habitat. Recovery of endangered species is the fundamental goal of the ESA. Recovery planning is addressed in section 4(f)(1) of the ESA. However, the USFWS has limited resources and little authority to address the major threats to the ocelot's recovery outside U.S. borders. Also, knowledge regarding the status of the species in much of its range is very limited, and USFWS lacks the resources and authority to coordinate large-scale international research and recovery for the entire species. Therefore, it is not practicable to establish site-specific management actions, objective and measurable recovery criteria, or cost estimates throughout the species' entire range. However, USFWS has an established relationship with Mexico to address a number of issues of mutual concern, including managing cross-border populations of rare and endangered species. Because the USFWS's limited resources are better applied to planning and on-the-ground implementation of conservation actions within the boundaries of the U.S. and in partnership with adjacent Mexico, we focused this plan on two management units that cover the subspecies *L. p. sonoriensis* and *L. p. albescens*.

Literature citation of this document should read as follows:

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Copies may be obtained online (species search: ocelot):
http://www.fws.gov/endangered

or by contacting:

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Laguna Atascosa National Wildlife Refuge
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Los Fresnos, Texas 78566

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Ocelot on Laguna Atascosa National Wildlife Refuge/USFWS

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<u>The Technical Subgroup of the Ocelot Recovery Team</u>

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The USFWS would also like to thank the Implementation Subgroup of the Bi-national Ocelot Recovery Team for their participation and valuable insights provided during the development of this plan, and for all the work they do to conserve and recover ocelots. We look forward to future collaboration with the following individuals and others without whom ocelot recovery will not succeed and would not have made the progress we see today: Maria Araujo, Tyler Campbell, Dave DeLaney, Rene Celis Gurria, Thomas deMaar, Randy DeYoung, Daniel Kunz, and John Young.

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Michael Corbett, Eric Gardner, Paul Genho, Melissa Grigione, Karen Hunke, Aaron Haines, Mark Iglesias, Jan Janecka, Scotty Johnson,Terry Johnson, Linda Laack, Jody Mays, Stacy McReynolds, Brent Ortego, Oscar Ramirez-Flores, Mike Rabe, Eva Sargent, Bill Van Pelt, Sylvia Waggoner, Lisa Williams, and Roberto Wolf.

Michael Corbett was a private landowner from south Texas and he was an important part of the Implementation Subgroup, a champion for ocelot and wildlife conservation, as well as ranching in south Texas. We were deeply saddened by his passing in 2008.

Dedication

DAVID Steffen MAEHR, Ph.D.,
SEPTEMBER 18, 1955 – JUNE 20, 2008

The USFWS and the Ocelot Recovery Team are honored to dedicate this plan to the memory of Dave Maehr, with the hope that the objectives within it may be achieved for the benefit of the ocelot and the ecosystem in which it plays a role.

Dave Maehr was named Co-leader of the bi-national Ocelot Recovery Team by the USFWS's Southwest Regional Director, and served in that role from the first team meeting in May 2003 until June 2008 when he tragically died in a single-engine plane accident. As the leader in the United States, Dave had the primary responsibility for guiding the Team to meet the USFWS's standards, policies, and priorities.

Dave was Professor of Conservation Biology in the Department of Forestry at the University of Kentucky, Lexington, and was known internationally as a world expert on large carnivores, most notably black bear and Florida panther, and for the reintroduction of the elk population in eastern Kentucky. He was an accomplished scientist, author and editor, and has been described as the "quintessential field biologist; outdoorsman, highly observant, an incredible naturalist, wonderful at handling animals, and talented artist and photographer."

Although he did not have previous experience with ocelots, Dave accepted the challenge of leading the Ocelot Recovery Team with humility, enthusiasm, and commitment. He worked closely with the USFWS to assure that scientific and policy standards were met, and with his co-leader from Mexico, Arturo Caso, to integrate the objectives of both countries. Dave also brought his considerable facilitation and editorial skills to bear in knitting the contributions of the entire team into a cohesive and focused recovery plan. Along with a ferocious intellect, Dave brought a gracious and light-hearted presence to his role as team co-leader. Finally, he never lost sight of the importance of considering human communities in conserving endangered species.

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EXECUTIVE SUMMARY

OCELOT RECOVERY PLAN, FIRST REVISION

Current Status of the Species

The ocelot (*Leopardus pardalis*) is listed as endangered under the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*) throughout its range in the western hemisphere where it is distributed from southern Texas and southern Arizona through Central and South America into northern Argentina and Uruguay (Pocock 1941, Cabrera 1961, Hall 1981). The ocelot is also listed as endangered under law in Mexico (i.e., NOM-059-SEMARNAT-2010) (Secretaría de Medio Ambiente y Recursos Naturales 2010). The ocelot is listed as endangered by the States of Arizona and Texas (Arizona Game and Fish Department 2010, Texas Parks and Wildlife Department 2014). In the 1982 final rule (47 FR 31670), the U.S. Fish and Wildlife Service (USFWS) made a determination that the designation of critical habitat was not prudent because such a designation would not be in the best interests of conservation of the species. As of August 2015, there were 53 total known individuals in the two separate populations in south Texas (Hilary Swarts *unpubl. data* 2015, Mike Tewes *pers. comm.* 2015). A third and much larger population of the Texas-Tamaulipas ocelot (*L. p. albescens*) occurs in Tamaulipas, Mexico (Caso 1994, Carvajal-Villarreal *et al.* 2012, Stasey 2012, Conservación y Desarrollo de Espacios Naturales 2014), but it is thought to be isolated from ocelots in Texas (Walker 1997, Janečka *et al.* 2014).

In Arizona, five individual ocelots (four live and one dead) have been detected between 2009 and 2015 (Avila-Villegas and Lamberton-Moreno 2013, Culver *et al.* 2016). Prior to these five recently-known individuals the last documentable ocelot in Arizona was a male that had been killed by a vehicle near the town of Oracle in 1967 (López González *et al.* 2003). In addition to the recent Arizona sightings, ocelots have been documented in Sonora, Mexico (López González *et al.* 2003, Gómez-Ramírez 2015), including a female with a kitten about 48 km south of the U.S.-Mexico border in 2011 (Avila-Villegas and Lamberton-Moreno 2013).

While this plan considers the ocelot throughout its range, its major focus is on two cross-border management units, the Texas-Tamaulipas Management Unit (TTMU) and the Arizona-Sonora Management Unit (ASMU). Management units are a useful population management tool for species occurring across wide ranges, with multiple populations, varying ecological pressures, or different threats in different parts of their range. By using this management unit approach, we were able to set recovery goals for each unit and will be better able to measure their contribution toward ocelot recovery.

Habitat Requirements, Threats, and Other Limiting Factors

The ocelot uses a wide range of habitats throughout its range. Ocelots have been observed in thornscrub and semi-arid vegetation (Shindle and Tewes 1998, López González *et al.* 2003), coastal grasslands and coastal tropical forests (Caso 1994, 2013), tropical dry forests (Fernandez *et al.* 2002, López González *et al.* 2003, Servín *et al.* 2003), tropical rain forests (Cuarón 2000, Ávila-Nájera *et al.* 2015), oaks and grasslands (Avila-Villegas and Lamberton-Moreno 2012, López González *et al.* 2014, Culver *et al.* 2016), piedmont/montane scrub, cloud forest (Cuarón 2000, Martínez-Calderas *et al.* 2011), pine-oak forests (Iglesias *et al.* 2009, Bárcenas and Medellín 2010), and fir forests (Aranda *et al.* 2014).

As human population growth and development continue across much of the ocelot's range, habitat conversion, fragmentation, and loss still comprise the primary threats today (see Appendix II). It has been estimated that in Texas, more than 95% of the dense thornscrub habitat in the Lower Rio Grande Valley has been converted to agriculture, rangelands, or urban developments (Jahrsdoerfer and Leslie 1988, Tremblay *et al.* 2005). Small population sizes in Texas and isolation from conspecifics in Mexico threaten the ocelot in Texas with inbreeding (Janečka *et al.* 2011, Korn 2013). Connectivity among ocelot populations or colonization of new habitats is inhibited by the threat of road mortality to dispersing ocelots (Haines *et al.* 2005b). Issues associated with barriers such as the border fence and border wall on the U.S.-Mexico border, and agents regularly patrolling the boundary between the U.S. and Mexico, further exacerbate the isolation of Texas and Arizona ocelots from those in Mexico (Lorey 1999, Grigione and Mrykalo 2004, Flesch *et al.* 2009).

Commercial exploitation and illegal hunting were significant threats to the species when the ocelot was originally listed (Sunquist and Sunquist 2002). Although some illegal killing of the ocelot continues and regulations that protect the ocelot remain challenging to enforce, the harvest and export of ocelots has significantly declined and is prohibited by the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES) (Sunquist and Sunquist 2002). The Red List produced by the International Union for Conservation of Nature (IUCN), lists the ocelot as Least Concern (Nowell 2002), but in 2008, the IUCN recognized that some populations were threatened and decreasing (Caso *et al.* 2008). As a widespread species with cryptic habits and a low population density in any one country, understanding the ocelot's global status requires not only scientific knowledge of its distribution, ecological requirements, and population dynamics, but also knowledge of the varying threats and opportunities across international borders.

Many of the threats to the ocelot are common to Latin American countries (see Appendix II). Most studies have occurred on nationally-recognized preserves. Threats generally include habitat loss and fragmentation, subsequent isolation and genetic repercussions of such isolation, and illegal killing of the ocelot and overharvest of its prey.

Recovery Strategy

The strategy for recovery involves the following Recovery Actions:

1. The assessment, protection, reconnection, and restoration of sufficient habitat to support viable populations of the ocelot in the borderlands of the U.S. and Mexico;
2. The reduction of the effects of human population growth and development on ocelot survival and mortality;
3. The maintenance or improvement of genetic fitness, demographic conditions, and health of the ocelot;

4. The assurance of long-term viability of ocelot populations through partnerships, the development and application of incentives for landowners, application of existing regulations, and public education and outreach;
5. The use of adaptive management, in which recovery is monitored and recovery tasks are revised by the USFWS in coordination with the Bi-national Ocelot Recovery Team as new information becomes available;
6. The support of international efforts to ascertain the status of and conserve the ocelot south of Tamaulipas and Sonora.

Recovery Goals

The goal of this revised recovery plan is to recover and delist the ocelot, with downlisting from endangered to threatened status as an intermediate goal.

Recovery Criteria

The ocelot should be considered for reclassification from endangered status to threatened status when:

Downlisting Criterion 1: The ocelot should continuously qualify for "Least Concern" under the International Union for Conservation of Nature (IUCN) Red List criteria (IUCN 2014) for at least five years; and threats from habitat loss, habitat fragmentation, and poaching have been reduced such that the ocelot is no longer in danger of extinction.

Downlisting Criterion 2: The metapopulation of the Texas-Tamaulipas Management Unit (TTMU) is estimated through reliable scientific monitoring to be at least 200 ocelots in Texas and 1,000 ocelots in Tamaulipas for at least five years. The 200 ocelots in Texas should be distributed as either:

(a) a single metapopulation of at least 150 ocelots with interchange between it and ocelots in Tamaulipas that is sufficient to maintain genetic variability; or

(b) two populations of at least 75 ocelots each, with interchange between the two populations, and between the two populations in Texas and ocelots in Tamaulipas that is sufficient to maintain genetic variability.

In addition to either Downlisting Criterion 2(a) or 2(b), an additional 50 ocelots must be present in Texas, either as additional members of the existing population(s), or as less geographically stable individuals in search of mates or new home ranges. Interchange among populations may be facilitated by moving ocelots between populations to simulate natural dispersal and recruitment. Populations may include the current populations in Cameron and Willacy counties, but may also include a reintroduced population established within currently unoccupied historical range. Habitat protection must be in place to support ocelot populations for the foreseeable future, and potential corridors must be protected, and mechanisms must be developed to restore habitat connectivity between populations.

Downlisting Criterion 3: The Arizona-Sonora Management Unit (ASMU) metapopulation is estimated through reliable scientific monitoring to be at least 1,000 ocelots for at least five years. Habitat linkages to support an ASMU metapopulation have been identified. Threats to this metapopulation have been identified and are determined to be below the threshold of endangerment of extinction within the foreseeable future. Solutions to reduce or eliminate those threats have been developed that are specific and actionable.

The ocelot should be considered for removal from the list of threatened and endangered species when all of the following conditions are met:

Delisting Criterion 1: The ocelot should continue to qualify for "Least Concern" under the IUCN Red List criteria (IUCN 2014) for at least 10 years and populations are stable or increasing. Threats from habitat loss, habitat fragmentation, and poaching are reduced such that the ocelot can maintain healthy, viable populations for the foreseeable future.

Delisting Criterion 2: The TTMU metapopulation is estimated through reliable scientific monitoring to be at least 200 ocelots in Texas and 1,000 ocelots in Tamaulipas for at least 10 years. The 200 ocelots in Texas should be distributed as either:

(a) a single metapopulation of at least 150 ocelots with interchange between it and ocelots in Tamaulipas that is sufficient to maintain genetic variability; or

(b) two populations of at least 75 ocelots each, with interchange between the two populations, and between the two populations in Texas and ocelots in Tamaulipas sufficient to maintain genetic variability.

In addition to either Delisting Criterion 2(a) or 2(b), an additional 50 ocelots must be present in Texas, either as additional members of the existing population(s), or as less geographically stable individuals in search of mates and/or new home ranges. Interchange among populations must occur through natural dispersal rather than by translocating ocelots between populations; or

(c) if natural interchange between Texas and Tamaulipas is not occurring, cross-border interchange may be facilitated by moving ocelots to simulate natural dispersal and recruitment, but an additional population of at least 75 ocelots must be established within currently unoccupied historical range in Texas to compliment the two populations of 75 ocelots each. The third population of 75 ocelots should be established in a location that would expand the geographical range of the species in Texas to provide sufficient assurance against loss of the entire Texas population from catastrophic weather events or infectious disease.

Under any of these scenarios, habitat management and conservation must be in place to support and connect all ocelot populations within Texas and within Tamaulipas for the foreseeable future.

Under scenarios 2(a) or 2(b), there would have to be at least 200 ocelots in Texas to achieve Delisting Criterion 2. Under scenario 2(c), there would have to be at least 275 ocelots in Texas.

Delisting Criterion 3: The ASMU metapopulation is estimated through reliable scientific monitoring to be at least 1,000 ocelots for at least 10 years and the populations should be stable or increasing. Threats from habitat loss, habitat fragmentation, and poaching are reduced such that the ocelot can maintain healthy, viable populations for the foreseeable future. Habitat linkages to facilitate an ASMU metapopulation have been identified and are conserved for the foreseeable future.

Total Estimated Cost of Recovery (in U.S. dollars)[1]

Year	Priority 1a	Priority 1b	Priority 2	Priority 3	Total
2016	16,782,000	1,277,000	2,442,000	368,000	20,869,000
2017	15,782,000	1,409,000	2,953,000	834,000	20,977,000
2018	13,057,000	1,322,000	2,792,000	809,000	17,980,000
2019	12,727,000	747,000	2,792,000	712,000	16,978,000
2020	12,727,000	707,000	2,645,000	837,000	16,916,000
2021	12,117,000	697,000	2,670,000	857,000	16,341,000
2022+	12,117,000	726,000	2,575,000	637,000	16,055,000
Total	95,309,000	6,885,000	18,869,000	5,054,000	126,117,000

[1]Priority definitions can be found in section 3.2.

The estimated cost to implement this plan for the first 6 years is $126,117,000 as detailed in the implementation schedule. The total cost to implement this plan through the year 2115, the estimated recovery date described below, is estimated at $343,972,000.

Date of Recovery

If recovery efforts are fully funded and carried out as outlined in this plan, including strategic acquisitions and partnerships and significant investments in thornscrub restoration, recovery criteria for downlisting could be met by 2085. Based on continued recovery actions outlined and implemented into the future including strategic acquisitions and partnerships and significant investments in thornscrub restoration, the Recovery Team estimates that delisting for the ocelot could be initiated by 2115. These timeframes are based on the slow growth rate of ocelot populations and consideration of the time needed for restoration of sufficient habitat to support the ocelot populations identified in the recovery criteria.

PLAN DE RECUPERACIÓN DEL OCELOTE, PRIMERA REVISIÓN

Estado Actual de la Especie

El ocelote (*Leopardus pardalis*) se encuentra clasificado como especie en peligro bajo la Ley de Especies en Peligro de 1973 (ESA, por sus siglas en inglés) y sus enmiendas (16 U.S.C. 1531 *et seq.*) en todo su hábitat en el hemisferio occidental donde se distribuye desde el sur de Texas y el sur de Arizona a través de Centro y Sudamérica hasta el norte de Argentina y Uruguay. El ocelote también está listado como en peligro bajo la ley de México (es decir, NOM-059-SEMARNAT-2010) (Secretaría de Medio Ambiente y Recursos Naturales 2010). El ocelote se encuentra listado como en peligro por los estados de Arizona y Texas (Departamento de Caza y Pesca de Arizona 2010, Departamento de Parques y Vida Silvestre de Texas 2014). En la regla final de 1982 (47 FR 31670), el Servicio de Pesca y Vida Silvestre de los Estados Unidos (USFWS, por sus siglas en inglés) determinó que la designación de hábitat crítico no era prudente debido a que tal designación no sería en el mejor interés para la conservación de la especie. Desde agosto de 2015, había un total de 53 individuos conocidos en las dos poblaciones separadas en el sur de Texas (Hilary Swarts *unpubl. data* 2015, Mike Tewes *pers. comm.* 2015). Una tercera población mucho más grande del ocelote de Texas-Tamaulipas (*L. p. albescens*) ocurre en Tamaulipas, México (Caso 1994, Carvajal-Villarreal *et al.* 2012, Stasey 2012, Conservación y Desarrollo de Espacios Naturales 2014), pero se cree que está aislada de los ocelotes de Texas (Walker 1997, Janečka *et al.* 2014).

En Arizona se han detectado cinco ocelotes (cuatro vivos y uno muerto) entre 2009 y 2015 Ávila-Villegas and Lamberton-Moreno 2013, Culver *et al.* 2016); antes de esos descubrimientos, el último ejemplo de ocelote conocido en Arizona fue una mortalidad causada por un vehículo cerca de Oracle, Arizona, en 1967 (López González *et al.* 2003). Además de los recientes avistamientos de Arizona, los ocelotes se han documentado en Sonora, México (López González *et al.* 2003, Gómez-Ramírez 2015), incluyendo a una hembra con un cachorro aproximadamente a 48 km al sur de la frontera de EE. UU. y México en 2011 (Ávila-Villegas and Lamberton-Moreno 2013).

Si bien este plan considera al ocelote en toda su rango de distribución, su enfoque principal es en dos unidades de manejo transfronterizas, la Unidad de Manejo Texas-Tamaulipas (TTMU, por sus siglas en inglés) y la Unidad de Manejo Arizona-Sonora (ASMU, por sus siglas en inglés). Las unidades de manejo son una herramienta de gestión de poblaciones útil para especies que presentan amplios márgenes de distribución, con múltiples poblaciones, y diferentes presiones ecológicas o amenazas en diferentes partes de su área. Con el uso de esta estrategia de unidades de manejo, podemos establecer metas de recuperación para cada unidad y podremos medir de mejor manera su contribución hacia la recuperación del ocelote.

Requerimientos de Hábitat, Amenazas y Otros Factores Limitantes

Los ocelotes usan una amplia variedad de hábitats a lo largo de su rango de distribución. Se han observado ocelotes en vegetaciones de matorrales espinosos y semiáridos (Shindle and Tewes 1998, López González *et al.* 2003), praderas costeras y bosques tropicales costeros (Caso 1994, 2013), bosques tropicales secos (Fernandez *et al.* 2002, López González *et al.* 2003, Servín *et al.*

2003), selvas tropicales (Cuarón 2000, Ávila-Nájera *et al.* 2015), encinares y pastizales (Avila-Villegas y Lamberton-Moreno 2012, López González *et al.* 2014, Culver *et al.* 2016), piedemonte / matorral montano, bosque nublado (Cuarón 2000, Martínez-Calderas *et al.* 2011), bosques de pinos y encinos (Iglesias *et al.* 2009, Bárcenas y Medellín 2010) y bosques de abetos (Aranda *et al.* 2014).

Dado que el crecimiento y el desarrollo de la población humana continúan en gran parte del rango de distribución del ocelote, la conversión del hábitat, la fragmentación y la pérdida aún comprenden las principales amenazas de hoy (véase el Apéndice II). Se ha estimado que en Texas, más del 95% del hábitat de matorral espinoso denso en el Valle Bajo del Río Grande se ha convertido a la agricultura, pastizales o desarrollos urbanos (Jahrsdoerfer and Leslie 1988, Tremblay *et* 2005). El tamaño reducido de las poblaciones en Texas y su aislamiento de poblaciones en México, representa una amenaza por la endogamia para la especie en Texas (Janečka *et al.* 2011, Korn 2013). La conectividad entre las poblaciones de ocelotes o la colonización de nuevos hábitats se ven impedidas por la amenaza de mortalidades en los caminos que cruzan los ocelotes para dispersarse (Haines *et al.* 2005b). Los problemas asociados a barreras como las carreteras y el muro fronterizo en la frontera entre EE.UU. y México, así como el constante flujo de los agentes que patrullan regularmente la frontera entre los EE.UU. y México, agravan aún más el aislamiento de los ocelotes de Texas y Arizona de aquellos que se encuentran en México (Lorey 1999, Grigione y Mrykalo 2004, Flesch *et al.* 2009).

La explotación comercial y la cacería ilegal fueron amenazas graves para la especie cuando se listó al ocelote originalmente (Sunquist and Sunquist 2002). Aunque aún continúa la eliminación ilegal del ocelote, y los reglamentos que protegen el ocelote siguen siendo difíciles de hacer cumplir; la captura y exportación de ocelotes ha disminuido significativamente y está prohibida por la Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres (CITES) (Sunquist y Sunquist 2002). La Lista Roja de la Unión Internacional para la Conservación de la Naturaleza (UICN) considera al ocelote como de Preocupación Menor (Nowell 2002), pero desde 2008, la UICN reconoce que algunas poblaciones están amenazadas debido a que están disminuyendo (Caso *et al.* 2008). Al ser una especie muy extendida con hábitos crípticos y una baja densidad de población en cada país, la comprensión de la situación mundial del ocelote requiere no solo del conocimiento científico sobre su distribución, sus requisitos ecológicos y la dinámica de población, sino también del reconocimiento de las amenazas y oportunidades que varían a través de las fronteras internacionales.

Muchas de las amenazas al ocelote son comunes entre los países latinoamericanos (véase el Apéndice II). La mayoría de los estudios han ocurrido en reservas nacionalmente reconocidas. Las amenazas incluyen generalmente la pérdida de hábitat y la fragmentación, el aislamiento subsecuente y las repercusiones genéticas de dicho aislamiento, y la eliminación ilegal del ocelote y la eliminación de sus presas.

Estrategia de Recuperación

La estrategia de recuperación implica las siguientes acciones:

1. La valoración, protección, reconexión y restauración de suficiente hábitat para mantener poblaciones viables del ocelote en las líneas fronterizas de EE. UU y México;
2. La reducción de los efectos del crecimiento y desarrollo de la población humana sobre la sobrevivencia y mortalidad de los ocelotes;
3. El mantenimiento o mejora de la variabilidad genética, condiciones demográficas y salud del ocelote;
4. La garantía de la viabilidad a largo plazo de las poblaciones de ocelotes a través de asociaciones, el desarrollo y la aplicación de incentivos para los propietarios de tierras, la aplicación de la normativa existente, y la educación y la divulgación públicas;
5. El uso del manejo adaptativo, en la cual se da seguimiento a la recuperación y se revisan las tareas de recuperación por parte del USFWS en coordinación con el Equipo Binacional de la Recuperación del Ocelote a medida de que se disponga de nueva información;
6. El apoyo de esfuerzos internacionales para determinar el estado de conservación del ocelote en el sur de Tamaulipas y Sonora.

Metas de Recuperación

El objetivo de este plan de recuperación revisado es recuperar y remover de la lista de especies en riesgo al ocelote, bajándolo del nivel de especie en peligro a la condición de amenazado como un objetivo intermedio.

Criterios de Recuperación

El ocelote debe considerarse para reclasificación del estado de en peligro a estado de amenazado cuando:

Primer criterio: El ocelote debe seguir calificando como "Preocupación Menor" ("Least Concern") en la Unión Internacional para la Conservación de la Naturaleza (IUCN) Criterios de la Lista Roja (IUCN 2014) por lo menos cinco años; y las amenazas de la pérdida de hábitat, la fragmentación del hábitat y la caza furtiva hayan disminuido de tal manera que el ocelote ya no esté en peligro de extinción.

Segundo criterio: La metapoblación de ocelotes en la Unidad de Manejo de Texas-Tamaulipas (TTMU) estima a través de un monitoreo científico y confiable por lo menos 200 ocelotes en Texas y 1,000 ocelotes en Tamaulipas por lo menos cinco años. Los 200 ocelotes de Texas deben distribuirse ya sea en:

(a) una metapoblación por lo menos 150 ocelotes con intercambio entre esta y los ocelotes de Tamaulipas que sea suficiente para mantener la variabilidad genética; o

(b) dos poblaciones de por lo menos 75 ocelotes cada una, con intercambio entre las dos poblaciones y entre las poblaciones centrales y los ocelotes de Tamaulipas que sea suficiente para mantener la variabilidad genética.

Ademas del criterio para reclasificación 2(a) o 2(b), 50 ocelotes adicionales deben estar presentes en Texas, ya sea como miembros adicionales de las poblaciones existentes o como individuos menos estables geográficamente en búsqueda de pareja o nuevos rangos de hogar. Puede facilitarse el intercambio entre poblaciones al mover a los ocelotes entre poblaciones para simular la dispersión y el reclutamiento natural. Las poblaciones centrales pueden incluir a las poblaciones actuales en los condados de Cameron y Willacy, pero también pueden incluir una población reintroducida y establecida dentro del rango histórico actualmente desocupado. Debe existir la protección del hábitat para apoyar a las poblaciones centrales de ocelotes para el futuro previsible, y deben protegerse los corredores potenciales; también deben desarrollarse los mecanismos para restaurar la conectividad del hábitat entre las poblaciones centrales.

Tercer criterio: La metapoblación de ocelotes en la Unidad de Manejo de Arizona-Sonora (ASMU) estima a través de un monitoreo científico y confiable para ser de por lo menos 1,000 ocelotes por lo menos cinco años. Se han identificado los enlaces de hábitat para apoyar la metapoblación de ASMU. Se han identificado las amenazas a esta metapoblación y se ha determinado que están por debajo del umbral de peligro de extinción dentro del futuro previsible. Se han desarrollado soluciones para disminuir o eliminar esas amenazas que son específicas y factibles.

Debe considerase la eliminación del ocelote de la lista de especies en peligro de extinción cuando se reúnan todas las siguientes condiciones:

Primer Criterio: El ocelote debe seguir calificando como "Preocupación Menor" ("Least Concern") bajo los criterios de la Lista Roja de IUCN (IUCN 2014) por lo menos 10 años y las poblaciones sean estables y estén en crecimiento. Las amenazas que provienen de la pérdida y fragmentación de hábitat, y la caza ilegal disminuyan de tal manera que el ocelote pueda mantener poblaciones saludables y viables para el futuro previsible.

Segundo Criterio: La metapoblación de TTMU estima a través de un monitoreo científico y confiable por lo menos 200 ocelotes en Texas y 1,000 ocelotes en Tamaulipas por lo menos 10 años. Los 200 ocelotes de Texas deben distribuirse ya sea en:

(a) una metapoblación por lo menos ocelotes con intercambio entre esta y los ocelotes de Tamaulipas que sea suficiente para mantener la variabilidad genética; o

(b) dos poblaciones de por lo menos 75 ocelotes cada una, con intercambio entre las dos poblaciones en Texas y entre las poblaciones y los ocelotes de Tamaulipas que sea suficiente para mantener la variabilidad genética.

Ademas del criterio para eliminación de la lista 2(a) o 2(b), 50 ocelotes adicionales deben estar presentes en Texas, ya sea como miembros adicionales de las poblaciones existentes o como individuos menos estables geográficamente en búsqueda de pareja y/o nuevos rangos de hogar.

El intercambio entre poblaciones debe ocurrir a través de la dispersión natural en lugar de translocar a los ocelotes entre poblaciones; o

(c) si el intercambio natural entre Texas y Tamaulipas no está ocurriendo, puede facilitarse el intercambio transfronterizo al mover a los ocelotes para simular la dispersión y reclutamiento naturales; pero debe establecerse otra población de por lo menos 75 ocelotes dentro del rango histórico desocupado en Texas para complementar a las dos poblaciones de 75 ocelotes cada una. La tercera población de 75 ocelotes debe establecerse en un lugar que ampliaría el alcance geográfico de la especie en Texas para ofrecer garantías suficientes contra la pérdida de toda la población de Texas a causa de fenómenos meteorológicos catastróficos o enfermedades infecciosas.

En cualquiera de estos escenarios, debe existir la gestión y la conservación del hábitat para apoyar y conectar todas las poblaciones centrales de ocelotes en Texas y en Tamaulipas para el futuro previsible.

Bajo los escenarios 2(a) o 2(b), tendría que haber por lo menos 200 ocelotes en Texas para cumplir con el segundo criterio. Bajo el escenario 2(c), tendría que haber por lo menos 275 ocelotes en Texas.

Tercer Criterio: La metapoblación de ASMU estima a través de un monitoreo científico y confiable de por lo menos 1,000 ocelotes por lo menos 10 años y las poblaciones deben ser estables o ir en incremento. Las amenazas que provienen de la pérdida y fragmentación de hábitat, y la caza ilegal disminuyan de tal manera que el ocelote pueda mantener poblaciones saludables y viables para el futuro previsible. Se han identificado enlaces de hábitat para facilitar una metapoblación de ASMU, y se conservan para el futuro previsible.

Costo Total Estimado de Recuperación (en Dólares Estadounidenses)[1]

Año	Prioridad 1a	Prioridad 1b	Prioridad 2	Prioridad 3	Total
2016	16,782,000	1,277,000	2,442,000	368,000	20,869,000
2017	15,782,000	1,409,000	2,953,000	834,000	20,977,000
2018	13,057,000	1,322,000	2,792,000	809,000	17,980,000
2019	12,727,000	747,000	2,792,000	712,000	16,978,000
2020	12,727,000	707,000	2,645,000	837,000	16,916,000
2021	12,117,000	697,000	2,670,000	857,000	16,341,000
2022+	12,117,000	726,000	2,575,000	637,000	16,055,000
Total	95,309,000	6,885,000	18,869,000	5,054,000	126,117,000

[1]Las definiciones de prioridad pueden encontrarse en la sección 3.2.

El costo estimado para implementar este plan para los primeros 6 años es $126,117,000 como detallado en la tabla de implementaction. El costo total para implementar este plan hasta el año 2110, la fecha de recuperación estimado descrito abajo, se estima en $343,972,000.

Fecha de Recuperación

Si los esfuerzos de recuperación se financian y se llevan a cabo totalmente como se describe en este plan, incluyéndose adquisiciónes y asociaciones estratégicos e inversiones significativas en restauración de los matorrales espinosos, los criterios de recuperación para reclasificar el ocelote del estado de en peligro a estado de amenazado podrían cumplirse para el año 2085. Sobre la base de las acciones de recuperación continuas descritos y aplicados en el futuro, incluyéndose adquisiciónes y asociaciones estratégicos e inversiones significativas en restauración de los matorrales espinosos, el equipo estima que el ocelote debe considerarse para la eliminación de la lista de especies en peligro de extinción en el año 2115. Estas estimaciones de tiempos están basadas en la tasa de crecimiento lento de poblaciones de oceote y la consideración del tiempo necesaria para la restauración de suficiente hábitat para apoyar las poblaciones de ocelote identificadas en los criterios de recuperación.

1.0 BACKGROUND

1.1 Introduction

The Endangered Species Act of 1973 (ESA) calls for preparation of recovery plans for threatened and endangered species likely to benefit from the effort, and authorizes the Secretary of the Interior to appoint recovery teams to prepare the plans (U.S. Congress 1988). According to section 4(f)(1) of the ESA, recovery plans must, to the maximum extent practicable, describe site-specific management actions as may be necessary to achieve the plan's goals, incorporate objective and measurable delisting criteria, and estimate the time and cost required for recovery. A recovery plan is not self-implementing, but presents a set of recommendations that are endorsed by an official of the Department of Interior for managers. Recovery plans also serve as a source of information on the overall biology, status, and threats of a species. It is the intent of the U.S. Fish and Wildlife Service (USFWS) to modify this recovery plan in response to management, monitoring, and research data.

The first recovery plan for the ocelot (*Leopardus pardalis*), *The Listed Cats of Texas and Arizona Recovery Plan (With Emphasis on the Ocelot)*, was completed in 1990 (USFWS 1990a). The former plan briefly addressed the jaguar (*Panthera onca*), jaguarundi (*Puma yagouaroundi*), and margay (*Leopardus wiedii*), but focused on the ocelot, primarily in Texas.

While considerable progress was made in conducting ocelot research in Texas, a number of recovery actions have received little attention. In addition, the demographic, social, economic, and political landscapes in south Texas, Arizona, and northern Mexico have changed since 1990. Finally, there is a need to address the ocelot as it is listed, throughout its range. In May 2003, a new bi-national ocelot recovery team was formed to revise the outdated plan. The team was composed of both Technical and Implementation Subgroups with representation from the United States and Mexico. The Technical Subgroup was composed of scientists, researchers, and biologists with expertise in feline biology and ecology, genetics, landscape ecology, and conservation planning. The Technical Subgroup's function was to compile and review extensive scientific information and develop recovery goals, criteria, strategies, and recommended actions. The Implementation Subgroup consisted of a broad range of interested parties including landowners, conservation organizations, biologists, academics, and state and Federal agencies. The role of the Implementation Subgroup was to assist the USFWS in developing an effective strategy for, and implementing the recovery actions developed through, the ocelot recovery planning process.

Because the ocelot is listed throughout its range, which includes 22 countries, the ocelot presents a significant challenge for recovery planning. Our knowledge regarding the status of the species in much of its range is very limited, and the USFWS and its partners lack the resources and authority to coordinate large-scale international research and recovery for the entire species. Therefore, it is not practicable to establish site-specific management actions, objective and measurable recovery criteria, or cost estimates throughout the species' entire range. However, we can establish the framework to better understand the status and conservation needs of ocelots throughout their range by identifying research needs as outlined in the recovery actions of this plan. The USFWS needs information on populations and threats internationally in order to evaluate whether its current listing status is appropriate. However, the USFWS does not have the potential to address the major threats to the species' recovery outside the U.S. Because the USFWS's limited resources are better applied to planning and on-the-ground implementation of conservation actions within the boundaries of the U.S and in partnership with adjacent Mexico, we have established specific criteria for recovery, and actions that, if implemented, will conserve viable ocelot populations in the borderlands (Arizona-Sonora and Texas-Tamaulipas). Priority is being given to the two subspecies that occur in this area, *L. p. sonoriensis* and *L. p. albescens*, which are most likely to benefit from such plans because this is where the USFWS has jurisdiction and the USFWS has an established working relationship to resolve issues of mutual conservation concern with its partners in Mexico.

Thus, our approach in this revision to the ocelot portion of the 1990 recovery plan is as follows:

- This plan focuses exclusively on the ocelot.

- We summarize what is known about the status of, and threats to, the ocelot throughout its range and identify primary information gaps and broad actions necessary to address conservation of the species outside of the borderlands of the U.S. and Mexico.

- We address in detail the actions necessary to conserve the existing and imperiled breeding populations in Texas, and populations across the border in Tamaulipas, Mexico.

- We address the status of, and threats to, the existing population in Arizona and Sonora, Mexico, and identify the actions necessary to understand its status and to conserve the population through cooperative efforts in the borderlands of Arizona and Sonora.

We submit that the approach described above meets our statutory requirements to the maximum extent practicable. As our knowledge of the ocelot increases and as the recovery actions described in this plan are implemented, the plan may be revised and refined.

1.2 Status of the Species

The ocelot was listed as endangered in 1972 under the authority of the Endangered Species Conservation Act of 1969 (USFWS 1972). The 1969 Endangered Species Conservation Act maintained separate lists for foreign and native wildlife. The ocelot appeared on the foreign list, but due to an oversight, not on the native list. Following passage of the ESA in 1973, the ocelot was included on the January 4, 1974, list of "Endangered Foreign Wildlife" that "grandfathered" species from the lists under the 1969 Endangered Species Conservation Act into a new list under the ESA (USFWS 1974). The entry for the ocelot included "Central and South America" under the "Where found" column in the new ESA list. Endangered status was extended to the U.S. portion of the ocelot's range for the first time with a final rule published July 21, 1982 (USFWS 1982). The "Historic range" column for the ocelot's entry in the rule reads, "U.S.A. (TX, AZ) south through Central America to South America." The entry on the current list (USFWS 2013) is essentially the same, and reads, "U.S.A. (TX, AZ) to Central and South America" (see Figure 1). The species has a recovery priority number of 5C, meaning that it has a high degree of threat, a low potential for recovery, and a relatively high degree of conflict with development projects.

The ocelot was upgraded to Appendix I of the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES) in 1986 (Fuller *et al.* 1987) and is considered endangered in Mexico by the Secretariat of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT]) under the authority of Mexico's law entitled NOM-059-SEMARNAT-2010.

In the U.S., the ocelot is also protected by the states within which it resides. In Arizona and Texas, the ocelot is included on their lists of *Species of Greatest Conservation Need* (e.g., in Arizona's Comprehensive Wildlife Conservation Strategy: 2005-2015 [AGFD 2006], and in the Texas Conservation Action Plan [TPWD 2012]). This conservation strategy provides policy guidance to both state and federal agencies and the public on AGFD's and TPWD's priorities. These plans do not provide specific legal or regulatory protection for listed species. However, the general provisions of Arizona Revised Statutes Title 17 protect all native wildlife, including federally-listed species. In Texas, the ocelot is protected by state law and is considered endangered (Texas Parks and Wildlife Department 2014).

Status south of the U.S. **–** We briefly review the status of the ocelot outside U.S. boundaries below. Please see Appendix II of this document for a more complete, fully cited review of ocelot status and threats in other countries.

The ocelot is found in every mainland country south of the U.S. except Chile (Pocock 1941, Cabrera 1961, Hall 1981). International trade of the ocelot was banned by CITES in 1975 in response to dwindling populations throughout its range, and as of 1990, all ocelot subspecies are listed under Appendix I, as a species threatened with extinction. The Red List produced by the International Union for Conservation of Nature (IUCN), lists the ocelot as Least Concern (i.e., populations estimated to be at least 50,000 across their entire range) (IUCN 2014). In 2008, the IUCN recognized that some populations were threatened and decreasing (Caso et al. 2008).

Figure 1. Current distribution of the ocelot.

As a widespread species with cryptic habits and a low population density in any one country, understanding the ocelot's global status requires not only scientific knowledge of its distribution, ecological requirements, and population dynamics, but also knowledge of the varying threats and opportunities across international borders.

Many of the threats to the ocelot are common to all Latin American countries. Most studies have occurred on nationally-recognized preserves. Threats generally include habitat loss and fragmentation, subsequent isolation and genetic repercussions of such isolation, and illegal killing of the ocelot and overharvest of its prey.

1.3 Description and Taxonomy

The ocelot *(Leopardus pardalis*; Linnaeus, 1758) is a medium-sized spotted cat (Figure 2). The coloration of the upper parts of the body is pale gray to cinnamon. There are spots on the head, two black stripes on the cheeks, and several longitudinal black stripes on the neck. The body shows elongated black-edged spots arranged in chain-like bands. The rounded ears are black dorsally, with a conspicuous white spot. The underparts are whitish, spotted with black. The tail is marked with dark bars or incomplete rings (Hall 1981). The dental formula is i3/3, c1/1, pm3/2, m 1/1, for a total of 30 teeth. Weights range from 7-16 kg, with males weighing more than females.

The ocelot belongs to the genus *Leopardus* which also includes the margay and the oncilla (*Leopardus tigrinus*). The ocelot has been divided into as many as 11 subspecies that ranged from the southwestern U.S. to northern Argentina (Pocock 1941, Cabrera 1961, Eizirik *et al.* 1998). Two subspecies have occurred in the United States: the Texas-Tamaulipas ocelot (*L. p. albescens*) and the Arizona-Sonora ocelot (*L. p. sonoriensis*) (Goldman 1943). For purposes of this recovery plan, we are using these common names for these subspecies referred to as the Texas ocelot and the Sonora ocelot by Goldman (1943).

Resolving correct taxonomy and genetic lineages for species or populations that are in decline is critical to selecting the most effective management strategy. Traditionally, the ocelot in northeastern Mexico and Texas was classified as a unique subspecies *Leopardus pardalis albescens* (Goldman 1943, Hall and Kelson 1959, Álvarez 1963). Ocelot phylogeography based on genetics has been used to examine the relevance of the currently defined subspecies of *L.p. albescens* (Eizirik *et al.* 1998, Janečka *et al.* 2007, Janečka *et al.* 2008, Janečka *et al.* 2011).

Eizirik *et al.* (1998) examined a segment of the mitochondrial control region in 39 ocelots originating mostly from South America and Central America. Based on his phylogenetic analyses, there were four phylogeographic groups of ocelots: 1) southern South America including Brazil (south of the Amazon River) and Bolivia; 2) north-northwest South America including Brazil (north of the Amazon River), Venezuela, Trinidad and Panama; 3) north-northeast South America, including French Guyana and northern Brazil; and 4) Central America from southern Mexico to northern Panama. These results suggested that the current ocelot subspecies designations (see Pocock 1941, Cabrera 1961, Hall 1981) were not valid and needed to be revised. It should be noted that Eizirik et al. (1998) did not include any samples from northern Mexico or Texas.

Figure 2. The ocelot is a medium-sized, long-tailed spotted cat. Photo credit Colton Fischer.

Janečka *et al.* (2007) sequenced the same mitochondrial control region in nine ocelots from Cameron and Willacy County, Texas and Tamaulipas, Mexico, to compare to ocelots examined by Eizirik *et al.* (1998). Results showed that the ocelot populations in Texas along with those in northern Mexico are within the Central American lineage (group #4 in Eizirik *et al*. [1998]) that includes ocelots from central Mexico, southern Mexico, Nicaragua and Guatemala. Janečka *et al.* (2007) also found that the ocelots in Texas and Tamaulipas had 1/10 of the nucleotide diversity of ocelots from South America. The ocelots in Texas had 1/5 of the nucleotide diversity of ocelots from Tamaulipas (Janečka *et al.* 2007).

These studies indicate there could be as many as four evolutionarily significant units (ESUs, Ryder 1986) for ocelot conservation. As suggested by Eizirik *et al.* (1998), the Central American and southern South American groups of ocelots meet the requirement of reciprocal monophyly of mtDNA lineages for ESU designation (Moritz 1994), and the sampled Texas ocelots fall within the Central American ESU. The two northern groups of South American ocelots could be considered separate ESUs although additional samples are required to improve the understanding of population structure in that region. Given that mitochondrial DNA is maternally inherited, a thorough assessment of subspecies designations and ESUs will require a range-wide phylogenetic study single nucleotide polymorphisms and an assessment of adaptive variation. Until such a study is conducted and ESU's are possibly refined, the USFWS should consider management actions in the ranges of *F.p. albescens* and *F.p. sonoriensis* as a valid way to focus actions towards the conservation of these ocelots.

1.4 Distribution and Population Trends

Historical distribution in the U.S. **–** Ocelot fossils from North America include the proximal end of a right femur from Alachua County, Florida (Kurten 1965), a left mandibular ramus from the Rancholabrean Reddick I fauna in Marion County, Florida (Ray *et al.* 1963, Kurten 1965), and a radius, a premaxilla and the distal end of a scapula from Yucatan, Mexico (Hatt *et al.* 1953). This sparse North America record may represent a brief extension of ocelot range during the Sangamonian paleo-environment (Werdelin 1985).

Although the exact date of habitation is unknown, a Native American archaeological site on the San Pedro River, near Redington, Arizona, had ocelot remains that predated the arrival of Spaniards (Burt 1961). There are no fossil records from Texas, but the ocelot probably occurred there in prehistoric times and may have ranged over much of the southern U.S. Moorehead (1968) reported a picture of an ocelot carved on human bone found in the Hopewell Mound Group in Ross County, Ohio, from between 1400 and 1500 A.D. Cahalane (1947) suggested this finding indicated the prehistoric range of the ocelot might have extended as far north as Ohio. However, Moorehead (1968) noted that many objects in the Hopewell burial mounds were the result of exchange with distant human populations.

Historically, the Texas-Tamaulipas ocelot inhabited southern and eastern Texas, north as far as Hedley, Texas, and west to Marfa, Texas (Davis 1951, Sealander 1979, Hall 1981). The type specimen for the Texas-Tamaulipas ocelot is from an unspecified locality in southwestern Arkansas along the Red River (Goldman 1943, Sealander 1979). The Texas-Tamaulipas ocelot may have also ranged into western Louisiana, but verified records from the Pleistocene are lacking (Ray *et al.* 1963, Kurten 1965, Lowery 1974).

The late 19th century range of the Arizona-Sonora ocelot included southeastern Arizona as far north as Fort Verde (Cockrum 1960, Hall 1981). Hoffmeister (1986) questioned the validity of the Fort Verde specimen and believed its origin may have been Mexico or Texas.

Recent distribution across its range **–** Currently, the ocelot ranges from extreme southern Texas and southern Arizona through the coastal lowlands of Mexico to Central America, Ecuador and northern Argentina. The ocelot does not occur south of the Province of Entre Rios in Argentina (Denis 1964, Redford and Eisenberg 1992). The ocelot also is known from Trinidad and Isla de Margarita, Venezuela, but not from the Antilles (Tewes and Schmidly 1987, Sunquist and Sunquist 2002). Although there are museum specimens of ocelots from California (Navarro-Lopez 1985, VertNet 2014) and fossil records from Florida (Ray *et al.* 1963, Kurten 1965), there are no recent verified reports of ocelots from California or Florida. The Texas-Tamaulipas ocelot is isolated from the Arizona-Sonora ocelot by the Sierra Madre highlands, and the dry areas of the Mexican Plateau (Goldman 1943, Sunquist and Sunquist 2002, Figure 3).

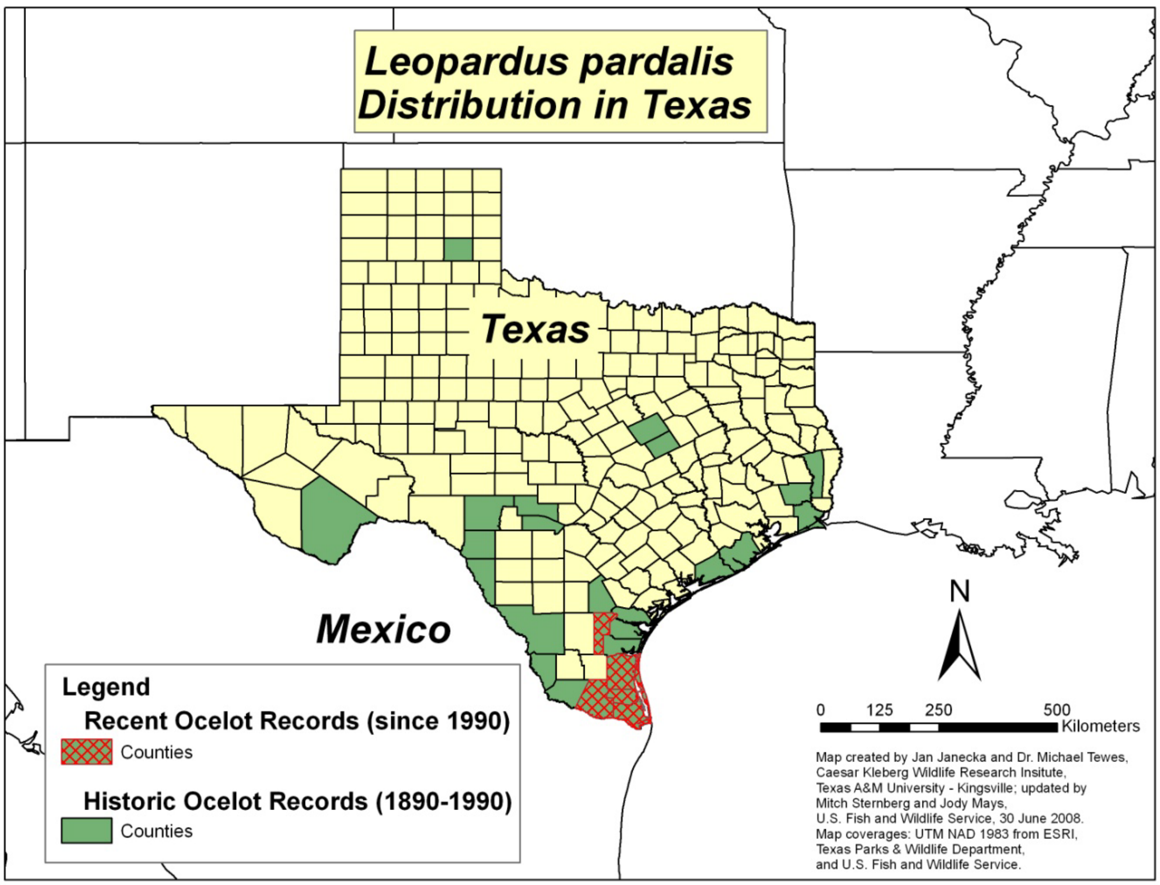
Figure 3. Recent ranges of the northern subspecies of ocelot.

<u>*Recent distribution in the TTMU*</u> **–** Since the 1960's, the ocelot was documented in Texas by photographs or specimens from Cameron, Hidalgo, Jim Wells, Willacy, and Kenedy counties (USFWS 1961, Navarro-Lopez 1985, Tewes 1986, Laack 1991, Shindle and Tewes 1998, Harveson *et al.* 2004, Jackson *et al.* 2005, Weaver *et al.* 2005, Haines *et al.* 2006a, Horn *et al.* 2009, Sternberg and Mays 2011, Rulison *et al.* 2015; Figure 4). Two populations occur in southern Texas (Tewes and Everett 1986). One occurs in Willacy and Kenedy counties primarily on private ranches (Navarro-Lopez 1985, Caso *et al.* 2012, Tewes 2014) and the other in eastern Cameron County, primarily on Laguna Atascosa National Wildlife Refuge (LANWR) (Laack 1991, Sternberg and Mays 2011). Individuals have occurred outside of these two

populations (Tewes 1986, Stangl and Young 2011), but there is no recent evidence that a breeding population occurs in other areas of Texas.

For example, in Hidalgo County, two ocelot kittens and their mother were seen by USFWS staff at Santa Ana National Wildlife Refuge (SANWR) in 1992, and seven days later an adult female was caught and radio-collared (USFWS 1992). She was tracked from 1992 to 1996 along the Rio Grande on and around SANWR (Fischer 1998). Fischer (1998) caught 21 bobcats (*Lynx rufus*), 300 non-target animals, and no other ocelots in 8,304 trap-nights in Hidalgo County near SANWR. The genetic profile of the female ocelot at SANWR was more closely aligned with Tamaulipas specimens than with those from Cameron or Willacy County populations (Walker 1997, Janečka *et al.* 2011).

Figure 4. Distribution of the ocelot records in Texas.



Both Texas populations occupy remnant habitat fragments and are isolated from each other by 30 km although natural dispersal between the two populations is possible according to observations of two ocelots in recent years. As an example, a male ocelot moved back and forth between areas of the Willacy County population (i.e., Yturria Ranch) and the Cameron County ocelot population (i.e., on the Arroyo Colorado Unit of Las Palomas Wildlife Management Area) during the period of 1997-2009 at least twice, based on the observations of multiple sources (Sam Patten *unpubl. data* 2006, David Shindle *pers. comm.* 2009, Mitch Sternberg *unpubl. data*

2009, Chappell 2010). The Arroyo Colorado Unit is located 30 km southeast of the Yturria Ranch and 8 km west of LANWR. The ocelot was trapped again on the Yturria Ranch in March 2006. Ocelots from LANWR have been found on the Arroyo Colorado Unit previously (Laack and Tewes 1988) therefore, this series of records represents the first documentation of an ocelot moving between the Willacy County and Cameron County ocelot populations in Texas.

On March 28, 2010, an adult male ocelot was killed by a vehicle on Highway 180 east of Palo Pinto, in Palo Pinto County, Texas, near Dallas-Fort Worth (Stangl and Young 2011), about 650 km from the south Texas populations. The ocelot had mitochondrial DNA similar to ocelots from South Texas and Tamaulipas (DeYoung and Holbrook 2010) and the possibility of the ocelot representing a wild specimen, not an escaped pet, and naturally-occurring in the area, could not be dismissed (Stangl and Young 2011).

<u>*Recent population estimates in Texas*</u> – The first ocelot recovery plan depicted "occupied habitat" in Jim Wells, Nueces, Live Oak, and Kleberg counties, 80 km north of the Willacy population (USFWS 1990a). Four ocelots have been killed by vehicles on State Highway-77 south of Kingsville in Jim Wells, Kleberg, and Willacy counties (Michael Tewes *pers. comm.* 2003; USFWS *unpubl. data* 2015a).

In 2009, based on camera-trapping, USFWS estimated there to be 7 ocelots (2 adult females, 3 adult males, and 2 juveniles) using conservation easements on the Yturria Ranch in Willacy County (Mitch Sternberg *unpubl. data* 2009). In May 2015, USFWS estimated there to be 12 ocelots (4 males, 6 female, 2 undetermined sex) using easements of USFWS and The Nature Conservancy on the Yturria Ranch (Mitch Sternberg *unpubl. data* 2015). The number of ocelots in the newly-discovered population on the East El Sauz Ranch in Willacy County by the fall of 2014 was estimated to be 22 ocelots (Tewes 2014). As of August 10, 2015, the ocelots in portions of Willacy and Kenedy counties numbered 39 and consisted of 15 males, 22 females, and two of unknown sex (Mike Tewes *pers. comm.* 2015).

From 2009-2010, 13 ocelots (8 adult males, 4 adult females, and 1 juvenile) were found on LANWR based on camera-trapping, live-trapping, and one road-killed specimen (Sternberg and Mays 2011). The number of identified ocelots for the LANWR population in May 2015 was 14 ocelots including 6 males, 7 females and one of unknown sex (Hilary Swarts *unpubl. data* 2015).

<u>*Recent population estimates in Tamaulipas*</u> **–** A third and much larger population of the Texas-Tamaulipas ocelot subspecies occurs more than 200 km south of the Texas/Mexico border in and around the Sierra of Tamaulipas, Mexico (Caso 1994, Carvajal-Villarreal *et al.* 2012, Stasey 2012, Conservación y Desarrollo de Espacios Naturales [CDEN] 2014). In February 2009, the Caesar Kleberg Wildlife Research Institute began camera-trapping on Rancho Caracól, Mexico, near the Sierra of Tamaulipas (Stasey 2012). Box-trapping was done in December 2009 and February 2010 from which 10 ocelots were captured and radio-collared in 314 trap nights (Carvajal-Villarreal *et al.* 2012). Carvajal-Villarreal *et al.* (2012) identified 41 individual ocelots on Rancho Caracól, with a population density of 0.3/km^2. Extrapolating the estimated density of ocelots on Rancho Caracól to the entire area of the same habitat patch for the Sierra of Tamaulipas produced a result of 371 ocelots in 1,560 km^2 (Stasey 2012).

<u>Recent distribution in the ASMU</u> **–** The Arizona-Sonora ocelot subspecies (*L. p. sonoriensis*) occurs in southern Arizona and northwestern Mexico (Sonora and northern Sinaloa) (Murray and Gardner 1997, López-Gonzalez *et al.* 2003, Avila-Villegas and Lamberton-Moreno 2013, Gómez-Ramírez 2015). Two other subspecies are present in the Pacific coast region of Mexico, *L. p. nelsoni* in the States of Sinaloa, Nayarit, Jalisco, Colima, Michoacan, Guerrero, and parts of Oaxaca, and *L. p. pardalis* in southern Oaxaca and Chiapas, and into Central America (Murray and Gardner 1997).

The Arizona-Sonora ocelot is isolated from the Texas-Tamaulipas ocelot by the Sierra Madre highlands and the dry areas of the Mexican Plateau, and once ranged from southeastern Arizona into the states of Sonora and Sinaloa in Mexico (Goldman 1943). The type specimen for the Arizona-Sonora ocelot was taken along the Rio Mayo, near Camoa, Sonora (Goldman 1925).

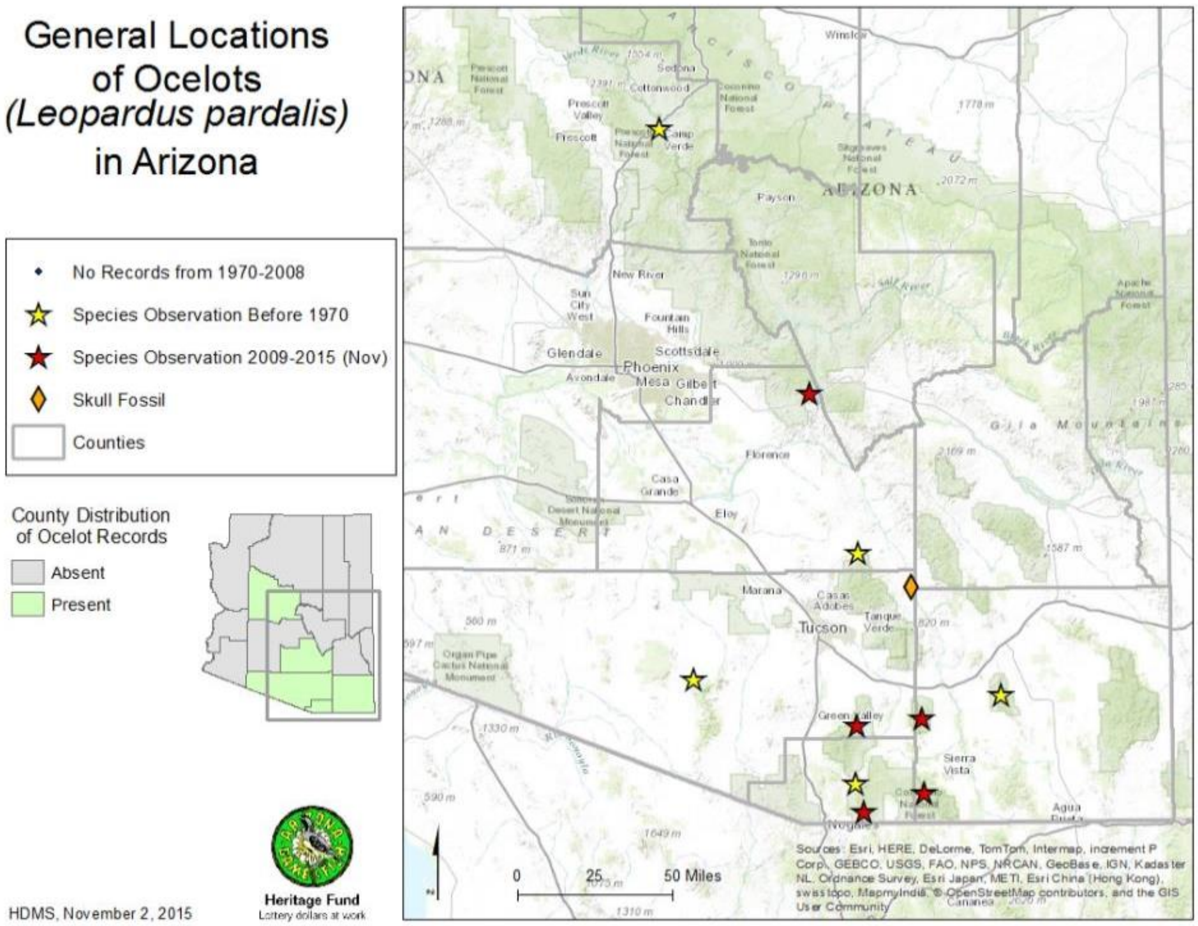
<u>Recent population status in the ASMU</u> **–** In Arizona, prior to 1980, there was one fossil record and 11 historical records of dead ocelots (carcass, skin, skull, mount).
There were no ocelots detected from about 1985 to 2009 in Arizona (Erin Fernandez *pers. comm.* 2015). Since 2009, however, a total of five ocelots have been detected in Arizona, including four detected by trail cameras and hunting dogs, and one dead ocelot that was struck by a vehicle. A description of these detections follows. In November 2009, a live ocelot (sex unknown) was documented in Cochise County, Arizona, with the use of camera-traps (Avila-Villegas and Lamberton-Moreno 2013). In April 2010, a second ocelot was found dead on a road near Globe, Arizona, and a genetic analysis was conducted for the ocelot, and all data indicated the young male ocelot was not of captive but wild origin (DeYoung and Holbrook 2010). Origin of the ocelot recovered in Globe is not conclusive due to a lack of comparative samples from Arizona or Sonora although in the DNA analyses, its lineage grouped with Mexico and Guatemala; however the limitations caused by so few regional samples prevented specific geographic assignment (Holbrook *et al.* 2011). A two-year camera-trap study in the area near Globe, Arizona, did not photograph any additional ocelots (Featherstone *et al.* 2013).

In February 2011, a third male ocelot was treed by a hunting dog and photographed in the Huachuca Mountains. He was subsequently detected multiple times by trail cameras, including once in the Patagonia Mountains (Culver *et al.* 2016), and was also treed by hunting dogs again (in the Huachuca Mountains) (Erin Fernandez *pers. comm.* 2015). After being detected in the Patagonia Mountains he returned to the Huachuca Mountains, meaning that he traveled an approximate round trip distance of 84 km. He was most recently detected in May 2013 (Culver *et al.* 2016).

In May 2012, a fourth male ocelot was detected in the Huachuca Mountains via trail camera. He has been detected many times via trail cameras and treed by hunting dogs once, most recently in May 2015 (Culver *et al.* 2016). In April 2014, a fifth male ocelot was detected in the Santa Rita Mountains via trail camera. He was photographed several times over a two-month period and has not been detected since (Culver *et al.* 2016). Additionally, an unknown individual ocelot of unknown gender ocelot was detected in December 2013 in the Santa Rita Mountains; it is not known if this was the same as the fifth ocelot described above or a different ocelot (Culver *et al.* 2016). Prior to these five recently-known individuals the last documentable ocelot in Arizona was a male that had been killed by a vehicle near the town of Oracle in 1967 (López González *et al.* 2003) (Figure 5).

In Sonora, Mexico, many records of ocelots exist, including documented breeding populations. López González *et al.* (2003) obtained 36 verified ocelot records for Sonora, 21 of which were obtained after 1990. A population of 2,025 ± 675 ocelots in Sonora was estimated by López González *et al.* (2003) based on the distribution of these records and the availability of potential habitat. Gómez-Ramírez (2015) estimated a population of 1,421 ocelots in Sonora.

Figure 5. Verified occurrences of the ocelot in Arizona.



Avila-Villegas and Lamberton-Moreno (2013) documented six ocelots, including a female with one kitten, from 2007-2011 in in the Sierra Azul of Sonora, located about 48 km south of the U.S.-Mexico border in Sonora, Mexico. Additionally, with the use of trail cameras, two ocelots have been documented (one in 2009 and one in 2013) in the Sierra de Los Ajos, located about 48 km south of the U.S.-Mexico border near Naco, Sonora, Mexico (USFWS 2010b, Rosa Elena Jimenez Maldonado *pers. comm.* 2013). Apart from the detection of the female with a kitten in the Sierra Azul, the northernmost breeding population in proximity to Arizona occurs about 200 km south of the U.S.-Mexico border in Sonora, Mexico. The original recovery plan (USFWS

1990a) did not include recommendations or contingency plans in the event that the ocelot re-occupied southeastern Arizona.

Population size – Estimating population sizes of elusive nocturnal carnivores that inhabit dense vegetative cover such as the ocelot is difficult. Thus, it is challenging to generalize about population status.

In Texas, Tewes and Everett (1986) provided "a crude estimate" of 80-120 individuals based on distribution of radio-tagged ocelots extrapolated to areas that were presumed to be suitable habitat. Based on several years of intensive study, Laack (1991) estimated a total of about 30 ocelots on LANWR during the mid-1980s and believed this was considerably higher than the population estimate from five years earlier. More recently, Haines *et al.* (2005a) estimated the number of breeding individuals in the LANWR population could be as many as 19 ocelots, and estimated there to be a sufficient amount of habitat for a potential total population of 38 ocelots in Cameron County. These estimates were calculated by averaging ocelot home range sizes reported by Navarro-Lopez (1985), Tewes (1986), and Laack (1991) and extrapolating this estimate to the amount of available dense thornscrub habitat. Although there has not been a population estimate calculated for the entire state of Tamaulipas, Stasey (2012) provided an extrapolated estimate of 874 ocelots based on the extent of the thornscrub and low spiny forests that was continuous from the area he sampled and into the Sierra of Tamaulipas.

There are no population estimates for Arizona; however, monitoring since 2009 has provided information on five male ocelots (Avila-Villegas and Lamberton-Moreno 2013, Culver *et al.* 2016). As discussed above, López González *et al.* (2003) estimated a population of 2,025 ± 675 ocelots in Sonora. More recently, Gómez-Ramírez (2015) estimated a state-wide population for Sonora of 1,421 ocelots.

Density estimates in the U.S. – Sternberg and Mays (2011) reported a density of 0.09 ocelots/km^2 for LANWR. Although ocelots have been studied extensively in Texas, few report density of ocelots. No density estimates have been reported for ocelots in Arizona but relatively few ocelots have been known to occur at any one time in the state, so the density might be quite low.

Density estimates outside the U.S. – Ocelot population density estimates include: for subtropical thornscrub to tropical deciduous forest of 0.30/km^2 (Carvajal-Villarreal *et al.* 2012) and 0.20/km^2 (Conservación y Desarrollo de Espacios Naturales [CDEN] 2014) in Tamaulipas, and 0.04/km^2 in Sonora, Mexico (Gómez-Ramírez 2015).

Dillon and Kelly (2007) estimated ocelot density for western Belize at 0.258-0.259/km^2 in tropical rainforest and 0.023-0.038/km^2 in adjacent pine forest. Other researchers have produced estimates of 0.56/km^2 for gallery forest, semi-deciduous forest, savanna, and marshlands of the Pantanal Reserve of southwestern Brazil (Trolle and Kery 2003), 0.80/km^2 in Amazon rainforest in southeastern Peru (Emmons 1988), and 0.40/km^2 for the llanos (interspersed dry tropical forest in savanna) of central Venezuela (Ludlow and Sunquist 1987). The Amazon forest of northwestern Peru appears to support the highest known densities of 0.75 to 0.95 ocelots/km^2 (Kolowski and Alonso 2010).

Emmons (1988) reported 0.8 ocelots/km^2 at Cocha Cashu in Peru, a density she characterized as "high." Ludlow and Sunquist (1987) estimated 0.4 adult ocelots/km^2 on their study site in Venezuela. All of these estimates were based on the spatial distribution of radio-tagged animals and evidence of unmarked animals (e.g., tracks and scats). In the Chamela-Cuixmala Biosphere Reserve of western Mexico, Casariego-Madorell (1998) estimated 0.45 to 2.25 ocelots/km^2 based on camera traps, radio-telemetry, and capture-recapture methods. Fernandez (2002) estimated the density of ocelots in Chamela as 0.25 to 0.39/km^2. Both of Fernandez's (2002) estimates were likely conservative as the lower estimate did not take overlap among ocelots into consideration. Smallwood and Schonewald (1996) documented a strong negative correlation between estimated population density and size of the study area. Maffei *et al.* (2005) used camera trap surveys to estimate a mean of 0.3 adult ocelots per km^2 in Bolivian dry-forests and noted a positive association between ocelot density and mean annual precipitation.

Because of limited overlap among adult male ocelots (Tewes 1986, Laack 1991, Caso 1994) and among adult female ocelots (Laack 1991, Emmons 1988), home range size may help approximate population density. This method, while valid, should be regarded with some caution, as most studies have been based on small numbers of animals and most researchers report that some additional untagged adults (especially females) occurred on their occupied study sites, raising the possibility that females may be less territorial than indicated by measures of home range overlap. However, Emmons (1988) supported her data on low overlap between adult females with observations that females concentrated their activity at the periphery of the home range, such that the entire home range boundary was visited every two to four days. Using camera data of known ocelots and correlating relatedness from genetic analyses in Panama, Rodgers *et al.* (2015) noted overlap more commonly between related ocelots but not necessarily between males.

<u>*Home range estimates*</u> – In Texas, Tewes (1986) reported ocelot home range size of 18 km^2 (5 males) and 11 km^2 (3 females), using 95% harmonic mean estimators (HME) for ocelots on Willacy County ranches and LANWR. In contrast, Navarro-López (1985) reported an average home range for males as 2.52 km^2 and females as 2.07 km^2. Similarly, Laack (1991) reported 3 male home ranges averaged 3.6 km^2 (95% HME), compared to 3 female home ranges that averaged 2.1 km^2 (95% HME) on LANWR. Caso *et al.* (2014) reported a home range estimate for male ocelots as 4.2 km^2 and 2.2 km^2 for female ocelots in Willacy County, Texas. Haines *et al*. (2006) reported a home range of a female ocelot with a GPS collar of 2.3 km^2 (95% fixed kernel) from Willacy County, Texas. In Tamaulipas, Caso (2013) reported home range of male ocelots as 15.1 km^2 and female ocelots as 8.5 km^2. In Arizona and Sonora, no home range estimates were available.

Home ranges of ocelots outside the TTMU and ASMU ranged from: 9.7 to 11.12 km^2 for males 1.8 to 6.9 km^2 for females in Venezuela (Ludlow and Sunquist 1987), 1.6 to 2.5 km^2 for females and 5.9 to 8.1 km^2 for males in Peru (Emmons 1988), 0.8 to 1.6 km^2 in the Pantanal of Brazil (Crawshaw and Quigley 1989), and 33 to 21 km^2 for males and females, respectively, in Belize (Dillon and Kelly 2007). More details of these studies are provided in Appendix II.

Realistic estimates of population dynamics and distribution are fundamental to successful management and recovery of the ocelot. Use of noninvasive techniques to estimate species presence as well as population size is a valuable tool for ocelot conservation. Remotely-triggered trail cameras are being used extensively to detect ocelots across their range. Trolle and Kery (2003) used capture-recapture analysis of camera-trapping data to estimate ocelot density in the Brazilian Pantanal. These methods have been used effectively for elusive species such as tigers (*Panthera tigris*) and jaguars, and support the use of mark-recapture models in estimating population size (Karanth 1995, Karanth and Nichols 1998, Silver *et al.* 2004). Increasingly, evaluation of fecal DNA is being used to estimate population size and distribution of vertebrates (Kovach *et al.* 2003, Zuercher *et al.* 2003). In particular, small populations may benefit from a combination of population estimation approaches including remotely-triggered cameras, hair samples from snares, scat samples, and radio-telemetry (Brown 2004).

1.5 Life History and Demography

Age at first reproduction, litter size, birth interval – There are few data on reproductive rates of wild ocelots. Based on captive studies, gestation averages 80 days with a range of 77 – 83 days (Eaton 1977, Fowler 1978, Mansard 1990a and 1990b, William Swanson *pers. comm.* 2013, Tewes and Schmidly 1987). Although breeding has been suggested to peak during autumn in Texas (Tewes and Schmidly 1987) year-round breeding is known (Eaton 1977, Laack *et al.* 2005). Inter-estrous periods of two to three weeks have been documented in captive animals (Swanson 2002, Stoops *et al.* 2007). Wild ocelots probably first produce young at about 18 to 30 months (Eaton 1977, Bragin 1994, Tewes and Schmidly 1987). Laack (1991) observed first reproduction in wild female ocelots between 30 and 45 months. Bragin (1994) reported that reproduction among females in captivity occurred between about 20 months to 15 years and for male captive ocelots between about 22 months to 17 years. Eaton (1977) reported that captive ocelots produce an average of about 1.4 young per litter, but suggested that the average in the wild may be closer to 2.0. Laack *et al.* (2005) reported an average of 1.2 kittens per litter for 16 litters born to 12 ocelots in Texas.

Emmons (1988) suggested that females in Peru produced young "about every other year." However, this estimate did not take into account occasional losses of complete litters, which would add to the interval of successful reproduction. No comparable data are available for Texas. Although an inter-birth interval of two years or less suggests that half or more of adult females breed each year, felid populations may contain adult females that never produce litters (Beier 1993, Logan and Sweanor 2001), and this can have important effects on demography (Beier 1993). There are no published reports on what fraction of female ocelots fail to produce litters.

Dispersal – An understanding of ocelot movements during dispersal is central to evaluating the impact of habitat fragmentation on populations, and evaluating the potential for corridors as a possible remedy for fragmentation. The literature summarizes only a handful of dispersal events, with most of the information coming from Texas (detailed dispersal information from Texas is provided below). In Tamaulipas, Booth-Binczik (2007) documented the 50-km dispersal of a male ocelot.

Dispersal distances have not been recorded for ocelots in Arizona and Sonora; however, one male ocelot in Arizona moved from the Huachuca Mountains to the Patagonia Mountains and back to the Huachucas, an approximate round-trip distance (straight line) of 84 km (Culver *et al.* 2016).

Outside of the TTMU and ASMU, Crawshaw (1995) recorded male ocelots moving up to 7.3 km in a single day. In Jalisco, Fernandez (2002) reported that 1 male dispersed 23 km (straight line distance) from the capture site. Ludlow and Sunquist (1987) reported that dense woody cover was important in facilitating dispersal movements of two subadult male ocelots in Venezuela. However, a translocated male in Brazil traveled 30 km through an agricultural landscape with limited cover to return to his capture site (Jacob 2002).

Tewes (1986) reported that one male ocelot apparently dispersed about 13 km before it died of injuries likely from an automobile collision. The death site was an isolated 150-ha brush patch surrounded by farms and grasslands. Tewes (1986) also reported movements by a young adult female, which probably represented dispersal from LANWR into croplands with small fragments of brushy habitat. Most of the locations of the female ocelot were in remnant thornscrub until she was killed by a vehicle. Navarro-Lopez (1985) reported that two young adult ocelots dispersed 10 km and 3.5 km. David Shindle (*unpubl. data* 1997) documented the dispersal of a Willacy County male ocelot that was killed while trying to cross State Highway 77 north of Harlingen, Texas. This would have been about 35 km away from the Willacy County population (shortest measure following ditches vegetated with thornscrub).

Laack (1991) provided the most detailed information on ocelot dispersal, reporting on dispersal of five male and four female subadult ocelots at LANWR. One ocelot dispersed at 14 months old, one at 20 months old, and five at 30 to 35 months old. Two others were captured as dispersers at less than 23 months old. There was no obvious sex difference in age at dispersal. Only four dispersers (three males, one female) lived to establish home ranges. Duration of successful dispersal (time elapsed between leaving natal range and establishing an independent home range) was 7 to 9.5 months. The one successful female disperser moved 2.5 km (distance between home range centers) whereas the successful males moved 7 to 9 km. In addition to these dispersers, one subadult female did not disperse but remained in her natal range after reaching adulthood. Laack (1991) hypothesized that the extensive explorations of these animals, use of agricultural and other marginal habitat during dispersal, and the dispersal interval suggested that suitable habitat in LANWR was saturated with resident ocelots during her study.

All dispersers in the Laack (1991) study used narrow (5-100 m) corridors of brush during dispersal. Most of these were along remnants of former river meanders and drainage ditches. Each disperser avoided areas occupied by adults, and repeatedly returned to one or more small, semi-isolated patches of thornscrub during dispersal. The established adult home ranges of these same animals did not include these semi-isolated patches. Transient home ranges were often farther from the natal range than the animal's eventual home range. Dispersal from LANWR typically involved movements to and beyond the point that scrub habitat became scarce, use of transient home ranges centered on small scrub patches within agricultural or pasture land, and eventual settling within the source population when a vacancy occurred, or when the animal gained enough mass and experience to displace a resident adult.

Dispersal was generally frustrated and circular, similar to that of pumas in urban southern California (Beier 1995) and panthers in south Florida (Maehr *et al.* 2002). Dispersers may have moved farther if corridors or even stepping stones of suitable habitat were available. Although such dispersal zones are technically “sink habitats” (sites where mortality exceeds reproduction), they also serve as areas free of resident adults where some young ocelots survive as a pool of non-breeding “floaters” that can be an important stabilizing force in population dynamics (see Dias 1996, Gaona *et al.* 1998)

According to Laack (1991), no disperser successfully joined a population outside of LANWR. Subsequent to Laack’s 1991 study, it was discovered that a male ocelot moved from the Willacy County ocelot population to the Arroyo Colorado Unit of TPWD where he was photographed several times between 2000 and 2003 (Chappell 2010). The Arroyo Colorado Unit is located 30 km southeast of the Yturria Ranch and 8 km west of LANWR. The male moved back to the Willacy County population where he was photographed in 2005, then back to the Arroyo Colorado Unit and photographed again on January 16, 2006 (Sam Patten *unpubl. data* 2006), and then back to the Willacy County population again by March 2006 where he had originally been captured in 1995 (David Shindle *pers. comm.* 2010). Photographs in 2009 showed the male was again in the area of the Willacy County population (Mitch Sternberg *unpubl. data* 2009).

Ocelots from LANWR have been found on the Arroyo Colorado Unit previously; this series of observations represents the first documentation of an ocelot moving between the Willacy and Cameron county populations in Texas. However, genetic evidence indicates there is a lack of gene flow between the LANWR and the Willacy County populations, and between either of these and ocelots in Mexico (Janečka 2006, Tewes *et al.* 2013). Although the number of dispersers was small in each study, it appears that young ocelots follow the typical felid pattern of obligatory male dispersal but that females can either disperse or remain philopatric depending on density of adult females and perhaps other factors (Logan and Sweanor 2001, Sunquist and Sunquist 2002).

Rivers, former river meanders, irrigation canals, irrigation drains, natural drainages, shorelines, fencelines, and brushy road margins all provide suitable travel corridors for ocelots, especially as density and percent-cover of thornscrub vegetation increase (Tewes *et al.* 1995). Where a corridor of thornscrub passed through otherwise barren agricultural fields, Tewes *et al.* (1995) recommended grass-forb strips to enhance eastern cottontail populations. They also recommended managing for wide corridors, dense thornscrub cover, earthen ridges or rows of trees to screen corridors from urban developments, retaining vegetation on at least one side of irrigation canals and drains, and reduced frequency of prescribed fire on margins of farms and ditches.

<u>*Survival and mortality*</u> – In Texas, Tewes (1986) reported a survival rate of 71% based on 4 mortalities during 5,022 ocelot-days of monitoring 12 radio-tagged ocelots. Haines *et al.* (2005b) estimated an annual survival rate at 87% for resident adults and 57% for transient ocelots (post-dispersal and before a stable home range is formed), with small and statistically non-significant differences between males and females. Laack *et al.* (2005) estimated 68% annual survival for newborn ocelots.

Collisions with vehicles represent the largest known cause of ocelot mortality (35%) in south Texas (Haines *et al.* 2005b). Of five ocelots recently detected in Arizona, one was found killed by a vehicle (DeYoung and Holbrook 2010). In northern Sonora, two ocelots were found killed by vehicles in 2008 (Avila-Villegas and Lamberton-Moreno 2013). Aggression and predation by other animals also account for some mortality (López González *et al.* 2002, Haines *et al.* 2005b). Poaching and hunting ocelots for their skins is still a significant source of mortality in some countries (Sunquist and Sunquist 2002). At her study site, which included the Chamela-Cuixmala Biosphere Reserve in Jalisco, Mexico, Fernandez (2002) noted that 3 of 25 ocelots captured were presumably killed illegally, as she only found the collars, which had been cut off the cats and discarded.

<u>Competition with other carnivores</u> – Although the ocelot overlaps with many other carnivores throughout its range, little is understood about the degree to which ocelot directly compete with these carnivores. In his comments on the draft recovery plan in 1987, Quigley observed "The Draft lists the bobcat as both a predator of, and competitor with, the ocelot (p. 16). In the proposed research, why not experiment with a brief removal of bobcats from small areas and monitor the response (if any) in the ocelot population. It's highly unlikely that this would have a negative effect on ocelots in the removal area" (USFWS 1990a).

Since Quigley's suggestion, there has not been an experimental look into meso-predator competition with the ocelot, although Emmons (1987) suggested that the ocelot is "in competition for prey with many snakes, raptors, and other small Carnivora of several families". Konecny (1989) suggested that the ocelot in Belize avoided competition with jaguarundi, margay, and tayra (*Eira barbara*) through temporal separation and the use of different prey. This latter observation seems to be the pattern among small carnivores in the Serengeti (Waser 1980), large carnivores in south Florida (Maehr 1997), and predators in Poland and Belarus (Jedrzejewska and Jedrzejewski 1998). Elsewhere, measurable competitive interactions have been observed between tiger and leopard (*Panthera pardus*) in Nepal (Seidensticker *et al.* 1990), between grey fox (*Dusicyon griseus*) and culpeo fox (*Dusicyon culpaeus*) in Chile (Creel *et al.* 2001), and between Santa Cruz Island foxes (*Urocyon littoralis santacruzae*) and island spotted skunks (*Spilogale gracilis amphiala*) (Jones *et al.* 2008). However, in different settings many of these same carnivore assemblages can exhibit a lack of measurable competitive interactions (Johnson *et al.* 1996).

The observations from Emmons (1987) notwithstanding, other studies that have examined ocelot food habits relative to sympatric, small and medium-sized carnivores suggest that direct competition with the ocelot is minimal (Brisbal 1986, Konecny 1989, Sunquist *et al.* 1989). Due to its similar size, relatively aggressive nature, and overlapping distribution, the bobcat, which does not occur in the tropical systems referenced above, is most likely to compete with the ocelot for food and space in Texas, Arizona, and northern Mexico. Regardless, the current seemingly-apparent ecological separation may reflect a mechanism to coexist under what may have been more significant competition in the past.

Competition between the ocelot and the bobcat may currently be minimal because the ocelot appears to select areas with more dense cover (see Sunquist and Sunquist 2002). However, studies have examined scats and found that ocelot and bobcat diets were similar – both consumed primarily rodents and cottontails, with about 30% of scats containing remains of birds (Tewes *et al.* 1997, Booth-Binczik *et al.* 2013). Booth-Binczik *et al.* (2013) collected and analyzed 81 ocelot and bobcat scats on LANWR from 1992-2007 and reported that lagomorphs were much more common in bobcat scats than in ocelot scats, while a greater diversity of birds were found in ocelot scats compared to bobcat scats. Although the diets of the two species appear very similar, they may be partitioning resources at the level of individual prey species and the microhabitats preferred by those species (Booth-Binczik *et al.* 2013). Perhaps spatial separation and habitat preferences prevent such dietary overlap from becoming interference competition. Nonetheless, further studies that are targeted at such relationships are warranted. A better understanding of the interactions between the ocelot and competitors will be important in the evaluation of habitat management actions aimed at improving landscape conditions and recovery potential for the ocelot.

<u>*Genetics*</u> – Small and declining populations, such as the ocelot in Texas, face both demographic and genetic threats. From a demographic perspective, smaller and more isolated populations have a greater extinction risk as they are more sensitive to environmental stochasticity (Lande 1993, Lande 1995, Kendall 1998, Wootton and Pfister 2013). Barriers to connectivity also prevent dispersers from supplementing declining populations and recolonizing vacant habitat (Fahrig and Merriam 1994, Gerlach and Musolf 2000). Because genetic variation is influenced by demographic processes, the level of genetic variation (heterozygosity, allele number) and how it is distributed among populations can be used to estimate current and historic population connectivity, dispersal rates, effective population size, the extent of recent population size changes (i.e., expansions or contractions). In addition, genetic factors in small populations strongly influence persistence by contributing to increased extinction risk (Palomares *et al.* 2012, Wootton and Pfister 2013). There are two primary reasons for this: (1) loss of genetic diversity as a result of genetic drift, (2) loss of fitness due to inbreeding, which is also referred to as inbreeding depression.

Population-level studies of the Texas and Tamaulipas ocelots have been performed to examine the following: the genetic diversity of the remaining ocelot populations in Texas (Janečka *et al.* 2008, 2011), the recent changes in genetic diversity (Janečka *et al.* 2008, 2011), effective population size (Janečka *et al.* 2008), population connectivity within Texas (Janečka *et al.* 2008), and the origin of road-killed ocelots that were found outside of known ocelot habitat patches (Holbrook *et al.* 2011, Janečka *et al.* 2011).

Fifteen microsatellite loci were genotyped in 87 wild ocelots captured and radio collared between 1986 and 2005 in Texas (Janečka *et al.* 2008) and these results showed that genetic diversity in Cameron and Willacy counties had declined over that period. The change in microsatellite diversity through time was combined with ocelot life history data from published sources to estimate the effective population size. The effective population size estimates ranged from 8 to 13.9 in Cameron County and from 2.9 to 3.1 in Willacy County (Janečka *et al.* 2008).

Janečka *et al.* (2011) evaluated genetic variation of ocelots captured from Cameron County (n=52), Willacy County (n=34), and Los Ebanos Ranch in Tamaulipas, Mexico (n=17). Microsatellite markers from the 25 independent loci had an average of 2.9 alleles in Cameron County, 3.7 alleles in Willacy County, and 4.6 alleles at Los Ebanos Ranch. Private alleles across all 25 loci included 6 in Cameron County, 22 in Willacy, and 42 in Mexico. Mean heterozygosity followed the same pattern with 0.399 in Cameron County, 0.553 in Willacy, and 0.637 in Mexico. All tests for subdivision (i.e., F_{st}, population assignment, and structure) indicated significant differentiation among all populations with greatest differentiation between Cameron County and Mexico (F_{st} = 0.272, P = 0.001). There was significant differentiation between Cameron County and Willacy (F_{st} =0.163, P = 0.001), and between Willacy and Mexico (F_{st} = 0.113 and P = 0.001). Structure analysis showed complete separation of the three populations. There was no genetic variation in the Cameron County population and in Willacy County population, the haplotype diversity and nucleotide diversity declined to 0 by 2005 (Janečka *et al.* 2008). The genetic diversity was higher in northeastern Mexico (nucleotide diversity = 0.00289 and haplotype diversity 0.667). Given the low genetic diversity and the low effective population size, Janečka *et al.* (2008, 2011) suggested that ocelots in Texas will begin to manifest problems associated with inbreeding and genetic drift.

Between 1989 and 2005, the heterozygosity of the Cameron County population declined 23%, and between 1998 and 2005 the heterozygosity of the Willacy population declined 10% (Janečka *et al.* 2008). In theory, a migration rate of one ocelot per generation is enough to prevent the two populations from diverging completely, whereas, a rate of 10 or more per generation is enough for the two populations to appear to have frequent mating of individuals between the populations (Mills and Allendorf 1996). Connectivity of two populations with varying levels of genetic diversity, through migration of individual ocelots, is one strategy to combat the loss of genetic diversity.

Recently, Korn (2013) analyzed samples collected between 1984 and 2013 to establish pedigree relationships among ocelots. The analysis showed the same trend as Janečka *et al.* (2011) with the lowest diversity in Cameron County, and continued genetic drift in the Texas populations (Korn 2013). In Cameron County the allelic richness changed from 2.90 (1991-1998) to 2.88 (1999-2005) to 2.59 (2006-2013). In the Willacy County population, allelic richness changed from 3.49 (1991-1998), to 3.34 (2006-2013). Korn (2013) also compared samples from a newly-discovered ocelot subpopulation on the East El Sauz Ranch in Willacy and Kenedy counties to other local ocelots. This subpopulation had an allelic richness of 3.48 in samples collected from 2006-2013 (Korn 2013).

According to Korn (2013), ocelots in south Texas exist as two genetically distinct and isolated populations, one in Cameron County and one in Willacy County. There has been little to no genetic exchange between Cameron and Willacy populations in Texas (Walker 1997, Janečka *et al.* 2011, Korn 2013), as well as between Texas and Mexico in recent decades (Walker 1997, Janečka *et al.* 2011). Both Texas populations have lost genetic diversity and are becoming increasingly isolated (Janečka *et al.* 2014).

These studies indicated that the Willacy County population retained more ancestral variation than Cameron County until 2005. This was supported by the higher levels of variation and also the lower F_{st} values between Willacy and Mexico, which reflect historic migration (Janečka *et al.* 2011). The Cameron County population has suffered from a more severe bottleneck event causing a more extensive reduction in genetic variation compared to the Willacy population. However, based on the genetic data from 2005 (Janečka *et al.* 2014), the Willacy County population currently has a smaller effective population size leading to loss of diversity.

A genetic analysis was conducted for the male ocelot found dead on a road near Globe, Arizona, in 2010 (Holbrook *et al.* 2011). Although the origin of the ocelot was inconclusive due to a lack of comparative samples from Arizona or Sonora, its lineage grouped with Mexico and Guatemala; however, sampling constraints prevented any explicit geographic assignments (Holbrook et al. 2011). To date, no studies examining the genetic diversity of ocelots in Arizona and Sonora have been published.

Data to inform Population Viability Analyses –The first ocelot recovery plan (USFWS 1990a) recommended major demography-related activities for ocelot recovery, namely "determining the precise population sizes and habitat sizes required for viability and the necessary spatial arrangement of habitat, and determining the impact of disease and other factors on the population; increasing ocelot numbers in Texas, in part by protecting at least 20,000 hectares of prime ocelot habitat in Texas (either in a single block or continuous blocks connected by corridors)." The first goal indicated a desire for Population Viability Analyses (PVA) and Population and Habitat Viability Assessment (PHVA) to provide "precise population sizes and habitat sizes" needed for viability. We now recognize that PVA and PHVA are more useful for ranking and comparing alternative scenarios (Beissinger and Westphal 1998, Ludwig 1999). Another important use of PHVA is to use sensitivity analysis to identify which natural history attributes (e.g., survival rate of a particular age class) and environmental attributes (e.g., lack of suitable and safe corridors) are crucial determinants of viability.

The PVA workshop conducted in conjunction with the April 2004 meeting of the Technical Subgroup suggested a number of challenges facing the species in Texas (Appendix III).

The ocelot in south Texas appears to be at considerable risk of extinction through intrinsic, stochastic fluctuations in demographic rates that are exacerbated by human activity, especially vehicles on roadways near ocelot habitat (Michael Tewes *pers. comm.* 2003, Haines *et al.* 2005b, DeYoung and Holbrook 2010, Stangl and Young 2011, USFWS *unpubl. data* 2015a). The proportion of adult females successfully producing a litter in a given year and additional mortality caused by vehicles are primary factors in determining future population growth. Range increase through habitat improvements was also identified as a potential mechanism to facilitate ocelot population growth and reduced extinction risk. Connecting small, fragmented ocelot populations may provide an additional buffer against extinction risk if: 1) subpopulations are increased in size in a way that approaches viability in the absence of connectivity; 2) dispersal rates – whether natural or artificial – are sufficiently high to maintain a functioning metapopulation; and 3) anthropogenic sources of mortality are reduced to acceptable levels. The PVA suggested that as few as one or two translocated females every two years may be enough to compensate for the destabilizing effect of stochastic demography operating on this small population.

Haines *et al.* (2006b) used a PHVA to evaluate four recovery strategies for the Texas-Tamaulipas ocelot and concluded that protection and restoration of habitat had the greatest positive impact on predicted population persistence, followed by linking the two known breeding populations and reduction of road mortality. Supplementation from Tamaulipas by itself was not an effective strategy. The PVA predicted a 33% probability that ocelots in southern Texas would become extinct within 50 years if existing conditions were not changed significantly (Haines *et al.* 2006b).

Janečka *et al.* (2007) reported that the best source for genetic restoration of ocelot populations in Texas would be from ocelots in Tamaulipas, Mexico. However, it is important that a better understanding of ocelot population characteristics in Tamaulipas be obtained to avoid possible negative demographic consequences on the source population.

Modeling was conducted by Stasey (2012) and CDEN (2014) to evaluate the effects of possible extractions of ocelots from the populations of ocelots on Rancho Caracól and near Soto La Marina, Tamaulipas, Mexico, respectively, for translocation to Texas. Stasey's (2012) evaluation included several different approaches: population modeling, habitat mapping, and field surveys. The objective of these evaluations was to ensure that no detrimental effect would be expected through the removal of ocelots from the population at that site in Mexico. The evaluation by Stasey (2012) and CDEN (2014) determined that a withdrawal of several ocelots per year would not have an impact on the source population and that translocation should be considered for increasing genetic diversity and increasing the population of ocelots in Texas.

Future research should investigate the influences of continued habitat loss in Texas, the impacts of epizootics, survivorship of offspring under different environmental variables such as drought, and the role of density-dependent survival as population size changes to better inform the PVA process.

No PVA has been conducted for the ASMU. In order to provide a more informed PVA for the ASMU, additional information is needed on ocelots in the area including: age of first reproduction, age of reproductive senescence, average percentage of adult females that successfully breed per year, annual environmental variation in female reproductive success, whether reproduction is density-dependent, sex ratios, age-sex-specific mortality rates, the effect of catastrophes, possibilities of inbreeding depression, initial population size, carrying capacity, and metapopulation dynamics.

1.6 Habitat Characteristics and Ecosystem

Habitat – The ocelot uses a wide range of habitats throughout its range (Tewes and Schmidly 1987, Shindle and Tewes 1998, López González *et al.* 2003, Avila-Villegas and Lamberton-Moreno 2013). In Mexico for example, ocelots have been observed in thornscrub and semi-arid vegetation (Shindle and Tewes 1998, López González *et al.* 2003), coastal grasslands and coastal tropical forests (Caso 1994, 2013), tropical dry forests (Fernandez *et al.* 2002, López González *et al.* 2003, Servín *et al.* 2003), tropical rain forests (Cuarón 2000, Ávila-Nájera *et al.* 2015), oaks and grasslands (Avila-Villegas and Lamberton-Moreno 2012, López González *et al.* 2014), piedmont/montane scrub, cloud forest (Cuarón 2000, Martínez-Calderas *et al.* 2011), pine-oak forests (Iglesias *et al.* 2009, Bárcenas and Medellín 2010), and fir forests (Aranda *et al.* 2014). In Venezuela ocelots used palm savanna, sandhills, shrub woodlands, and deciduous or gallery forest (Mondolfi 1986, Ludlow and Sunquist 1987, Sunquist *et al.* 1989). During diurnal resting periods, ocelots were primarily found in gallery forest. During the night, ocelots used the sandhills more than the diurnal periods, but still predominately occupied the gallery forest. Emmons (1987) found that ocelots in Peru generally avoided open habitats during the day, but sometimes foraged in them at night. Three ocelots used primarily forest or woody communities in Belize (Konecny 1989). A study of three females in the Pantanal Region of Brazil found them primarily in semi-deciduous forest with lesser use of marsh, riverine forest, and grassland (Crawshaw and Quigley 1989). Despite this, the species does not appear to be a habitat generalist. Ocelot spatial patterns are strongly linked to dense cover or vegetation (Emmons 1988, Horne *et al.* 2009).

Lack of suitable habitat has been cited as an important reason for the endangered status of the ocelot in the U.S. (Tewes and Everett 1986, Tewes and Miller 1987). In south Texas, the species occurs predominantly in dense thornscrub communities (Navarro-Lopez 1985, Tewes 1986, Laack 1991). Over 90% of this habitat in the Lower Rio Grande Valley has been altered for agricultural and urban development (Jahrsdoerfer and Leslie 1988, Tremblay *et al.* 2005). Tewes and Everett (1986) found <1% of south Texas supported the extremely dense thornscrub used by ocelots.

Sternberg and Donnelly (2008) conducted a coarse-scale landcover inventory across 40 contiguous counties in South Texas to identify areas of dense canopy shrubland and forest that could potentially be used by ocelot. They found a total of 11,937 individual wooded stands totaling 817,079 ha with an average size of 69 ha in the southern 40 counties of Texas. Of the counties that are considered part of the recent range of the ocelot (i.e., since 1995) (see Figure 4, page 9, i.e., Cameron, Hidalgo, Jim Wells, Kenedy, and Willacy counties), the total acreage of woodlands delineated by Sternberg and Donnelly (2008) was 86,728 ha. It is clear, even from such coarse land cover and habitat assessments, that the conservation of ocelots in Texas is likely to rely heavily on efforts of and partnership with private landowners.

Tewes (1986) found that core areas of ocelot home ranges contained more thornscrub than peripheral areas of their home ranges on LANWR in southern Texas. Laack (1991) also found ocelot use of dense thornscrub on LANWR. Caso (1994) found ocelots used primarily forest or woody communities in Tamaulipas, Mexico, and used the open pastures much less often. The pastures that were seldom used by ocelots supported little woody cover and were dominated by guinea grass (*Panicum maximum*). Jackson *et al.* (2005) suggested that the ocelot in Texas preferred closed canopy over other land cover types, but that areas used by this species tended to consist of more patches with greater edge.

Horne *et al.* 2009 reported that ocelots in Texas selected woodland communities with >75% visually-estimated canopy cover. Other microhabitat features important to ocelots appear to be canopy height (>2.4 m) and vertical cover (90.4% visual obscurity at 1-2 m). Ground cover at locations used by ocelots was characterized by a high percentage of coarse woody debris (50%) and very little herbaceous ground cover (3%), both consequences of the dense woody canopy (Horne 1998).

Shindle and Tewes (1998) quantified species composition of shrubs in three plant communities used by ocelots. Two of these communities occurred in southern Texas and another was located in northeastern Mexico. Within the dense thornscrub communities used by ocelots, 45 mostly woody species were found at the LANWR in Cameron County and 28 mostly woody species on the Yturria Ranch in Willacy County (Shindle and Tewes 1998). The dominant species were granjeno (*Celtis pallida*), crucita (*Eupatorium odoratum*), Berlandier's fiddlewood (*Citharexylum berlandieri*), honey mesquite (*Prosopis glandulosa*), and elbowbush (*Forestiera angustifolia*) at LANWR, and honey mesquite and snake-eyes (*Phaulothamnus spinescens*) contributed >50% of the total relative cover at their sites in Willacy County, Texas.

In addition to the loss of habitat from development, impacts along the U.S. border include roadways, international bridges, night lighting with effects on prey and ocelot movement (Grigione and Mrykalo 2004), increased noise and pollution, and increased exposure to diseases from feral animals (Grigione *et al.* 2009).

Little is known about ocelot habitat use in Arizona and Sonora; however, López González *et al.* (2003) found that 27 of the 36 records (75%) of ocelots in Sonora were associated with tropical or subtropical habitat, namely subtropical thornscrub, tropical deciduous forest, and tropical thornscrub. Only males (11.1% of the total records) were recorded in temperate oak and pine-oak woodland. Ocelots were photographed by the Sky Island Alliance in Sonora and Arizona in Madrean evergreen woodland (Avila-Villegas and Lamberton-Moreno 2013). A male ocelot that was killed by a vehicle in Globe, Arizona, in 2009 (Holbrook *et al.* 2011) was in an area of mixed habitat types of Sonoran Desert, chaparral, and Madrean evergreen woodland (Avila-Villegas and Lamberton-Moreno 2013, Featherstone *et al.* 2013). Recent detections of three other ocelots in Arizona were located in the semidesert grassland (46%), Madrean evergreen woodland (46%), and Great Basin grassland (8%) biotic communities (Culver *et al.* 2016). On average, these ocelot locations had 23% tree cover and were found at an elevation of 1,832 m. Additionally, on average, they were 2,335 m from perennial water sites and 6,337 m from major roads (Culver *et al.* 2016).

<u>*Habitat restoration in Texas*</u> – Ocelots will use narrow strips of shrub or forests for travel and dispersal (Ludlow and Sunquist 1987, Caso 1994, Tewes *et al.* 1995). Such corridors can provide critical landscape connectivity, thus they are important aspects of ocelot conservation (Tewes *et al.* 1995, Tewes and Blanton 1998). Although transportation corridors represent a significant danger, wildlife underpasses at the intersections of roads and linear habitat features used by ocelots can mitigate potential losses (Tewes and Hughes 2001).

Where habitat is degraded and fragmented, as in most areas of south Texas, restoration is critical to recovery of the ocelot. The success of ocelot habitat restoration is a product of an area's soil characteristics, climatic stability, and the density and survivorship of the planting treatment. Ocelots and their habitat are associated with certain soil types in southern Texas (Harveson *et al.* 2004). Camargo, Laredo, Olmito, and Point Isabel soil series have the best ability to support habitats that have been used by ocelots in greater proportion than they were available (Harveson *et al.* 2004). This ocelot-soil relationship is a consequence of ocelot preference of dense thornscrub cover that appears more frequently on these soils (Harveson *et al.* 2004). The selection of specific restoration areas should be based on their potential to serve as occupied breeding habitat, or travel corridors that could link disjunct patches of occupied or potential habitat. The re-establishment of thornscrub habitat in appropriate locations and spatial configurations will facilitate ocelot dispersal and colonization.

Some treatments have been examined for restoring ocelot habitat, although information is needed to maximize their efficiency and ultimate use by ocelots. Young and Tewes (1994) evaluated tree shelters, fertilizer, tree branch trimming, and elimination of herbaceous growth to increase and enhance growth of woody seedlings. They concluded that fertilizer, clipping, and weeding did not impact seedling growth or survival. Tree shelters tubes significantly increased survival and growth of tree seedlings, but may add significant cost to a project (Young and Tewes 1994).

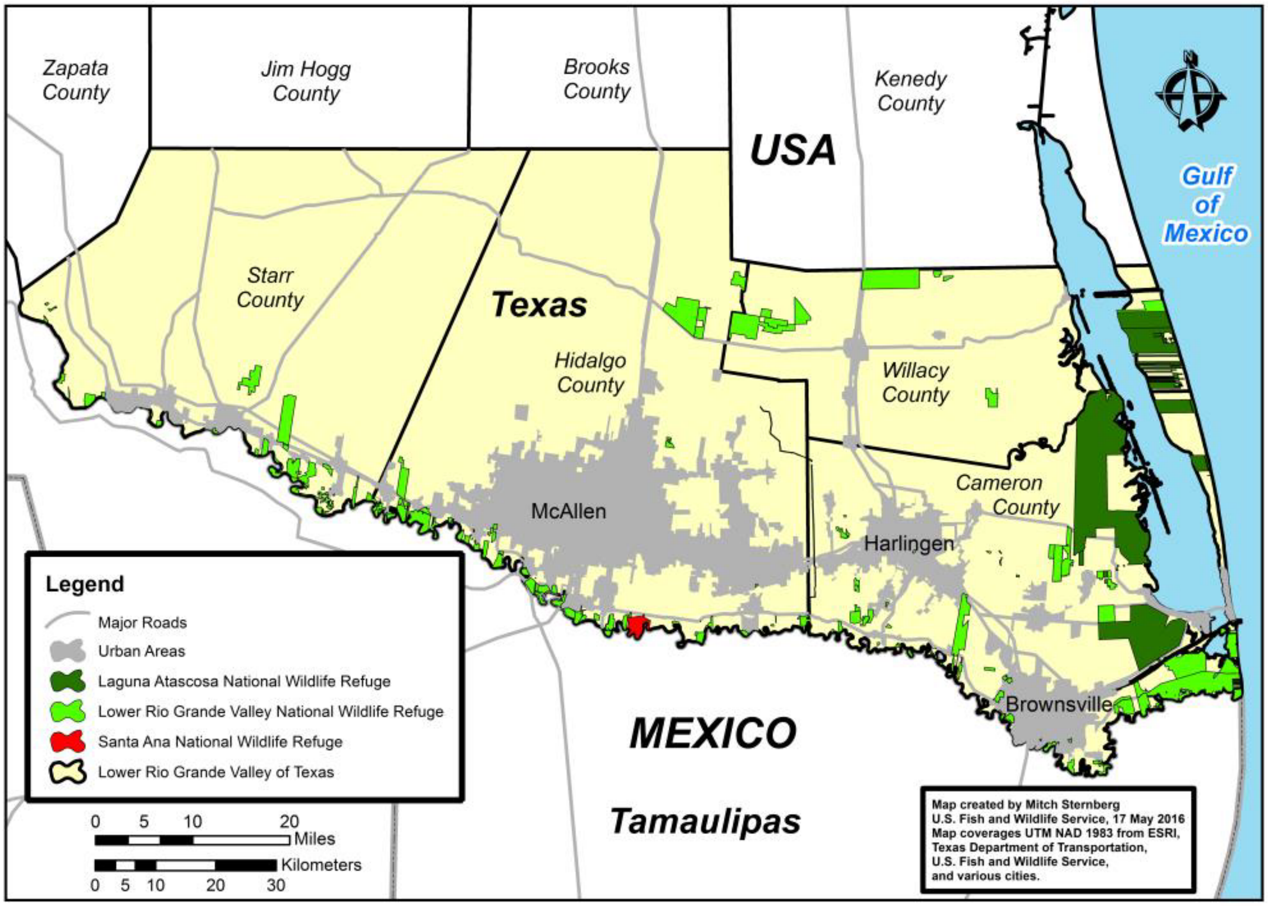
Recent thornscrub restoration research conducted adjacent to occupied ocelot habitat demonstrated that the use of tree-shelter tubes as well as herbicide use for invasive grasses facilitated faster, more efficient and effective thornscrub restoration (Alexander *et al*. 2015). Current research suggests that increasing seedling density may provide some positive synergistic effects among grouped seedlings, resulting in improved success at re-establishing thornscrub (Vela *et al.* 2015).

Identification of ocelot cover types, mapping of important corridors and habitat patches, and development of restoration blueprints for the ocelot can be facilitated by the application of remote sensing (e.g., satellite imagery) and geographic information systems (Anderson *et al.* 1997, Tewes *et al.* 1999, Jackson 2005, Sternberg and Donnelly 2008). Such technology would also be helpful in identifying the most likely pathways of dispersal and potential restoration zones needed to link disjunct populations.

<u>Development and Urban Sprawl</u> – The population of the San Antonio area grew 16% from 1990 to 2000 with an estimated population of over 1.5 million people in 1995. The Lower Rio Grande Valley, location of the largest ocelot populations in the U.S., has the poorest and most rapidly-growing human population along the U.S.-Mexico border (Fulbright and Bryant 2003). The expanding human population, poverty, and high unemployment represent increasing threats to ocelot habitat and ultimate recovery. The four southernmost counties in Texas where ocelots have been observed during the period of 1990 to 2014 have seen significant changes in the human population. From 1990 to 2014, the following changes occurred in the human population of the following counties: Cameron County increased 62%, Hidalgo County increased 117%, Kenedy County decreased 13%, Willacy County increased 24% (U.S. Census Bureau 1995, 2015).

<u>Private lands</u> – Much of the area required to provide habitat for viable ocelot populations in Texas and Mexico, and to a lesser extent in Arizona, occurs on private ranches. Most of the confirmed ocelot sightings in Arizona have been on public lands (Erin Fernandez *pers. comm.* 2015) but there remains the possibility that ocelots could be using suitable habitat on private lands. Landowners' anxiety over the implications of having an endangered species on their land may hinder cooperation from this key group of stakeholders.

Figure 6. South Texas urban areas relative to USFWS refuges.



Genho *et al.* (2003) described the early human settlement patterns in southern Texas and the development of ranching in this area. The region is becoming increasingly urban (Figure 6) and south Texas is bordered on the north and on the south by regions of rapid human population growth (Fulbright and Bryant 2003).

The economy that has supported large south Texas ranches, and that formerly supported the biodiversity of the area, is changing (Potts 2003). These changes, including the subdivision of existing ownerships (Wilkins *et al.* 2000), may present significant challenges to ocelot recovery. Potts (2003) outlined three strategies that landowners use to help increase the profitability of their ranches and reduce the chances that they will have to sell their ranches for economic reasons.

The first strategy emphasizes the private markets currently operating for wildlife in southern Texas. Hunting and outdoor recreation potentially contribute more to land value than agriculture or urban development in many south Texas counties (Fulbright and Bryant 2002). The demand for beef fluctuates and traditional sources of revenue from ranches have been somewhat inconsistent since 1980 (Ryne 1998). However, the market for both consumptive and non-consumptive use of natural resources has grown since the 1990's, with recreational uses of private lands providing more value to landowners than cattle ranching alone at times (Ryne

1998). Undoubtedly, many ranches in Texas would have been subdivided and sold if not for consumptive uses such as hunting and the income it generates. This reality is reflected in area land appraisals that value hunting uses above agricultural uses (Potts 2003). Likewise, an economic analysis of South Texas hunting operations (Dodd *et al.* 2013) found that landowners' hunting operation–related expenses generate an additional $166.1 million in output and $75.7 million in value added in the South Texas regional economy.

Non-consumptive recreation is beneficial to the ocelot's future. Ecotourism and bird-watching are growing markets in southern Texas and Arizona. Eubanks and Stoll (1999) found that a person spent an average of $117 per day while participating in the Rio Grande Valley Birding Festival. Economic incentives for private landowners to maintain ocelot habitat on their land, through the promotion of ecotourism activities, could foster recovery of the species.

The second strategy for private lands conservation is government incentives, particularly those for habitat conservation provided by various funding programs of the U.S. Department of Agriculture (Potts 2003). These funds could greatly complement consumptive and non-consumptive wildlife markets. Safe harbor agreements (USFWS 1997a, 1999) and conservation banks may provide the security "umbrella" and incentives sought by private landowners that enable proactive conservation of the ocelot in the U.S.

The third strategy would promote conservation easements and tax incentives (Potts 2003) that allow landowners to retain ownership and keep the habitat intact without fragmentation (Fulbright and Bryant 2003). One of the primary threats to the continuation of large family ranches in the U.S. is the transfer of property to subsequent generations. Death of a landowner can produce estate taxes that result in the heirs selling property to pay inheritance taxes. Often, the end result is fragmentation of the initial large property into several smaller tracts with a mosaic of land uses that can have negative effects on animals that need larger, intact landscapes and ecosystems. The USGS and University of Arizona created a landowner incentives brochure for landowners and ranchers in Arizona to conserve jaguar habitat that could be used as a model to assist in maintaining ocelot habitat (Erin Fernandez *pers. comm.* 2015).

Effects of ocelot conservation on other wildlife in Texas – Although in Texas ocelots show a preference for woody plant communities with dense understory cover, they will also use coastal grasslands for hunting and denning (Laack 1991). Habitat restoration projects conducted by the USFWS in south Texas are focused on maintaining or restoring dense thornshrub and coastal grassland communities, both communities having been identified as important for ocelot denning (Laack 1991) and other life functions (appropriate references). Thornscrub restoration projects of USFWS use quantitative targets of species composition and density when planning treatments on appropriate soils. Similarly, a soils assessment has been made by the USFWS to determine which sites are most suitable for coastal grassland habitat management or thornscrub restoration.

Applying thornscrub restoration actions for ocelots according to this plan would result in additional habitat for many species including the Texas tortoise (*Gopherus berlandieri*), Texas indigo snake (*Drymarchon melanurus erebennus*), cat-eyed snake (*Leptodeira septentrionalis*), hook-billed kite (*Chondrohierax uncinatus*), red-billed pigeon (*Patagioenas flavirostris*), yellow-billed cuckoo (*Coccyzus americanus*), northern ferruginous pygmy-owl (*Glaucidium* *brasilianum*), elf owl (*Micrathene whitneyi*), brown-crested flycatcher (*Myiarchus tyrannulus*), Couch's kingbird (*Tyrannus couchii*), white-eyed vireo (*Vireo griseus*), green jay (*Cyanocorax yncas*), tropical parula (*Parula pitiayumi*), olive sparrow (*Arremonops rufivirgatus*), pyrrhuloxia (*Cardinalis sinuatus*), Altamira oriole (*Icterus gularis*), plain chachalaca (*Ortalis vetula*), and other native species. The various successional stages of thornscrub development of replanted fields and augmented sites to dense thornscrub may provide habitat for gray hawk (*Buteo plagiatus*), white-tailed hawk (*Geranoaetus albicaudatus*), golden-fronted woodpecker (*Melanerpes aurifrons*), verdin (*Auriparus flaviceps*), cactus wren (*Campylorhynchus brunneicapillus*), long-billed thrasher (*Toxostoma longirostre*), curve-billed thrasher (*Toxostoma curvirostre*), painted bunting (*Passerina ciris*), and hooded oriole (*Icterus cucullatus*).

Thornscrub near the coastal portions of Cameron and Willacy counties, Texas, are often found on clay soils perched above lower areas. The lower areas are the natural locations for savannahs, coastal grasslands, salt-marsh, and wind/tidal flats. Those savannahs are ideal places for the endangered northern aplomado falcon (*Falco femoralis septentrionalis*) (USFWS 1990b, Jenny *et al.* 2004). Since these species use such different habitats which are supported by drastically different soils, there should be little to no conflicts between efforts to manage or restore areas for the ocelot and the northern aplomado falcon.

In south Texas, USFWS intends to treat and manage for appropriate native habitat stands on sites that would have supported dense thornscrub or native grasses prior to the landscape-wide changes caused by human settlement of the area since the 1700's. It is the intention of the USFWS to restore and maintain parts of the disturbed landscape back into its native grassy areas, coastal prairies, open savannahs as well as woodlands and dense thornscrub (see USFWS 2010a). USFWS focuses efforts on doing restoration treatments on refuge lands but also on providing technical assistance to landowners wishing to manage or restore ocelot habitat on their land.

Management of these more open habitats such as prairies and savannahs will benefit numerous species such as northern aplomado falcon, northern harrier (*Circus cyaneus*), white-shouldered kite (*Elanus leucurus*), white-tailed hawk, Cassin's sparrow (*Aimophila cassinii*), horned lark (*Eremophila alpestris*), Lincoln sparrow (*Melospiza lincolnii*), long-billed curlew (*Numenius americanus*), jaguarundi, Coue's rice rat (*Oryzomys couesi*).

1.7 Reasons for Listing/Threats

Section 4(a)(1) of the ESA outlines five factors (threats) to consider when a species is a candidate for listing as threatened or endangered. The following analysis considers these factors in contributing to the endangered status of the ocelot. Below, we address threats throughout the species range but focus upon the Management Units in the borderlands where we have the most information and greater ability to share resources and collaborate more easily with partners. Additional information about threats to the ocelot south of the United States is provided in Appendix II.

Factor A - The present or threatened destruction, modification, or curtailment of its habitat or range

The final rule listing the ocelot as endangered in the U.S. (47 FR 31670, July 21, 1982) stated that the present or threatened destruction, modification, or curtailment of its habitat or range posed the greatest threat to the survival of the ocelot in the U.S. The ocelot's range and distribution in the U.S. have been drastically reduced in the last two centuries. In the mid-1800s ocelots occurred from the Red River in Arkansas south through central and eastern Texas to the Rio Grande (Hall 1981; Navarro *et al.* 1993). Current known ocelot distribution in the U.S. is limited to several counties in southernmost Texas (Haines *et al.* 2006a, Sternberg and Mays 2011, Rulison *et al.* 2015) and several counties in Arizona (AGFD *unpubl. data* 2014, Culver *et al.* 2016).

Over 95% of the dense thornscrub habitat that supported the ocelot in the Lower Rio Grande Valley of Texas (LRVG) has been altered for agricultural and urban development (Jahrsdoerfer and Leslie 1988). In Cameron County, 91% of native woodlands were lost during the mid-1900s, primarily for agricultural use (Tremblay *et al.* 2005). A significant amount of native habitat was lost in northern Mexico during what was termed the "Green Revolution", which was actually a period of conversion of much of the natural landscape to one of agricultural production in northern Tamaulipas (Purdy 1983). Sánchez-Ramos *et al.* (1993) reported that in northeastern Mexico the predominant land uses were agriculture, cattle-ranching, and utilization of forest products (e.g., harvesting timber for multiple uses such as for firewood and charcoal production).

More recently, rapid population growth in south Texas has caused causing agricultural land to be converted to more urban development, resulting in further land and habitat fragmentation (Wilkins *et al.* 2000), and decreasing opportunities for habitat restoration. The human population in the LRGV increased 39.8% from 1990 to 2000, compared to an increase of 22.8% in Texas and 13.2% in the U.S. during the same period (Murdock *et al.* 2002). Population levels in the LRGV are projected to increase 130.1 – 181.1% from 2000 to 2040 (Murdock *et al.* 2002). From 2010 to 2014, the human population of the LRGV continued to increase 5.7% (U.S. Census Bureau 2015).

The amount of ocelot habitat loss in Arizona and Sonora has not been quantified, but it is thought to be much less than in the TTMU. A current threat to ocelot habitat in Arizona includes mining development (Erin Fernandez *pers. comm.* 2015, USFWS 2016).

Throughout its range, the ocelot has declined in most areas because of illegal hunting or poaching and habitat loss, but more recently, habitat loss has probably replaced hunting as the major threat (Sunquist and Sunquist 2002). Habitat alteration, particularly from deforestation, agriculture, and ranching, has reduced and fragmented ocelot habitat range-wide (Ceballos and Garcia 1995, López González *et al.* 2003, Tremblay *et al.* 2005). In Central America, less than half of the region retains its original forest cover (Critical Ecosystem Partnership Fund [CEPF] 2004).

Factor B - Overutilization for commercial, recreational, scientific, or educational purposes

In the 1960s and early 1970s, ocelots were imported for the pet trade and were heavily exploited, primarily by the fashion industry, for their pelts. Ocelot imports peaked in the U.S. in 1970, with 140,000 skins documented by U.S. Customs officials (McMahan 1986). Between 1967 and 1973 the commercial export of wildlife was outlawed in many countries in Central and South America (Mann and Plummer 1995). Following these prohibitions, the commercial trade in ocelot skins dropped significantly, and continues to decline (Sunquist and Sunquist 2002). Many European countries banned the import of ocelot skins in 1986. Also, the ocelot was included in Appendix I of CITES in 1989, an action that outlawed international commerce in skins and live animals (Sunquist and Sunquist 2002). However, implementation and enforcement of these laws and regulations have not been universal (MacMahan 1986, Broad 1987, Sunquist and Sunquist 2002). Also, subsistence hunting, and retaliatory killing of the ocelot for the suspicion of the ocelot killing their livestock, as well as outright poaching, continue to be impediments to conservation of ocelots in some areas (Ceballos and Garcia 1995, Villa Meza *et al.* 2002, López González *et al.* 2003).

In the U.S., private operations of predator control and fur-trapping could be a source of mortality given the small number of ocelots in existence, and as trap-related injury and mortality is likely under-reported by private trapping operations. Tewes and Everett (1986) recommended that lethal traps be prohibited in ocelot habitat and daily trap checks should be mandated to reduce deaths and injuries in traps. They also recommended selective methods of predator control, and educating hunters not to shoot ocelots. The TPWD has no restrictions on trapping for furbearing animals in or near areas occupied by the ocelot. In Arizona, fur trapping is allowed on public lands with cage traps and daily trap checks, and foot-hold traps and snares are allowed on private lands (Arizona Game and Fish Department 2015).

The USFWS completed a section 7 consultation with the U.S. Department of Agriculture's Animal Damage Control (ADC, now named Wildlife Services) program regarding the ocelot in 1997 (Starnes 1997), and concluded that after implementing ocelot-protective practices, ADC's use of leg-hold traps, snares, and M-44s in south Texas was unlikely to jeopardize the continued existence of the species. Although ocelots were regularly taken before the species was listed, no take has been documented from the ADC program since 1983. Major provisions of the protective practices by ADC included using only shooting and cage-traps for control of predators in occupied ocelot habitat, and prohibition of neck-snares or leg-hold traps larger than #3 within 4.8 km of occupied territories and adjacent to travel corridors. The USFWS, in its Conservation Recommendations, asked that ADC personnel alert landowners with whom it conducts control activities of the need to limit lethal activities within ocelot habitat, and that ADC report any non-ADC control activities that fail to comply with state or federal laws to law enforcement agents.

In 2007, reinitiation of the 1997 ESA section 7 consultation process with the U.S. Department of Agriculture's Wildlife Services, formerly ADC, was necessary on their Wildlife Damage Management (WDM) Program due to the expansion of existing, and establishment of new, operational activities and implementing procedures, and/or the development and use of new methods (USFWS 2010b). Methods referenced included use of M-44 devices (which were no longer used after 2012), foot-hold traps, cage traps, foot, leg, and neck-snares, ground shooting, and aerial operations. Use of these methods by WDM follows the state restrictions on foot-hold traps and snares on public lands. The USFWS stated that these methods “have the potential to result in accidental take of an ocelot” but were “not likely to jeopardize the continued existence of the ocelot” (USFWS 2010b). It was recognized in the Biological Opinion that the WDM Program staff limit their activities in travel corridors and occupied ocelot habitat and that there has not been an incident of ocelot capture in Arizona or Texas by ADC/Wildlife Services staff in over 30 years. Terms and conditions to implement reasonable and prudent measures as suggested by the Biological Opinion were listed to minimize the impacts of WDM Program activities to the ocelot (USFWS 2010b). While Wildlife Services’ WDM Program could result in the “take” of one ocelot in the U.S., it is not considered a significant threat to the species.

Factor C - Disease or predation

Disease can have dramatic impacts on wild populations including those of wild cat species (May 1988, Roelke-Parker *et al.* 1996). Cunningham *et al.* (2008) found that all of the Florida panthers (*Puma concolor coryi*) that tested positively for feline leukemia virus in their blood (5 of 131) died of various causes, even if they did not necessarily show clinical signs of the disease when captured. Data showed that, as in domestic cats, exposure to feline leukemia resulted in Florida pumas presenting regressive, latent, and/or persistent infections.

Artois and Remond (1994) suggested why disease-monitoring in wild populations deserves more emphasis in field studies:

1. Disease can have a devastating impact on small populations. A proper disease monitoring program for small populations allows the best chance for successful intervention.
2. Even for larger populations, disease can be a major environmental influence. Infectious disease can affect populations in a manner independent of host density such that sparse and widely dispersed populations are nonetheless at risk.
3. Biological samples promote clinical and ecological knowledge of the circulation of pathogens.

Population and ecosystem trends can be derived by sampling individuals. For the ocelot this could be done by the opportunistic collection of samples during routine management activities or field studies (Karesh and Cook 1995). Anesthetized animals can easily have blood, hair, and fecal samples taken for immediate analysis or archived for future study (Munson and Karesh 2002). Such data are important in understanding major mortality events and in examining long-term trends in disease and condition.

Relatively few studies in the TTMU have been conducted on diseases and their effects on ocelots. From 1991 to 2010, 52 ocelots in Texas provided 101 blood collection events and were tested for a variety of infectious diseases (deMaar *et al.* 2008). All samples showed low titers to *Toxoplasma gondii*. One hundred percent were negative for titers to *Coccidioides immitis, Histoplasma capsulatum*, feline leukemia virus, Coronavirus, microfilaria; 98% were negative on the *Dirofilaria immitis* antigen test; 97% were negative for Herpesvirus; 89% were negative for hemoparasites, whereby there were observed three instances of *Hepatozoon*, two of *Cytauxzoon* and one of *Hemobartonella*. Forty-five percent of samples showed various types and irregular frequencies of gastrointestinal parasites (deMaar *et al.* 2008).

Of the 13 ocelots sampled in Texas by Mercer *et al.* (1988), 6 had *Hepatozoon* in the blood, 3 had *Cytauxzoon* in their red blood cells, and all were infested with fleas and dog ticks (*Dermacentor variabilis*). An unreported number also had *Amblyomma* ticks. Because Mercer *et al.* (1988) reported that all ocelots were in "good physical condition," the impact of these parasites on health and survival is not clear. Pence *et al.* (2003) reported helminths in 100% of 15 adult road-killed ocelots, with low abundances of potentially pathogenic species. Although a single heartworm (*Dirofilaria imitis*) infection may have contributed to the death of one ocelot, Pence *et al.* (2003) concluded that helminths in general were probably of little significance to the population. Additionally, in south Texas, notoedric mange may have killed at least one ocelot, and has the potential to cause a mange epizootic in these small populations (Pence *et al.* 1995). In both the TTMU and the ASMU, bobcats, feral cats (*Felis catus*), coyotes (*Canis latrans*), and raccoons (*Procyon lotor*) provide potential reservoirs for most diseases to which ocelots are susceptible.

No studies have been conducted for diseases and their effects on ocelots in the ASMU. Like diseases, environmental toxins in ocelots have only been studied in Texas. Based on blood samples from 20 ocelots, hair samples from 32 ocelots, and tissue samples from four ocelots from south Texas, Mora *et al.* (2000) reported low concentrations of polychlorinated biphenyls, mercury, and DDE. They concluded that these environmental toxins did not pose any direct threat to the health or survival of the ocelot.

The studies above, while important, have done little to assess the potential for disease and contaminants to affect the ocelot at the population-scale. As habitat becomes more fragmented, interactions with increasingly more bobcats, coyotes, feral cats, dogs (*Canis lupus familiaris*) and livestock will increase, while prey populations and the ability to understand the dynamics of disease will become more challenging. Establishing a baseline of "normal" disease dynamics should be part of the basic foundation of ocelot conservation and management.

A possible model for the development of such a database can be found in the Jaguar Health Program Manual (Deem and Karesh 2005). This document outlines procedures that should occur in both the field and the laboratory for proper sampling and diagnoses. The protocol in this document would: 1) provide standardized methods to assess the overall health of ocelots in the wild; 2) allow the determination of disease threats (e.g., infectious diseases - intraspecific and conspecific via domestic animals, livestock, other free-ranging felids, and prey) and indirect threats (e.g., habitat fragmentation and degradation that may increase disease risks); and 3) facilitate recommendations for the long-term management and conservation of the ocelot.

Frequent trapping, health examinations during sedation and handling, and analyzing of blood samples from ocelots, and other felines in close proximity to ocelots, are necessary to assess the effects of disease on small ocelot populations in particular. Radio telemetry and GPS-tracking offers the only real solution to finding an injured or dead ocelot so that it can provide samples to monitor the effects of disease or disease outbreaks. Radio telemetry is necessary because ocelots are highly secretive animals, and the predominantly warm temperatures where ocelots are found, do not lend themselves to providing valuable necropsy results unless specimens are recovered and preserved the same day (Thomas deMaar *pers. comm.* 2015)

Aggression and predation by other animals also account for some ocelot mortality. Texas ocelots were killed by other ocelots, domestic dogs, coyotes, unknown mammals, and a diamondback rattlesnake (*Crotalus atrox*) (Haines *et al.* 2005b). The remains of two radio-collared ocelots were found in ponds occupied by American alligators (*Alligator mississipiensis*) (Linda Laack *pers. comm.* 2005). Mountain lions (*Puma concolor*) killed three radio-collared ocelots (one male and two females) between 1994 and 2001 in the Chamela-Cuixmala Biosphere Reserve in Jalisco, Mexico (López González *et al.* 2002). Mondolfi and Hoogesteijn (1986) and González-Maya *et al* (2010) noted that jaguar, on occasion, killed and ate ocelots.

Factor D - The inadequacy of existing regulatory mechanisms

The ocelot and its habitat are protected by the ESA in the U.S. In Texas, sections 68.002, 68.015 of the Texas Parks and Wildlife Code and section 65.171 of the Texas Administrative Code provide designation and protections to listed threatened and endangered animals, including the ocelot as endangered, which prohibit a range of actions including, but not limited to take, possession, various commercial activity, and take attempts. Due to the anxiety of some landowners about the potential implications of having an endangered species on their property, much of the remaining potential ocelot habitat has not been surveyed and protection of that habitat has not been enforced.

In Arizona, Commission Order 14, an active law under Title 17, prohibits the take of ocelots. Arizona Game and Fish Department regulation, R12-4-404, regarding the taking of live wildlife under a hunting or fishing license, prohibits live possession of ocelots. In addition, the AGFD and TPWD have the authority over scientific collection permits, and can approve, modify, or deny permit applications for ocelot research.

In Mexico, although the ocelot was formerly an important game species, hunting was banned in 1986, and now the ocelot is considered endangered by federal laws in Mexico, and researchers are required to possess a federal research permit for activities that may harm an ocelot (SEMARNAT 2010). In Mexico, there are a number of laws and regulations that directly or indirectly protect ocelots.

The Norma Oficial Mexicana, NOM-059-SEMARNAT-2010, entitled “Environmental Protection – Native species of wild flora and fauna of Mexico – Risk categories and specifications for inclusion, exclusion, or reclassification – List of species at risk” (“Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo”; SEMARNAT 2010), is a list of endangered species in Mexico. This law has no direct restrictions to protect the listed species, but it includes the criteria for including, excluding, or changing the risk category for species or populations on the list, and it is related with other instruments of environmental protection. It lists four categories: Probably Extinct in the Wild, Endangered, Threatened, and Subject to Special Protection.

The General Wildlife Law (“Ley General de Vida Silvestre”; SEMARNAT 2000) has several restrictions that only apply to species at risk (i.e., species listed in the NOM-059-SEMARNAT-2010). For example, it has strict provisions on the collection and capture of threatened and endangered species. It also contains general provisions on the sustainable use of wildlife; incentives for land owners; cooperation among federal, state, and municipal governments and private individuals; wildlife diseases; ethical use of wildlife; restrictions on exotic species, wildlife research and rehabilitation centers; wildlife use by indigenous people; environmental education; species at risk and their critical habitat; reintroduction and translocation protocols; scientific collection permits; control of nuisance species; and law enforcement investigations and citations (Valdez *et al.* 2006).

In March 2014, the List of Species and Priority Populations for Conservation was published in accordance with the General Wildlife Law of Mexico (SEMARNAT 2010, SEMARNAT 2014). This list includes the species or populations that the federal government of Mexico ranks as high priority for conservation, recovery, reintroduction and reproduction projects. Currently the ocelot is not on the list but the list is scheduled for updates every three years in accordance with the General Wildlife Law (SEMARNAT 2010, SEMARNAT 2014).

In addition, the Federal Penal Code (Código Penal Federal) includes Article 420, which, among other things, assigns a fine and/or prison sentences for illegally capturing, trafficking, transporting, or exporting species at-risk (i.e., those listed in the NOM-059-SEMARNAT-2010) or species considered in international treaties signed by Mexico (i.e. CITES) (Government of Mexico 2009). Penalties increase in cases involving illegal activities in natural protected areas.

The General Act for Ecological Balance and Protection of the Environment (Ley General Del Equilibrio Ecológico y Protección al Ambiente) can protect habitat for ocelots through ecological land zoning, environmental impact assessments, and establishment of natural protected areas (Government of Mexico 2015). Exploration, extraction, and mining of minerals are among the activities requiring an environmental impact assessment. Protected natural areas can be one of eight types: biosphere reserves, national parks, natural monuments, areas for the protection of natural resources, areas for the protection of flora and fauna, sanctuaries, state parks and reserves, and ecological preservation zones in populated areas.

A recent law, the Federal Environmental Responsibility Law (Ley Federal de Responsabilidad Ambiental) (), recognizes damages to the environment and charges responsible parties for reparations and compensation of said damages (Government of Mexico 2013). Its function is to protect, preserve, and restore the environment and ecological equilibrium, and to guarantee a healthy environment for the development and well-being of people.

Some states in Mexico, like Sonora, also have laws that provide general protection for wildlife. The state of Sonora's Ecological Balance Law (Ley del equilibrio ecológico del estado de Sonora) aims to encourage sustainable development and provides some protection of wildlife and habitat (Government of Sonora 2008).

There are several federal environmental authorities in Mexico, including SEMARNAT, the federal law enforcement agency for environmental protection (Procuraduría Federal de Proteccion del Ambiente, PROFEPA)), and the National Commission for Protected Natural Areas (Comisión Nacional de Áreas Naturales Protegidas, CONANP). CONANP is the federal government agency responsible of the land management and protection of protected areas, but it also conducts the Endangered Species Conservation Program, (Programa de Conservación de Especies en Riesgo, PROCER). The program is implemented through species action plans (Programas de Acción para la Conservación de Especies, PACE), which are developed by specialists from academic institutions, non-government organizations (NGOs), and government agencies. As of September 2015, there is not a PACE written for the ocelot.

In 2000, one of the strategies of CONANP and PROFEPA to support wildlife conservation activities in protected areas is the promotion and support of Environmental Surveillance Committees (Comités de Vigilancia Ambiental Participativa), which are rural community groups responsible for observation and participatory defense of the natural heritage within their communities. These committees are organized, supported, and supervised by Mexican environmental governmental institutions and are qualified to patrol areas. If illegal activity is detected, they must report it to the local, state, or federal authorities (PROFEPA 2002). More recent explanations of this effort can be found online (PROFEPA 2012).

Throughout Central and South America, poverty, ineffective law enforcement, and lack of incentives that could support conservation, are root causes of poaching, logging, and human encroachment that threaten the ocelot (CEPF 2004). The U.S. has little authority to implement actions needed to recover species outside its borders, especially when recovery requires the employment of laws and regulations. In many of the foreign countries in the range of the ocelot, key threats include the killing of ocelots and destruction of their habitat. The powers that the USFWS can employ in this regard are limited to prohibiting unauthorized importation of listed species into the U.S., prohibiting persons subject to U.S. jurisdiction from engaging in commercial transport or sale of listed species in foreign commerce, and assisting foreign entities with education, outreach, and other aspects of conservation through our authorities in section 8 of the ESA.

The "take" prohibitions of section 9 of the ESA only apply within the U.S., within the territorial seas of the U.S., and on the high seas. They do not apply in the foreign countries where the majority of ocelots are actually found. Section 7 of the ESA, which provides for all federal agencies to use their authorities to carry-out programs for the conservation of the species, and to insure that any action authorized, funded, or implemented by the agency is not likely to jeopardize the continued existence of listed species or adversely modify its critical habitat, is the primary tool within the ESA to address conflict with development or construction. The USFWS has no section 7 authority outside the boundaries of the U.S. and there are examples of waivers of the ESA in the U.S. For example, section 7 authority was waived in a specific instance regarding threats to endangered species and construction of the border infrastructure pursuant to the Real ID Act (Public Law 109-13; see Factor E, page 34).

Factor E - Other natural or anthropogenic factors affecting its continued existence

<u>Roads</u> **–** Roads have two documented impacts, and a third potential impact, on ocelot populations. First, collisions with motor vehicles in Texas are the leading cause of known ocelot mortality (Tewes 1986, Tuovila 1999, USFWS *unpubl. data* 2015a) and accounted for 45% of deaths of 80 radio-tagged ocelots (Haines *et al.* 2005b) between 1983 and 2002, and vehicle-related mortalities continue to be the most significant factor of ocelot mortality in Texas

(USFWS *unpubl. data* 2015a). Ocelot mortality due to vehicular collisions has also been documented in Arizona, Sonora (López González *et al.* 2003, Holbrook *et al.* 2011), and Tamaulipas (Francisco Illescas *pers. comm.* 2014; René Celis Gurría *pers. comm.* 2015). Second, roads can decrease the probability of successful dispersal between patches of suitable habitat, thus increasing demographic and genetic isolation of populations (Janečka *et al.* 2011). Third, to the extent that ocelots might avoid areas of high road density, some otherwise suitable habitats may not be occupied by ocelots or may serve as a population sink due to the risks posed by vehicles. Such avoidance of otherwise suitable habitat has been reported for wolves (*Canis lupus*) (Theil 1985, Mech *et al.* 1988) and black bears (*Ursus americanus*) (Brody and Pelton 1989, Orlando 2003).

Recovery efforts would benefit from information on how ocelots establish and move around in their home ranges relative to roads, or in their use of culverts or underpasses to negotiate roads. Roads in ocelot habitat facilitate increased human presence which increases disturbance to ocelots and may lead to increased mortality of ocelots and their prey. While some underpasses and culverts have been installed for ocelots in Texas, more are needed, and correct placement and supporting infrastructure (e.g., fencing) are critical for them to be used by ocelots as travel corridors (Tuovila 1999, Cain 1999).

In 2016, the Texas Department of Transportation (TXDOT) plans to begin installation of nine highway underpasses for ocelots along Highway 106 and Buena Vista Road in Cameron County, Texas, three large bridge style crossings on State Highway 77 between Raymondville and Sarita, Texas, and four wildlife crossings between Los Fresnos and Laguna Vista, Texas, on State Highway 100. These roads are in areas used by ocelots and where numerous ocelot mortalities due to vehicle collisions have been documented. These projects should provide a significant improvement in the conservation of ocelots in Texas.

<u>Border issues</u> – Actions such as the signing of the North America Free Trade Act in 1994, increased border monitoring associated with illegal immigration starting in 1998, and homeland security since 2001 have impacted current and future ocelot recovery efforts. Borderland factors that impact ocelots include urbanization (brush-clearing for buildings, sewage dumped into the Rio Grande River and its tributaries, lighting, human activity, and road construction and maintenance), water development (brush-clearing, channeling, draining), agriculture (brush-clearing, pesticide run-off), U.S. Border Patrol operations (brush-clearing, lighting, road construction and maintenance, tower construction and maintenance, human activity, including on and off-road vehicular activity) (Jahrsdoerfer and Leslie 1988, Lorey 1999), and the construction of fences to prevent illegal immigration into the U.S. (brush-clearing, construction and maintenance, blocking of travel corridors). In 2015, there were 11 existing international bridges and one proposed international bridge within Cameron, Hidalgo, and Starr counties in Texas. If not properly designed or constructed, the bridges and the resulting secondary development can act as significant east-west barriers to ocelot movement. The possible effects of roads created by people engaged in illegal activities or the U.S. Customs and Border Protection officers patrolling under and around the bridges should be considered more often in the design-phase of such projects.

In 2006, Congress passed the Secure Fence Act (Public Law 109–367), mandating that 1,130 km of physical fencing be installed along the U.S./Mexico border by the end of 2008. The Real ID Act of 2005 also gave the Secretary of the Department of Homeland Security the ability to waive any law or treaty in order to ensure the construction of the fence, including environmental laws such as the National Environmental Policy Act, Clean Water and Clean Air Acts, Refuge Improvement Act, Migratory Bird Treaty Act, and Endangered Species Act. On April 1, 2008, Department of Homeland Security Secretary, Michael Chertoff, invoked his ability to waive these laws and continued construction without compliance.

Approximately 42 km of pedestrian fence (not permeable to ocelots) in 21 sections were proposed in the Lower Rio Grande Valley and as of March 2015, 18 sections (34 km) of fence were complete except for temporary gaps in the structure to allow landowners access to their property. These fence-gaps are expected to receive at least basic utilities (e.g., electricity to control motorized gates, security keypads, area-lighting). Of these 42 km, 13 km of flood control infrastructure was installed in Hidalgo County that permanently fragmented habitats and limited wildlife access to the Rio Grande which is in some places the only reliable source of freshwater for drinking. The flood walls, 4-5 m tall concrete walls, 2-20 km long, are a significant impediment to north-south connectivity for the ocelot. The infrastructure directly and indirectly impacts traditional access to dozens of private lands as well as units of Las Palomas Wildlife Management Area managed by TPWD, the Southmost Preserve managed by The Nature Conservancy (TNC), and the Audubon Sabal Palm Sanctuary managed by Gorgas Science Foundation.

In Arizona, the border from the Tohono O'odham Nation to the Arizona-New Mexico border is a mix of pedestrian fence (not permeable to ocelots), vehicle fence (generally permeable enough to allow for the passage of ocelots), and unfenced areas. Nearly the entire southern border of the Tohono O'odham Nation has vehicle fence. To the east, nearly the entire southern border of the Buenos Aires National Wildlife Refuge (BANWR) has pedestrian fence. From BANWR to Nogales, only a portion of the Coronado National Forest has vehicle fence, the rest is unfenced. Pedestrian fence exists from Nogales east to the boundary of the Coronado National Forest and from Douglas west through the Coronado National Memorial. Most of the Coronado National Forest, which lies between Nogales and Naco, is bordered by vehicle fence, but the steepest, most rugged areas are unfenced. The San Rafael Valley is bordered by vehicle fence. Vehicle fence also exists from about 3 km west of the Arizona/New Mexico border west to the terminus of the pedestrian fence on the east side of Douglas. The USFWS Arizona Ecological Services Field Office continues to recommend to U.S. Customs and Border Protection (CBP) that openings large enough to allow for the passage of ocelots be installed in pedestrian fence in Arizona.

Impenetrable fences are and will continue to be barriers to wildlife, especially terrestrial species such as the ocelot (Bies 2007). Specific impacts to the ocelot are the losses of habitat and travel corridors necessary for population maintenance (Tewes *et al.* 1995, Flesch *et al.* 2009). In addition, opportunities for re-creating landscape connectivity across this international border will be much more difficult in the future. Thus, ocelot recovery in the U.S. will be greatly hindered as ocelots become more genetically and demographically isolated from the much larger populations in Mexico, in particular if additional barriers are constructed in Cameron County, Texas, or in the mountain ranges and woodland corridors of southern Arizona.

Another factor affecting the continued existence of ocelots in the U.S. is the increased pressure by the CBP on traditionally used points of entry by undocumented immigrants. Thus, immigration shifts into the most inaccessible zones where impacts on the ocelot and other species may be high (Ackerman 1998). For example, after implementing Operation Gatekeeper near San Diego in 1994, apprehension of undocumented immigrants dropped 46% in California whereas apprehensions increased 88% in Arizona and Texas where intense monitoring efforts were not implemented (Ackerman 1998). Through cooperation and consultation with CBP, border security actions will need to be addressed as they relate to ocelot recovery and maintaining connectivity with populations of ocelots in Mexico. Actions on behalf of ocelot survival and recovery will need to consider the cumulative impacts of fencing, lighting, vehicle traffic, and disturbance to habitat patches.

<u>Genetics</u> – Small and declining populations, such as the ocelot in Texas, face a variety of genetic challenges. Maintaining overall genetic variability of small populations is vital for persistence, as is preserving natural genetic differentiation of declining populations relative to other populations of the same species. Heterozygosity levels, allelic diversity, gene flow, level of inbreeding, and census and effective population sizes, are all important to estimate in managing declining populations.

When managing small isolated populations, genetic health can be maintained most effectively by connecting them either with corridors or through translocations. According to Korn (2013), the LANWR ocelot population had the greatest need for linkage to other ocelot populations as it has had a history of cases of close inbreeding (i.e., parent-offspring matings). If translocations are implemented as a recovery action, it will be important to monitor the genetic characteristics of the source and recipient populations prior and following translocation events. In the Florida Panther Genetic Restoration Project, the temporary inclusion of only 6 female mountain lions from Texas caused significant improvements in numbers of panthers, genetic heterozygosity, survival and fitness, and declining inbreeding correlates (Johnson *et al.* 2010).

<u>Climate change</u> – According to the Intergovernmental Panel on Climate Change (IPCC) (2007), "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Average Northern Hemisphere temperatures from 1983 to 2012 likely represent the warmest 30-year period of the last 1,400 years in this hemisphere, where such assessment is possible (IPCC 2014). The globally averaged combined land and ocean surface temperature data show a warming of 0.85 °C (1.5 ºF) between 1880 and 2012 (IPCC 2014). The earth's surface has warmed by an average of 0.74 ºC (1.3 ºF) during the 20th century and, over the past 50 years, cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that heat waves have become more frequent over most land areas, and the frequency of unusually heavy precipitation events has increased over most areas (IPCC 2007).

The IPCC (2007) predicts that changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century. The IPCC projects heat waves will occur more often and last longer and extreme precipitation events will become more intense and frequent in many regions (IPCC 2014). For the next two decades, a warming in the range 0.3 °C to 0.7 °C (0.5 °F to 1.26 °F) is projected, with future temperature projections increasingly dependent on specific emission scenarios (IPCC 2014). Various emission scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.3 °C to 4.8 °C (0.5 °F to 8.6 °F) with the greatest warming expected over land (IPCC 2014). It is predicted that tropical storms will increase in frequency and intensity along the Gulf Coast of Mexico and with the additional height gained by rising sea levels, storm surges could cause considerably more damage to human communities as well as certain habitats (Moser *et al.* 2014, Shafer *et al.* 2014). South Texas is fortunate to have Padre Island, the largest of the Texas barrier islands as well as the world's longest barrier island (Tunnel and Judd 2002) and the Laguna Madre, both of which provide buffers from storm surges from the Gulf that would otherwise impact inland areas that provide habitat for ocelot. Unfortunately, a recent report on a Sea-Level Affected Marshes Model (Western Pinnacle Consulting Inc. [WPCI] 2011) demonstrated that as sea level rises by 2100, Padre Island may have become a series of smaller islands, or part of the shallow Laguna Madre. Vermeer and Rahmstorf (2009) suggest that in order to account for possible model error in predicting sea level rise, it is feasible to expect that the range would be 75 to 190 cm of sea level rise by 2100. The accuracy of these predictions should be monitored closely in order to efficiently manage the conservation of wildlife resources.

Although the inundation of South Padre Island and coastlines of the Laguna Madre are of concern for the long-term conservation and management of certain wildlife of the LRGV, the report predicted relatively little change to the inland prairies and ridges of dense ocelot habitat along the south Texas coast (see WPCI 2011). In coastal areas, some low-lying inland sites are expected to change into marsh habitats, and shallow marshes will likely transition to deeper marshes or open water by 2100 (WPCI 2011). As the effects of climate change and sea level rise become more apparent, parcels further inland could provide redundancy in the availability of habitats and corridors used by the ocelot. Given the current expectations for continued urban growth and developments in the coastal area of Texas, especially for Cameron County, uncoordinated, short-sighted urban developments could severely limit recovery of the ocelot.

In 2009, South Texas Refuge Complex (Complex) began development of a strategic plan for the protection of additional lands to conserve wildlife resources of the Lower Rio Grande Valley of Texas (LRGV) (USFWS 2012). The Complex used a combination of many datasets to identify the best future footprint for wildlife conservation in the LRGV. In 2011, Refuges incorporated prudent and long-term wildlife conservation measures resulting from evaluation from a Sea-level Affecting Marshes Model (SLAMM 6) that was developed for the area (WPCI 2011). These measures included provisions through time for habitat adaptability of wildlife trust resources like the ocelot. Six major landscape corridors in the LRGV (see USFWS 2010a) and three international corridors between the U.S. and Mexico are the focus for the efforts of the USFWS and its partners in this border area. The USFWS has communicated the need for Refuges, state parks, landowners and local planners, developers, road designers, and decision-makers to coordinate long-range planning for climate change scenarios and the needs of wildlife that will be affected by the additional stressors of climate change and variability.

Localized projections suggest the southwestern U.S., such as Arizona and Sonora, may experience the greatest temperature increase of any area in the lower 48 states (IPCC 2007, Garfin *et al.* 2014, Shafer *et al.* 2014). It is very likely that hot extremes, heat waves, and strong storms and hurricanes, sometimes accompanied by heavy precipitation will increase in frequency in the Gulf Coast of Mexico (IPCC 2007, Shafer *et al.* 2014), while models indicate that many semi-arid areas like Arizona and Sonora will suffer a decrease in water resources due to climate change (IPCC 2007, Garfin *et al.* 2014).

Regional annual average temperatures are projected to rise by 2.5°F to 5.5°F by 2041-2070 and by 5.5°F to 9.5°F by 2070 to 2099. Heat waves are projected to become longer and more intense (Gershunov *et al.* 2009; Garfin *et al.* 2014) while cold winters are projected to decline (Kodra *et al.* 2011). Projections of precipitation changes are less certain than those for temperature, yet reductions in winter and spring rains are projected for the ASMU by 2100 as well as other subtropical areas (Cayan *et al.* 2013).

We do not know whether the changes that have already occurred have affected ocelot populations or distribution, nor can we predict with a great degree of certainty how ocelots will be affected by the type and degree of climate changes forecasted by a range of models. Although many species already listed as endangered or threatened may be particularly vulnerable to changes in climate, we also recognize that, for some listed species, the effects may be positive or neutral. In any case, the identification of effective recovery strategies and actions for recovery plans, as well as assessment of their results in five-year status reviews, should include consideration of climate-related changes and interactions of climate and other variables. These analyses may also contribute to evaluating whether an endangered species can be reclassified as threatened, or whether a threatened species can be delisted.

Stochastic threats such as the effects of drought on ocelot, their prey, or their core habitat may make the ocelot especially vulnerable. Monitoring of populations and ocelot habitat will be needed to evaluate and hopefully address the interactions of climate change and other variables. Therefore, monitoring is a necessity for adapting our recovery and management strategies to meet the challenges of changing conditions.

<u>*Miscellaneous*</u> – Agricultural pesticides and herbicides may also have negative impacts on the ocelot. While common contaminants have appeared in ocelots, they occur at low levels and do not seem to be a major problem (Mora *et al.* 2000). On the other hand, impacts to potential prey have been observed. For example, in the Lower Rio Grande Valley of Texas the number of amphibian and reptile species was estimated to have been reduced by 65% and 51%, respectively, perhaps the result of pesticides (Thornton 1977). Continued monitoring for impacts to ocelots will be needed. Riley *et al.* (2007) documented 80% of bobcats and several mountain lions tested in the Santa Monica Mountains of California had secondary poisoning from anticoagulant rodenticides. In 2002-2003, survival rates of both felids dropped by about 50% due to deaths attributable to an interaction between notoedric mange and these secondary poisons. Additionally, the widespread use of Round-Up herbicide in and around ocelot habitats should be evaluated as research has shown that glyphosate, its active ingredient, is toxic to

human placental cells at concentrations lower than used for agricultural purposes and may have effects across mammal species (Richard *et al.* 2005).

A few cases of other mortality factors have been reported from Texas. In 1991, an ocelot was killed by being poisoned by a hunter who was trying to rid his deer feeder of raccoons. The hunter laced chicken meat with aldicarb, a carbamate insecticide, and threw it into the brush, indiscriminately poisoning all carnivores and scavengers that ate the meat (Linda Laack *pers. comm*. 2005). In 1999, an archery hunter misidentified an ocelot as a bobcat and killed it (Linda Laack *pers. comm.* 2005).

1.8 Biological Constraints to Ocelot Recovery

Little is known about biological constraints to ocelot recovery outside of the borderlands of the U.S. and Mexico. Extreme cold temperatures may limit ocelot reproduction and survival more so than other native cat species (i.e., bobcat with a more widespread distribution in the U.S; Sunquist & Sunquist 2002). However, the ocelot as well as the jaguar were once found in eastern and central Texas during the pre-settlement era (Bailey 1905), but they may not have been in great abundance. Navarro-Lopez (1985) suggested that habitat around riparian corridors is what allowed ocelots to move northward from their more tropical range.

In the TTMU, the ocelot has shown a preference for thick thornscrub habitat within the fragmented landscape (Laack 1991, Shindle and Tewes 1998, Harveson *et al.* 2004, Horne *et al.* 2009). The recovery of the ocelot in Texas will likely depend on the protection and reestablishment of thick thornscrub habitat as core habitat and landscape linkages among population segments (Tewes and Everett 1986, Tewes and Miller 1987). Habitats other than dense thornscrub should be considered for protection and restoration as ocelots have occurred in other habitats historically and even recently (Navarro 1986, Stangl and Young 2011). Some of these other more dominant habitat types in south Texas used by ocelots include scattered thornscrub (Harveson *et al.* 2004, Horne *et al.* 2009), coastal grasslands (Laack 1991), and oak mottes (Navarro 1986).

In Arizona and Sonora, López González *et al.* (2003) found that ocelots were associated with tropical or subtropical habitat, namely subtropical thornscrub, tropical deciduous forest, and tropical thornscrub and rarely temperate oak and pine-oak woodland. Ocelots in Arizona have been documented in semi-desert grassland, Madrean evergreen woodland, and Great Basin biotic communities (Culver *et al.* 2016).

Other biological constraints of the ocelot reaching recovery goals include low fecundity compared to the bobcat and mountain lion (Cisin 1967, Eaton 1977, Fagan and Wiley 1978, Mellen 1989), species that range more widely in North America. Low fecundity decreases the intrinsic growth rate so populations will take longer to expand. However, the relatively low interparturition periods of the ocelot and its ability to breed year-round may compensate for low fecundity (Eaton 1977, Laack *et al.* 2005). Another potential biological constraint may be a low percentage of breeding females. Emmons (1988) believed that female ocelots breed only every other year as an adaptation to low expected rates of energy acquisition. However, both captive and wild ocelots can breed every year (Eaton 1977, Laack *et al.* 2005).

Short interparturition periods, the ability to breed year round, concentration of resources on few young and the preference for thick canopy cover for den sites (Laack *et al.* 2005) may be well-suited for species in tropical environments. Similar reproductive adaptations are found in other small to medium-sized Neotropical cats, such as the oncilla and margay (Fagan and Wiley 1974, Quillen 1981, Widholzer *et al.* 1981, Eaton 1984). However, these adaptations may not be advantageous in climates that are more temperate. The Lower Rio Grande Valley and Gulf Coast of Texas are in a sub-tropical region – some years are more tropical (i.e., warm temperatures year-round, moist conditions) than other years (i.e., cold winters, drought conditions) (Thornthwaite 1948, Lonard *et al.* 1991). Ocelots may be constrained by their reproductive ecology and preference for dense canopy cover, and their level of fitness may not be as high within subtropical regions as in more tropical areas. These variables should be considered when developing recovery strategies and defining delisting parameters for ocelots in the U.S.

The possibility of competition for space and food resources exists with other native cat species (see Mondolfi and Hoogesteijn 1986, López González *et al.* 2002, González-Maya *et al.* 2010) and other carnivores such as the coyote. The potential for competition is discussed elsewhere in this document, but is likely more of an issue for ocelots at the limits of the species' northern distribution where a variety of factors may interact synergistically to limit fecundity, survival, and the potential for range expansion.

1.9 Captive-breeding and Management

The first ocelot recovery plan (USFWS 1990a) did not describe a role for breeding and management of captive wild ocelots. Since the publication of the first recovery plan in 1990, much work and research has been done on ocelot biology, husbandry, and breeding strategies in captivity. In Texas, member institutions of the American Zoo and Aquarium Association (now called the Association of Zoos and Aquariums [AZA]) formed the Texas Ocelot Research and Conservation Consortium (Kaemmerer *et al.* 1996, Kaemmerer 1999). Its primary purpose was to facilitate research on captive "generic" (i.e., of unknown geographic origin) ocelots based on recommendations from experts who identified topics that could not be adequately addressed in the field, but could be in captivity. Studies included determination of activity patterns and time budgets (Weller and Bennett 2001), responses to olfactory cues (Cooke 1999, Rypkema 2000), and nutrition and digestion of prey (Bennett *et al.* 2010).

Research in ocelots over the past 20 years has characterized their basal reproductive traits through semen collection and analysis, as well as fecal hormone analysis (Moriera *et al.* 2001, Morais *et al.* 2002, Swanson *et al.* 2003). In addition, studies have investigated laparoscopic artificial insemination (AI), semen-freezing methods, in vitro fertilization (IVF) and embryo transfer (ET) for assisted reproduction (Swanson *et al.* 1996, Moraes *et al.* 1997, Swanson 2002, Stoops *et al.* 2007). Among other findings, these studies established that male and female ocelots show minimal seasonality and that females are polyestrous with 2-3 week cycle lengths and no spontaneous ovulation. Furthermore, females are minimally responsive to exogenous gonadotropins, requiring higher dosages on a per-body weight basis, but are capable of becoming pregnant after laparoscopic intrauterine AI with freshly-collected and frozen-thawed spermatozoa. Pregnancy success was relatively low (25%, 2/8) in two earlier AI studies.

More recent research with IVF/ET has shown that most oocytes (~60-70%) recovered from gonadotropin-treated ocelots can be fertilized in vitro and that ocelot IVF embryos are developmentally competent following cryopreservation and transfer into synchronized recipients (Swanson 2002, Conforti *et al.* 2008). Overall, 50% (5/10) of frozen embryo transfers resulted in pregnancy and development of term offspring. Ongoing research is assessing a new oviductal AI method, combined with a novel gonadotropin regimen and semen freezing protocol, which may substantially improve AI pregnancy success in ocelots, especially when using frozen-thawed spermatozoa (Lambo *et al.* 2011).

There are records of ocelots in captivity since 1891 (Bragin 1994). The first studbook for North America was developed under the auspices of the American Zoo and Aquarium Association (now, AZA), and recorded in the International Species Inventory System (Bragin 1994). The system is a listing of all ocelots in the program, living and deceased, their origin, if known, their dams and sires, if known, when and to where they were transferred, and their last captive location. Other individual information is often recorded including identifying marks, rearing history, medical conditions, and geographic origin. Changes in the captive population through births, deaths, imports or exports are tracked through updated studbooks (Bragin 2014). There are no ocelots in the studbook identified as *L. p. albescens* or *L. p. sonoriensis.* Beginning in 1997 a population management master plan recommended potential reproductive pairings in the captive population to improve genetic representation of founder lines and demographic structure; this has been done regularly as population changes have occurred (Kaemmerer *et al.* 2014)

Under the conservation and science branch of the AZA, the Felid Taxon Advisory Group (Felid TAG) serves as an umbrella group to advise, monitor, and represent all activities performed through felid studbooks, Species Survival Plan (SSP) committees, and specialized felid task force groups. When a felid species, which has a viable captive population being tracked through a studbook, is also threatened or endangered in the wild, has significant educational relevance, and has the potential to be an umbrella species for particular ecosystems, the Felid TAG may develop a Species Survival Plan (SSP) (Wiese and Hutchins 1994). The SSP has a steering committee elected by representatives from every AZA institution holding that species. The steering committee is responsible for setting goals for captive population structure and growth, initiatives to educate the public, research needs, and initiatives to enhance and promote conservation in the wild. To further conserve the species, the SSP collaborates with governmental organizations including the USFWS, as well as non-governmental organizations.

The goal of the Ocelot SSP, formed in 2001, is ocelot conservation in North America by supporting the efforts of the USFWS Ocelot Recovery Team and Ocelot Recovery Plan. (Kaemmerer *et al.* 2004). The Felid TAG directed that the future North American captive population should represent the Brazilian subspecies *L. p. mitis* so that it eventually replaces the current, mostly generic population. As such, one of the SSP's primary goals has been to collaborate with Brazilian governmental and non-governmental organizations to fund six projects through the formation and administration of the Brazilian Ocelot Consortium. These include publication of felid studbooks and husbandry manuals, captive propagation and management of

Brazilian ocelots, professional training of Brazilian zoo staff and scientists, maintenance of a biological resource bank for Brazilian felids, environmental education, and habitat restoration. In return, 10 pairs of unrelated Brazilian ocelots were to be imported over a 5-year period to form the foundation of the future North American captive population (William Swanson *pers. comm.* 2003).

One of several tools for conservation of an endangered species is the creation of a captive population to serve as "insurance" in the event the wild population suffers catastrophic losses, as well as to facilitate research that could not be done in the wild (Wiese and Hutchins 1994). Some captive breeding programs and management plans developed from agreements among SSPs (e.g., black-footed ferret, red wolf), USFWS, and other agencies have provided valuable information through research, as well as directly augmenting wild populations through release of captive animals. With the vast experience in captive husbandry, education, and research, the AZA and Ocelot SSP can assist in the recovery of the Texas-Tamaulipas ocelot, *L. p. albescens* and the Arizona-Sonoran ocelot, *L. p. sonoriensis.* The potential and need for such assistance should be further examined for the ocelot.

1.10 Public Education

Because ocelot recovery in Texas-Tamaulipas and Arizona-Sonora is an interstate and bi-national effort, it is important for education to address school systems and regional cultures specific to northern Mexico, southern Arizona, and southern Texas.

<u>Texas-Tamaulipas Management Unit</u> – Friends of Laguna Atascosa National Wildlife Refuge (FLANWR), a nonprofit group, created the Adopt-an-Ocelot program. This program allows supporters to symbolically 'adopt' an ocelot by contributing to a fund to be used for education, research, and habitat restoration for the ocelot. Supporters receive educational materials about ocelot ecology, the species' conservation challenges, and details of the lives of individual ocelots found at LANWR. To date the program has gained supporters from throughout the U.S. and Canada.

LANWR, FLANWR, and numerous partners host an annual ocelot conservation festival in the Lower Rio Grande Valley of Texas. This outreach and educational event raises awareness about the ocelot and its ecology and promotes ocelot and habitat conservation in local communities. The event includes a visit from a captive-reared ocelot (Mays 2009), live wildlife exhibits, educational nature programs, and family-oriented nature activities. In 2014, this event drew over 1,500 participants and 1,286 of them attended the live ocelot show (Bray 2014, Marion Mason *pers. comm.* 2014). Proceeds from the event go to FLANWR which funds ocelot habitat conservation. Established in 2014, the purchase of "Save the Ocelot" specialty license plates in Texas provides funds to FLANWR to support ocelot conservation. FLANWR also maintains a social media online page through *Facebook* entitled "Viva the Ocelot!" to promote education and outreach on ocelot conservation.

In addition flyers and posters have been published and disseminated to the public in English and Spanish on ocelot identification, status, conservation needs. Information and contact phone numbers have also been provided to the public for the USFWS if an ocelot is seen, including the

USFWS produced “Ocelot Guide for the Public” (Nancy Brown *pers. comm*. 2010), and the Cincinnati Zoo & Botanical Garden’s “Save the Texas Ocelot” (Bray 2015). In Tamaulipas, Mexico, a poster in Spanish has been distributed to the public on the identification and status of the ocelot, “Ocelote *Leopardus pardalis,*” through the efforts of FLANWR, USFWS, Gladys Porter Zoo, Conservacion y Desarrollo de Espacios Naturales (CDEN) and San Antonio Zoo (Luis Jaime Peña *pers. comm*. 2014).

Arizona-Sonora Management Unit – In Arizona, the U.S. Geological Survey (USGS) signed an intra-agency agreement with the USFWS in 2013 to develop and implement a citizen science program for jaguar monitoring, develop and conduct education and outreach on jaguar conservation, and write grants for jaguar conservation. Although jaguar conservation was the emphasis of the program, ocelot conservation was also incorporated and implemented for two years.

The purpose of the citizen science component of the agreement was to develop, implement and evaluate a citizen science program to survey and monitor for jaguars and ocelots within the U.S. portion of the Northwestern Recovery Unit for the jaguar (Reynolds *et al.* 2015). The program was very successful and, although the agreement has been completed, the citizen scientists trained as part of the program continue to survey and monitor jaguars and ocelots in Arizona with the use of trail cameras.

The purpose of the education component of the agreement was to provide K-12 students with a general understanding of conservation and the importance of conserving native wildlife, and to develop and implement an education program for jaguars and ocelots in southern Arizona (Neils *et al.* 2015). To accomplish this, USGS worked closely with Arizona educators to train, teach, and evaluate learning occurring in the classroom and in the field. USGS aimed to instill not only an appreciation for Arizona jaguars and ocelots, a well-rounded knowledge of their ecology, and how they fit into wildlife communities, but also a sense of responsibility to protect these charismatic species and the habitats in which they live.

The purpose of the outreach component of the agreement was to provide, through presentations, accurate information to the general public about jaguars and ocelots and their conservation importance, focusing primarily within the areas of southern Arizona and southwestern New Mexico in which the University of Arizona's Jaguar Survey and Monitoring Project was being conducted, but also disseminating this information to a wider audience through presentations at zoos, museums, and other organizations throughout the U.S. (Merlin *et al.* 2015).

In Sonora, Mexico, Naturalia conducts environmental education and CONANP is also heavily involved in public outreach, and outreach on spotted cats in particular. The Northern Jaguar Project runs an incentive program for people that document wild cats.

1.11 Conservation Actions To Date

While many threats adversely affect ocelot populations, a number of conservation actions have occurred or are being implemented which are improving conditions for the species in the TTMU and ASMU.

<u>*Conservation Actions in the TTMU*</u>

- Both LANWR and LRGVNWR are restoring agricultural land to native thornscrub. LRGVNWR reforests about 250 ha/year through cooperative farming agreements (USFWS 1997c). LANWR set aside about 400 ha of farmland in the 1980s where the planting of native shrubs (see Young and Tewes 1994) and natural plant colonization from surrounding thornscrub has occurred. These re-established thornscrub areas are being used by ocelots (USFWS *unpubl. data* 2015b).
- A separate but parallel habitat restoration program, operated by the South Texas Refuge Complex, the Burned Area Emergency Response (BAER) Program provides funding for restoration of areas impacted by wildfires. From 2004 to 2014, nine sites totaling 750 acres were treated with herbicide for invasive grass control and replanted with native brush species.
- CONANP announced in April 2005 that a new Flora and Fauna Protected Area, Laguna Madre and Delta del Rio Bravo, was created in Tamaulipas, Mexico. This conservation work areas covers 572,808 ha of the Laguna Madre and adjoining coastline and will protect ocelot habitat in the region as CONANP continues to collaborate with the people that live in the area.
- In 2005, a new USDA-Natural Resources Conservation Service standard was written which describes how to establish thornscrub on cropland for the benefit of the ocelot. This standard is being employed under the Farm Services Agency practices called CP4B and CP4D. This program provides a financial incentive for landowners to restore ocelot habitat on their property.
- In 2005, USFWS began installation of rainwater catchments, or guzzlers, on Refuge lands managed by LANWR, in response to the ongoing drought and the needs of wildlife for fresh drinking water. Fifteen 2,200-Liter guzzlers were installed over several years and distributed across most management units of LANWR, in areas that had few or no ponds to hold freshwater for drinking. These sites have been monitored with game cameras nearly continuously since 2005.
- The USFWS approved a Safe Harbor Agreement (SHA) developed by the Environmental Defense Fund for the ocelot in 2006. The SHA was designed to encourage restoration of private lands to provide suitable habitat for the ocelot and to provide connectivity between areas currently occupied by ocelot. Although several parties were interested, none sought and received certificates of inclusion.
- The Nature Conservancy (TNC) has acquired thousands of acres in land to help protect ocelot habitat and create corridors between existing habitats. On January 31, 2008, TNC purchased a conservation easement of 282 ha to further protect the Willacy County population and other wildlife. On December 14, 2009, TNC purchased an additional 526-ha conservation easement for the protection of wildlife corridors in south Texas and

to help in the recovery of ocelots. These TNC easements compliment the adjacent 191 hectares under conservation easement with USFWS.

- In 2009, South Texas Refuge Complex developed a strategic acquisition plan and, in 2012, LRGVNWR developed a draft preliminary project proposal to expand the capacity for LRGVNWR to work with more private landowners as conservation partners on the landscape. Each of these plans focuses the growth of the Refuges on the acquisition of lands critical to conservation of trust resources, including the ocelot.
- In 2009, the Translocation Working Group was formed from members from the Implementation Subgroup of the Ocelot Recovery Team. These individuals developed a plan to assist in the translocation of ocelots from larger populations of ocelots in Mexico to smaller populations in Texas that were in need of genetic augmentation.
- From 2009-2011, researchers from Caesar Kleberg Wildlife Research Institute at Texas A&M University – Kingsville, Texas, studied the ocelot population on Rancho Caracól near Soto La Marina, Tamaulipas, Mexico (Stasey 2012, Carvajal-Villarreal *et al.* 2012). They identified numerous ocelots from photographs, calculated a density estimate for the ocelots, took blood and other samples from live-trapped ocelots, and radio-tracked several ocelots. In 2011, security issues in Tamaulipas ended the work.
- In 2011, the South Texas Refuge Complex developed a long-term habitat restoration plan for the ocelots of south Texas. This plan identified current and proposed areas managed by refuges in south Texas that had suboptimal habitat in need of augmentation and areas with soils suitable for habitat restoration (see Harveson *et al.* 2005).
- In 2012, the USFWS began a collaborative project with a non-profit conservation group from Tamaulipas, Mexico, Conservación y Desarrollo de Espacios Naturales (CDEN), as well as with Friends of Laguna Atascosa National Wildlife Refuge, Gladys Porter Zoo, and San Antonio Zoo. The project identified another relatively large population of ocelots near Soto la Marina, Tamaulipas, capable of supporting translocation of ocelots to small populations in need of genetic augmentation, such as those in Texas (CDEN 2014).
- Starting in 2014, the USFWS began a collaborative project with the University of Queretaro, to assess the size of the ocelot population in the Sierra Gorda Biosphere Preserve in Queretaro, Mexico.
- LANWR located in Cameron and Willacy counties, Texas, has grown from 18,287 ha in 1999 to 31,798 ha in 2014 (USFWS 2014). These lands were acquired from willing sellers and acquisition of some of these tracts included habitats readily used by ocelots. LANWR has a Refuge Expansion Plan (USFWS 1999a) and a Comprehensive Conservation Plan (USFWS 2010) each providing the rationale for the acquisition of up to 43,758 ha under management by LANWR.
- LRGVNWR, located in Starr, Hidalgo, Willacy, and Cameron counties of Texas has grown from 5,526 ha in 1984 to 32,038 ha in 2014 (USFWS 2014). The LRGVNWR Land Protection Plan (USFWS 1984) targets the acquisition of up to 53,621 ha. Several areas of the LRGVNWR have habitat suitable for ocelots, including the area around the salt lakes in Hidalgo and Willacy counties and parts of eastern Cameron County.
- With additional acquisitions in 2014, LRGVNWR has over 2,400 ha in conservation easements with landowner Frank Yturria in Willacy County whose land is occupied by ocelots.

- In 2016, the Texas Department of Transportation (TXDOT) plans to install nine highway underpasses for ocelots along Highway 106 and Buena Vista Road in Cameron County, Texas, three large bridge style crossings on State Highway 77 between Raymondville and Sarita, Texas, and four wildlife crossings between Los Fresnos and Laguna Vista, Texas, on State Highway 100. Six ocelots have been killed along State Highway 186 and a crossing has been proposed in that area by USFWS to TXDOT. All these roads run through areas used by ocelots and where ocelot mortalities due to vehicle collisions have been documented.

Conservation Actions in the ASMU

- In Sonora, there are at least two federally-recognized protected areas that provide for the conservation of the ocelot including the Ajos-Bavispe National Forest Reserve and Wildlife Refuge (Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe) and the Sierra de Alamos-Rio Cuchujaqui Flora and Fauna Protection Area (Área de Protección de Flora y Fauna Sierra de Alamos-Rio Cuchujaqui).
- Since 2004, Arizona Department of Transportation (ADOT) has actively cooperated with AGFD to identify important wildlife linkages across the state of Arizona, develop high-resolution conservation plans in priority linkages, and build wildlife crossing structures in locations recommended in linkage conservation plans. For instance, ADOT has built eight large wildlife underpasses on SR-260 and three wildlife overpasses on US-93, and has committed to build new wildlife crossing structures on SR-77, US-89A, and SR-64.
- From 2004-2011, Naturalia (an NGO from Mexico) and the Northern Jaguar Project (NJP) (an NGO from the U.S.), purchased four ranches: Ranchos Los Pavos (4,047 ha), Rancho Zetasora (14,164 ha), Rancho Las Tesotas and Rancho El Carricito (2,535 ha). These four ranches are now collectively referred to as the Northern Jaguar Reserve (NJR) and support a breeding ocelot population.
- In 2007, Naturalia started a working group with diverse governmental and non-governmental partners, to address conservation concerns of carnivores, particularly felids, in Sonora. Naturalia and Northern Jaguar Project developed and implemented the Feline Photo Project. Under this project, participating rural landowners are paid when they produce a photograph of a felid on their ranch. Ten ranch owners near the NJR are enrolled in the project and have signed agreements not to harm wildlife. Their land encompasses a total of 16,592 ha, effectively increasing the protected area for wild felids.
- The Rancho El Aribabi, a 4,000-ha ranch in Sonora, Mexico, 48 km south of Nogales, Arizona, where ocelots and jaguars have been documented, received a Certificate of Voluntary Land Conservation by CONANP in the state of Sonora in 2011 (Avila-Villegas and Lamberton-Moreno 2013). The landowner and his staff have invested heavily in supporting researchers of ocelot and all wild felids on the property.
- From 2012 to 2015, with funding from the Department of Homeland Security, the USFWS funded the University of Arizona to conduct a jaguar/ocelot camera survey in Arizona. The project photographed three male ocelots and one jaguar multiple times and provided information on ocelot habitat associations (Culver *et al.* 2016).
- From 2012 to 2015, with funding from the Arizona Game and Fish Department, the Culver Conservation Genetics laboratory collected and analyzed ocelot samples from Arizona, U.S. and Sonora, Mexico to obtain a genetic profile for this ocelot population,

as well as the genetic relationship of Arizona/Sonora ocelots to other ocelot populations in Mexico, Texas, and throughout Central and South America.

2.0 RECOVERY

2.1 Goal of the Plan

The goal for this plan is to restore and protect the ocelot and its habitat so that its long-term survival is secured and it can be removed (i.e., delisted) from the list of threatened and endangered species.

As a species that is listed throughout its range (21 countries in addition to the United States), the ocelot presents a significant challenge for recovery planning. Our knowledge regarding the status of the species in much of its range is limited, and the USFWS and its partners lack the resources and authority to coordinate large-scale international research and recovery for the entire species. However, we can establish the framework to better understand the status and conservation needs of ocelots for recovery throughout their range. We can cooperate with our partners, including private landowners, in the border states of Mexico to focus efforts within our respective jurisdictions to conserve and recover ocelot populations in the northern limits of the species' range. We can establish specific criteria for recovery, and actions that, if implemented, will conserve viable ocelot populations in the borderlands (Arizona, Sonora, Tamaulipas, and Texas).

2.2 Recovery Strategy

Our approach in this revision to the ocelot portion of the 1990 "endangered cats" recovery plan is as follows:

- To summarize what is known about the status of the ocelot throughout its range, and identify primary information gaps and broad actions necessary to address conservation of the species.

- To address in significant detail the actions necessary to conserve the existing and highly imperiled breeding populations in Texas and population across the border in Tamaulipas, Mexico.

- To address the status of the existing population in Arizona and Sonora, Mexico, and identify the actions necessary to understand its status and to conserve the population through cooperative efforts in the borderlands of Arizona and Sonora.

While we consider the ocelot throughout its range, we focus the details of this recovery plan on two management units, the Texas-Tamaulipas Management Unit (TTMU) and the Arizona-Sonora Management Unit (ASMU). We recognize the conservation needs and challenges facing the ocelot elsewhere in its range, but there are compelling circumstances that dictate this focus. The USFWS has little authority to implement actions needed to recover species outside the U.S. borders. The management and recovery of listed species outside the U.S. borders, including the ocelot, is primarily the responsibility of the countries in which the species occur, with, as appropriate, the help of available technical and monetary assistance from the U.S. Thus, it is appropriate to focus this plan and resources on conservation of the ocelot in the northern part of its range as a contribution toward an international effort to conserve and recover the ocelot rangewide. Therefore, we have defined the boundaries of these two management units as the original subspecies' ranges as described by Goldman (1943) and summarized visually by Hall (1981) with extended boundaries given discoveries of ocelots in additional areas in central Mexico (Figure 3, page 8; see Appendix II).

Management units are a useful tool for species occurring across wide ranges, with multiple populations, varying ecological pressures, or different threats in different parts of their range. Management units are individually necessary to conserve demographic and genetic robustness for the sake of long-term sustainability of the species. Management units are primarily delineated on a biological basis; however, boundaries may be modified to reflect differing management regimes. Management units are not necessarily self-sustaining viable units on their own, but instead need to be collectively recovered to ensure recovery of the entire listed entity.

Texas supports isolated, highly imperiled populations that once were demographically linked to the State of Tamaulipas. The TTMU is a logical management unit because: 1) it encompasses the current known range of the subspecies (*L. p. albescens*); 2) the U.S. population was historically contiguous with a larger regional population across the Rio Grande River; 3) it has distinct habitat conditions that occur nowhere else in the species' range; 4) peripheral populations such as these are important genetic resources; and 5) there are established international cooperative efforts on behalf of the species in this area that are currently underway. Further, peripheral populations may be beneficial to the protection of evolutionary processes and the environmental systems that are likely to generate future evolutionary diversity (Lesica and Allendorf 1995). This may be particularly important considering the potential threats of global climate change (see Factor E above).

The ASMU is similarly logical, although less is known about this population. Although we lack evidence of a breeding population in Arizona, it is clear that the subspecies *(L. p. sonoriensis*) occurs in the state at least as dispersing individuals, and breeding is evident in Sonora (López-Gonzalez *et al.* 2003, Avila-Villegas and Lamberton-Moreno 2013, Gómez-Ramírez 2015). Due to unique habitat that occurs in northern Sonora and southern Arizona, the ASMU also represents a distributional extreme and the important genetic and adaptive resources that can characterize peripheral populations (Lomolino and Channell 1995).

<u>*Texas-Tamaulipas Management Unit*</u> – Habitat loss and the fragmentation of remaining suitable habitat is clearly the greatest threat to the persistence and recovery of the ocelot in this borderland population. Whereas a variety of recovery actions are needed to fully address the conservation challenges of the ocelot, the most immediate concerns relate to the negative consequences of habitat limitations in Texas and loss of connectivity with ocelots in Tamaulipas. Recent records of the ocelot are known for only five south Texas counties, a tiny fraction of the ocelot's overall historic distribution in Texas.

Reduced genetic variability in Texas ocelots suggests that these small Texas populations have been isolated for many generations. The widespread conversion of thornscrub habitat to agriculture and other intensive land uses has not only reduced the total population, but has reduced the potential for dispersing ocelots to reach habitat fragments and other subpopulations, and has made the natural recolonization of vacant range unlikely. Such isolation is exacerbated by the proliferation of roads and highways throughout the region, and the subsequent habitat effects and mortality that directly impact both resident and dispersing ocelots.

In the absence of population expansion, restoration of demographic linkages with other populations, and a significant reduction in fatal strikes from vehicles, the ocelot in Texas faces a high risk of extinction in less than 40 years as the result of the combined effects of reduced genetic variability and environmental stochasticity (Appendix III). Successful recovery will be the product of population management that improves genetic fitness and population size, and longer term efforts that protect and restore habitat, enhance landscape linkages among populations, promote range expansion, and reduce threats from roads and other sources of development-related mortality (Haines *et al.* 2005a).

Arizona-Sonora Management Unit – Less is known about the ASMU population. López González *et al.* (2003) estimated a population of 2,025 ± 675 in the State of Sonora. However, with such a wide confidence interval based on relatively short-term efforts, a more refined estimate was needed. Gómez-Ramírez (2015) estimated a density of 0.04 ocelots/km^2 using camera-trap data and mark-recapture methods. Given these updates, the estimated state-wide population estimate is 1,421 ocelots. Yet, continuing field studies to provide additional detailed information about population density, demographics, habitat use, food habits, and spatial ecology are needed for the ASMU.

International border issues continue to threaten ocelot populations in this area. These include fencing, lighting, vehicle and pedestrian traffic from U.S. Border Patrol and undocumented immigrant activities, and habitat alteration to facilitate law enforcement. These challenges can be addressed, in part, through interagency cooperation and biological monitoring. Recovery planning for the ASMU should focus on basic research that details habitat suitability, distribution, and threats. More than three decades of research investment in the Texas-Tamaulipas population have been necessary to understand the spatial and demographic challenges of recovery planning in this area. Certainly, many of the issues facing the current ocelot population in Texas will pertain to ocelots in Arizona and Sonora. Nonetheless, dramatic climatic and landscape differences, ecological differences, and possibly different socio-political circumstances will dictate original research and conservation planning for the ASMU.

As previously stated, the ocelot is listed as endangered throughout its range, which includes 21 countries in addition to the United States. The entire species is the listed entity under the ESA. In this recovery plan, we have identified two recovery management units for the Texas-Tamaulipas and Arizona-Sonora subspecies, *L. p. albescens* and *L. p. sonoriensis*, respectively. At this time, these management units cover the range of these two ocelot subspecies and only represent subspecies units. These management units cannot be considered for delisting separately from the listed entity (i.e., the entire species) until it meets all the recovery criteria for each management unit and has completed a formal reclassification evaluation and designation, which would involve a proposed rulemaking, public review and comment, and a final rulemaking (USFWS and NMFS 1996, 61 FR 4722). We used a combination of geographic distribution and separation, genetic differences, geopolitical boundaries, and distinct habitat conditions to assess the designation of these TTMU and ASMU subspecies units.

2.3 Recovery Objectives

Recovery objectives collectively describe the specific conditions under which the goals for recovery of the ocelot will be met. These objectives apply to the recovery of the ocelot throughout its range and the five listing factors:

1) Assess, protect, and restore sufficient habitat to support viable populations of the ocelot in the shared borderlands between the United States and Mexico (Listing Factor A).
2) Reduce the effects of human population growth and development on ocelot survival and mortality (Listing Factors A, E).
3) Maintain or improve genetic fitness, demographic conditions, and health of the ocelot (Listing Factors C, E).
4) Assure the long-term viability of ocelot conservation through partnerships, the development and application of incentives for landowners, application of existing regulations, and public education and outreach (Listing Factors A, D, E).
5) Practice adaptive management in which recovery is monitored and recovery tasks are revised by the USFWS in coordination with the Recovery Team as new information becomes available.
6) Support international efforts to ascertain the status of and conserve the ocelot south of Tamaulipas and south of Sonora (Listing Factors A, B, C, D, E).

Please see “Reasons for Listing/Threats” on page 28 for a description of the five Listing Factors.

2.4 Recovery Criteria

Recovery criteria are the objective, measurable criteria that provide a basis for determining whether a species can be considered for reclassification (downlisting to threatened status or removing it from the list of threatened and endangered species [delisting]). Because the same five statutory factors must be considered in delisting as in listing, 16 U.S.C. § 1533 (a), (b),(c), the USFWS, in designing objective, measurable criteria, must address each of the five statutory delisting factors and measure whether threats to the [species] have been reduced or eliminated (see Fund for Animals v. Babbitt, 903 F. Supp. 96 [D.D.C1995]). The criteria below were established for the ocelot throughout its range, as listed by the ESA to the maximum extent practicable, with specific objectives that can be met for the borderland management units. We submit that the approach described above meets our statutory requirements to the maximum extent practicable. As our knowledge of the ocelot across its range increases and as the recovery actions described in this plan are implemented, the plan may be revised and refined.

If recovery efforts are fully funded and carried out as outlined in this plan, including strategic acquisitions and partnerships and significant investments in thornscrub restoration, recovery criteria for downlisting could be met by 2085. Based on continued recovery actions outlined and implemented into the future including strategic acquisitions and partnerships and significant investments in thornscrub restoration, the Recovery Team estimates that delisting for the ocelot could be initiated by 2115. These timeframes are based on the slow growth rate of ocelot populations and consideration of the time needed for restoration of sufficient habitat to support the ocelot populations identified in the recovery criteria.

Downlisting Criteria

The ocelot should be considered for downlisting to threatened status when:

Downlisting Criterion 1 – The ocelot should qualify for "Least Concern" under the International Union for Conservation of Nature (IUCN) Red List criteria (IUCN 2014) for at least five years; and threats from habitat loss, habitat fragmentation, and poaching have been reduced such that the ocelot is no longer in danger of extinction. The IUCN currently lists the ocelot as "Least Concern" with a decreasing global population trend (Caso *et al.* 2008).

Rationale for Downlisting Criterion 1 – We acknowledge that this criterion is broad and general, but it was developed to the maximum extent practicable based on our limited knowledge of the species throughout its range south of Tamaulipas and Sonora. As we learn more about the species in this part of its range, this criterion may be modified in the future.

As a global organization, the IUCN helps the world find pragmatic solutions to the most pressing environment and development challenges. Conserving biodiversity is central to the mission of IUCN, including developing and maintaining a species "Red List," which provides information on the status of wild species, including assessing their risk of extinction. Several categories are used to define risk, including Least Concern (LC), Near Threatened (NT), and Threatened, which is further divided into Vulnerable (VU), Endangered (EN), and Critically Endangered (CE). For more information about these categories, see the IUCN Red List website (http://www.iucnredlist.org/).

Downlisting Criterion 2 – The TTMU metapopulation is estimated through reliable scientific monitoring to be at least 200 ocelots in Texas and 1,000 ocelots in Tamaulipas for at least five years. The 200 ocelots in Texas should be distributed as either:

(a) a single metapopulation of at least 150 ocelots in Texas with interchange between it and ocelots in Tamaulipas that is sufficient to maintain genetic variability; or

(b) two populations of at least 75 ocelots each in Texas, with interchange between the two populations, and between the populations in Texas and ocelots in Tamaulipas that is sufficient to maintain genetic variability.

In addition to either Downlisting Criterion 2(a) or 2(b), an additional 50 ocelots must be present in Texas, either as additional members of the existing population(s), or as less geographically stable individuals in search of mates or new home ranges. Interchange among populations may be facilitated by moving ocelots between populations to simulate natural dispersal and recruitment. Populations may include the current populations in Cameron and Willacy counties, but may also include a reintroduced population established within currently unoccupied historical range. Habitat protection must be in place to support ocelot populations for the foreseeable future, and potential corridors must be protected and mechanisms must be developed to restore habitat connectivity between populations.

Rationale for Downlisting Criterion 2 – Minimum sizes of populations in Texas of 75 ocelots. The results of the ocelot PVA indicated that the ocelot populations in Texas (estimated at 30 and 40 ocelots for LANWR and Willacy, respectively) were not sufficient to avoid extinction of the species in Texas within the next 100 years (Appendix III). Increasing the initial sizes of the two populations in the PVA to at least 75 ocelots each reduces the extinction risk of a population compared to initial population sizes of 50 or 60 ocelots under a variety of conditions (Appendix III, Table 4, Figure 4).

Minimum population size in Tamaulipas of 1,000 ocelots. An estimate of 1,000 ocelots may be an underestimate of the current population in the entire State of Tamaulipas based on recent research by Carvajal-Villarreal *et al.* (2012), Stassey (2012) and CDEN (2014) conducted in the area of Soto La Marina, Tamaulipas, from 2008-2014. A population of 1,000 or more ocelots in Tamaulipas would not be significantly impacted by the number of extraction events modeled (Appendix III, Risk Analysis II: Translocation and Metapopulation Viability).

Downlisting Criterion 3 – The ASMU metapopulation is estimated through reliable scientific monitoring to be above 1,000 ocelots for at least five years. Habitat linkages to support an ASMU metapopulation have been identified. Threats to this metapopulation have been identified and are determined to be below the threshold of endangerment of extinction within the foreseeable future. Solutions to reduce or eliminate those threats have been developed that are specific and actionable.

Rationale for Downlisting Criterion 3 – Minimum population size of 1,000 ocelots in the ASMU population. Based on the results of the PVA for the ocelot in south Texas and northern Tamaulipas and the larger size of Sonora and southern Arizona, we determined that at least 1,000 ocelots are needed for the persistence of the ASMU into the foreseeable future. The Sonoran populations are thought to be large enough that they are currently providing for natural dispersal of ocelots and serving as a source for ocelots in Arizona, which indicates a robust population. López González *et al.* (2003) estimated the ocelot population of Sonora to be 2,025 $\pm$ 675 ocelots. Gómez-Ramírez (2015) estimated a density of 0.04 ocelots/km^2 using camera-trap data and mark-recapture methods and provided a state-wide population estimate for Sonora, Mexico, of 1,421 ocelots. More research is needed to refine this estimate in order to apply it accurately to all of Sonora. A minimum population size of 1,000 ocelots is currently considered appropriate, at least until additional information can be gathered for the ASMU.

Delisting Criteria

The ocelot should be considered for delisting when:

Delisting Criterion 1 – The ocelot should continue to qualify for "Least Concern" under the International Union for Conservation of Nature (IUCN) Red List criteria (IUCN 2014) for at least 10 years and populations should be stable or increasing. Threats from habitat loss, habitat fragmentation, and poaching are reduced such that the ocelot can maintain healthy, viable populations for the foreseeable future.

Rationale for Delisting Criterion 1 – This is similar to Downlisting Criterion 1, except it was extended over a longer time frame to ensure populations are sufficiently stable.

Delisting Criterion 2 – The TTMU metapopulation is estimated through reliable scientific monitoring to be at least 200 ocelots in Texas and at least 1,000 ocelots in Tamaulipas for at least 10 years. The 200 ocelots in Texas should be distributed as either:

(a) a single metapopulation of at least 150 ocelots with interchange between it and ocelots in Tamaulipas that is sufficient to maintain genetic variability; or

(b) two populations of at least 75 ocelots each, with interchange between the two populations, and between the two populations in Texas and ocelots in Tamaulipas sufficient to maintain genetic variability.

In addition to either Delisting Criterion 2(a) or 2(b), an additional 50 ocelots must be present in Texas, either as additional members of the existing population(s), or as less geographically stable individuals in search of mates or new home ranges. Interchange among populations must occur through natural dispersal rather than by translocating ocelots between populations; or

(c) if natural interchange between Texas and Tamaulipas is not occurring, cross-border interchange may be facilitated by moving ocelots to simulate natural dispersal and recruitment, but an additional population of at least 75 ocelots must be established within currently unoccupied historical range in Texas to compliment the two populations of 75 ocelots each. The third population of 75 ocelots should be established in a location that would expand the geographical range of the species in Texas to provide sufficient assurance against loss of the entire Texas population from catastrophic weather events or infectious disease.

Under any of these scenarios, habitat management and sufficient conservation measures must be in place to support and connect all populations of ocelots within Texas and within Tamaulipas for the foreseeable future. Under scenarios 2(a) or 2(b), there would have to be at least 200 ocelots in Texas to achieve Delisting Criterion 2. Under scenario 2(c), there would have to be at least 275 ocelots in Texas.

Rationale for Delisting Criterion 2 – This delisting criterion differs from element two of the downlisting criterion as follows:

The criteria must be met for 10 years. The increase in time is appropriate to ensure that the populations and their management are sufficiently stable to project that the population is recovered.

Connectivity among populations is through natural dispersal rather than by translocation. Adequate natural corridors for dispersal should be more reliable because they do not rely on long-term commitments by management agencies to translocate animals and better incorporate natural spatial behavior. In addition, natural connectivity avoids or minimizes the risk to individual animals by capture and handling and avoids the disruption of local populations by removal or supplementation.

The criterion requires the establishment of an additional Texas population, which in part, serves as an alternative to natural colonization from Tamaulipas. This allows for delisting even if natural connectivity cannot be maintained between Texas and Tamaulipas, by substantially increasing the security of the species in Texas.

Delisting Criterion 3 – The ASMU metapopulation is estimated through reliable scientific monitoring to be at least 1,000 animals for at least 10 years and populations should be stable or increasing. Threats from habitat loss, habitat fragmentation, and poaching are reduced such that the ocelot can maintain healthy, viable populations for the foreseeable future. Habitat linkages to facilitate an ASMU metapopulation have been identified and are conserved for the foreseeable future.

Rationale for Delisting Criterion 3 – The criteria must be met for 10 years. This is similar to Downlisting Criterion 3, but extended over a longer time frame. The increase in time is appropriate to ensure that the populations and their management are sufficiently stable to ensure that the metapopulation is recovered.

2.7 Threats Tracking Table

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS

Listing Factor	Threats	Recovery Criteria	Recovery Actions
ALL		3	1.3.5 Identify threats to ASMU populations
(A, B, C, D, E		3	1.3.6 Reduce and alleviate threats to ASMU
Collectively)		1,2,3	2.1.4.1 Support interagency planning
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2,3	4.1.6 Partner with Mexican agencies and landowners
		2	5.1 Develop monitoring plan for populations
		2	5.2 Develop agreements for non-federal land surveys

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare report of ocelot monitoring
		1,2,3	6.1 Track origins of illegal pelts
		1,2,3	5.6 Run periodic PVAs as new information acquired
		1,2,3	5.7 Update recovery tasks as new information acquired
		1,2,3	6.2.1 Support workshops every 3-5 yrs.
		1	6.2.2 Support Meso-american corridor
Factor A	**Habitat loss and range curtailment**	2	1.1.1 Map habitat in Texas
		2	1.1.2 Map habitat in Tamaulipas
		2	1.1.3 Document status in Texas habitat
		2	1.1.4 Document status in Tamaulipas habitat
		2	1.1.5 Estimate areas needed in TTMU
		2	1.1.6 Refine knowledge of prey and competition
		2	1.1.7 Identify conservation lands in TTMU range
		1,2,3	1.2.3.1 Protect habitat around populations
		1,2,3	1.2.3.2 Protect known Texas populations
		1,2,3	1.2.3.3 Protect habitat recently occupied by ocelots
		1,2,3	1.2.3.4 Support creation of natural protected areas in Mexico
		1,2,3	1.2.3.5 Create Texas-Tamaulipas corridor
		1,2,3	1.2.3.6 Protect habitat in the historic range of the ocelot in Tamaulipas and Texas
		3	1.3.2.1 Map habitat in ASMU
		3	1.3.1.3 Expand surveys in ASMU habitat
		3	1.3.1.4 Establish at least 3 monitoring areas in ASMU
		3	1.3.2.2 Identify conservation lands in ASMU range
		3	1.3.1.5 Monitor genetic variability in ASMU
		2	3.1.1 Monitor genetic diversity, evaluate genetic augmentation in Texas
		2	3.1.2 Monitor genetic diversity, evaluate genetic augmentation in Tamaulipas
		3	3.1.3 Characterize genetic status in Sonora
		2	3.1.4 Develop genetic augmentation for populations
		2,3	3.1.5 Evaluate artificial reproduction, gene bank
		2	3.1.6 Evaluate genetic breeding program
		2	3.2.1 Conduct experimental translocations
		2	3.2.2 Augment populations through translocation
		2	3.2.3 Evaluate use of confiscated ocelots
		2	3.3 Identify area for new population in Texas

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		2	3.4 Establish new population in Texas
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor A	**Habitat Modification (Management)**	1,2,3	1.2.1 Develop, distribute, implement habitat guidelines
		1,2,3	1.2.2 Foster partnerships with landowners
		2	1.2.4.1 Identify and map soils for thornscrub restoration
		2	1.2.4.2 Restore thornscrub around populations in Texas
		2	1.2.4.3 Implement thornscrub restoration in secondary areas
		2	1.2.4.4 Develop and implement a monitoring program for restored thornscrub
		2	1.2.4.5 Refine methods to restore thornscrub
		3	1.3.5 Identify threats to ASMU populations
		3	1.3.6 Reduce and alleviate threats to ASMU
		1,2,3	2.1.4.1 Support interagency planning
		1,2,3	2.3 Minimize impacts from development and human activities
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2	4.1.3 Develop projects with landowners
		2	4.1.4 Develop incentive programs for landowners
		1,2,3	4.1.5 Support Mexican habitat surveys
		2,3	4.1.6 Partner with Mexican agencies and landowners
		2,3	4.1.7 Partner with Homeland Security, Border Patrol
		2,3	4.2.2 Assure compliance of oil, gas, seismic operations
		2,3	4.3.1 Maintain education/outreach working group
		2	4.3.2.1 Develop education materials for Texas and Arizona
		2,3	4.3.2.2 Develop education materials for Tamaulipas, Sonora
		2,3	4.3.3 Monitor, evaluate outreach efforts
		2	5.1 Develop monitoring protocol for populations
		2	5.2 Develop agreements to survey on non-federal land
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.6 Run periodic PVAs as new information acquired
		1,2,3	6.1 Track origins of illegal pelts
		1,2,3	6.2.1 Support workshops every 3-5 years
		1	6.2.2 Support implementation of Meso-american corridor
Factor A	**Habitat Degradation**	2,3	1.1.11 Identify, prioritize lands for habitat restoration
		2	1.2.4.1 Identify and map soils for thornscrub restoration

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		2	1.2.4.2 Restore thornscrub around populations in Texas
		2	1.2.4.3 Implement thornscrub restoration in secondary areas
		2	1.2.4.4 Develop and implement a monitoring program for restored thornscrub
		2	1.2.4.5 Refine methods to restore thornscrub
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor A	**Loss of Habitat Connectivity**	2	1.1.8 Map connections between TTMU populations
		1,2,3	1.1.9 Study dispersal of ocelots
		1,2,3	1.1.10 Model movement and dispersal
		1,2,3	1.3.3.1 Determine habitat selection in ASMU
		1,2,3	1.3.3.2 Determine movements and dispersal in ASMU
		1,2,3	1.3.3.3 Identify conduits and barriers in ASMU
		1,2,3	1.3.3.4 Identify food and prey habits in ASMU
		2,3	2.2.1 Identify border crossing locations for ocelots
		2,3	2.2.2 Reduce border structure impacts on ocelot movement
		2,3	2.2.3 Recommend alternative security structures
		2,3	2.2.4 Maintain, enhance border thornscrub and other appropriate habitats
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor A	**Road Fragmentation and Mortality**	2	1.1.12 Identify and design landscapes and crossing structures in Texas and Arizona
		2	2.1.1 Quantify road effects, road density and international bridge threshold
		2	2.1.2 Identify locations for road-crossing structures
		2	2.1.3 Design crossing structures
		2,3	2.1.4.2 Minimize new road and international bridge impacts
		2,3	2.1.4.3 Implement crossing structures and designs
		2	2.1.4.4 Construct crossing structures
		2	2.1.4.5. Monitor crossing structure usage and success
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor B	**Overutilization**	3	1.3.1.4 Establish monitoring areas in ASMU
		1,2,3	1.3.3.1 Determine habitat selection in ASMU
		3	1.3.5 Identify threats to ASMU populations
		3	1.3.6 Reduce and alleviate threats to ASMU
		1,2,3	2.1.4.1 Support interagency planning
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		2	4.1.3 Develop projects with landowners
		2	4.1.4 Develop incentive programs for landowners
		2,3	4.1.6 Partner with Mexican agencies and landowners
		2,3	4.3.1 Maintain education/outreach working group
		2	4.3.2.1 Develop education materials for Texas and Arizona
		2,3	4.3.2.2 Develop education materials for Tamaulipas, Sonora
		2,3	4.3.3 Monitor, evaluate outreach efforts
		1,2,3	4.3.4 Educate hunters to refrain from killing ocelots
		2	5.1 Develop monitoring protocol for populations
		2	5.2 Develop agreements to survey on non-federal land
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.6 Run periodic PVAs as new information acquired
		1,2,3	6.1 Track origins of illegal pelts
		1,2,3	6.2.1 Support workshops every 3-5 years
		1	6.2.2 Support implementation of Mesoamerican corridor
Factor C	**Disease, Toxins, Predation**	1,2,3	1.1.6 Refine knowledge of prey and competition
		1,2,3	1.3.3.1 Determine habitat selection in ASMU
		1,2,3	1.3.3.4 Identify food and prey habits in ASMU
		3	1.3.5 Identify threats to ASMU populations
		3	1.3.6 Reduce and alleviate threats to ASMU
		1,2,3	2.1.4.1 Support interagency planning
		2,3	3.5.1 Establish physiological identification protocols
		2,3	3.5.2 Conduct serology and pathology surveys
		2,3	3.5.3 Create tissue bank
		2,3	3.5.4 Establish protocols for injury, diseases, parasites
		1,2,3	3.5.5 Establish medical and genetic database
		1,2,3	3.5.6 Investigate disease prevention
		2,3	3.6.1 Research contamination
		1,2,3	3.7.1 Research niche overlap with competitors
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2,3	4.1.6 Partner with Mexican agencies and landowners
		2	5.1 Develop monitoring protocol
		2	5.2 Develop agreements to survey on non-federal land
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.5 Develop data sharing and repository
		1,2,3	5.6 Run periodic PVAs as new information acquired

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		1,2,3	6.1 Track origins of illegal pelts
		1,2,3	6.2.1 Support workshops every 3-5 years
		1	6.2.2 Support implementation of Mesoamerican corridor
Factor D	**Inadequacy of Regulation**	3	1.3.1.4 Establish at least 3 monitoring areas in ASMU
		1,2,3	1.3.3.1 Determine habitat selection in ASMU
		3	1.3.5 Identify threats to ASMU populations
		3	1.3.6 Reduce and alleviate threats to ASMU
		1,2,3	2.1.4.1 Support interagency planning
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2	4.1.3 Develop projects with landowners
		2	4.1.4 Develop incentive programs for landowners
		2,3	4.1.6 Partner with Mexican agencies and landowners
		1,2,3	4.2.1 Encourage regulations in Mexico
		1,2,3	4.2.2 Convene experts to discuss PACE for Mexico
		2,3	4.2.3 Assure compliance of oil, gas, seismic operations
		2,3	4.3.2.2 Develop education materials for Tamaulipas and Sonora
		2,3	4.3.3 Monitor and evaluate outreach efforts
		2	5.1 Develop monitoring protocol
		2	5.2 Develop agreements to survey on non-federal land
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.6 Run periodic PVAs as new information acquired
		1,2,3	6.1 Track origins of illegal pelts
		1,2,3	6.2.1 Support workshops every 3-5 years
		1	6.2.2 Support implementation of Mesoamerican corridor
Factor E	**Roads**	1,2,3	1.1.9 Study dispersal
		1,2,3	1.1.10 Model movement and dispersal
		2	1.1.12 Identify and design landscapes and crossings in Texas and Arizona
		1,2,3	1.3.3.1 Determine habitat selection in ASMU
		1,2,3	1.3.3.2 Determine movements and dispersal in ASMU
		1,2,3	1.3.3.3 Identify conduits and barriers in ASMU
		2	2.1.1 Quantify road effects and road density threshold
		2	2.1.2 Identify locations for road-crossing structures
		2	2.1.3 Design crossing structures
		2,3	2.1.4.2 Minimize new road impacts
		2,3	2.1.4.3 Implement crossing structures and designs
		2	2.1.4.4 Construct crossing structures
		2	2.1.4.5. Monitor crossing structure usage and success

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor E	**Border issues**	1,2,3	1.1.9 Study dispersal
		1,2,3	1.1.10 Model movement and dispersal
		2,3	2.2.1 Identify border crossing locations for ocelots
		2,3,	2.2.2 Reduce border structure impacts on ocelot movement
		2,3	2.2.3 Recommend alternative security structures
		2,3	2.2.3 Maintain, enhance border thornscrub habitats
		2,3	4.1.6 Partner with Mexican agencies and landowners
		2,3	4.1.7 Partner with Homeland Security, Border Patrol
		2,3	4.3.1 Maintain education/outreach working group
		2	4.3.2.1 Develop education materials for Texas
		2,3	4.3.2.2 Develop education materials for Tamaulipas, Sonora
		2,3	4.3.3 Monitor, evaluate outreach efforts
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor E	**Genetics**	1,2,3	1.1.9 Study dispersal
		1,2,3	1.1.10 Model movement and dispersal
		2	3.1.1 Monitor genetic diversity, evaluate genetic augmentation in Texas
		2	3.1.2 Monitor genetic diversity, evaluate genetic augmentation in Tamaulipas
		3	3.1.3 Characterize genetic status in Sonora
		2	3.1.4 Develop genetic augmentation
		2,3	3.1.5 Evaluate artificial reproduction, gene bank
		2	3.1.6 Evaluate genetic breeding program
		2	3.2.1 Conduct experimental translocations
		2	3.2.2 Augment populations through translocation
		2	3.2.3 Evaluate use of confiscated ocelots
		2	3.3 Identify area for new population in Texas
		2	3.4 Establish new population in Texas
		1,2,3	3.5.5 Establish medical and genetic database
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2	4.1.3 Develop projects with landowners
		2	4.1.4 Develop incentive programs for landowners
		2,3	4.1.6 Partner with Mexican agencies and landowners
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.5 Develop data sharing and repository
		1,2,3	5.6 Run periodic PVAs as new information acquired

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		1,2,3	6.3 Coordinate genetic zoo data
Factor E	**Pesticides, Herbicides**	2,3	3.5.1 Establish physiological, identification protocols
		2	3.5.2 Conduct serology and pathology surveys
		2,3	3.5.3 Create tissue bank
		2,3	3.5.4 Establish protocols for injury, diseases, parasites
		1,2,3	3.5.5 Establish medical and genetic database
		2,3	3.6.1 Research contamination
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2	4.1.3 Develop projects with landowners
		2	4.1.4 Develop incentive programs for landowners
		2,3	4.1.6 Partner with Mexican agencies and landowners
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.5 Develop data sharing and repository
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor E	**Competition**	1,2,3	1.1.6 Refine knowledge of prey and competition
		1,2,3	1.3.3.4 Identify food and prey habits in ASMU
		1,2,3	3.7.1 Research niche overlap with competitors
		1,2,3	5.6 Run periodic PVAs as new information acquired
Factor E	**Information Needs**	2	1.1.5 Estimate areas needed in TTMU
		2	1.1.6 Refine knowledge of prey and competition
		2	1.1.7 Identify conservation lands in TTMU range
		1,2,3	1.1.9 Study dispersal
		1,2,3	1.1.10 Model movement and dispersal
		1,2,3	1.2.2 Foster partnerships with landowners
		3	1.3.1.3 Expand surveys in ASMU habitat
		3	1.3.1.4 Establish at least monitoring areas in ASMU
		1,2,3	1.3.3.1 Determine habitat selection in ASMU
		3	1.3.5 Identify threats to ASMU populations
		3	1.3.6 Reduce and alleviate threats to ASMU
		2,3	4.1.1 Develop recovery working groups
		1,2,3	4.1.2 Continue recovery through Recovery Team
		2	4.1.3 Develop projects with landowners
		2	4.1.4 Develop incentive programs for landowners
		2,3	4.1.6 Partner with Mexican agencies and landowners
		2,3	4.1.7 Partner with Homeland Security, Border Patrol
		2,3	4.3.1 Maintain education/outreach working group

SUMMARY OF OCELOT LISTING FACTORS, THREATS, AND THE RECOVERY ACTIONS TO CONTROL THOSE THREATS			
Listing Factor	**Threats**	**Recovery Criteria**	**Recovery Actions**
		2	4.3.2.1 Develop education materials for Texas and Arizona
		2,3	4.3.2.2 Develop education materials for Tamaulipas and Sonora
		2,3	4.3.3 Monitor and evaluate outreach efforts
		2	5.1 Develop monitoring protocol
		2	5.2 Develop agreements to survey on non-federal land
		1,2,3	5.3 Conduct monitoring of recovery and revise recovery actions
		1,2,3	5.4 Prepare annual report of monitoring results
		1,2,3	5.5 Develop data sharing and repository
		1,2,3	5.6 Run periodic PVAs as new information acquired
		1,2,3	5.7 Update recovery tasks as new information acquired
		1,2,3	6.1 Track origins of illegal pelts
		1,2,3	6.2.1 Support workshops every 3-5 years
		1	6.2.2 Support implementation of Mesoamerican corridor
Factor E	**Natural Factors - Drought, Climate Change**	1	1.2.5 Make fresh drinking water available
		1	1.2.6.1 Study climate change effects on TTMU habitat
		1	1.2.6.2 Develop strategic climate change plan for TTMU
		3	1.3.4.1 Study climate change effects on ASMU habitat
		3	1.3.4.2 Develop strategic climate change plan for ASMU
		1,2,3	5.6 Run periodic PVAs as new information acquired

2.8 Recovery Actions

Recovery actions below are those that are underlined. These underlined actions represent the most stepped-down levels of the recovery action narrative. These items are discrete, specific actions and are the actions listed in the Implementation Schedule found on page 83.

1. Assess, protect, and enhance ocelot populations and habitat in the borderlands of the U.S. and Mexico.

1.1. Develop a comprehensive habitat model for conservation of ocelots in the TTMU that addresses population needs and habitat connectivity.

1.1.1. <u>Map existing brushlands suitable for supporting ocelots in Texas.</u> GIS maps of all remaining brushlands in Texas should be developed to determine where suitable habitat remains, where populations may be found or re-established, and where it may be feasible to establish habitat connectivity through restoration.

1.1.2. <u>Map existing brushlands suitable for supporting ocelots in Tamaulipas.</u> Identification of existing habitat in Tamaulipas is vital to monitoring and protecting the Tamaulipan subspecies of *L.p. albescens*. The Tamaulipas metapopulation may provide genetic and demographic enhancement essential to ocelot populations in the U.S. and northeastern Mexico. Ideally, landscape linkages will facilitate interchange between ocelot populations in these countries.

1.1.3. <u>Document the status of ocelots in known and potential habitat in Texas.</u> A focus on building relationships and trust with landowners is necessary to obtain information about ocelots on private lands. A combination of efforts using remote imaging technology, ocelot sign, camera traps, radio-telemetry and GPS-collar tracking, hairs snares, existing reports, road-mortality locations, and accessing unsurveyed lands will be needed.

1.1.4. <u>Document the status of ocelots in known and potential habitat in Tamaulipas.</u> A focus on building relationships and trust with landowners is necessary to obtain information about ocelots on private lands. A combination of efforts using remote imaging technology, ocelot sign, camera traps, radio-telemetry and GPS-collar tracking, hairs snares, existing reports, road-mortality locations, and accessing unsurveyed lands will be needed.

1.1.5. <u>Estimate the area necessary to support 200 ocelots in Texas and 1,000 ocelots in Tamaulipas.</u> This action will require analysis of digital land cover data, field verification, and integration of the most current knowledge of ocelot habitat requirements. Preliminary estimates for the Texas populations indicate that 230,000 acres of suitable habitat may be necessary to support 200 individuals.

1.1.6. <u>Further refine knowledge of ocelot food habits and predator-prey relationships.</u> Increased knowledge of the specific food choices and availability of prey for ocelots and the effects of such climatic variation as drought are essential in understanding the challenge of ocelot conservation. Prey overlap with competitors may also be an important factor in the conservation of ocelots.

1.1.7. Identify existing and proposed conservation lands in current and potential ocelot range in Texas and Tamaulipas. A graphic representation of all occupied and suitable areas in Texas and Tamaulipas is fundamental to understanding population dynamics, potential locations for corridors, risk assessment associated with roads, and long-term population sustainability. It will be necessary to identify and prioritize those lands most critical to target for conservation of the ocelot.

1.1.8. Identify, field verify, and map the most practical connections between areas of existing and potential ocelot populations. Identification of linkages will be a critical component of a comprehensive habitat conservation model. Priority should be given to areas with minimal need for habitat restoration and a maximum potential for long-term protection.

1.1.9. Study ocelot dispersal behavior. A better understanding of ocelot dispersal behavior and associated demography should be obtained using GPS/satellite-monitoring technology.

1.1.10. Develop computer simulations to identify and predict the conditions associated with dispersal and movement of ocelots. Software such as that available for use with ArcMAP (ESRI, Redlands, CA) is useful for modeling the virtual resistance of a landscape to the movements of wide-ranging carnivores (Larkin *et al.* 2004). Such modeling can assist with the identification of dispersal barriers, filters, and conduits, and can be an aid in designing blueprints for habitat restoration and habitat protection. Beier *et al.* (2006) described other GIS approaches to linkage design that should be evaluated for this action.

1.1.11. Identify and prioritize lands for habitat restoration in the TTMU. Ultimately, adding habitat to the range of the ocelot will depend on landowners' cooperation and interest in restoration, or the availability of the land in question and the resources to acquire it or otherwise protect it. Where these challenges can be met, habitat with restoration potential should be prioritized according to its proximity to occupied range, its ability to serve as occupied range, and its utility as a landscape linkage between occupied areas. In addition, the difficulty of the restoration should be estimated and based on the condition of existing soils and vegetation (i.e., all things being equal, the area in need of less preparation should have a higher restoration priority than an area that requires more).

1.1.12. Collaborate with landowners and experts to design feasible landscapes to manage habitat and specify the locations for road-crossing structures to maintain linkages in TTMU. Linkages are needed between Laguna Atascosa National Wildlife Refuge (LANWR) and Willacy populations, between LANWR and Tamaulipas, between previously-occupied and currently-occupied ocelot habitat in Willacy County (see Tewes 1986), and between Hidalgo and Starr counties in Texas, between Texas and Tamaulipas, and within Tamaulipas.

1.2. Develop and implement strategies to preserve and expand habitat and enhance habitat connectivity in the TTMU.

1.2.1. Develop, distribute, and implement guidelines for managing and enhancing existing ocelot habitat. Guidelines, in the form of a detailed brochure or manual, should be developed that describe best management practices for ocelot habitat, tools and resources for assistance, and benefits and incentives for land managers. Guidelines should be distributed to interested managers, landowners, and posted on appropriate web sites.

1.2.2. Develop and implement strategies and incentives to foster partnerships and enlist landowner cooperation. Successful recovery of the ocelot will require significant cooperation among organizations and participation of private landowners. Most of the important habitat for the species in both the U.S. and Mexico occurs on non-Federal lands or on public lands where wildlife may not be the primary target of management. Overcoming the perception that endangered species may be a liability on private lands is a significant challenge in parts of the species range, whereas, conflict with land use such as conversion to agriculture or development is more important in others. Strategies to conduct outreach to local communities and create incentives for their specific needs will need to be developed through the efforts of focused, long-term efforts. An outreach working group of the Recovery Team should be formed with this as a primary priority.

1.2.3. Where feasible, prioritize, protect, and acquire necessary habitat and conservation lands in the TTMU.

1.2.3.1. Protect habitat occupied by ocelots and surrounding known ocelot populations. Habitat protection can include, among other legal instruments, conservation easements or fee title acquisitions from willing sellers. Protected habitat around LANWR in Cameron County and around occupied habitat in Willacy County must be expanded in order to meet recovery goals. The priorities for acquisition should be evaluated regularly and opportunities for funding through partnerships of interested organizations (e.g., non-traditional section 6 grants) aggressively pursued. Create a task force of the Recovery Team to provide guidance and make initial contacts pertaining to this action, if not already being conducted by the USFWS or other partners. Protection of habitat occupied by and surrounding known ocelot populations in Tamaulipas should be supported through landowner agreements, national protection, or other programs in Mexico.

1.2.3.2. Protect a corridor of habitat to connect known populations in Texas. Accomplish connectivity by protecting at least 3,000 acres of habitat in a corridor at least 0.4 km wide and approximately 30 km long between the ocelot populations in Willacy and Cameron counties. This protection can be accomplished through a combination of USFWS Partners agreements, conservation easements, or fee title acquisition from willing sellers.

1.2.3.3. Protect habitat in areas recently occupied by ocelots. Habitat protection can include conservation easements and fee title acquisition from willing sellers. Protected habitat in areas known to be recently occupied by ocelots should be increased (USFWS 2010a), such as the areas of Willacy County and north Hidalgo County (see Tewes 1986, Haines *et al.* 2005a, Haines *et al.* 2006a).

1.2.3.4. Protect habitat in areas of Mexico through the support of the development of additional Natural Protected Areas and Biosphere Reserves. Mexico is considered one of the most diverse countries of the world (Mittermeier and Mittermeier 1992, Instituto Nacional de Ecología 1998) and the government of Mexico has developed significant plans to conserve its biological diversity (Instituto Nacional de Ecología 2000). These efforts conserve habitat for a myriad of species including the ocelot. The Sierra of Tamaulipas has long been discussed as a potential and valuable national protected area and is a known refuge for many ocelots, jaguars, jaguarundi, margay, among other priority species.

1.2.3.5. Protect a bi-national corridor of habitat to connect the Cameron County ocelot population to the northernmost known ocelot population in Tamaulipas. Habitat protection can include conservation easements or fee title acquisition from willing sellers. Creation of a Bi-national Coastal Wildlife Corridor from LANWR, Cameron County, Texas, to the Flora and Fauna Protected Area of the Laguna Madre and Delta del Rio Bravo in Tamaulipas, Mexico, has been identified as a shared goal of the USFWS and CONANP. This corridor should be at least 0.4 km wide and provide habitat connectivity from the Cameron County ocelot population at LANWR in Texas to the northernmost known ocelot population in Tamaulipas.

1.2.3.6. Protect habitat in other portions of the historic range in Texas and Tamaulipas. Where feasible, remaining habitat in Texas and Tamaulipas should be protected through partner agreements, conservation easements, or fee title acquisition from willing sellers.

1.2.4. Restore thornscrub habitat in the TTMU.

1.2.4.1. Identify and map appropriate soils for thornscrub restoration. Suitable ocelot habitat in Texas is associated with soils that are also desirable for agricultural uses. Existing soil maps should be available and useful in identifying potential habitat restoration zones. The selection of specific restoration areas should be a function of their potential to serve as occupied breeding habitat and travel corridors that link currently disjunct tracts of occupied or potential habitat. The re-establishment of thornscrub habitat in appropriate locations and spatial configurations will facilitate colonization by ocelots.

1.2.4.2. Restore thornscrub habitat around ocelot populations in Texas. In Willacy and Cameron counties, thornscrub habitat around existing, occupied habitat should be restored through invasive grass control and planting native seedlings.

1.2.4.3. Implement thornscrub restoration on a priority basis to benefit ocelots. Restoration of habitat in secondary areas should be prioritized according to its proximity to occupied range, its ability to serve as occupied range, its utility as a landscape linkage between occupied areas, and its suitability with regard to soils and water regimes. Thornscrub retention should be encouraged with landowners whenever possible, e.g., when irrigation ditches are being converted to underground water delivery systems.

1.2.4.4. Develop and implement a monitoring program for restored thornscrub. The rate of recovery, growth, and spread of restored thornscrub should be systematically monitored and the information used to adapt and improve restoration methodologies.

1.2.4.5. Evaluate and refine methodologies for thornscrub restoration. Small-scale experiments have demonstrated that some aspects of thornscrub can be restored relatively quickly on suitable soils. However, such small-scale efforts have not resulted in the measurable expansion of ocelot habitat or the restoration of landscape connectivity. Monitoring should continue on existing restoration sites, and best methodologies should be developed that encourage the species diversity and structure that constitute occupied ocelot habitat in Texas.

1.2.5 Assure available drinking water during periods of drought.
Identify strategic well sites and install solar-powered pumps or rainwater catchments to provide regular access to water during dry years. Also, restore freshwater wetlands where possible.

1.2.6 Consider what climate change adaptation and mitigation measures may be necessary to ensure recovery in the TTMU.

1.2.6.1. Study the effects of climate change (i.e., drought and varying degrees of salinity) on the dominant woody plants found in ocelot habitat of the TTMU. Adhikari and White (2014) found that simulated moderate drought and the concomitant increased soil salinity had a moderate to strong effect on five dominant plants found in south Texas. Results such as these provide a basis for evaluating the best plants to be used to re-establish the structure of restored brushlands.

1.2.6.2. Develop a strategic climate change adaptation and mitigation plan for ocelots in the TTMU. An adaptation plan for the TTMU should include alternatives to allow ocelots to use more inland habitat stands and alternate corridors given the impacts of climate change and sea level rise and the concomitant changes of plant communities, especially along the coastal areas. The adaptation plan should assess and rank lands and habitat stands so that they can be protected and or acquired for ocelot recovery goals.

1.3. Determine the status, trends, ecology, and threats to ocelots in the ASMU.

1.3.1. Survey for new populations and monitor existing populations of ocelots in the ASMU.

1.3.1.1. Document the status of ocelots in known and potential habitat in Arizona. A focus on building relationships and trust with landowners is necessary to obtain information about ocelots on private lands. A combination of surveying and monitoring efforts using remote imaging technology, camera traps, hairs snares, existing reports, and accessing unsurveyed lands should be employed.

1.3.1.2. Document the status of ocelots in known and potential habitat in Sonora. The Sonoran population was estimated in 2002 as 2,025 ± 675 ocelots (López González et al. 2003) but a more recent estimate of the population is 1,421 (Gómez-Ramírez 2015). The population should continue to be monitored for more detailed information across the region or to provide population updates.

1.3.1.3. Continue and expand surveys to document the presence of ocelots in known and potential habitat. Presence/absence surveys and systematic field monitoring are needed to determine the current status and distribution of the ocelot in ASMU. Field data will be combined with GIS data to extrapolate the location and abundance of potential ocelot populations in Sonora and Arizona.

1.3.1.4. Establish a minimum of three long-term monitoring areas in Sonora and Arizona. This information should provide baseline population data (with small confidence intervals) to detect population trends and establish whether recovery criteria are met.

1.3.1.5. Monitor genetic variability among ocelots in the ASMU. Determine the level of heterogeneity among ocelots in these areas and evaluate the need for improved genetic diversity of small populations no longer connected to larger more genetically-diverse populations.

1.3.2. Refine distribution map of the ASMU ocelot populations.

1.3.2.1. Map existing habitat potentially suitable for supporting ocelots in Sonora and Arizona. Incorporate satellite data, topographic maps, and elevation maps into GIS to estimate land cover throughout the region and determine suitable habitat. Identify areas that could provide corridors for movement between Sonora and Arizona.

1.3.2.2. Identify existing and proposed conservation lands in current and potential ocelot range in Sonora and Arizona. Property boundaries of state and Federal lands in Sonora and Arizona need to be incorporated into GIS models to understand the spatial configurations of conserved areas and preferred ocelot habitats. Ideally land of property owners willing to support ocelot recovery would be incorporated into the model.

1.3.3. Determine spatial requirements of ocelot populations in the ASMU.

1.3.3.1. Conduct GPS telemetry studies and noninvasive monitoring to determine habitat selection. An understanding of habitat use in core and peripheral areas will assist with calculating the quantity and quality of habitat required to support viable ocelot populations in the ASMU.

1.3.3.2. Determine daily and seasonal movements, including patterns of subadult dispersal. GPS telemetry data complemented with track/scat transects will aid in providing home range size, travel routes, and connectivity between core areas and peripheral habitats.

1.3.3.3. Identify conduits and barriers to movements. Studies of vegetation types, degree of cover, topography, water distribution, in conjunction with ocelot presence and repeated use will reveal habitat linkages important to ocelot dispersal. After these corridors are identified, ocelots can be monitored and barriers to movement can be detected and managed.

1.3.3.4. Identify food habits, prey preferences, prey abundance and distribution. As ocelots tend to be found where there is adequate vegetative cover and prey, an analysis of the quantity of prey needed in conjunction with the location of favored prey species is a valuable predictor of suitable ocelot habitat.

1.3.4. Consider what climate change adaptation and mitigation measures may be necessary to ensure recovery in the ASMU.

1.3.4.1. Study the effects of climate change on the plant communities in areas used by ocelot in the ASMU. Climate change in the southwest U.S. and northwest Mexico as well as the resulting effects on the plant communities necessitate assessing the habitat needs for ocelots in the future. Changes in plant communities should be monitored.

1.3.4.2. Develop a strategic climate change adaptation and mitigation plan for ocelots in the ASMU. An adaptation plan for the ASMU should utilize the expected change in plant communities and identify alternate habitat communities and travel corridors to connect public lands which, based on previous use and future predictions of availability of habitats, are likely to support ocelot use in the future.

1.3.5. Identify significant threats to ASMU populations. The extent to which habitat loss, mortality due to vehicular collisions, and illegal killing are affecting ocelots in Sonora or Arizona should be determined. Increasing border activity, human population growth and its accompanying development may be decreasing and fragmenting available habitat.

1.3.6. Develop solutions to reduce or alleviate significant threats to ASMU populations. As understanding of the scope and significance of threats to the ASMU are identified, corresponding solutions should be developed to protect habitat and promote conservation and recovery.

2. Reduce the effects of human population growth and development on the ocelot.

2.1. Avoid, reduce, and minimize impacts of roads and international bridges to the ocelot.

2.1.1. Quantify the effects of roads and international bridges on habitat suitability and determine road density threshold for ocelots. Noss and Cooperrider (1994) observed that "Open road density has been found to be a good predictor of habitat suitability for large mammals, with habitat 'effectiveness' and population viability declining as road density increases." The relation between characteristics of road networks and ocelot presence needs better quantification to determine thresholds of tolerance. This information can be obtained by examining the distribution of occupied and unoccupied tracts of thornscrub and other appropriate habitats and comparing structural characteristics that are related to highways and bridges such as wildlife connectivity, characteristics of wildlife crossing structures, nearness to traffic, traffic noise, traffic levels, and daily patterns of vehicle use.

2.1.2. Identify optimal locations for crossing structures. This should incorporate ocelot density and movement data from radio-telemetry, camera studies, live trapping, dens, scats, tracks, road kills, and digital land cover analysis from ongoing field studies.

2.1.3. Identify design specifications for crossing structures and other features to reduce vehicle-related mortality. Examples from Texas, Florida, the western U.S. and Europe should serve as preliminary models for ocelot-specific designs (Forman *et al.* 2003, Mathews *et al.* 2014, 2015). Designs should also incorporate ocelot behavioral information (i.e., aversion to open areas). Appropriate vegetation should be maintained around crossing areas to shield and funnel ocelots to crossing structures, and fencing should be integrated with crossing structures whenever possible.

2.1.4. Engage federal and state departments of transportation in ocelot conservation.

2.1.4.1. Support participation in interagency planning to conserve ocelots. Coordination, including section 7 consultations and other mechanisms, between wildlife management agencies, transportation departments and Border Patrol is critical to implementation. The participation of representatives from these departments on the Ocelot Recovery Team and local working groups should be cultivated and supported.

2.1.4.2. Avoid, reduce, and minimize the impacts of new roads and international bridges in ocelot habitat and corridors. Good coordination among agencies, as described above, will assist in genuine assessment of possible alternatives to or mitigation of construction of new roads and international bridges in prime ocelot habitat through preplanning of route adjustment, maximum retention or restoration of vegetation, and strategic location of crossing structures.

2.1.4.3. Where new roads or international bridges are unavoidable, implement crossing structures and other appropriate designs to minimize road mortality habitat loss, and loss of habitat connectivity. Information from ocelot monitoring data and vegetation mapping should be used to include crossing structures in new road and international bridge construction. In ocelot habitat, crossing structures should be built where new roads or international bridges bisect natural landscape pathways such as drainages. Consider habitat management strategies on the landscape, on federal lands as well as those of cooperators that are more likely to lead ocelots to cross roads in areas with functional crossings (e.g., do not support thornscrub restoration in some areas where safe road-crossing cannot be achieved).

2.1.4.4. Construct new crossing structures or other design features on existing roads and international bridges to reduce mortality in areas of ocelot use. In Texas, a minimum of 25 crossings should be constructed at key locations, including Highway 77 (I-69), Highway 186, FM106, Buena Vista Road, FM510, Highway 100, Highway 4, and Highway 281. In Arizona and Sonora, before crossing structures are constructed, more information is needed to determine which roads have the greatest impact or potential impact on ocelots in the MU. While this hasn't been done for ocelots in the ASMU, it has been done for jaguars in the northwestern portion of their range (Stoner *et al.* 2015). After roads or road segments are identified, field studies will be needed to determine the exact location(s) along these roads where crossing structures should be constructed. Information from monitoring data and design development (Recovery Actions 2.1.1 and 2.1.3) should be used to prioritize and construct crossing structures on existing roads to reduce ocelot mortality yet provide a range of designs that may reduce costs yet be effective.

2.1.4.5. Monitor with cameras, and other means, the effects of roads and wildlife crossings on habitat suitability and potential or actual use by ocelots. Wildlife crossings are being recommended to both the state and federal departments of transportation in Texas but this should occur across the range of TTMU and ASMU where small ocelot populations are impacted by roads. Typically these are planned to be installed as part of a roadway redesign project, or when a new road is being designed. Roads in need of crossings should be prioritized for improvements based on the need for ocelots. These crossings and areas in need of crossings should be monitored through the use of animal-vehicle collision data, radio telemetry data, and/or remote cameras.

2.2. Avoid, reduce, and minimize U.S.-Mexico border infrastructure, maintenance, and development impacts on ocelot habitat and behavior.

2.2.1. Identify and communicate strategic locations for ocelot border crossings. This will require the application of knowledge about ocelot habitat requirements and dispersal behavior, and the mapping information developed for the model in Recovery Actions 1.1.1 – 1.1.10.

2.2.2. Design border-associated structures and activities to address necessary border security and facilitate cross border movements by ocelots. Coordination through NEPA and other procedures with agencies on both sides of the border is needed to affect changes in current use and management of borderlands structures and activities. Minor modifications to planned or existing structures such as maintaining natural vegetation (especially thornscrub or structurally similar vegetation) under bridges, around dams, within power line corridors, or beside roads can provide opportunities for ocelot travel and discourage undocumented immigration. Lighting should be minimized in strategic ocelot crossing locations and pointed away from dense woody vegetation. Openings large enough to allow for the passage of ocelots should be incorporated into existing and planned border fences in ocelot habitat, such as has been done in some areas in Texas.

2.2.3. Recommend alternative methods for maintaining national security other than structures that limit wildlife connectivity. Coordinate with DHS and CBP to recommend that if additional border security measures are needed that alternative methods other than fences or walls be used such as drones, additional camera towers, or motion sensors.

2.2.4. Maintain and enhance thornscrub habitats or similar vegetative structure near the border. Thornscrub and structurally similar habitats along border riparian zones are especially important to encourage river crossings and provide year-round access to water. Fires set by patrolling vehicles or undocumented immigrants and other associated activities along the border sometimes destroy thornscrub and structurally similar habitat. However, dense thornscrub or structurally similar habitat may be a deterrent to illegal border crossings by humans, making its maintenance or restoration potentially attractive to enforcement authorities. Communication and relationship development with enforcement authorities, as described in Recovery Actions 2.1.4.1 and 2.2.3 are critical to making progress in this area.

2.3. Avoid, reduce, minimize, and/or mitigate impacts from other development projects and human activities, including residential and commercial construction, wind farms, mines, and other developments and activities in ocelot habitat or corridors. Partnerships and collaboration between wildlife management agencies and private landowners, developers, irrigation and drainage districts, utility companies, and other entities should be cultivated in order to promote preservation of and reduce impacts to ocelot habitat and corridors. Section 7 consultations and other mechanisms should be used to ensure impacts are minimized or avoided. Where feasible, agreements to protect a corridor of habitat along one side of irrigation canals and drainage ditches should be developed to protect these linear habitat corridors that are or could be used by ocelots.

3. Maintain or improve genetic fitness, demographic conditions, and health of the ocelot in borderland populations.

3.1. Maintain or increase genetic diversity within populations.

3.1.1. Monitor genetic health and diversity in Texas ocelot populations; evaluate genetic augmentation. Reduced genetic diversity in Texas is a threat. Analysis of the Texas populations should continue to assess its status and track progress towards recovery as translocations occur and the population grows. Tissue samples collected during routine capture activities and the use of hair collected from baited hair snares can provide the samples necessary for standard protocols to track genetic changes in the population. The genetic augmentation plan should include a monitoring protocol for evaluating results and appropriate adaptive management. Both source and recipient populations will be evaluated prior to translocation. After translocation, monitor recipient populations for multiple generations. The collection of data on indicators of reduced fitness and inbreeding depression (such as fertility and infant mortality) are important components for evaluating genetic health. Such data could provide compelling evidence of a need for genetic augmentation.

3.1.2. Monitor genetic health and diversity in Tamaulipas ocelot populations; evaluate genetic augmentation. Research and monitoring of ocelots in Tamaulipas should include genetic studies, including microsatellite diversity and mitochondrial cytochrome-b haplotypes analyses. Regular genetic analysis will establish and track the genetic structure and stability of translocation source populations and determine the efficacy of any translocation programs to augment populations in Texas or Tamaulipas. Both source and recipient populations should be evaluated prior to translocation. After translocation, monitor recipient populations for multiple generations. The collection of data on indicators of reduced fitness and inbreeding depression (such as fertility and infant mortality) are important components for evaluating genetic health. Such data could provide compelling evidence of a need for genetic augmentation.

3.1.3. Characterize the genetic status and variability of the ocelots in Arizona and Sonora. Although the ocelot populations in Arizona-Sonora and those of Texas-Tamaulipas are considered separate subspecies, the genetic variability between the two ocelot populations is unknown, as is the genetic diversity within the Arizona-Sonora population. This information could assist in management of borderland populations.

3.1.4. Design a genetic and population augmentation program and protocols for populations as necessary. Analyses have indicated that both populations in Texas have limited gene diversity and would benefit from augmentation. Janečka *et al.* (2007) reported that the best source for genetic restoration of ocelot populations in Texas would be from ocelots in Tamaulipas, Mexico. The plan for translocation (Translocation Working Group 2009) should be reviewed under the oversight of the Recovery Team and implemented in order to address both genetic and population augmentation.

3.1.5. Evaluate the need and feasibility of artificial reproductive techniques to manage genetic diversity; if appropriate, implement techniques for and development of a genetic gamete tissue bank program. Artificial reproduction techniques such as artificial insemination may be an alternative or supplement to translocation to improve genetic structure of the population. Developing a gamete tissue bank would help organize and maintain frozen samples and broaden options for genetic enhancement.

3.1.6. Evaluate the need and efficacy of establishing a captive breeding program. Many ocelots are being held in zoos and much is known about their husbandry. Resources at appropriate zoos should be examined to determine the feasibility of expanding numbers of wild-captured or captive animals of known origin in zoological parks to be used in genetic augmentation and for reintroduction. Any captive breeding program should be explicitly organized to support and not replace *in situ* conservation (Snyder *et al.* 1996).

3.2. Increase the number of ocelots in populations as necessary.

3.2.1. Conduct experimental translocations. Conduct experimental translocations, following protocols (see Recovery Action 3.1.3) approved by the Ocelot Recovery Team, to evaluate and refine techniques as necessary. Capture and translocation methodology and the characteristics (such as age and sex) of ocelots that contribute to successful translocation should be evaluated. A monitoring plan and evaluation measures should be established which will ensure the longevity of the source population.

3.2.2. Augment existing populations as necessary through translocation. If suitable habitat exists near core areas that are currently unoccupied, ocelots may be translocated to improve demographic and genetic stability.

3.2.3. Evaluate the feasibility of using confiscated ocelots to augment populations. If the subspecific origin of individuals can be determined and they are sufficiently healthy, such animals should be considered for supplementation for wild populations.

3.3. Identify an area for establishing a new ocelot population within the historical range in Texas. The potential for establishing additional ocelot populations in Texas should be thoroughly evaluated. Additional populations would enhance recovery of the ocelot by reducing the loss of genetic variability and by spreading the extinction risk to multiple units that are geographically and therefore demographically independent.

3.4. If an area suitable for a new ocelot population is identified, establish a new population within historical range in Texas. Social acceptance of reintroduction is critical to success of the effort and to building tolerance and support for endangered species. If ocelots are reintroduced on public lands, the surrounding private landowners must be engaged and assured of protection from real or perceived liability from endangered species. Introduction of a non-essential experimental population would be appropriate if the reintroduced population is geographically separated from ocelots with fully endangered status at the time of introduction. A special rule under section 4(d) of the ESA could be written to provide flexibility of management which would apply to all ocelots within the experimental population area boundary.

3.5. Protect ocelots from life threatening diseases, parasites, and injuries.

3.5.1. Establish protocols for physiological assessment and individual identification. For all ocelots handled, collect physical data reflecting health and reproductive status (e.g., gender, weight, body measurements, age, body temperature, pulse, respiration, and overall condition). Photographs of each individual will be taken to record distinguishing patterns and other unique features. Passive integrated transponder (PIT) tags will be injected under the skin between the shoulder blades for permanent identification whenever possible.

3.5.2. Conduct serology and pathology surveys to determine genetic profile, overall condition, and the presence and effect of diseases and parasites. Blood, hair, urine, and fecal samples (as possible) will be collected by experienced researchers to document genetic status, disease, parasites, hormone levels, and general health of captured ocelots.

3.5.3. Create a tissue bank for ocelot samples. A tissue bank would maintain samples for reference and future study. A list of what samples to collect, how to collect them, where to store samples, and other useful data will standardize data collection and proper storage.

3.5.4. Establish protocols for treatment of injury, diseases, and parasites as appropriate. Specific to each type of condition, treatment protocols may bring more rapid and efficient assistance to ailing ocelots and can give field researchers guidance for administering ocelot first aid should immediate assistance be required.

3.5.5. Establish a database of medical and genetic ocelot data. A computer database containing health, identity, and treatment information from captured ocelots will help to maintain a record of each ocelot's condition. A standardized, long-term database will allow the detection of trends, predictions, and will facilitate recovery. Links to protocol procedures and equipment lists should be included.

3.5.6. Investigate measures to prevent disease. The efficacy of preventative measures, such as vaccinations vs. biological methods, such as controlling vectors of disease (including feral cats), needs to be investigated. Killed-virus rabies vaccines have been given to captured ocelots since 1995 and this practice should be continued.

3.6. Identify and reduce the impacts of environmental contaminants on the ocelot.

3.6.1. Conduct research that identifies pathways of contamination in ocelots and their prey and provides solutions to existing toxicity problems. Evaluate the effects of rodenticides, herbicides, crop-spraying, water contamination, and bioaccumulation on ocelots and their prey. This will include an examination of the physiological effects of these toxins on the ocelot, the differences in pesticide usage in the U.S. and Mexico, and recommendations for solving the problems revealed in this research.

3.7. Investigate competitive interactions among the bobcat, coyote, and ocelot.

3.7.1. Conduct field studies designed to explicate the degree of niche overlap between the ocelot and its potential competitors. Studies that are targeted at such relationships are warranted. A better understanding of the interactions between the ocelot and competitors will be important in the evaluation of habitat management targeted at improving landscape conditions and recovery potential for the species. Continue to document food habits and direct interactions between individuals of all three species. Consider conducting experiments whereby bobcats and coyotes are removed from ocelot home ranges.

4. Assure the long-term success of ocelot conservation through partnerships, landowner incentives, community involvement, application of regulations, and public education and outreach.

4.1. Develop partnerships with other agencies, organizations, and citizens.

4.1.1. Develop regional recovery working groups that practice broad-based community planning for ocelot conservation. Implementation of recovery actions for the ocelot throughout its range is necessary. However, breaking down the tasks with a regional or local focus makes recovery more manageable and feasible. Working groups with a membership and focus on locally important issues in U.S. and Mexico should be formed as a function of the Recovery Team, and encouraged and supported by the USFWS over the long term. Because funding for recovery is a significant challenge, each working group should consider establishing a funding coordinator to ensure viability of local recovery efforts. Many agency and private programs, grants, and foundations are available to assist in recovery efforts.

4.1.2. Continue momentum for recovery through the Recovery Team. The Ocelot Recovery Team should function as an oversight body for the implementation of the recovery plan. A system of communication among working groups, the Technical Team, and the USFWS should be implemented through periodic reporting or meetings so that adaptive management can be used to support their efforts, track recovery, and modify the plan as necessary.

4.1.3. Restore and protect habitat through cooperative conservation projects such as Safe Harbor Agreements, Habitat Conservation Plans, and acquiring key property through easements or fee title with willing landowners on non-Federal lands in the U.S. One of the primary roles of the USFWS in recovery is to assure that appropriate resources and tools for partnership implementation are understood and available to its partners. Because of the significant amount of private lands essential to ocelot recovery, the USFWS should be vigilant in making such resources available that support projects with willing landowners.

4.1.4. Develop other incentive programs with landowners who have existing ocelot habitat or who want to restore habitat on non-Federal lands in the U.S. Incentives need to be developed for landowners, including drainage and irrigation agencies, to encourage them to maintain existing thornscrub or other ocelot habitat and to restore habitat where it was previously cleared. A system of communication between local working groups and the USFWS is essential to identify opportunities, work with local people, and provide the appropriate technical or financial support. Encourage the restoration of linear corridors on private lands or other partners when restoration of larger patches is not feasible.

4.1.5. Support work by biologists in Mexico to survey existing and potential habitat. Resources, including funding and technical support will be essential to assuring that information regarding the ocelot in Tamaulipas and Sonora is obtained and shared. Local communities will benefit and generate more interest if resources are made directly available to Mexican biologists.

4.1.6. Develop partnerships with Mexican agencies and landowners to implement recovery actions. Ocelot conservation in Mexico is fundamental to recovery for the ocelot in the U.S. A working group for trans-border and Mexico issues should be formed to develop partnerships, research incentives, and find support for recovery and conservation in Mexico. Continued support of Mexican partners on the Ocelot Recovery Team will be the key to coordination of these actions.

4.1.7. Encourage participation of the Department of Homeland Security and the Border Patrol with agencies responsible for ocelot conservation. It is important to develop relationships with DHS and BP to assure that conservation needs of ocelots are considered within the context of the charges and missions of the DHS, BP, and USFWS. Collaborations among agencies will minimize potential conflicts and enable federal agencies to balance the needs of immigration policies and wildlife conservation.

4.2. Protect the ocelot by using or developing regulations where necessary.

4.2.1. Encourage development and enforcement of regulations in Mexico to protect ocelots. Technical assistance and conservation recommendations should be made available to Mexican authorities. Although national and international laws exist to protect the ocelot in Mexico, funding is insufficient for effective enforcement. Because ocelot harvest is likely only a local problem, the Mexican government should be encouraged to protect areas where ocelots are present.

4.2.2. Convene international experts to discuss the possibility of developing a conservation plan for ocelots in Mexico known as Programas de Acción para la Conservación de Especies (PACE). CONANP is the federal government agency responsible of the land management and protection of protected areas, but it also conducts the Endangered Species Conservation Program, (Programa de Conservación de Especies en Riesgo, PROCER). The program is implemented through a species action plan called a PACE. These are developed by specialists from academic institutions, NGOs, and government agencies. As of September 2015, there is no PACE written for the ocelot.

4.2.3. Assure compliance with existing regulations for oil and gas development and seismic exploration that could negatively affect the ocelot. Through section 7 compliance and other means, the USFWS should lead efforts to coordinate with other regulatory agencies and developers to promote activities that would not constrain movement of ocelots or alter potential ocelot habitat in the U.S. Use mitigation opportunities to enhance ocelot habitat.

4.3. Expand education and outreach to promote ocelot conservation.

4.3.1. Maintain an education/outreach working group under the Ocelot Recovery Team to coordinate efforts for the ocelot. Outreach and education are crucial and should be performed at all levels of the recovery effort, including interactions with private landowners by researchers and managers, education in schools, outreach to hunters, non-government organizations (NGO), and legislators. Many current members of the Recovery Team have expertise, and potential resources for outreach. Zoos, NGOs, Universities, USFWS, state agencies, and other partners should collaborate in a working group to coordinate outreach and assist in implementation efforts. Many outreach materials and efforts will need to have a local focus and purpose; therefore, frequent interaction between outreach and regional working groups is important. Materials should be provided in Spanish and English.

4.3.2. Develop regional outreach plans for the TTMU and ASMU.

4.3.2.1. Develop education materials and plans for Texas and Arizona. An outreach plan should identify and cultivate the most effective partners and audiences and develop targeted educational materials. Development of materials should consider what may motivate the public to get involved with or support the recovery effort, and promote such incentives. Involving a marketing specialist in the development of each plan is advised. All possible venues, including websites, interconnectivity of web links, list server messages, social media, paper, film and other media should be considered.

4.3.2.2. Develop education materials and plans for Tamaulipas and Sonora. Efforts and audiences in Mexico will be different from those in the U.S. and may require a different strategy. An education and outreach specialist from Mexico should be identified and an education and outreach working group should be considered to assure the effort is effective.

4.3.3. Monitor and assess the effectiveness of outreach efforts. To the extent possible, methods for monitoring the effectiveness of outreach strategies should be built into the outreach plans. The working group should seek funding for appropriate research or survey work to monitor and adapt the effort as necessary.

4.3.4. Educate hunters, landowners, and predator management personnel to recognize ocelots and refrain from killing them. Hunter education programs should be promoted by state wildlife agencies to prevent accidental shooting. Brochures (in both Spanish and English) with basic information and identification keys should be distributed to landowners, hunters, and predator control agents at appropriate venues.

5. Practice adaptive management in which recovery is monitored and recovery tasks are revised by USFWS in coordination with Recovery Team as new information becomes available.

5.1. Develop a monitoring schedule and protocol for populations. To track progress for recovery, population monitoring must be regular, thorough, and standardized. Funding for monitoring by researchers and USFWS in both Texas and northern Mexico should be a priority. A monitoring protocol that uses remote-activated cameras was described by Grassman *et al.* (2005) and Sternberg and Mays (2011). The use of scent lures is often recommended when a non-invasive method is needed to survey ocelots (Weaver *et al.* 2005, Sternberg and Mays 2011, CDEN 2014). Attracting ocelots to scent lures provides the opportunity for collecting hairs for DNA analysis when using hair snares.

5.2. Develop agreements with willing landowners to survey for ocelots and monitor populations and habitats on non-Federal lands. The lack of information about ocelot populations on private lands is a major impediment to their recovery. Developing landowner trust and cooperation is essential. The Recovery Team should work to develop and implement strategies to involve landowners, build trust, and encourage information sharing.

5.3. Conduct monitoring. Monitoring on public and private lands, in accordance with landowner consent, should be a high priority and conducted using standardized protocols.

5.4. Prepare annual reports of ocelot monitoring results. Monitoring data at the scales of Management Unit, state, county and individual population segment should be compiled and provided to the Recovery Team annually to track progress toward recovery.

5.5. Develop cooperation among agencies and organizations for data sharing and data repository. Cooperation and communication among all the partners working towards recovery of the ocelot is essential to success. Population data should be shared regularly with the Recovery Team so that the status of the ocelot, progress towards recovery, and necessary adjustments to planning and implementation efforts are made. Data should be reported at a scale that protects landowner privacy and proprietary rights to original data, while conveying needed biological and management information. Building trust with landowners and assuring the protection of unpublished research data is fundamental to achieving this action.

5.6. Conduct periodic population viability analyses as new significant information is acquired. Changes in population forecasting based on new information such as the addition of a population nearby to other known populations, development of information regarding a threat from a disease, better survivorship data for kittens, or significant improvements in longevity of a population due to the installation of wildlife crossings and improved connectivity are examples of why population viability analyses should be updated periodically. New techniques or software advances are other good reasons to reassess analyses of population viability.

5.7. Update recovery tasks based on discovery of new populations and threat assessments to those populations. Populations such as the one discovered in Willacy County, Texas, in

2010 need to be studied so that they can be better conserved. Recovery actions need to be implemented, such as expressing to partners the susceptibility of new populations to impacts from road projects and other developments.

6. Support efforts to ascertain the status and conserve ocelot populations south of Tamaulipas and Sonora.

6.1. Track origins of pelts to determine source of illegal harvest. Genetic markers can be used to pinpoint source populations using specific alleles from confiscated pelts. The collection and assessment of ocelot genetic information from different countries and their unique genetic markers can be used to compare to those of illegally obtained pelts to determine the location of harvest.

6.2. Promote data collection and sharing among countries with ocelots.

6.2.1. Provide support for a routine workshop every three to five years to gather ocelot information. Seek financial resources to bring IUCN Cat Specialist Group together with the Ocelot Recovery Team and other researchers to share data and ideas. Such a meeting would provide a forum for information exchange to assess the status, address research, education, and conservation needs for ocelots.

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6.2.2. Support efforts of international conservation groups to implement the Meso-American corridor (formerly the Paseo Pantera Corridor). The Ocelot Recovery Team will assist land and resource managers from any interested nations with developing guidelines for habitat conservation and the preservation of key linkages, such as those involved in the Meso-American corridor. This is to ensure that the ocelot’s current and future needs for natural dispersal are addressed.

6.3. Coordinate recommendations and available genetic data from international zoos. Zoos are a valuable source of information about ocelot reproduction, food requirements, and habitat conditions. Much data describing ocelot genetics, biology, and natural history comes from zoo studies. Adding information in the ocelot database that provides rearing and genetic information may be helpful for monitoring genetic diversity and assist zoos in the proper care of their ocelot population, as well as to provide insights into the biology and natural history of wild ocelots.

3.0 IMPLEMENTATION SCHEDULE

The following Implementation Schedule (table on page 86) outlines priorities, potential responsible parties, and estimated costs for the specific actions for recovering the ocelot. It is a guide to meeting the goals, objectives, and criteria from the Recovery Section of this plan (Section 2.0). The schedule: (a) lists the specific recovery actions, corresponding outline numbers, the action priorities, and the expected duration of actions; (b) recommends agencies or groups for carrying out these actions (in alphabetical order); and (c) estimates the financial costs for implementing the actions. These actions, when completed, should accomplish the goal of this plan – recovery of the ocelot.

3.1 Responsible Parties and Cost Estimates

The value of this plan depends on the extent to which it is implemented; the USFWS has neither the authority nor the resources to implement many of the proposed recovery actions. The recovery of the ocelot is dependent upon the voluntary cooperation of many other organizations and individuals who are willing to implement the recovery actions. The implementation schedule identifies agencies and other potential “responsible parties” (private and public) to help implement the recovery of this species. This plan does not commit any “responsible party” to carry out a particular recovery action or to expend the estimated funds. It is only recognition that particular groups may possess the expertise, resources, and opportunity to assist in the implementation of recovery actions. Although collaboration with private landowners and others is called for in the recovery plan, no one is obligated by this plan to any recovery action or expenditure of funds. Likewise, this schedule is not intended to preclude or limit others from participating in this recovery program.

The cost estimates provided are not intended to be a specific budget but are provided solely to assist in planning. The total estimated cost of recovery, by priority, is provided in the Executive Summary. The schedule provides cost estimates for each action on an annual or biannual basis. Estimated funds for agencies include only project-specific contract, staff, or operations costs in excess of base budgets. They do not include ordinary operating costs (such as staff) for existing responsibilities.

3.2 Recovery Action Priorities and Abbreviations

Priorities in column 1 of the following implementation schedule are assigned using the following guidelines:

Priority 1a = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 1b = An action that by itself will not prevent extinction, but which is needed to carry-out a Priority 1a action.

Priority 2 = An action that must be taken to prevent a substantial decline in species population/habitat quality or some other substantial negative effect short of extinction.

Priority 3 = All other actions necessary to meet the recovery objectives.

The assignment of these priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented.

The following abbreviations are used in the Implementation Schedule:

ADOT = Arizona Department of Transportation
AGFD = Arizona Game and Fish Department
AZA = Association of Zoos and Aquariums
BP = U.S. Border Patrol
CDEN = Conservación y Desarrollo de Áreas Naturales
CKWRI = Caesar Kleberg Wildlife Research Institute
CONANP = Comisión Nacional de Áreas Naturales Protegidas (of Mexico)
DHS = Department of Homeland Security
DOW = Defenders of Wildlife
GPZ = Gladys Porter Zoo
IBWC = International Boundary and Water Commission
IEA = Instituto de Ecologia y Alimentos
LANWR = Laguna Atascosa National Wildlife Refuge
NAT = Naturalia
PL = Private Landowners
PRNA = Pronatura
SCT = Secretaría de Comunicaciones y Transportes (of Mexico)
SEM = Secretaría de Medio Ambiente y Recursos Naturales (of Mexico)
SIA = Sky Island Alliance
TNC = The Nature Conservancy
TPWD = Texas Parks and Wildlife Department
TXDOT = Texas Department of Transportation
UA = University of Arizona
UNAM = Universidad Nacional Autónoma de México
USDOT = U.S. Department of Transportation
USFWS = U.S. Fish and Wildlife Service
WS = USDA APHIS Wildlife Services

IMPLEMENTATION SCHEDULE

Priority Number	Action Number	Recovery Action Description	Recovery Criterion Number(s)	Threats	Action Duration (Years)	Responsible Parties	Is USFWS Lead?	Total Cost ($1,000s)	Cost Estimate by Year (by 1,000s)						
									2016	2017	2018	2019	2020	2021	2022+
1b	1.1.1	Map existing and suitable brushlands in Texas	2	A	1	CKWRI, PL, TPWD, USFWS	Yes	70		70					
1b	1.1.2	Map existing and suitable brushlands in Tamaulipas	2	A	1	CDEN, CKWRI, CONANP, PRNA, SEM, USFWS	Yes	70		70					
1b	1.1.3	Document ocelot's status in known and potential habitat in Texas	2	A	7	CKWRI, PL, TPWD, USFWS	No	470	65	65	65	65	70	70	70
1b	1.1.4	Document ocelot's status in known and potential habitat in Tamaulipas	2	A	7	CKWRI, CDEN, CONANP, PL, PRNA, SEM, USFWS	No	400	55	55	55	55	60	60	60
1b	1.1.5	Estimate area for 200 ocelots in Texas and 1,000 in Tamaulipas	2	A,E	1	CKWRI, CDEN, CONANP, PRNA, SEM, USFWS	No	15	15						
3	1.1.6	Refine knowledge of ocelot food habits and predator-prey relationships in TTMU	2	A	2	CKWRI, USFWS	No	60		30	30				
2	1.1.7	Identify conservation lands in TTMU	2	A,E	1	CKWRI, CDEN, CONANP, PRNA, SEM, TNC, USFWS	Yes	15		15					
2	1.1.8	Identify, field verify, and map connections between TTMU populations	2	A	1	CKWRI, CDEN, CONANP, PRNA, SEM USFWS,	Yes	25			25				
2	1.1.9	Study ocelot dispersal behavior	1,2,3	A,E	4	CKWRI, CONANP, PRNA, SEM, USFWS	No	210		60	50	50	50		

2	1.1.10	Develop computer simulations of ocelot movement and dispersal	1,2,3	A,E	2	CKWRI, PRNA, SEM, USFWS	No	90	45	45					
2	1.1.11	Identify and prioritize lands for habitat restoration in TTMU	2	A	2	CKWRI, PL, PRNA, SEM, TPWD, USFWS	Yes	50	25	25					
1b	1.1.12	Identify areas needing linkages and crossing structures in the TTMU	2	A,E	3	CKWRI, PRNA, SEM, TPWD, TXDOT, USDOT, USFWS	No	60	20	20	20				
3	1.2.1	Develop, distribute, and implement habitat guidelines	1,2,3	A	1	TPWD, USFWS	No	20	20						
1a	1.2.2	Foster partnerships with landowners	1,2,3	A,E	7	AGFD, CKWRI, IEA, PRNA, SEM, SIA, TPWD, USFWS	No	45	10	10	5	5	5	5	5
1a	1.2.3.1	Protect habitat in and around known populations	1,2,3	A	7	PRNA, SEM, TNC, TPWD, USFWS	Yes	70,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
2	1.2.3.2	Protect a corridor connecting Texas populations	1,2,3	A	7	PL, TNC, TPWD, USFWS	Yes	1,400	200	200	200	200	200	200	200
1a	1.2.3.3	Protect habitat in recently occupied areas	1,2,3	A	7	AGFD, NAT, PL, PRNA, SEM, TNC, TPWD, USFWS	Yes	10,000	1,600	1,600	1,600	1,600	1,600	1,000	1,000
1a	1.2.3.4	Protect habitat in Tamaulipas by creating national protected areas	1,2,3	A	7	CONANP, PL, PRNA, SEM, TNC, TPWD, USFWS	No	300			300				
2	1.2.3.5	Protect a corridor connecting Texas and Tamaulipas populations	1,2,3	A	7	CONANP, PL, PRNA, SEM, TNC, TPWD, USFWS	Yes	11,200	1,600	1,600	1,600	1,600	1,600	1,600	1,600
2	1.2.3.6	Protect habitat within historical range in Texas and Tamaulipas	1,2,3	A	7	CONANP, PL, PRNA, SEM, TNC, TPWD, USFWS	No	1,700	200	250	250	250	250	250	250
2	1.2.4.1	Identify and map soils for thornscrub restoration	2	A	1	CKWRI, PRNA, TPWD, USFWS	Yes	31		31					

1b	1.2.4.2	Restore thornscrub around populations in Texas	2	A	7	CKWRI, TNC, PL, USFWS	Yes	2,100	300	300	300	300	300	300	300
2	1.2.4.3	Implement thornscrub restoration in secondary areas	2	A	7	CKWRI, DOW, PL, TNC, TPWD, TXDOT, USFWS	No	1,700	200	250	250	250	250	250	250
2	1.2.4.4	Develop and implement a monitoring program for restored thornscrub	2	A	7	CKWRI, TPWD, USFWS	No	190	20	20	20	30	30	30	40
2	1.2.4.5	Refine methods to restore thornscrub	2	A	4	CKWRI, TPWD, USFWS	No	175		50	45	45	35		
2	1.2.5	Assure available drinking water during periods of drought	2	E	6	TNC, PL, TPWD, USFWS	Yes	60		10	10	10	10	10	10
2	1.2.6.1	Study effects of climate change on habitat in TTMU	2	A	1	CONANP, SEM, USFWS	Yes	45			45				
2	1.2.6.2	Develop climate change adaptation plan for ocelots in TTMU	2	A	1	CONANP, SEM, TPWD, USFWS	Yes	45				45			
2	1.3.1.1	Document status of ocelots in known and potential habitat in Arizona.	3	A	7	AGFD, UA, PL, SIA, USFWS	No	470	65	65	65	65	70	70	70
2	1.3.1.2	Document status of ocelots in known and potential habitat in Sonora	3	A	7	AGFD, CONANP, SEM, SIA, USFWS	No	400	55	55	55	55	60	60	60
2	1.3.1.3	Continue and expand surveys in ASMU habitat	3	A,E	7	AGFD, CONANP, SEM, SIA, USFWS	No	350	50	50	50	50	50	50	50
3	1.3.1.4	Establish at least 3 long-term monitoring areas in Sonora and Arizona	3	A,B,D, E	6	AGFD, CONANP, NAT, SEM, SIA, USFWS	No	1,200		200	200	200	200	200	200
3	1.3.1.5	Monitor genetic variability among ocelots in the ASMU	3	A,E	3	AGFD, CONANP, SEM, UA, USFWS	No	120	40	40	40				
2	1.3.2.1	Map existing habitat suitable for ocelots in Sonora and Arizona	3	A	2	AGFD, CONANP, PL, PRNA, SEM, SIA, USFWS	No	200		100	100				

2	1.3.2.2	Identify conservation lands in ASMU range	3	A	2	AGFD, CONANP, NAT, PL, SEM, SIA, USFWS	No	50			25			25	
3	1.3.3.1	Determine habitat selection in Sonora and Arizona	3	A,B,C, D,E	5	AGFD, CONANP, USFWS	No	750		150	150	150	150	150	
3	1.3.3.2	Determine movements and sub-adult dispersal in Sonora and Arizona	1,2,3	A,E	7	SEM, NAT, AGFD, USFWS	No	420	60	60	60	60	60	60	60
2	1.3.3.3	Identify conduits and barriers to movements in Sonora and Arizona	3	A,E	4	AGFD, NAT, USFWS, SEM	No	200				50	50	50	50
3	1.3.3.4	Identify food habits and prey preference, abundance, and distribution in Sonora	3	A,E	5	SEM, NAT	No	500		100	100	100	100	100	
2	1.3.4.1	Study climate change effects on ocelot habitat in ASMU	3	A	1	AGFD, CONANP, NAT, SEM, USFWS		45			45				
2	1.3.4.2	Develop strategic climate change plan for ocelots in ASMU	3	A	1	AGFD, CONANP, NAT, SEM, USFWS		45				45			
2	1.3.5	Identify significant threats to ASMU populations	3	A,B,C, D,E	3	AGFD, CONAP, SEM, USFWS	No	150		50		50		50	
2	1.3.6	Develop solutions to reduce and alleviate threats to ASMU	3	A,B,C, D,E	3	AGFD, BP, SEM, USFWS	No	150		50		50		50	
1b	2.1.1	Quantify road and international bridge effects on habitat suitability; determine ocelot road density threshold	2	A,E	4	CKWRI, TPWD, TXDOT, USDOT, USFWS	Yes	200	50	50	50	50			
1a	2.1.2	Identify optimal locations for road crossing structures	2	A,E	2	CKWRI, TPWD, TxDOT, USDOT, USFWS	Yes	40	20	20					
1a	2.1.3	Identify design specifications for crossing structures and other mortality-reducing features	2	A,E	On-going	CKWRI, TxDOT, USDOT, USFWS	No	225	35	35	35	35	35	25	25

1a	2.1.4.1	Support participation in interagency planning to conserve ocelots	1,2,3	A,B,C, D,E	On-going	AGFD, CKWRI, PL, SCT, TPWD, TxDOT, USDOT, USFWS, WS	Yes	70	10	10	10	10	10	10	10
1a	2.1.4.2	Minimize impacts of new roads and international bridges in ocelot habitat	2,3	A,E	7	ADOT, SCT, TPWD, TXDOT, USFWS	No	105	15	15	15	15	15	15	15
1a	2.1.4.3	Implement crossing structures and designs	2,3	A,E	7	ADOT, SCT, TPWD, TXDOT, USDOT, USFWS	No	160	40	40	40	10	10	10	10
1a	2.1.4.4	Construct new crossing structures in heavy use areas	2	A,E	7	ADOT, SCT, TPWD, TXDOT, USDOT, USFWS	No	14,000	5,000	4,000	1,000	1,000	1,000	1,000	1,000
1b	2.1.4.5	Monitor effects of roads on habitat use by ocelots.	2,3	A,E	7	ADOT, AGFD, SCT, SEM, TPWD, TXDOT, USDOT, USFWS	No	350	50	50	50	50	50	50	50
1b	2.2.1	Identify locations for ocelot border crossings	2,3	A,E	4	AGFD, PRNA, SEM, SIA, UA, USFWS	Yes	40	10		10		10		10
1b	2.2.2	Reduce impacts of border-associated structures	2,3	A,E	On-going	BP, DHS, IBWC, SCT, TXDOT, USDOT, USFWS	No	210	30	30	30	30	30	30	30
1b	2.2.3	Recommend alternative methods for maintaining national security other than structures that limit wildlife connectivity	2	A,E	On-going	CKWRI, TPWD, USFWS	Yes	140	20	20	20	20	20	20	20
2	2.2.4	Maintain and enhance thornscrub and other appropriate habitats near the border	2	A,E	3	DHS, IBWC, PL, TNC, USFWS	No	180					60	60	60
1a	2.3	Minimize impacts to ocelots from residential and commercial development, wind farms, and other activities	2,3	A,E	On-going	TPWD, USFWS	Yes	364	52	52	52	52	52	52	52

1b	3.1.1	Monitor genetic health and diversity in Texas populations; evaluate genetic augmentation	2	A,E	7	CKWRI, UA, USFWS	Yes	42	6	6	6	6	6	6	6
1b	3.1.2	Monitor genetic health and diversity in Tamaulipas populations; evaluate genetic augmentation	2	A,E	7	CKWRI, SEM, UNAM, USFWS	Yes	42	6	6	6	6	6	6	6
3	3.1.3	Characterize genetic status and variability of the Arizona-Sonora ocelots	3	A,E	3	AGFD, CONANP, SEM, UA, USFWS	No	120	40	40	40				
2	3.1.4	Design genetic augmentation program and protocols for populations	2	A,E	4	CKWRI, UA, USFWS	No	115		40	25	25	25		
2	3.1.5	Evaluate artificial reproductive techniques; if appropriate, create gene bank	2,3	A,E	7	AZA, CKWRI, USFWS	No	35	5	5	5	5	5	5	5
3	3.1.6	Evaluate establishment of genetic breeding program	2	A,E	1	AZA, CKWRI, USFWS	No	10				10			
1b	3.2.1	Conduct experimental translocations	2	A,E	3	CKWRI, SEM, TPWD, USFWS	Yes	1,500	500	500	500				
1b	3.2.2	Augment existing populations as necessary through translocation	2	A,E	7	CKWRI, SEM, TPWD, USFWS	No	1,050	150	150	150	150	150	150	150
3	3.2.3	Evaluate feasibility of using confiscated ocelots to augment populations	2	A,E	1	CONANP, GPZ, SEM, TPWD, USFWS	No	5	5						
2	3.3	Identify an area in Texas for establishing a new ocelot population	2	A,E	2	CKWRI, PL, TPWD, USFWS	Yes	40						10	30
3	3.4	If appropriate, establish a new population in Texas	2	A,E	3	CKWRI, PL, TPWD, USFWS	Yes	550					150	200	200
2	3.5.1	Establish protocols for physiological assessment and individual identification	2,3	C,E	2	CKWRI, SEM, UNAM, USFWS	No	4	2	2					

3	3.5.2	Conduct serology and pathology surveys	2,3	C,E	On-going	CKWRI, CONANP, SEM, UNAM, USFWS, WS	No	70	10	10	10	10	10	10	10
3	3.5.3	Create a tissue bank for ocelot samples	2,3	C,E	On-going	CKWRI, SEM, UNAM, USFWS	No	7	1	1	1	1	1	1	1
2	3.5.4	Establish protocols for treatment of injury, diseases, parasites	2,3	C,E	4	AZA, CKWRI, UNAM	No	8	2	2	2	2			
3	3.5.5	Establish database of medical and genetic ocelot data	1,2,3	C,E	7	AZA, CKWRI, UNAM	No	10	4	1	1	1	1	1	1
3	3.5.6	Investigate measures to prevent disease	1,2,3	C	On-going	AZA, CKWRI, GPZ, UNAM, USFWS, WS	No	8	2	1	1	1	1	1	1
3	3.6.1	Research contamination in ocelots and prey; provide solutions to toxicity problems	2,3	C,E	3	CKWRI, UNAM, USFWS	No	95	35	35	25				
3	3.7.1	Conduct field studies of niche overlap between ocelot and competitors	1,2,3	E	4	AGFD, CKWRI, UNAM, USFWS	No	205	60	50	50	45			
2	4.1.1	Develop regional recovery working groups for ocelot conservation	2,3	A,B,C, D,E	3	AGFD, CONANP, PL, SEM, TPWD, USFWS, WS	Yes	30	10	10	10				
2	4.1.2	Continue recovery through Recovery Team	1,2,3	A,B,C, D,E	On-going	AGFD, AZA, PL, TPWD, USFWS, WS	Yes	35	5	5	5	5	5	5	5
1b	4.1.3	Develop cooperative conservation projects with willing landowners	2	A,B,D, E	On-going	AGFD, CONANP, DOW, SEM, TPWD, USFWS	Yes	35	5	5	5	5	5	5	5
1b	4.1.4	Develop and implement incentive programs for landowners to implement recovery on non-federal lands	2	A,B,D, E	On-going	AGFD, SEM, TPWD, USFWS	Yes	115	5	15	15	20	20	20	20
2	4.1.5	Support work by biologists in Mexico to survey habitat	1,2,3	A	2	AGFD, DOW, NAT, PRNA, SEM, SIA, TPWD, USFWS	No	100	50	50					

1b	4.1.6	Develop partnerships with Mexican agencies and landowners to implement recovery actions	2,3	A,B,C, D,E	4	CDEN, DOW, ED, NAT, PRNA, SEM, SIA,TNC, USFWS	Yes	40	10	10	10	10		
1b	4.1.7	Encourage participation by DHS and BP with conservation agencies	2,3	A,E	7	BP, DHS, USFWS	Yes	35	5	5	5	5	5	5	5
1b	4.2.1	Encourage development and enforcement of regulations in Mexico to protect ocelots	1,2,3	D	7	PRNA, SEM	No	140	20	20	20	20	20	20	20
1b	4.2.2	Convene experts to discuss new PACE for Implementing recovery actions in Mexico	1,2,3	A,B,C, D,E	On-going	AGFD, CONANP, PRNA, SIA, SEM, TPWD, USFWS	No	50			50				
2	4.2.3	Assure compliance with regulations for oil and gas development and seismic operations	2,3	A,D	On-going	TPWD, USFWS	Yes	14	2	2	2	2	2	2	2
2	4.3.1	Maintain an education/outreach working group	2,3	A,B,E	On-going	AGFD, AZA, DOW, TPWD, USFWS	No	14	2	2	2	2	2	2	2
2	4.3.2.1	Develop education materials and plans for Texas and Arizona	2	A,B,E	7	AGFD, AZA, TPWD, USFWS	No	50	5	10	10	10	5	5	5
2	4.3.2.2	Develop education materials and plans for Tamaulipas and Sonora	2,3	A,B,D, E	7	AZA, CONANP, PRNA, NAT, SEM	No	35	5	5	5	5	5	5	5
3	4.3.3	Monitor and assess effectiveness of outreach efforts	2,3	A,B,D, E	5	AZA, DOW, PRNA	No	40			10	5	10	5	10
2	4.3.4	Educate hunters, landowners, and predator management personnel to refrain from killing ocelots	1,2,3	B	7	SEM, TPWD, WS	No	7	1	1	1	1	1	1	1
2	5.1	Develop monitoring schedule and protocol for populations	2	A,B,C, D,E	2	CKWRI, CONANP, SEM, TPWD, USFWS	Yes	10	5	5					

1b	5.2	Develop agreements to survey populations and habitats on non-federal lands	2	A,B,C, D,E	On-going	AGFD, CKWRI, TPWD, USFWS	No	35	5	5	5	5	5	5	5
3	5.3	Conduct monitoring of recovery and revise recovery actions	1,2,3	A,B,C, D,E	On-going	AGFD, CKWRI, SEM, TPWD, USFWS	Yes	896	128	128	128	128	128	128	128
3	5.4	Prepare annual report of ocelot monitoring results	1,2,3	A,B,C, D,E	On-going	CKWRI, TPWD, USFWS	No	7	1	1	1	1	1	1	1
2	5.5	Develop data sharing and data repository	1,2,3	C,E	7	AGFD, CKWRI, SEM, SIA, TPWD, UA, USFWS, WS	No	35	5	5	5	5	5	5	5
1b	5.6	Conduct periodic population viability analyses	1,2,3	A,B,C, D,E	On-going	AGFD, CKWRI, CONABIO, SEM, TPWD, USFWS	Yes	20		5					15
1b	5.7	Update recovery tasks for new populations and threat assessments	1,2,3	A,B,C, D,E	On-going	AGFD, CONABIO, SEM, TPWD, USFWS, WS	Yes	6		2					4
2	6.1	Track skin locations to determine source of illegal harvest	1,2,3	A,B,C, D,E	On-going	CKWRI, USFWS	No	7	1	1	1	1	1	1	1
3	6.2.1	Provide support for a routine workshop every 3-5 years to gather ocelot information	1,2,3	A,B,C, D,E	3	CKWRI, DOW, NAT, PRNA, SEM, USFWS	Yes	75		25			25		25
2	6.2.2	Support international groups to implement Mesoamerican corridor	1	A,B,C, D,E	On-going	DOW, NAT, PRNA, SEM, TPWD, USFWS	Yes	24	2	2	4	4	4	4	4
3	6.3	Coordinate recommendations and available genetic data from international zoos	1,2,3	E	3	AZA	No	6	2	2	2				

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Appendix I – Status of Other Neotropical Felids in the United States

The first recovery plan (USFWS 1990a) provided information on the history, distribution and status of jaguarundi (*Herpailurus yaguarondi*), margay (*Leopardus weidii*), and jaguar (*Panthera onca*) in the United States. The USFWS has decided not to address these species in this plan but to focus strictly on the ocelot.

Appendix II – Status of the Ocelot Outside of the United States

The ocelot is found in every mainland country south of the U.S. except Chile (United Nations Environment Programme – World Conservation Monitoring Centre [UNEP-WCMC] 2014). The island nation of Trinidad and Tobago, located off the Venezuelan coast, also supports an ocelot population on Trinidad (Mondolfi 1986). Within the 22 countries supporting the species, 11 ocelot subspecies are commonly described (Pocock 1941, Cabrera 1961, Hall 1981, Eizirik *et al.* 1998), although Wilson and Reeder (2005) only recognized 10 subspecies. The 11 commonly described subspecies include: *L. p. aequatorialis* Mearns 1902 (Ecuador), *L. p. ablescens* Pucheran, 1855 (Arkansas, U.S.), *L .p. maripensis* J.A. Allen 1904 (Venezuela), *L. p. mearnsi* J.A. Allen 1904 (Costa Rica), *L. p. mitis* F. Cuvier 1920 (Brazil), *L. p. nelsoni* Goldman 1925 (Mexico), *L. p. pardalis* Linnaeus 1758 (Mexico), *L. p. pseudopardalis* Boitard 1842 (Colombia, Venezuela), *L. p. pusaea* Thomas 1914 (Ecuador), *L. p. sonoriensis* Goldman 1925 (Mexico), and *L. p. steinbachii* Pocock 1941 (Bolivia) (Pocock 1941, Goldman 1943, Hall and Kelson 1959, Cabrera 1961, Álvarez 1963, Eizirik *et al.* 1998). Wilson and Reeder (2005) treat *L. p. maripensis* as a synonym for *L. p. melanurus* and *L. p. mearnsi* as a synonym for *L. p. aequatorialis* but consider the other 8 subspecies as described above (with the exception of the spelling of two subspecies names: *L. p. pusaea* is considered *L. p. pusaeus*, and *L. p. steinbachii* is considered *L. p. steinbachi*). Five of these occur in North America: *albescens*, *mearnsi* (or *aequatorialis* following Wilson and Reeder 2005), *nelsoni*, *pardalis*, and *sonoriensis* (Hall 1981).

Throughout much of its range the ocelot is rare and often thought to be declining. Following the listing in the U.S. of the ocelot as federally-endangered under the Endangered Species Act in 1973, international trade of the ocelot was banned by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) in 1975. The ocelot was listed by CITES in response to dwindling ocelot populations caused by commercial export (McMahan 1986). Originally, the ocelot was categorized as *L. pardalis* under Appendix II in CITES, with two subspecies (*L. p. mearnsi*, the Costa Rican ocelot, and *L. p. mitis*, the Brazilian ocelot) listed on Appendix I (UNEP-WCMC 2014). Appendix II species may not be threatened with extinction but need controls on trade to avoid over-utilization (UNEP-WCMC 2014). Appendix II species may be commercially exported as live animals, with required permits, and may be used in products, if the exporting country deems that this use is not detrimental to the survival of a species (McMahan 1986). From 1990 to the present, the ocelot has been listed as a threatened species under Appendix I, with no subspecies designations, i.e. the species is currently treated as a single entity (UNEP-WCMC 2014).

The International Union for Conservation of Nature (IUCN) produced the Red List, which includes the ocelot as a species of "Least Concern" over its entire range (Nowell 2002). Species of Least Concern have estimated population sizes of at least 50,000 (Nowell 2002). Prior to 2002, the ocelot was listed as vulnerable (IUCN 1994). The 1996 IUCN Status Survey and Conservation Action Plan for Wild Cats ranked the ocelot as: Global 5a; Regional 4. Species holding a G5 rank are considered secure over their entire range (Master 1991). Regional rankings of 4 confer a status of apparent security in a region (100 to 1000 known extant populations), but the species may be rare in parts of its range (Master 1991).

Ocelot population data often are unavailable and vary with changing landscapes and human activities. Nowell (2002) estimated the ocelot's global effective population size as 235,000. Effective population size is the portion involved in breeding and, in this case, is obtained using half of the estimated total population (Nowell 2002). Currently, the ocelot is federally-protected through most of its range. To create a strategy for the ocelot's long-term survival across the Americas, an assessment of ocelot status in each country is needed. Such information may assist international conservation planning and clarify how ocelot research outside the U.S. can be prioritized.

Ocelot pelts were heavily exploited in the 1960s and early 1970s; some ocelots also were imported for the pet trade. During this time, the ocelot was the most sought-after spotted cat in the fur industry, mainly for use as fur-skins, garments, and rugs (McMahan 1986). Up to 200,000 ocelot skins may have been harvested annually for global trade (Geitling 1972 as cited in Payan and Trujillo 2006). Ocelot imports peaked in the U.S. in 1970, with 140,000 skins documented by U.S. Customs (McMahan 1986). With the advent of CITES, ocelot imports dropped to 24,600 skins annually from 1976 to 1983 (Broad 1987). Most international ocelot trade ceased during the late 1980s (Felid Taxon Advisory Group 2015).

Habitat alteration, particularly from deforestation, agriculture, and cattle ranching, has reduced and fragmented ocelot habitat (Ceballos and Garcia 1995, López González *et al.* 2003). Moreover, continued subsistence hunting and poaching of the ocelot are causes of decline or impediments to population recovery (López González *et al.* 2003, de Villa Meza *et al.* 2002, Ceballos and Garcia 1995). Although the ocelot is still widespread in Central and South America, densities are low and populations are often patchy (Dobson and Yu 1993). Ocelot habitats include coastal mangroves, marshes, grasslands, thornscrub, dry semideciduous forests, riverine forests, subtropical forests, and tropical forests.

The following represents an attempt to capture some of the more recent and/or valuable information that could be found on the status and distribution of the ocelot, its habitat or the ecology of the species outside of the U.S. It is in no way a complete or up-to-date bibliography of the subject. There is a wealth of knowledge about the species that could not fit in this document and with the recent reliance on the use of camera-trapping, fortunately, new information about ocelots is growing rapidly.

OCELOT STATUS SOUTH OF THE UNITED STATES

MEXICO

In Mexico, the ocelot is listed as endangered under Mexican law (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT] 2010). Among 31 states in Mexico, 19 states are known to have had ocelots documented since 2000. The range of the ocelot in Mexico occurs in the Sierra Madre Oriental in western Mexico as well as the Sierra Occidental in eastern Mexico and south throughout the country. The status of the ocelot is poorly-known in the following states although they comprise portions of its range: Campeche, Coahuila, Colima, Guerrero, Hidalgo, Nayarit, Queretaro, Tabasco, Tlaxcala, Yucatan, and Zacatecas.

Within the 19 states of Mexico where ocelots have been studied recently, ocelots appear to use a variety of habitats including subtropical and tropical thornscrub, Neotropical dry forest, tropical rain forest, tropical riparian and coastal forest, grasslands, and swamps. Most surveys of ocelots have been limited to noting presence or absence and, most often, in federally protected areas.

Aguascalientes: Bárcenas and Medellín (2010) documented ocelots in Sierra Fria in Aguascalientes. Valdez-Jiménez (2013) documented an ocelot in the southeast part of Aguascalientes in Sierra de Laurel and the closest records of ocelots are 226 km to the east in San Luis Potosi (Martínez-Calderas *et al.* 2011) and 291 km away to the southeast in Guanajuato (Iglesias *et al.* 2008).

Campeche: Hernández-Pérez *et al.* (2015) recorded ocelots in a camera trapping study in the Yucatan Peninsula that included sites in Los Petenes Biosphere Reserve in Campeche. The state of Campeche contains the Calakmul Biosphere Reserve. It became the largest tropical protected area in Mexico (7231.9 km^2) in 1989 (Escamilla *et al.* 2000). Logging, subsistence agriculture, hunting, and other non-timber forest uses (such as chicle-tapping and apiculture) (Escamilla *et al.* 2000) in southwestern Campeche are causing declines in tropical moist forest, croplands, and wetlands, and increases in grasslands (Cuarón 2000). Hunting combined with habitat loss are the main threats to the ocelot and other wildlife in this region.

Chiapas: Chiapas contains the largest portion of tropical rain forest remaining in Mexico and the highest mammal species richness in the country (Medellín 1994). Montes Azules Biosphere Reserve holds the most diverse ecosystem in Mexico with many endemic and migrant species (Medellín 1994). Much of Chiapas and neighboring Oaxaca has been highlighted as an area in Mexico worthy of the highest priority for conservation due to the concentration of endangered species, endemic species, and species richness (Ceballos *et al.* 1998). Chiapas contains protected areas such as the tropical rain forests of Lacandona and the dry forests of La Sepultura (Ceballos *et al.* 1998), but tropical forest is being converted to subsistence agriculture and cattle pasture (Cuarón 2000).

Cuarón (2000) found the ocelot in tropical moist forest, cloud forest, wetland, and tropical secondary vegetation in Palenque National Park (1,801 ha) and Montes Azules (116,559 ha). Habitat availability for the ocelot declined 18% from 1974 to 2000 in Chiapas, with an additional 24% decline projected by 2034 (Cuarón 2000). Cuarón (2000) determined that ocelots would use fallow croplands and agricultural areas, particularly if they were associated with natural vegetation.

Antonio de la Torre *et al.* (2016) used 33 camera trap stations in the southern Montes Azules Biosphere Reserve for a total sampling effort of 1,920 trap days and estimated population density of ocelots to be 0.08 to 0.18 ocelots/km^2 in the Lacandona region. Their results are similar to those obtained in other areas located in tropical rain forests of Central America.

Chihuahua: López González *et al.* (2014) recorded an ocelot in the northern end of the Sierra Occidental, 110 km NE of the closest record in Sonora (Avila-Villegas and Lamberton-Moreno 2012). It was discovered during a 12-day camera-trapping effort in open oak woodlands and native grasslands.

Coahuila: Goldman (1943) mentioned that ocelots were collected from the U.S. side opposite of Coahuila, in Eagle Pass, Texas, and in Brewster County, Texas. Leopold (1959) made reference to the presence of ocelot in Coahuila but nothing recent was found.

Colima: Ocelots were recorded from Colima by Goldman (1943) but no recent documentation of ocelots was found.

Durango: The ocelot was not found in Durango by Webb and Baker (1962), but residents assured them that it occurred in the tropical deciduous habitat in the area. An ocelot skin from Durango in 1994 (Servín *et al.* 2003) marked the first physical evidence of the ocelot for this state.

Guanajuato: Using camera-traps, Iglesias *et al.* (2009) recorded the ocelot in Guanajuato at about 2000 m above sea level in the Sierra Fria, extending the range east of Nayarit and further northwest into the state of Guanajuato, Mexico, and providing the first record of an ocelot in pine-oak forests in Mexico (see Bárcenas and Medellín 2010). Iglesias-Hernández *et al.* (2012) reported ocelot among the 341 wildlife photographs they collected from remote cameras in the Sierra Gorda Biosphere Reserve in the state.

Guerrero: Before the recent work by Almazán-Catalán *et al.* (2013), who documented ocelots in three different sites in the state, ocelots were known from Guerrero only from dated museum specimens (Goldman 1925). The work by Almazán-Catalán *et al.* (2013) consisted of interviewing residents of Guerrero and attempting to take photographs, and/or collect the skull or entire skeleton of specimens they documented, including numerous margay, several mountain lions and two jaguars from the state.

Jalisco: Threats to tropical dry forest in Jalisco include burning and clearing for agriculture and grazing, selective logging, and resort development (particularly along the coast), which causes isolation of remnant native vegetation. Construction of resort hotels, real-estate developments, polo fields, and marinas has destroyed habitats and reduced the availability of freshwater (Lott 1995). Jalisco includes Pacific coastal beaches, mangroves, and marshes that merge into the Sierra Madre Occidental. The forests of Jalisco that parallel the Pacific coast of Mexico (Valero *et al.* 2001) maintain high species richness and endemism (Ceballos and Garcia 1995).

The Chamela-Cuixmala Biosphere Reserve (13,600 ha) comprises the only protected area in the Jalisco dry forest ecoregion, which includes the adjacent states of Nayarit and Colima (Ceballos *et al.* 1998). The reserve protects less than 10% of the ecoregion (Valero *et al.* 2001). Fernandez (2002) monitored 15 radio-collared ocelots in the reserve between 2000 and 2001 and estimated that the reserve could support 33 to 53 adult ocelots (0.3 ocelots/km^2).

Indirect threats to the ocelot in Chamela-Cuixmala Biosphere Reserve may include competition from subsistence hunters for prey that are considered a delicacy for people (de Villa Meza *et al.* 2002). The spiny-tailed iguana (*Ctenosaura pectinata*) was the most important prey of ocelots in this area, followed by the spiny pocket mouse (*Liomys pictus*) (de Villa Meza *et al.* 2002).

Fewer iguanas may reduce ocelot kitten survival by forcing females to spend more time foraging for smaller prey (de Villa Meza *et al.* 2002).

Ortega Reyes (2004) recorded ocelots as relatively rare based on their cage-trapping in the area around Presa Cajón de la Peña, near Tomatlán, Jalisco. Moreno-Arzate *et al.* (2011) and later Ahumada-Carrillo *et al.* (2013) recorded ocelot using forests at high elevations in Jalisco and the state of Mexico, in what was previously a distributional gap between Nayarit and Aguascalientes, Mexico.

Mexico: Romero and Ceballos (2004) did not find evidence of ocelots, only bobcats, puma and coyotes among the carnivore community of Polotitlán in the state of Mexico. Bárcenas and Medellín (2010) documented one or possibly two ocelots during a study using camera traps to assess density and diet of the bobcat. The site where they detected ocelot was in a pine-oak forest at an elevation of 2,400-2,900 m above sea level in the Sierra Fria, and apparently was located in the state of Mexico, not in Aguascalientes (see Valdez-Jiménez 2013). Two ocelot photographs were obtained from different sites during 15 days of monitoring in November-December 2007. At the time, their report was only the second to document ocelot in oak-pine forests in Mexico (see Iglesias *et al.* 2009).

Monroy-Vilchis *et al.* (2011) documented ocelot using camera-traps in the Sierra of Nanchititla in the state of Mexico but no other data was provided. Aranda *et al.* (2014) reported the highest altitude of an observed ocelot (3,150 m) and the first record of an ocelot in a fir (*Abies religiosa*) forest in the state of Mexico in the Lagunas de Zempoala National Park which spans the states of Mexico and Morelos.

Michoacan: Chávez-León (2005) studied mammal richness from Barranca del Cupatitzio National Park, Michoacán, Mexico, and recorded ocelot along with 42 other mammal species from 2003-2004, through photo-trapping, although no density estimate was provided. During a project to compile feline species presence records for the central-western part of the state, Charre-Medellín *et al.* (2015) recorded ocelots most often; with respect to their camera surveys, ocelots exhibited 29.8 observations/100 camera-nights. Urrea-Galeano *et al.* (2016) also documented ocelots with camera traps at the Zicuirán-Infiernillo Biosphere Reserve in Michoacán.

Morelos: Álvarez-Castañeda and López-Forment (1995) were not able to collect any ocelots in the hills around Palpan, Morelos. Alvarez-Castañeda (1996) reported that two pelt specimens recorded as margay at the University of Kansas were actually ocelot but we found no other reports for ocelot from the state. Aranda *et al.* (2014) reported an adult male ocelot in the Lagunas de Zempoala National Park which spans the states of Mexico and Morelos. Given the proximity of the observation and the vastness of this forest, ocelots likely continue to occupy areas of Morelos still.

Nayarit: Anecdotes from 1905 reported the ocelot in coastal dunes in Nayarit (Allen 1906, de Villa Meza *et al.* 2002); however, no recent studies documenting ocelots could be found.

Nuevo León: The pelt of an ocelot shot in 1940 was seen by Moreno-Valdez (1998), and Jiménez-Guzmán *et al.* (1999) witnessed a taxidermied ocelot that was reported as having been shot in 1946 in Generál Bravo, Nuevo León. Recent surveys for jaguarundi in Nuevo León did not detect ocelots (Arturo Caso *pers. comm.* 2006) nor did work by Tewes *et al.* (2009) after 2,802 camera-nights during a study northeast of Monterrey, Nuevo León, in 2008. Yet, a wildlife monitoring project using remote cameras in the Sierra Madre Oriental mountains in central Nuevo León has documented several ocelot individuals, including photos with females and their young (Velazco-Macías and Peña-Mondragón 2015, Carrera-Treviño *unpubl. data* 2015).

Oaxaca: Lira Torres *et al.* (2005) documented ocelots among 51 other species in the area of the Cerro de la Tuza on the southwestern coast of Mexico. Recently, Galindo-Aguilar *et al.* (2016) documented ocelot presence through camera trapping and interviews in the Sierra Mazateca of Oaxaca near the border with Puebla. Using 30 camera traps from 2009 to 2013, Briones-Salas *et al.* (2016) found that ocelots were the most abundant felid sampled in their study area in Chimalapas, Oaxaca. During a study to determine the ecology of the rainforests of Los Chimalapas in the state of Oaxaca, Pérez-Irineo and Santos-Moreno (2014) used 29 camera-traps from March 2011 to June 2013. A total of 103 ocelot observations were recorded with a sampling effort of 8,529 trap-days. The density of ocelots was estimated at 0.22-0.38 individuals/km^2. They found the ocelot population had a high percentage of transient individuals (55%) and that the sex ratio was roughly 50:50. They claimed that the ocelot population there appears to be stable and to have a density similar to other regions in Central and South America, which could be attributed to the diversity of prey species and a low degree of disturbance in Los Chimalapas.

Puebla: Ramírez-Bravo *et al.* (2010a) made the first observation of an ocelot in Puebla in the mountains in the northern part of the state. Ramírez-Bravo *et al.* (2010b) interviewed a wide variety of people in the state of Puebla and their results suggested there may also be populations of ocelots in the southern part of the state and these populations may have a connection across Puebla between the states of Morelos and Oaxaca, Mexico. More recently, Galindo-Aguilar *et al.* (2016) documented ocelots in the Sierra Negra of Puebla near the border with Oaxaca indicating that this area is an important component of the proposed Sierra Madre Oriental biological corridor.

Queretaro: The ocelot has been documented in the 3000 km^2 Sierra Gorrda Biosphere Reserve, but population data are not known (Carlos López González *pers. comm.* 2014). The Reserve, located in central Mexico, covers 14 different habitat types, from semi-desert scrub to tropical cloud forests. Tropical deciduous gallery forests dominate the region, with some areas of coniferous and tropical oak forests. The diversity of flora and fauna is a result of the topographic extremes and the interplay of Nearctic and Neotropic regions (Grupo Ecológico Sierra Gorda 2014).

Quintana Roo: Ávila-Nájera *et al.* (2015) used four years of data from remote cameras in a spatially-explicit capture-recapture model and reported densities at El Eden Ecological Reserve in Quintana Roo at 0.02 to 0.05 ocelots/km^2.

San Luis Potosi: Ocelots were recorded from San Luis Potosi by Dalquest (1953). Using camera-trapping, Martínez-Calderas *et al.* (2011) documented ocelots in eight different habitats including tropical deciduous forest, semitropical thornscrub, piedmont scrub, and cloud forest, extending its range more to the west than was previously recorded. They also urged for the development of conservation strategies for ocelots in the state and for continued work to monitor ocelots in neighboring states. Martínez-Calderas *et al.* (2015) also created a potential ocelot distribution map for northeastern Mexico based on their field work and using literature of others field studies. Martinez-Hernandez *et al.* (2014) estimated the number of ocelots in the Sierra Abra-Tanchipa Biosphere Reserve, San Luis Potosí, Mexico, at nine ocelots in the dry season, and 21 and 15 in the early and late humid seasons, respectively. Spatial density estimates were 0.04/km^2 in the dry season and and 0.03 to 0.18/km^2 in the humid seasons. Ocelots were considered to have a low population density and the population faced ongoing threats from habitat loss and fragmentation resulting from agricultural development (Martinez-Hernandez *et al.* 2014).

Sinaloa: Threats to native landscapes (e.g., coastal plain, mangrove, marsh, semi-arid woodlands, and montane woodland) in Sinaloa (Armstrong *et al.* 1972) include wetland pollution, intensive agriculture, and shrimp farming along the coast. Inland areas with steeper terrain are well-preserved (Carlos López González *pers. comm.* 2005). Carrera-Treviño (*unpubl. data* 2015) recently acquired several photographs of ocelots in the Meseta de Cacaxtla Natural Protected Area, north of Mazatlán, Sinaloa. The ocelot was apparently common in southern Sinaloa until the 1950s (Burt 1938, Leopold 1959). The ocelot may occur in forested areas throughout Sinaloa but population estimates were not found.

Sonora: Previous ocelot estimates reported that Sonora supported 0.057 ocelots/km^2 for an estimated state-wide population of 2025 ± 675 (López González *et al.* 2003). These numbers were estimated from interviews, tracks, artifacts, and a predictive model. Thirty-three ocelots were documented in Sonora from 1998 to 2003 (López González *et al.* 2003). The core habitat necessary to support ocelot populations in the region was calculated to be 35,525 km^2, with 1.9% of this area minimally protected (López González *et al.* 2003). As the second largest state in Mexico and with one of the lowest human population densities, Sonora offers a large area of contiguous habitat including thornscrub and other semi-arid vegetation (López González *et al.* 2003). Gómez-Ramírez (2015) estimated a density of 0.04 ocelots/km^2 using camera-trap data and mark-recapture methods. Given these updates, the estimated state-wide population estimate is 1,421 ocelots.

Tabasco: Gordillo-Chávez et al. (2015) recently reported a record of ocelots in their camera trapping surveys in the Chaschoc-Seja wetland in Tabasco. Cuarón (2000) predicted an increase in grasslands and decrease in tropical moist forests, croplands, and wetlands in the panhandle of Tabasco. The expected decrease in vegetative cover and accompanying fragmentation of remaining forest may have a negative effect on the local abundance and metapopulation dynamics of the ocelot in the panhandle region.

Tamaulipas: Ocelot habitat ranges from thornscrub, coastal gulf grasslands, and lowland tropical moist forest. Arturo Caso (*unpubl. data* 2006) photographed two ocelots in northern Tamaulipas (located approximately 175 km south of Texas). Caso (1994) captured a total of 36 ocelots from Los Ebanos Ranch in southeastern Tamaulipas. Probably, the most important area with ocelot habitat in northeast Mexico is located in the Sierra of Tamaulipas, where Caso captured 10 ocelots in 1996 (Arturo Caso *unpubl. data* 2006). Martínez-Calderas (2009) documented ocelots in Tamaulipas and created a map identifying different levels of suitability of existing habitat for ocelot based on their new records and historic records of ocelot in Tamaulipas.

Stasey (2012), Carvajal-Villarreal *et al.* (2012), and CDEN (2014) have documented an abundance of ocelots in the hills north and east of the Sierra of Tamaulipas. Trapping in 2009 and 2010 resulted in the capture and radio-collaring of 10 ocelots in 314 trap-nights (Carvajal-Villarreal *et al.* 2012). Carvajal-Villarreal and others (2012) identified 41 individual ocelots using game cameras on Rancho Caracól resulting in a density of 0.3/km^2. Based on the estimate by Stasey (2012), the habitat for the Sierra of Tamaulipas could contain 371 ocelots in the 1,560km^2 area. Stasey (2012) used population modelling to evaluate the effects of possible extractions of ocelots from the population on Rancho Caracól for translocation to Texas. The evaluation determined that a withdrawal of 4 ocelots per year would not have an impact on the source population (Stasey 2012) and that translocation should be considered for increasing genetic diversity and increasing the population of ocelots in Texas.

Tlaxcala: Although we could find no records of ocelots being documented in Tlaxcala, it is expected given the close proximity to ocelots documented in adjacent states like Puebla. (see Ramírez-Bravo *et al.* 2010a).

Veracruz: Veracruz is the type locality for the ocelot described as *Felis pardalis* by Linneas in 1758 (Hall 1981). Recent ocelot population data for Veracruz is not published, however, two ocelots were captured 48 km south of Tampico, at La Mesa Ranch, Veracruz in 1994 (Arturo Caso *pers. comm.* 2006) and the ocelot has been reported from the Los Tuxtlas Biosphere Reserve in southern Veracruz. Los Tuxtlas is a 700 ha biosphere reserve within a patchwork of reserve areas consisting of Neotropical moist forest and pine-oak forest on volcanic soils, totaling 155,122 ha.

CENTRAL AMERICA

The seven countries here support an estimated 17,000 species of vascular plants (3,000 endemics), 440 mammals (65 endemics), hundreds of indigenous human tribes, and more reptile and amphibian diversity that any other region on earth (Critical Ecosystem Partnership Fund [CEPF] 2004, 2007). Less than half of the region retains its original forest cover, and an estimated 45 ha of forest are lost every hour (4,000 km^2/yr) (CEPF 2004). Nearly half of the people live in rural areas. Population growth and poverty place increased pressure on natural resources. The penalties for illegal resource extraction are often negligible compared to the profits. Poverty, ineffective law enforcement, and the lack of incentives that support conservation, are root causes of poaching, logging, and human encroachment that may threaten the ocelot (CEPF 2001).

Central American governments have taken some steps to protect biodiversity. All nations are signatories of the Convention of Biological Diversity, a United Nations 1992 initiative which promotes the conservation of biodiversity at the genetic, species, and ecosystem levels and the sustainable use of its components, and supporters of Agenda 21, a 1992 United Nations global partnership fostering sustainable development and human empowerment. In addition, they all participate in the Central American Protected Areas System and the Mesoamerican Biological Corridor, a plan to maintain connectivity between protected areas (CEPF 2001). Currently, protected areas cover approximately 18% of Central America, ranging from less than 3% in El Salvador to 45% in Belize (CEPF 2001).

BELIZE

Belize has been a party to CITES since 1981 and has all five species of felines listed under CITES I (i.e., jaguar, puma, ocelot, margay, and jaguarundi) (Carrillo and Vaughan 1994). Approximately 47% of Belize is under some form of protected status, forming large, contiguous blocks of forest that abut Mexico and Guatemala (Wildlife Conservation Society 2005). Likewise, Belize's Wildlife Protection Act (Government of Belize 2000) protects many species, including the ocelot, from hunting and live capture. Belize has a relatively small human population, and less deforestation and illegal wildlife hunting than elsewhere in the region (Wildlife Conservation Society 2005). Ecoregions include subtropical and tropical forest, tropical and subtropical coniferous forest, and coastal mangroves in a country that covers 2,800 km^2. Hurricanes and timber harvest provide irregular disturbances (Konecny 1989). Land clearing for ranching, agriculture, and shrimp farming have fragmented ocelot habitat (Wildlife Conservation Society 2005).

Two radio-collared ocelots used second growth forest, but preferred late successional forest (Konecny 1989). Home ranges, habitat associations, and diet were related to prey density, conspecifics, and competitors (Konecny 1989). Similarly, Davis *et al.* (2011) found that ocelots were using areas with higher road cover and more small birds and appeared to be attracted to areas where jaguars were present, although the two species may have been independently selecting similar habitat. The low number of ocelots trapped in Konecny's (1989) two year study was attributed to illegal hunting. However, Davis *et al.* (2011) also had low camera-trap success numbers for ocelots when compared to jaguars and grey foxes in their study.

In northwest Belize, ocelots have used fallow fields as well as tropical forests (C. Miller *pers. comm.* 2006). During a 60-day jaguar study in 2004, 18 ocelots were photographed, yielding a relative abundance of 30 ocelots/100 trap-nights (C. Miller *pers. comm.* 2006).

Dillon and Kelly (2007) estimated ocelot density in western Belize at $0.26/km^2$ in tropical rain forest and $0.023\text{-}0.038/km^2$ in adjacent pine forest. Home ranges of 3,300 ha and 2,110 ha were estimated for males and females, respectively, with more overlap between and within sexes than in other ocelot studies (Dillon 2005, Dillon and Kelly 2008). Daily distances traveled were 2.6 km for males and 1.8 km for females (Dillon 2005). Ocelots were active mainly at night, with peaks at sunset and midnight (Dillon and Kelly 2007).

COSTA RICA

The ocelot is classified as endangered in Costa Rica (Government of Costa Rica 2005) and is protected by Costa Rica's Wildlife Conservation Law (Government of Costa Rica 1992) and their Environmental Law (Government of Costa Rica 1995). Costa Rica has been a party to CITES since 1975. This country contains the most privately-owned protected areas in Central America (CEPF 2001) and 24% (12,295 km^2) of the total area of the country is protected. Since the 1990s, tourism has been Costa Rica's primary source of income, but some of the tourism industry has developed at a pace that disregards local ecosystems (CEPF 2001). Banana and coffee plantations are used by ocelots if located near large natural forests (Daily *et al.* 2003). Subsistence hunting, mining, forest extraction, and human encroachment impact primary forests (Carrillo *et al.* 2000).

Costa Rica has at least 165 protected areas covering approximately 16,000 km^2 (Triana and Arce 2009). The ocelot is known to use various habitat types within several of these protected areas including: La Selva Biological Station (Wilson 1989, Medellin 1994), Piedras Blancas National Park (Landmann *et al.* 2008), the Talamanca-Caribbean Biological Corridor (Gonzalez-Maya and Cardenal-Porras 2011), Corcovado National Park (418 km^2), and Golfo Dulce Forest Reserve (627 km^2) (Carrillo *et al.* 2000). Typically, conservation laws are better enforced in national parks than in forest reserves (Carrillo *et al.* 2000). Based on transects in 1990, 1992, and 1994, Carrillo *et al.* (2000) reported 0.12 ocelot tracks/km in Corcovado National Park and 0.08 tracks/km in Golfo Dulce Forest Reserve. Although humans do not hunt ocelots in these areas, they do hunt ocelot prey (Carrillo *et al.* 2000). The increase in human population, changes in hunting methods, and the sedentary habits of people intensively using a limited area are other factors responsible for increased effects of subsistence and commerce hunting on native wildlife (Carrillo *et al.* 2000).

Ocelots used tropical forest and adjacent coffee and banana plantations at Las Cruces Biological Field Station (Daily *et al.* 2003). The ocelot was categorized as a 'moderately sensitive' species, using a wide range of forest habitats (Daily *et al.* 2003). Mature coffee plantations near forest remnants may enhance the conservation value of fragmented forests (Daily *et al.* 2003).

EL SALVADOR

The ocelot is listed as endangered under El Salvador's Official List of Threatened and Endangered Species (Government of El Salvador 2009). Hunting in El Salvador is only legally permitted for 15 species (Government of El Salvador 2012) although resources for enforcement continue to be limited. Since the passage of El Salvador's Wildlife Conservation Law (Government of El Salvador 1994) in 1994, hunting has been prohibited for species that are listed as threatened or endangered as well as for those species which are listed under CITES. El Salvador became a signatory to CITES in 1987 (CITES 2015). However, ocelots have been illegally captured for the pet trade and have been hunted for their skins in El Salvador in recent times (Ministerio de Medio Ambiente y Recursos Naturales 2005).

El Salvador is the smallest country in the Americas, but it supports approximately 7 million people with a density of 324 humans/km^2 (Woodward 2005). Natural vegetation is dominated by deciduous tropical forest, with areas of temperate grasslands and sparse forests of oak and pine. As a result of its high population density and farming, only 6% of El Salvador remains forested, with 2% considered primary forest (Scialabba and Williamson 2004). El Salvador's primary export is coffee, 25% of which is "shade-grown" under a canopy of both cultivated and native trees that often grow adjacent to native forests (Scialabba and Williamson 2004). Shaded coffee polycultures are floristically and structurally complex, have relatively high species diversity, and are used by ocelots (Scialabba and Williamson 2004).   At least 77 protected areas exist in El Salvador covering an area of approximately 281 km^2 which is 1% of the country (Triana and Arce 2009).

There is limited information on the ocelot in El Salvador, but historically it occurred widely throughout the country. In fact, one of the states in El Salvador, Usulutan, actually means "city of the ocelots" in the native Pipil or Nawat language. There are at least 6 museum specimens of ocelots from 4 different states across the country: Auhachapan, Sonsonate, Santa Ana, and La Union (Owen and Girón 2012). In addition, there was a felid diet study conducted in Walter Thilo Deninger Natural Protected Area in 2002 confirming the current presence of ocelots in the state of La Libertad (Menéndez Zometa 2003). There are many other areas where ocelots may occur and there are recent reports of ocelots in protected areas, as well as anecdotal evidence of ocelots on various coffee farms, though their numbers are likely quite low (Komar *et al.* 2006).

GUATEMALA

The ocelot is listed as endangered in Guatemala (Government of Guatemala 2009) and since 1996, has been protected from hunting and live-capture by their Protected Areas Law (Government of Guatemala 1996). Guatemala has been a party to CITES since 1980. The ocelot occurs in the northeast Petén section of the country (Lickey *et al.* 2005). Guatemala is dominated by tropical moist forest (~70%), with 26.3% protected (CEPF 2004). Today, Petén and its surrounding forests represent the largest remaining expanse of tropical forest in Central America (Lickey *et al.* 2005) and include: El Mirador National Park, Dos Laguna Biotope, Rio Azul National Park, El Zotz Biotope, Tikal National Park, and the Maya Biosphere Reserve (Novack 2003). Human encroachment into parks and protected areas, proposed highway projects, and proposed dam construction, threaten ocelot habitat (Jose Soto-Shoender *pers. comm.* 2006). In addition to logging, road building, illegal poaching, land conversion for agriculture and rangelands, Guatemala also has a high incidence of forest fires. Periodic drought and creation of rangelands have resulted in fires covering large areas (CEPF 2004).

In Mirador Rio Azul National Park, 5.7 ocelots/100 trap-nights were documented (Jose Soto-Shoender *pers. comm.* 2006). Novack (2003) photographed 9 ocelots at 32 locations, producing 1.1 ocelot captures/100 trap-nights (Novack 2003). He also had 1.3 ocelots/100 trap-nights in Rio Azul/Dos Lagunas National Park (Novack 2003). Eight years earlier, 1.05 ocelots/100 trap-nights were photographed in Tikal National Park (Kaewanishi 1995). To the south, 1.4 ocelot captures/100 trap-nights and 0.83 track detections/km were recorded in the 14,000 ha Lachua Lagoon National Park, an area surrounded by human communities (Jose Soto-Shoender *pers. comm.* 2006).

Land cover patterns may remain stable through 2034 (Cuarón 2000). Previously, change in land area altered by agriculture from 1980 to 1999 involved 76.7 million ha (CEPF 2004). In 2008, Palomo-Muñoz *et al.* (2014) found that ocelots had a density of 0.11 ocelots/km^2 in a nearly 4,000 ha protected area, and the ocelots followed a bimodal nocturnal activity pattern of 20:00-22:00h and 0:00-02:00h. Otherwise, little is known of the ocelot's status in Guatemala, but given the stability and the existence of available habitat, threats to the ocelot in this region appear to be minimal.

HONDURAS

Murie (1935) and Goldman (1943) both formally documented the ocelot in Honduras and there are numerous anecdotal reports of ocelots, but little, if any, research has been conducted. The ocelot is listed in Honduras as endangered (Government of Honduras 1998) and, as such, it is a species protected by the Honduran General Environmental Law (Government of Honduras 1993). Honduras has been a party to CITES since 1985.

Tropical forests cover almost 50% of Honduras, although these are dwindling due to deforestation from logging, agriculture, and ranching. In 2005, the human population was nearly 7 million, with an average population density of 62/km^2 (Encarta 2005). National parks, reserves, and refuges account for 20.8% of the country, with the Río Plátano Biosphere Reserve covering about 5,250 km^2 in north-eastern Honduras. This reserve extends from the mangroves (Miskito Coast), through lowland pine savanna, and into the mountains (Herrera-MacBryde 1993). This area, combined with the Nicaragua's adjacent Bosawas Reserve, was the largest tract of lowland primary tropical rain forest combined with intact pine forests in Central America (Herrera-MacBryde 1993). Deforestation by migratory farmers and loggers in the Rio Plátano Biosphere Reserve is estimated to be 645 km^2/yr mainly in lowland hardwoods (Herrera-MacBryde 1993).

NICARAGUA

Little historic documentation of the ocelot's occurrence in Nicaragua exists, but many reports suggest the species may have been relatively abundant in the past (Goldman 1943, Nietschmann 1972, Oldfield 1988, Hendrix 2000). The Nicaragauan Ministry of Environment and Natural Resources states that the species is present in the mountainous areas of the three western states of the country as well as several other locations (Ministerio de Ambiente y los Recursos Naturales 2008). Nicaraguan laws prohibit hunting of the ocelot and live-capture is only permitted for authorized conservation and scientific purposes (Ministerio de Ambiente y los Recursos Naturales 2008). Nicaragua has been a party to CITES since 1977.

Protected areas in Nicaragua include five parks, reserves, or refuges, and cover 7,209 km^2 (CEPF 2001). Nicaragua's largest forest reserve is the Bosawas, (located just south of Honduras' Rio Plátano Biosphere Reserve), which encompasses several indigenous groups and several distinct ecoregions, such as coastal grassbeds, mangrove lagoons, and tropical forest. Nicaragua also has 68 other protected areas, totaling 21,888 km^2, many of which border the Atlantic Ocean and may serve as corridors between larger, protected areas (CEPF 2001). Many reserves are vulnerable to deforestation and subsistence hunting because they contain rural indigenous communities (CEPF 2001). From 1990-1995, Nicaragua had annual deforestation rates of 2.3-2.5% (CEPF 2001).

Much of this habitat alteration was driven by the demand for increased pastures and plantations (CEPF 2001).

The Nicaragua Canal project, a 278 km canal planned to cut east-west through the country via Lake Nicaragua, has raised concerns among scientists and environmental groups for its potential to affect habitat availability, fragmentation, and terrestrial animal movements and migrations, among other environmental and human concerns (Meyer and Huete-Pérez 2014). Construction, which began in December 2014, did not require environmental analysis or clearance to look at possible effects of this grand-scale project on the biodiversity and sustainability of Nicaragua's natural resources (Huete- Pérez *et al*. 2015). The project's scope and size, including the vast infrastructure that will be necessary for its operation, are likely to have negative effects on ocelots living near the proposed route and may affect ocelots that need that area for ranging and dispersal purposes.

Many ocelots have been observed at street markets as part of the illegal pet trade selling for $10-$150 (Hendrix 2000). Adult female ocelots were killed formerly to obtain their kittens to supply the pet demand (Oldfield 1988). Enforcement of environmental laws is weak, but the Ministry of Environment and Natural Resources is beginning to study the pet trade trends and aims to change Nicaragua's role as a major source for the illegal wildlife trade (Hendrix 2000).

PANAMA

Panama has been a party to CITES since 1978, and the ocelot is listed as endangered and hunting is illegal (Government of Panama 1995, 2008a, b). Panama has protected areas covering 26,803 km^2 (Government of Panama 2011). Deforestation may be the biggest threat to the ocelot in Panama, occurring at 2.3-2.5%/yr from 1990-1995 and in preserved lands despite environmental protection laws (CEPF 2001); however, significant reforestation efforts are underway and from 1992-2008 nearly 1% of the national land area was reforested (Government of Panama 2011). Designated parks were considered to be too understaffed to provide needed enforcement, with 149 guards assigned to 14 national parks (9,125 ha/guard) (CEPF 2001). Large-scale mining projects, land conversion and subsequent erosion due to cattle grazing, illegal hunting, conflicting claims of land ownership, and population growth are challenges to biodiversity conservation in the region (CEPF 2001).

Much of the wildlife research in Panama has taken place on Barro Colorado Island (BCI), a 1,500 ha island preserve that was formed by the creation of the Panama Canal. The island has never been inhabited by humans with the exception of visiting researchers and has been completely protected since 1940 (Glanz 1990). Jaguars rarely exist on the island, but puma were frequently detected (Moreno *et al.* 2006). The Smithsonian Tropical Research Institute (STRI) is located on BCI where 11 radio-collared ocelots are part of an eco-physiological study of the species. In 2003, a male ocelot was captured that weighed 18.4 kg, the largest recorded in the wild (STRI 2004). Moreno *et al.* (2006) found that ocelots consumed larger prey items in the absence of top predators such as jaguars. Ocelots are present on BCI and the mainland, but not on islands smaller than BCI (Asquith *et al.* 1997).

An agreement supported by Panama's National Environmental Authority and the Wildlife Conservation Society will initiate the first long-term study of native cats in Central America and will cover the 57,000 km^2 Darien Park which borders Colombia and the 200,000 ha Friendship Park of Panama and Costa Rica (Franco 2003). Goals of this agreement are to promote better management of biological corridors, and to reduce deforestation (particularly of remaining primary forest) and shooting of cats (especially jaguars) by ranchers (Franco 2003).

SOUTH AMERICA

ARGENTINA

Argentina has been a party to CITES since 1981 and they have a wildlife conservation law that offers some protection to threatened or endangered species (Government of Argentina 1981). The ocelot inhabits the northern half of Argentina, including the central Gran Chaco area and vicinity (Redford and Eisenberg 1989), the Upper Parana Atlantic Forest (Di Bitetti *et al.* 2010) and the Tropical Andes Forest (Lucherini *et al.* 2004). The primary threat to the ocelot in Argentina is habitat loss (Di Bitetti *et al.* 2006); however, recent documentation of significant road mortality indicates that this threat may be a more widespread concern (Nigro and Lodeiro Ocampo 2009). Areas in both the Atlantic Tropical Forest and the Tropical Andes Forest contain at least five other cat species (Lucherini *et al.* 2004), and Di Bitetti *et al.* (2011) consider the Yungas Biosphere Reserve in northwestern Argentina to be a hot spot of wild cat diversity with nine cat species present. In terms of habitat selectivity, the ocelot is considered the most specialized (Lucherini *et al.* 2004).

Yanosky (1994) documented the ocelot on the El Bagual Ecological Reserve in northeastern Argentina. In 1995, Crawshaw used radio-telemetry to estimate an ocelot population density of $0.14/km^2$ in a northern portion of Iguazu National Park. Di Bitetti *et al.* (2006) used cameras in two study areas in the Atlantic Forest within the northeastern panhandle, bordering Paraguay to the west and Brazil to the east. One study area encompassed mature forest in most of Urugua-i Provincial Park, Urugua-i Private Reserve, and a mixed pine plantation owned by a timber company. The second study site was situated within southern Iguazu National Park, established in 1934, that has an intact native species assemblage and is strictly protected. A population density of 0.129 ocelots/km^2 was estimated for the Urugua-i site of 155 km^2, and the Iguazu site of 278 km^2 contained an estimated 0.19 ocelots/km^2 (Di Bitetti *et al.* 2006). Di Bitetti *et al.* (2008) found that ocelot densities were 2-3 times higher in areas with relatively low levels of logging and poaching and that density decreased with latitude and increased with rainfall across their study area. Di Bitetti *et al.* (2011) documented seven cat species, including ocelot, in three camera trap surveys in the Yungas Biosphere Reserve in northwestern Argentina and found that ocelots used both corridors and forested areas.

BOLIVIA

The ocelot occurs in Bolivia and is a resident of the Kaa-Iya del Gran Chaco National Park (34,400 km^2) (Taber *et al.* 1997). As the largest, protected dry forest in the world (Wildlife Conservation Society 2004), this park protects 22% of the Bolivian Chaco and 4.7% of the Gran Chaco ecoregion of south-central South America (Taber *et al.* 1997). Ocelots ranged from 0.017 to 0.52 ocelots/km^2 in the national park (Noss *et al.* 2012). Ocelots of the Hondo River in the Madidi National Park ranged in density from 0.41/km^2 to 0.66/km^2 (Ayala *et al.* 2010). The main threats concern human encroachment and the conversion of forest and riparian areas into soybean monoculture (Taber *et al.* 1997). Another threat is the Santa Cruz-Sao Paulo gas pipeline, one of South America's most extensive construction projects (Taber *et al.* 1997, U.S. Energy Information Administration 2012). The pipeline crosses the remote northern one-third of the park, an area that was previously inaccessible (Taber *et al.* 1997, U.S. Energy Information Administration 2012).

Population densities of ocelots were assessed using camera trapping models at five Bolivian dry forest sites occurring within the Kaa-Iya del Gran Chaco National Park in the northern end of the Gran Chaco region (Maffei *et al.* 2005). Results ranged from zero ocelots at a site consisting of chaco woodland on sand dunes in alluvial plains to 0.6 ocelots/km^2 for the largest study area, characterized by transitional and mature chaco forest on sandstone (Maffei *et al.* 2005). The total ocelot population in Kaa-Iya National Park likely exceeds 10,000 adults (range 9,300-11,300), based on an average ocelot density of 0.30 individuals/km^2 (Maffei *et al.* 2005).

BRAZIL

Because of its large size, Brazil likely has the most ocelots (*L. p. mitis*) of any country, but nation-wide population estimates were not found. Brazil contains several ecoregions, including the Amazonian rainforest, the Pantanal (the world's largest continuously flooded region), the Cerrado (the world's most biologically diverse savanna/dry forest occupying 20% of the country), and the fragmented Atlantic coastal forest, of which only 8% remains (Leite *et al.* 1999, Cullen *et al.* 2005). Commercial export of all wildlife was outlawed in 1967, but enforcement of these laws occurred later (McMahan 1986).

In 1984, Emmons failed to document Brazilian ocelots in a study conducted at seven tropical forest sites. She speculated that the species was still recovering from former hunting pressures (Emmons 1984). Home ranges of 3 ocelots on a 730 ha private ranch in the Pantanal ranged from 76 to 157 ha (Crawshaw and Quigley 1989). Habitat use was in proportion to availability and home ranges of the two adults did not overlap (Crawshaw and Quigley 1989). Using cameras and modeling, Trolle and Kery (2003) estimated 9-14 ocelots in a 1,771 ha of Pantanal consisting of open and closed canopy forest in a research and conservation reserve area. In this reserve, ocelot density was estimated to be 0.51-0.79 ocelots/km^2. Viana *et al.* (2005) estimated that the ocelot was three times more abundant than other felid species in the Parque Estadual do Rio Doce (360 km^2) rainforest in the State of Minas Gerais. Gomes da Rocha *et al.* (2016) estimated an ocelot density of 0.19-0.31 ocelots/km^2 in the Brazilian Amazon which is considered an important stronghold for the species. Although ocelot density remained stable for the three years of the study, it was lower than expected.

Wild Cats of Brazil was initiated in 2004 to examine the status and management needs of 15 cat species in Brazil (Oliveira 2006), and it has grown to involve 23 researchers and 11 institutions. The multidisciplinary effort uses cameras, radio-telemetry, and scat analysis to provide data on species community composition within habitats, abundance, home range movements, genetic status, and the viability of captive zoo-bred cats for re-introduction (Oliveira 2006). Sympatric ocelots and jaguars may be reducing numbers of the oncilla (*Felis tigrina*) (Oliveira 2006).

The Brazilian Ocelot Consortium (BOC) was initiated in 2002 as a conservation partnership under the auspices of the Association of Zoos and Aquariums' (AZA) Ocelot Species Survival Plan (SSP), Felid Taxon Advisory Group (TAG) and Brazil Conservation Action Partnership, in cooperation with Brazil's Permanent Committee for Conservation of Brazilian Felids, the Associaçao Mata Ciliar (a Brazilian NGO) and the Brazilian Institute for the Environment and Natural Renewable Resources (William Swanson *pers. comm.* 2003). The primary goal of the BOC was to identify issues affecting the survival of the Brazilian ocelot (*L. p. mitis*) and develop a comprehensive management strategy that addresses both *in situ* and *ex situ* conservation. It targets the ocelot as the ambassador for conserving all endangered Brazilian cats. Six priority projects were identified for funding to improve the genetic management of captive populations in both the U.S. and Brazil, and enhance *in situ* conservation and education in Brazil: 1) publication of Brazilian felid studbooks and husbandry manual; 2) training of Brazilian zoo staff and scientists; 3) captive propagation of Brazilian ocelots; 4) maintenance of a biological resource bank for Brazilian felids; 5) habitat restoration; and 6) environmental education (William Swanson *pers. comm.* 2003).

The BOC conservation strategy depends on monetary and in-kind support from Consortium participants, with financial and logistical oversight provided by a bi-national Consortium steering committee. To provide funding (a minimum of $90,000-$100,000) for all BOC projects, ten AZA institutions were recruited as full participants in the BOC, with additional support donated from other AZA institutions as partial participants. During each calendar year, funding from each full participant is divided proportionally among the funded projects. As one component of the BOC, each full participant will be allowed to import a breeding pair of ocelots from Brazil to assist the Ocelot SSP in establishing a founder population of this subspecies in U.S. zoos. Offspring from these founder pairs will be distributed preferentially to partial participants in the BOC and other AZA institutions. The ultimate goal is to manage the Ocelot SSP population and the Brazilian zoo population as a global metapopulation while maintaining strong linkages to *in situ* conservation efforts (William Swanson *pers. comm.* 2003).

From 2003 to 2008, the BOC planted more than 50,000 trees, representing 81 native Brazilian species, in the primary ocelot habitat restoration areas bordering the Japi Biosphere Reserve, the largest remaining tract of semi-deciduous forest in São Paulo State (Swanson 2008). In 2006 a camera trap survey in the Reserve was initiated to assess the resident carnivore community, including ocelots. Four ocelots were photographed over a short period of time, and based on ocelot densities in other regions of Brazil, it was estimated that as many as 225 ocelots may have been present in the Reserve (BOC 2006).

COLOMBIA

Colombia has been a party to CITES since 1981 and the ocelot has been protected in Colombia since 1973 (CITES 2005). The ocelot inhabits mountainous areas in Colombia (Guggisberg 1975). Payán and Trujillo (2006) wrote about the abundance and harvest of ocelots for pelts in Colombia and Peru. Payán (2009) studied hunting by indigenous peoples and its effect on prey and carnivores. An edge effect from hunting sites was evident and he found a significantly higher probability of detecting prey and carnivores farther from towns. Ocelot densities (0.12-0.20 ocelots/km^2) did not vary significantly outside or inside the park (Payán 2009). Diaz-Pulido and Payán Garrido (2011) documented 0.06 – 0.11 ocelots/km^2 in the seasonally-flooded plains and associated riparian forests. Ocelots had never been documented in that habitat type in Colombia before.

ECUADOR

Ecuador has been a party to CITES since 1975 and has a Biodiversity Law in place that prohibits hunting of ocelots and only authorizes hunting of animals specified on the list included in the law (Government of Ecuador 2003a). Ecuador's forestry law (Government of Ecuador 2003b) prohibits live capture of any CITES listed species without a valid permit and only authorizes permits for scientific or conservation purposes.

Leopardus pardalis aequatorialis was documented on the eastern side of the Andes in 1925 (Lonnberg 1925). In the tropical province of Pastaza, the largest of 22 provinces in Ecuador, Emmons (1984) looked for ocelots but did not find any. She attributed the absence of ocelots to hunting for at least 2 decades prior to the study (Emmons 1984). The ocelot can be found in many areas of Ecuador (Government of Ecuador 2013) and projects in the Yasuni Biosphere Preserve in the Amazon Basin have yielded images of ocelots (Vaca 2015). However, very little published information exists about ocelot presence or abundance in Ecuador.

FRENCH GUIANA

French Guiana is a party to CITES because it is an overseas department of France, which has been a signatory since 1978. However, any transport of wildlife to France from French Guiana is not treated as international trade. In the past many species were collected in French Guiana and entered the European market through France, including wild cats (CITES 1989). No studies of the ocelot in French Guiana or any references in the literature were located, however, there has been speculation that the population status was similar to that of adjacent Suriname (CITES 1989).

GUYANA

Guyana has been a party to CITES since 1977 and established Species Protection Regulations in 1999, but this legislation has loopholes and is rarely enforced (United Nations Environment Programme [UNEP] 2010). Wildlife Import and Export Regulations have been drafted, but have not yet been passed as legislation and there remain gaps in Guyana's wildlife legislation that would help protect the ocelot (UNEP 2010). The status of the ocelot in Guyana is unknown and no studies on the species could be found.

PARAGUAY

Paraguay has been a party to CITES since 1977, but was the main export source for feline skins, including ocelot, in 1979 and 1980 (McMahan 1986). The Gran Chaco region, a vast plain shared by Argentina, Bolivia, Brazil, and Paraguay, is one of South America's largest ecoregions (Taber *et al.* 1997). Gran Chaco translates into "Great Hunting" (Redford and Eisenberg 1989) or "Hunting Land" and covers an area of about 1,000,000 km^2 and contains high mammalian diversity (Taber *et al.* 1997). The Gran Chaco has been subjected to unsustainable land-uses including agriculture and hunting (Taber *et al.* 1997). The three national parks in this region cover about 11,000 km^2 and protect 3.1% of the Gran Chaco (Taber *et al.* 1997).

Four ocelots were encountered during a 1994-1996 study of the hunting impact on larger wildlife species in the 60,000 ha Mbaracayu Nature Reserve of Paraguay, but no ocelots were reported killed by hunters between 1980 and 1996 (Hill *et al.* 1997). The Mbaracayu Nature Reserve is in the Atlantic rainforest of eastern Paraguay and contains 90% of all recorded species in the country (Hill *et al.* 1997). Although ocelots are not hunted by local tribes, poaching by non-native hunters occurs (Hill *et al.* 1997). McBride and Giordano (2010) reported the first apparent leucistic variant for the ocelot: a white female with black markings that was observed on three occasions over a 3-year period in the western Paraguay.

PERU

Although Peru has been a party to CITES since 1975, tourist markets offer illegal wild cat products, including pelts, teeth, and skulls (Payan and Trujillo 2006). Trade in these products appears to be rather small (Bodmer and Lozano 2001), but meat from hunted carnivores was also consumed locally in rural Peru (Bodmer and Lozano 2001).

Conflicting claims to land, poorly managed logging, road construction, and hunting in reserves may threaten the ocelot in Peru. Loggers have been supplied with guns or employ local hunters to kill large or unusual game (Naughton-Treves 2002). As in formerly inaccessible forests elsewhere, logging leads to settlement, slash and burn agriculture, and ranching.

Emmons (1984) did not record ocelots at Cocha Cashu Biological Station in Manu National Park, or Tambopata Reserve in northeastern Peru. She attributed these findings to recent overhunting of ocelots in the region. A later study at Cocha Cashu estimated 0.8 resident ocelots/km^2 (Emmons 1988). Home ranges of two adult females were 1.6 and 2.5 km^2 and home ranges of two adult males were 5.9 and 8.1 km^2 (Emmons 1988). Ocelot density at Cocha Cashu Biological Station was estimated at 0.8 ocelots/km^2 (Janson and Emmons 1990). The high density of ocelots was attributed to prey partitioning, the absence of human hunting, high primary productivity, and high regional biodiversity (Janson and Emmons 1990). The forests of the Amazon in northwestern Peru appear to support the highest known densities of 0.75 to 0.95 ocelots/km^2 (Kolowski and Alonso 2010).

Naughton-Treves *et al.* (2003) estimated an ocelot density of 0.8/km^2 in the Tambopata-Candamo Reserve of southeastern Peru. Hunting of ocelots is permitted if livestock is threatened (Naughton-Treves *et al.* 2003). Local respondents to questionnaires blamed the ocelot for 32% of poultry and pig losses, followed by hawks (28%) and jaguar (5%) (Naughton-Treves *et al.* 2003). Ocelots used fallow fields more than expected, followed by forests, with a lower use of agricultural fields than either fallow fields or forests (Naughton-Treves *et al.* 2003). Use of fallow fields could be attributed to the greater amount of understory and the high abundance and diversity of small mammals.

SURINAME

Suriname has been a party to CITES since 1981. The coexistence of several felid species, including ocelots, was studied and compared by Sanderson *et al.* (*unpubl. data* 2012). They sampled 40 locations over 3 1/2 years in the Bakhuis Mountains of southwest Suriname, a mountainous rainforest 1,300 m above the surrounding lowlands. Ocelots were recorded in 437 independent photographs at 35 locations. They reported that ocelots and jaguarundis divided their time as almost strictly nocturnal versus diurnal, respectively, while the margay was arboreal and primarily nocturnal. They speculated that ocelots preyed upon nocturnal species, while jaguarundi preyed upon diurnal species that were relatively common in their study area.

TRINIDAD

Hunting and trade has been regulated in Trinidad since 1933 (CITES 1988) and they have been a party to CITES since 1984. The ocelot occurs on this island (CITES 2005) but no additional information was available for this area.

URUGUAY

Uruguay has been a party to CITES since 1975. The ocelot was documented for the first time in Uruguay in 1988, extending its known range southward by 350 km (Ximénez 1988). Its population status is unknown.

VENEZUELA

The ocelot occurs throughout Venezuela in tropical dry forest, tropical humid forest, evergreen forest, and tropical dry thorn forest (Bisbal 1989). Tropical dry forest is the most extensive vegetation type in Venezuela (Bisbal 1989). In addition to being a party to CITES since 1978, Venezuela has its own laws protecting the ocelot. It was listed in the Official Venezuelan List of Game Animals under Total Protection in 1970, but the law is rarely enforced (Mondolfi 1986).

The ocelot occurs at lower altitudes from sea level to 1000 m (Mondolfi 1986). In gallery forest along a river adjacent to the Masaguaral cattle ranch, at least 23 ocelots occurred in an area also inhabited by jaguar, puma, and margay (Mondolfi 1986). The Masaguaral private ranch covers 8,000 ha and has been protected from hunters for 50 years. The ocelot occurs in over half of the 25 Venezuelan national parks, as well as in at least three reserves. Mondolfi also stated (1986) that in forestry reserves, however, the ocelot is not protected and hunting occurs. Illegal shooting (done primarily at night with headlamps), baited traps, hunting with dogs, and habitat loss are the primary threats to the ocelot in Venezuela (Mondolfi 1986).

In the llanos region, located in central Venezuela, predator activity was dictated by the schedules and locations of preferred prey, and ocelots were recorded in open areas only at night (Sunquist *et al.* 1989). In seasonally flooded savannas, broken riparian forests, tropical deciduous forests, and sandhills of the Masaguaral ranch where the study was conducted, five ocelots were captured, radio-collared, and monitored. Sunquist *et al.* (1989) estimated an ocelot density of 1.0/km^2. Ludlow (1986) estimated ocelot density at 0.4/km^2 at the Masaguaral ranch. Ludlow and Sunquist (1987) estimated the ocelot density to be 0.38/km^2.

Farrell *et al.* (2000) found evidence of prey partitioning among the jaguar, puma, ocelot, and crab-eating fox at the Hato Pinero cattle ranch in the western Venezuelan llanos. Reptiles made up 43% of ocelot scat biomass, with small mammals, medium mammals, birds, and crabs also taken (Farrell *et al.* 2000). By consuming prey from all categories except large mammals and fish, the ocelot displayed a broader niche breadth than jaguar or puma (Farrell *et al.* 2000).

CONCLUSION

As a widespread species with low population densities, the ocelot will require international cooperation to ensure its long-term survival. The ocelot seems tolerant of limited and nearby human settlement, but is susceptible to over-hunting. It requires areas with relatively dense cover. The ocelot may adapt to changing habitats if there is adequate cover and limited fragmentation.

Some ocelot populations have rebounded since the decline of the fur trade. However, poverty, urban and rural development, subsistence hunting, poaching, logging, and extraction of forest products present current challenges to the ocelot. Wildlife conservation in impoverished regions will be more successful if it does not create short-term losses to local livelihoods, such as a reduction in harvests of wild species upon which a community's economic status depends (Bodmer and Lozano 2001). Land uses compatible with earning a sustainable livelihood and maintaining areas for ocelots, such as shade-grown coffee plantations or harvesting nuts or other resources from intact forests, benefit both people and wildlife. Balancing economic incentives with ocelot habitat protection will likely foster more effective local survival and global conservation for the ocelot.

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Preliminary Population Viability Assessment for the Ocelot (*Leopardus pardalis*) In South Texas and Northern Tamaulipas

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Introduction

In 1990, the USFWS published *The Listed Cats of Texas and Arizona Recovery Plan (With Emphasis on the Ocelot)* through the United States Fish and Wildlife Service. While considerable progress was made over the last decade in conducting ocelot research, there are a number of recovery actions that have received little attention following the publication of this important document. In addition the geographic, economic, and political landscapes in south Texas and northern Tamaulipas have changed considerably since 1990, thereby necessitating a review and probably revision of the Plan's information and recommended actions. In response to this need, an Ocelot Recovery Team was formed in May 2003 for the purpose of revising the outdated plan. The team was composed of both a Technical and an Implementation subgroup with representation from the United States and Mexico.

The 1990 recovery plan recommended some major demography-related activities for ocelot recovery, namely "determining the precise population sizes and habitat sizes required for viability and the necessary spatial arrangement of habitat, and determining the impact of disease and other factors on the population; increasing ocelot numbers in Texas, in part by protecting at least 20,000 hectares of prime ocelot habitat in Texas (either in a single block or continuous blocks connected by corridors)." Population viability analysis (PVA) has been identified by the Recovery Team as a valuable tool for determining the likely fate of the ocelot populations currently distributed throughout south Texas and northern Tamaulipas, and to assist in the process of identifying the most promising recovery actions.

A PVA can be an extremely useful tool for investigating current and future risk of wildlife population decline or extinction. In addition, the need for and consequences of alternative management strategies can be modeled to suggest which practices may be the most effective in managing populations of the ocelot in its wild habitat in south Texas and northern Tamaulipas. *VORTEX*, a simulation software package written for population viability analysis, was used here as a mechanism to study the interaction of a number of ocelot life history and population parameters treated stochastically, to explore which demographic parameters may be the most sensitive to alternative management practices, and to test the effects of selected management scenarios.

The *VORTEX* package is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. *VORTEX* models population dynamics as discrete sequential events (e.g., births, deaths, sex ratios among offspring, catastrophes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or random variables that follow specified distributions. The package simulates a population by stepping through the series of events that describe the typical life cycles of sexually reproducing, diploid organisms.

PVA methodologies such as the *VORTEX* system are not intended to give absolute and precise "answers," since they are projecting the interactions of many randomly-fluctuating parameters used as model input and because of considerable measurement uncertainty we observe in typical wildlife population demography datasets. Because of these limitations, many researchers have cautioned against the sole use of PVA results to promote specific management actions for threatened populations (e.g., Ludwig 1999; Beissinger and McCullough 2002; Reed *et al.* 2002; Ellner *et al.* 2002; Lotts *et al.* 2004). Instead, the true value of an analysis of this type lies in the assembly and critical analysis of the available information on the species and its ecology, and in the ability to compare the quantitative metrics of population performance that emerge from a suite of simulations, with each simulation representing a specific scenario and its inherent assumptions about the available data and a proposed method of population and/or landscape management. Interpretation of the output depends upon our knowledge of the biology of the ocelot in this portion of its habitat, the environmental conditions affecting the species, and possible future changes in these conditions. For a more detailed explanation of *VORTEX* and its use in population viability analysis, refer to Appendix I below, Lacy (2000) and Miller and Lacy (2003).

Specifically, we were interested in using this preliminary analysis to address the following questions:

What is our best estimate of stochastic population dynamics of the ocelot within its current range in south Texas and northern Tamaulipas?
What are the primary factors that drive population growth dynamics of ocelots in south Texas and northern Tamaulipas?
How vulnerable are small, fragmented populations of ocelots in south Texas and northern Tamaulipas to local extinction in the absence of demographic interaction with other populations?
What are the benefits to the ocelot of increasing range and connectivity in the landscape?
How successful might translocation be as a conservation management strategy for smaller populations of ocelots in south Texas?
How many individuals could be removed from a given source population such as northern Tamaulipas for translocation into smaller populations in south Texas at risk of extinction without negatively impacting the persistence of the source?

The *VORTEX* system for conducting population viability analysis is a flexible and accessible tool that can be adapted to a wide variety of species types and life histories as the situation warrants. The program has been used around the world in both teaching and research applications and is a trusted method for assisting in the definition of practical wildlife management methodologies.

Baseline Input Parameters for Stochastic Population Viability Simulations

The relatively scarce data on the population biology and ecology of the ocelot in the northern extreme of its global range comes primarily from Tewes and Schmidly (1987), Laack (1991), Caso (1994), and López Gonzalez *et al.* (2003). Moreover, the recent analyses of A. Haines (Texas A&I, Kingsville) proved valuable in the development of appropriate model input parameters. Discussion of baseline model input focused on our understanding of the ocelot population within the Laguna Atascosa National Wildlife Refuge, Cameron County, Texas. Where data were absent, we utilized similar information from captive populations and from studies focused on other geographic areas.

Breeding System: Ocelots will often form stable breeding groups that remain intact over more than one year. Therefore, we used the "long-term polygyny" option within *VORTEX* to model this breeding system. Under this option, a set of adult females are therefore randomly selected each year to breed with a given male. Pairs that are produced in a given year are then retained in future years until one of the mates dies.

Age of First Reproduction: *VORTEX* considers the age of first reproduction as the age at which the first kittens are born, not simply the onset of sexual maturity. All available information indicates wild female ocelots produce their first offspring no earlier than about 30 months of age. We therefore set this parameter at three years. In order to test the sensitivity of our models to uncertainty in this parameter, we ran additional models with this variable set to either two years or four years of age. Because males must typically wait for the opportunity to fill vacancies within a given territory, their age of first reproduction is typically older. We set this parameter to four years in all models.

Age of Reproductive Senescence: In its simplest form, *VORTEX* assumes that animals can reproduce (at the normal rate) throughout their adult life. There are no real data available on senescence in ocelots. Captive animals have lived up to 15-17 years, but it is quite likely that this cannot be achieved under much more competitive conditions in the wild. We therefore estimated that ocelots could live up to 11 years in the wild. In reality, achieving this age is unlikely given mortality rates (see below). In order to test the sensitivity of our models to uncertainty in this parameter, we ran additional models with this variable set to either 9 or 13 years of age.

Offspring Production: Based on our knowledge of ocelot life history, we have defined reproduction in these models as the production of kittens observed in the field. Indirect evidence suggests that ocelots often breed every other year, but there are no direct data of this type in south Texas/northern Tamaulipas. Our best "guesstimate" of the average percentage of adult females that successfully breed per year was therefore set at 50%. There are some data (Laack et al, in press) to suggest that this value is an underestimate, although data to the contrary are sparse and difficult to interpret conclusively. In order to test the sensitivity of our models to uncertainty in this parameter, we ran additional models with this variable set to a higher value of 75%.

Annual environmental variation in female reproductive success is modeled in *VORTEX* by specifying a standard deviation (SD) for the proportion of adult females that successfully produce kittens within a given year. While no data are available for this parameter, we propose that annual variance is relatively low. We therefore set the standard deviation in the percentage of adult females breeding at 5%.

Many studies have cited an average ocelot litter size of about 1.4 – 1.5 kittens per successful female. We developed the following distribution of possible litter sizes for a given successful female:

Number of kittens	%
1	66.0
2	33.0
3	1.0

This distribution yields an average litter size of 1.35 kittens. Litters of three individuals are thought to be possible but quite rare. In order to test the sensitivity of our models to uncertainty in this parameter, we ran additional models with a reversed distribution of litters of size 1 and 2, thereby giving a new average litter size of 1.68. The overall population-level sex ratio among newborns is assumed to be 50%.

<u>Density-Dependent Reproduction</u>: *VORTEX* can model density dependence with an equation that specifies the proportion of adult females that reproduce as a function of the total population size. In addition to including a more typical reduction in breeding in high-density populations, the user can also model an Allee effect: a decrease in the proportion of females that bread at low population density due, for example, to difficulty in finding mates that are widely dispersed across the landscape.

At this time, there are no data to support density dependence in reproduction in ocelot populations occupying this portion of their range. Consequently, this option was not included in the models presented here. It is possible that population decreases could actually stimulate higher levels of reproductive success through a decline in intraspecific competition; the detailed mode of action of this relationship, however, was not determined for this analysis.

<u>Male Breeding Pool</u>: In many species, some adult males may be socially restricted from breeding despite being physiologically capable. This can be modeled in *VORTEX* by specifying a portion of the total pool of adult males that may be considered "available" for breeding each year. Within any given year, we assume that all adult male ocelots are equally capable of siring offspring; this is not to say, however, that all adult males actually meet with the same level of success during a given breeding season.

<u>Mortality</u>: Age-sex-specific mortality rates for this PVA are based on new analyses by Aaron Haines. When developing a mortality schedule for ocelots in south Texas, it is vitally important to separate out the impact of road-kill mortality from background mortality. Vehicle impacts are a major source of mortality in this geographic area, especially among subadult individuals that are attempting to disperse to new territories. From the available field and Haines' analysis, we have developed the following schedules, with and without the effect of vehicle-impact mortality:

Age Class	% Mortality (SD) (Road mortality excluded)		% Mortality (SD) (Road mortality included)	
	Females	Males	Females	Males
0 – 1	30.0 (6.0)	30.0 (6.0)	33.0 (7.0)	33.0 (7.0)
1 – 2	15.0 (3.0)	15.0 (3.0)	15.0 (3.0)	15.0 (3.0)
2 – 3	16.0 (4.0)	30.0 (6.0)	30.0 (7.0)	37.0 (8.0)
3 – 4	8.0 (2.0)	13.0 (3.0)	13.0 (3.0)	13.0 (3.0)
4+	8.0 (2.0)	8.0 (2.0)	13.0 (3.0)	13.0 (3.0)

Note the high levels of mortality among 2-3 year-olds, especially among males. In addition, Haines' analysis indicates the significant effect that vehicle impacts have on the mortality of dispersing females in this same age class. Under these conditions, the probability of a female reaching reproductive age is about 50% in the absence of road mortality, but this drops to 40% when road mortality is included. Similarly, the probability of a female reaching the maximum age drops from about 24% in the absence of road mortality to about 12% in the presence of road mortality.

Catastrophes: Catastrophes are singular environmental events that are outside the bounds of normal environmental variation affecting reproduction and/or survival. Natural catastrophes can be tornadoes, floods, droughts, disease, or similar events. These events are modeled in *VORTEX* by assigning an annual probability of occurrence and a pair of severity factors describing their impact on mortality (across all age-sex classes) and the proportion of females successfully breeding in a given year. These factors range from 0.0 (maximum or absolute effect) to 1.0 (no effect), and are imposed during the single year of the catastrophe, after which time the demographic rates rebound to their baseline values.

We suspected that a drought event could severely affect the reproductive capability of adult females. Therefore, we included a drought catastrophe in many of our models. Calculations by Haines at the workshop suggested that such a severe event would occur approximately once every 9-10 years, so we assumed that the annual probability of such an event occurring was 11%. We also assumed that such a drought would reduce the population-level measure of reproductive success (percentage of adult females breeding each year) by 50%. In other words, if approximately 50% of adult females bred successfully in a year without drought, only about 25% would be expected to do so during a serious drought. In order to test the sensitivity of our models to uncertainty in this parameter, we ran additional models with the drought event removed from the analysis.

Inbreeding Depression: *VORTEX* includes the ability to model the detrimental effects of inbreeding, most directly through reduced survival of offspring through their first year. While specific data on inbreeding depression in either captive or wild ocelot populations were not available for this analysis, the preponderance of evidence for the deleterious impacts of inbreeding in mammal populations suggests that it can be a real factor in small populations of ocelots. We therefore elected to include this process in our models, with a genetic load of 3.14 lethal equivalents and approximately 50% of this load expressed as lethal genes. In order to test the sensitivity of our models to uncertainty in this parameter, we ran additional models with inbreeding depression removed from the analysis.

Initial Population Size: Estimates at the time this model was run put the total ocelot population size within the Laguna Atascosa National Wildlife Refuge (LANWR) in Cameron County at approximately 30 individuals, while the population occupying the lands in Willacy and Kenedy Counties is considered to be slightly larger (i.e., around 40 individuals). The closest population in Mexico, approximately 130 km to the south in Tamaulipas, is thought to be about 200 animals. These values were used for specific models designed to evaluate the risk of extinction of existing populations.

Because of the uncertainty in these estimates, and because of a greater interest in the more general results that can be obtained from a systematic analysis of population size and its influence on persistence in the face of random demographic fluctuations in ocelot populations, we decided to also focus on a set of population size classes throughout the analysis. The size classes studied were:
N_0 = 30, 40, 50, 60, 75, 100, 150, 200

VORTEX distributes the specified initial population among age-sex classes according to a stable age distribution that is characteristic of the mortality and reproductive schedules described previously.

Carrying Capacity: The carrying capacity, or K, for a given habitat patch defines an upper limit for the population size, above which additional mortality is imposed randomly across all age classes in order to return the population to the value set for K.

All observations suggest that, through the action of habitat alteration and destruction by local human activities, ocelot populations in south Texas and northern Tamaulipas are at or very near their ecological carrying capacity within existing habitat. Therefore, we initialized all our models with K equal to the appropriate initial population size.

Metapopulation Analysis: An important issue for management of ocelot in the northern extent of their range is the feasibility of "linking" the three populations mentioned above by artificial dispersal, i.e., translocation. Natural dispersal has not been observed in this part of their range and does not appear to be a realistic expectation at this time. To evaluate artificial dispersal as a conservation tool, we developed a set of simulations that involved the removal of four 2-year-old animals (equal sex ratio) – those that have the highest probability of mortality through natural dispersal and associated vehicle impacts – from the Tamaulipas population every other year and distributing them into the two United States populations. During this process, we assume a 50% loss of individuals during transport, so that only one ocelot is being added to each of the LANWR and Willacy-Kenedy populations during the process. Moreover, we assume that this process can not last forever, so we continue the process at 2-year intervals for either 30 or 60 years. In addition to assessing the efficacy of this procedure for potential "rescue" of the much smaller United States populations, we also want to evaluate the impact that such a rate of removal might have on the source Mexican population.

Iterations and Years of Projection: All population projections (scenarios) were simulated 500 times. Each projection extends to 100 years, with demographic information obtained at annual intervals. All simulations were conducted using *VORTEX* version 9.45 (June 2004).

Table 1 below summarizes the baseline input dataset upon which all subsequent *VORTEX* models are based.

Table 1. Demographic input parameters for the baseline *VORTEX* models for populations of ocelot in south Texas and northern Tamaulipas. See accompanying text for more information.

Model Input Parameter	**Baseline value**
Breeding System	Long-term polygynous
Age of first reproduction (♀ / ♂)	3 / 4
Maximum age of reproduction	11
Inbreeding depression?	Yes
Lethal equivalents	3.14
Annual % adult females reproducing (SD)	50
Density dependent reproduction?	No
Maximum litter size	3
Mean litter size†	1.35
Overall offspring sex ratio	0.5
Adult males in breeding pool	100%
% annual mortality, ♀ / ♂ (SD)	
0 – 1	33.0 / 33.0 (7.0)‡
1 – 2	15.0 / 15.0 (3.0)
2 – 3	30.0 / 37.0 (8.0)
3 – 4	13.0 / 13.0 (3.0)
4 – +	13.0 / 13.0 (3.0)
Catastrophe?	Drought
Annual frequency of occurrence	11%
Severity: Reproduction	0.5
Severity: Survival	1.0
Initial population size / K	
Laguna Atascosa (LANWR)	30 / 30
Willacy – Kenedy Counties	40 / 40
Tamaulipas, Mexico	200 / 200

† Exact probability distribution of individual clutch size specified in input file.
‡ Includes road mortality; see text for specification of natural mortality levels.

Results of Baseline Simulation

Results reported for each modeling scenario include:

$\underline{r_s}$ (SD) – The mean rate of stochastic population growth or decline (standard deviation) demonstrated by the simulated populations, averaged across years and iterations, for all simulated populations that are not extinct. This population growth rate is calculated each year of the simulation, prior to any truncation of the population size due to the population exceeding the carrying capacity.

$\underline{P(E)_{100}}$ – Probability of population extinction after 100 years, determined by the proportion of 500 iterations within that given scenario that have gone extinct within the given time frame. "Extinction" is defined in the *VORTEX* model as the absence of either sex.

$\underline{N_{100}}$ (SD) – Mean (standard deviation) population size at the end of the simulation, averaged across all simulated populations, including those that are extinct.

$\underline{GD_{100}}$ – The gene diversity or expected heterozygosity of the extant populations, expressed as a percent of the initial gene diversity of the population. Fitness of individuals usually declines proportionately with gene diversity.

T(E) – The average time to population extinction, in years.

The set of demographic, genetic, and ecological input data that represents our best understanding of the life history of ocelots in south Texas is hereafter referred to as our *baseline model*. This model simulates the predicted trajectory of a small population inhabiting Laguna Atascosa NWR when all sources of mortality – both natural and anthropogenic – are included. The results of this analysis are presented in Figure 1 below. The average population growth rate is -0.082, and the extinction probability over 100 years is 100%.

It is clear from this Figure that, under our best estimates of ocelot population biological parameters, the population currently occupying Laguna Atascosa NWR is expected to decline rapidly toward extinction within the next 50 years. The high rate of decline seen in the model is no doubt due at least in part to pessimistic estimates of certain key demographic parameters, such as the age of first reproduction or the percentage of adult female breeding success. In other words, we may be assuming that females begin breeding at an age that is older than the real situation in the wild, and we may be underestimating the rate of breeding success among adult females. However, this decline also surely results from a more accurate portrayal of other tangible consequences of ocelot biology and local anthropogenic activity, including:

- habitat loss around Laguna Atascosa National Wildlife Refuge (LANWR) that leads to a very small suitable area and an associated small ocelot population subjected to stochastic demographic fluctuations;
- "frustrated dispersal," with a significant proportion of dispersing individuals killed while attempting to move across compromised habitat in search of new territories; and
- increased mortality through vehicle impacts.

The working group developing this model concludes that, while perhaps more severe in absolute magnitude compared to the actual situation in the wild, our simulation model of ocelot population dynamics within LANWR is a fairly accurate simulation of the likely fate of this population in the absence of intensive management.

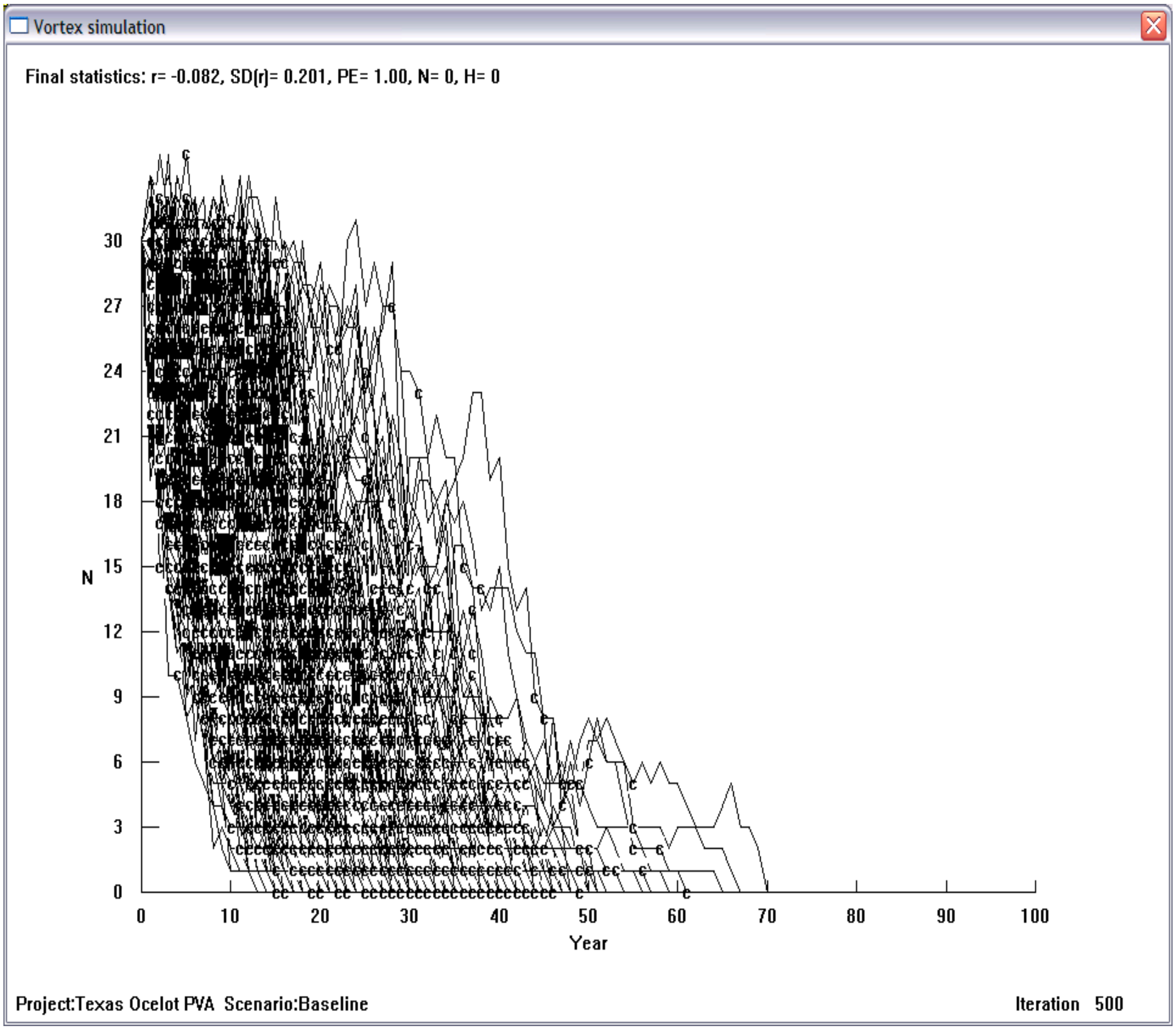


Figure 1. Plot of 500 individual iterations of the baseline *VORTEX* model of predicted ocelot population dynamics in Laguna Atascosa National Wildlife Refuge, Texas. The average rate of population growth across these iterations is -0.082, indicating a considerable rate of decline with extinction occurring within 40 years. Note the level of variance in the model as defined by both demographic and environmental sources of stochasticity included in the model. See text for accompanying details.

Demographic Sensitivity Analysis

During the development of the baseline input dataset, it quickly became apparent that a number of demographic characteristics of ocelot populations in south Texas and northern Tamaulipas were being estimated with varying levels of uncertainty. This type of measurement uncertainty, which is distinctly different from the annual variability in demographic rates due to extrinsic environmental stochasticity and other factors, impairs our ability to generate precise predictions of population dynamics with any degree of confidence. Nevertheless, an analysis of the sensitivity of our models to this measurement uncertainty can be an invaluable aid in identifying priorities for detailed research and/or management projects targeting specific elements of the species' population biology and ecology.

To conduct this demographic sensitivity analysis, we identify a selected set of parameters from Table 1 whose estimate we see as considerably uncertain. We then develop biologically plausible minimum and maximum values for these parameters (see Table 2).

Table 2. Uncertain input parameters and their stated ranges for use in demographic sensitivity analysis of simulated ocelot populations in south Texas and northern Tamaulipas. Values in bold are those used in the baseline model. See accompanying text for more information.

	Estimate		
Model Parameter	Minimum	Midpoint	Maximum
Age of First Reproduction	2	**3**	4
Maximum Age	9	**11**	13
Inbreeding Depression	No	**Yes**	
% Adult Females Reproducing		**50**	75
Average Litter Size		**1.35**	1.68
Road Mortality	No	**Yes**	
Drought	No	**Yes**	

For each of these parameters listed above we construct multiple simulations, with a given parameter set at its prescribed minimum and/or maximum value, with all other parameters remaining at their baseline value. With the 7 parameters identified above, and recognizing that the aggregate set of baseline values constitute our single baseline model, the table above allows us to construct a total of 10 additional, alternative models whose performance (defined, for example, in terms of average population growth rate) can be compared to that of our starting baseline model. For the entire suite of sensitivity analysis models, we will consider a population very similar to that occupying Laguna Atascosa NWR, i.e., initial population size and ecological carrying capacity equal to 30 individuals.

The results of the sensitivity analysis are shown graphically in Figure 2 and in tabular form in Table 3.

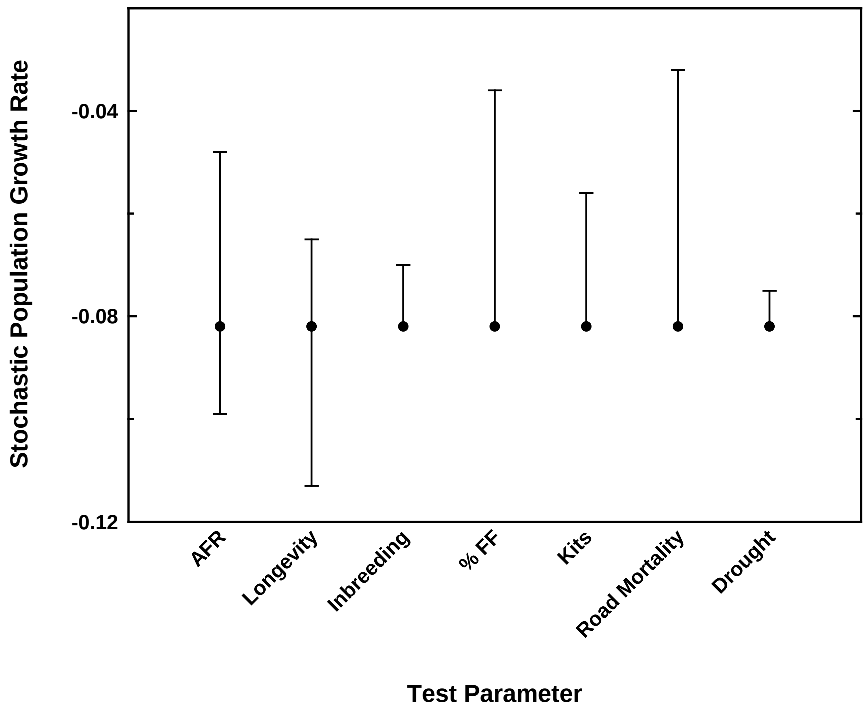


Figure 2. Demographic sensitivity analysis of a simulated LANWR ocelot population. Stochastic population growth rate for a set of models in which the specific parameter is varied across a range of biologically plausible values. The baseline model growth rate of -0.082 is given by the central data point for each parameter. The general model of ocelot population dynamics is most sensitive to uncertainty in those parameters giving the widest range in simulated population growth rates. See text for additional details.

Table 3. South Texas / northern Tamaulipas ocelot PVA. Output from demographic sensitivity analysis models. See text for additional information on model construction and parameterization.

Model conditions	**r_s (SD)**
Baseline	-0.082 (0.201)
Age of First Reproduction	
2	-0.048 (0.188)
4	-0.099 (0.205)
Maximum Breeding Age	
9	-0.113 (0.209)
13	-0.065 (0.191)
Inbreeding Depression	
No	-0.070 (0.204)
% Adult Females Breeding	
75	-0.036 (0.186)
Litter Size	
1.68	-0.056 (0.198)
Road Mortality	
No	-0.032 (0.168)
Drought	
No	-0.075 (0.195)

It is clear from the analysis that our model of ocelot population dynamics is most sensitive to uncertainty in adult female reproductive success (defined here as the percentage of adult females that successfully produce a litter) and to additional mortality of ocelots through vehicle impacts. Uncertainty in reproductive lifespan also leads to significant model response, but not to the level of that seen among the aforementioned variables. While in exclusion of inbreeding depression does not significantly alter the results of our baseline model, we are reluctant to discount its potential impact in small or isolated populations of ocelots in the periphery of the species' range. There is an abundance of evidence suggesting that small populations of mammals can suffer markedly from the impacts of inbreeding depression; there are simply too many other factors conspiring to drive this population into rapid decline for us to be able to discern the precise action of this genetic factor in our particular model.

Once the generalized sensitivity analysis was successfully completed, we set out to develop a set of models with the goal of more precisely identifying the relative contributions of adult and juvenile mortality to the overall growth dynamics of our simulated ocelot population. This was done in order to provide a better understanding of species population dynamics, to define a broad set of minimal conditions necessary to increase the chances of population persistence, and to gain additional insight into the magnitude of any detrimental impact of proposed major mortality factors. This type of analysis can provide a simple benchmark to which wild population management and associated field monitoring efforts can then be directed.

A total of 50 individual models were constructed that provided all possible combinations of 2 levels of reproductive success, 5 levels of juvenile mortality, and 5 levels of adult mortality. This was done in order to more effectively address the relationship between reproductive success and age-specific mortality required for population growth.

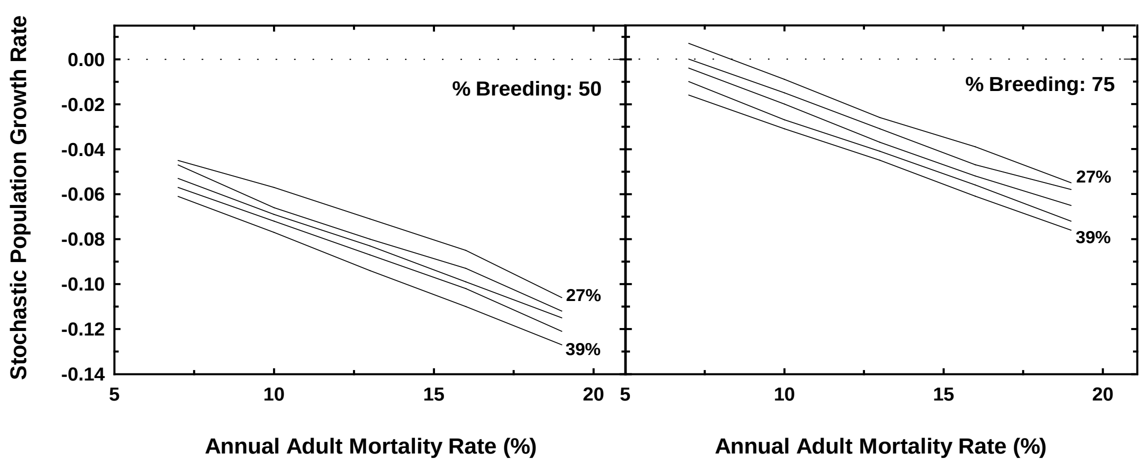


Figure 3. South Texas / northern Tamaulipas ocelot population mortality analysis. Plots give average stochastic population growth rate (r_s) as a function of annual mortality rate of adults with individual lines corresponding to different levels of juvenile mortality. Two panels correspond to variable levels of adult female reproductive success (see text for additional details on the determination of success). Initial population size for all simulations is set at 30 individuals.

The results of this mortality analysis are shown in Figure 3 above. It is clear that, under the conditions modeled here, only a very small number of combinations of juvenile and adult mortality can result in a population that is expected to grow over time (i.e., $r > 0.0$). Inspection of these graphs lead to the following additional conclusions:

- Nearly all simulated populations have negative growth rates, with many showing high rates of decline. Based on our understanding of the growth dynamics exhibited in the baseline model described earlier in this section, this poor level of population performance most likely reflects the high mortality present in small, isolated ocelot populations subjected to abnormal levels of vehicle impacts.
- Higher levels of reproductive success result in considerably higher levels of stochastic population growth under the same suite of mortality values. Nevertheless, the relatively high levels of vehicle-impact mortality present in the subadult (dispersing) stages included here reduce overall growth rates so that population growth is possible only under the most optimistic mortality schedule.
- A given percentage change in ocelot adult mortality results in a proportionally much larger change in mean population growth rate compared to a change in juvenile mortality of the same magnitude. In other words, the results of our simulation models are considerably more sensitive to adult mortality.

While it is very instructive to investigate the sensitivity of our model to uncertainty in demographic input, it is also important to recognize that detecting mortality rates to the level of precision discussed here is rather impractical at best. For example, statistical power analyses conducted on typical types of field demographic and survey data (e.g., Forcada 2000) suggest that either large sample sizes (say, in the hundreds of individuals) or long periods of observation (10 – 15 years) are necessary to detect meaningful changes in population numbers in the short term with reasonable levels of precision. Similarly, very large and detailed field studies would be required to successfully differentiate between, for example, juvenile mortality rates of 27% and 30%. Consequently, the analysis presented here should typically be used at a more "strategic" level. When faced with the need for population management in the face of measurement uncertainty and limited institutional resources, research and/or management prioritization can be accomplished through a comparative study of sensitivity analysis data. Having said this, it is also important to note that those parameters to which a demographic model is most sensitive may not be the same parameters that are most directly affected by human activities and are therefore putting the population at risk. Successful conservation requires careful additional study to identify the specific risks the populations face and to develop appropriate remedial actions. In the case of the ocelot in south Texas, however, we may in fact have a more direct relationship between the primary demographic drivers influencing population growth dynamics and the anthropogenic factors leading to population endangerment. The next section will explore these relationships in greater detail.

Risk Analysis I: Population Size, Road Mortality, and Extinction Risk

With our demographic sensitivity analysis complete, our next task was to investigate the relationship between the size of an ocelot population and its vulnerability to extinction in the presence of significant anthropogenic disturbance. To do this, we ran simulations for each initial population size discussed in the Input Parameters section across each of three alternative values of female reproductive success, deemed to be one of the most sensitive parameters in our model. This yields a total of 24 different model scenarios. To investigate the impact of road mortality, we then repeated this set of models but removed the additional mortality brought about through vehicle impacts – thereby producing a grand total of 48 models for analysis.

Essentially, our goal in this analysis is to identify, for a given scenario of assumed ocelot demography, the minimum population size necessary to reduce the risk of extinction below a defined threshold. Unfortunately for us biologists, the identification of this extinction threshold is based more on political and social factors than on anything else. The agreement upon a threshold must be done within a more participatory framework that includes a diversity of perspectives among those involved in the management and utilization of the taxon under study.

Table 4 and Figure 4 present the aggregate results of this analysis. Examination of these results lead us to the following conclusions:

- Road mortality has a considerable impact on the estimated viability of our simulated ocelot populations. When this additional mortality source is included, even the largest populations experience rapid population decline and very high extinction probabilities over the 100-year time span of the simulations. Average time to extinction varies from 25 – 50 years. When this additional mortality source is removed, overall population growth rates rebound markedly.
- In the absence of road mortality, small ocelot populations still have a considerable risk of extinction. This results from the detrimental impact of stochastic variability in demographic rates, leading to a general level of population instability and a subsequent reduction in growth potential.
- Under conditions of low reproductive success – i.e., when only 50% of adult females successfully produce a litter in any given year – ocelot populations have a significantly lower growth potential. In fact, inspection of these data indicate that when road mortality is present, the risk of population extinction in 100 years drops below 50% only under the most favorable conditions modeled here: a relatively large population of 150 – 200 individuals with the highest level of female reproductive success (70%). Even here, however, the average growth rate is about -0.025 and the final population size is reduced from the initial value by approximately 80%.

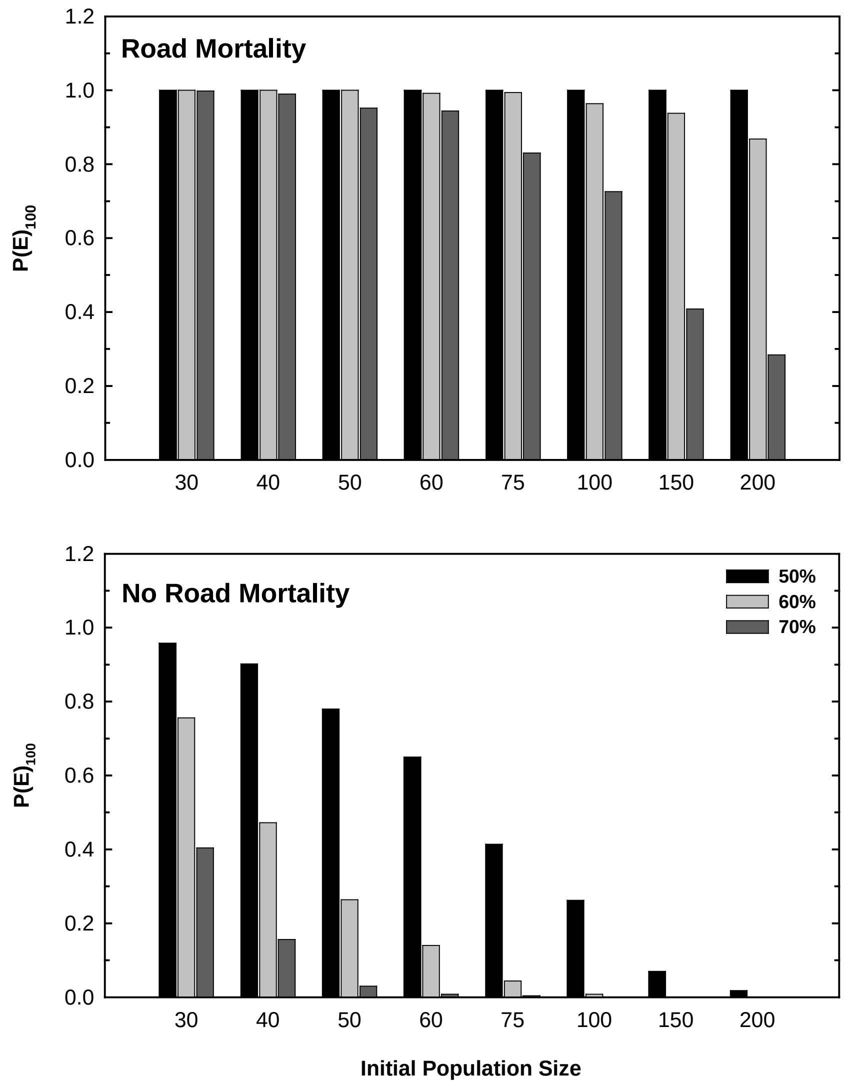
Table 4. South Texas/northern Tamaulipas ocelot PVA. Results of population size risk analysis models in the presence (top half) and absence (bottom half) of road mortality and under alternative conditions of underlying female reproductive success. See page 7 for definitions of column headings.

% ♀♀	**N_0**	**r_s (Obs) (SD)**	**$P(E)_{100}$**	**N_{100} (SD)**	**GD_{100}**	**T(E)**
Road Mortality						
50	30	-0.082 (0.199)	1.000	–	–	25
	40	-0.085 (0.199)	1.000	–	–	29

	50	-0.084 (0.192)	1.000	–	–	32
	60	-0.082 (0.182)	1.000	–	–	34
	75	-0.080 (0.175)	1.000	–	–	38
	100	-0.078 (0.168)	1.000	–	–	43
	150	-0.078 (0.160)	1.000	–	–	48
	200	-0.077 (0.156)	1.000	–	–	52
60	30	-0.062 (0.195)	1.000	–	–	31
	40	-0.061 (0.187)	1.000	–	–	37
	50	-0.059 (0.179)	1.000	–	–	41
	60	-0.057 (0.173)	0.992	6 (2)	0.436	47
	75	-0.057 (0.167)	0.994	9 (6)	0.596	51
	100	-0.056 (0.163)	0.964	7 (5)	0.446	57
	150	-0.053 (0.152)	0.938	12 (15)	0.543	69
	200	-0.050 (0.146)	0.868	13 (11)	0.653	78
70	30	-0.047 (0.194)	0.998	2 (–)	0.000	39
	40	-0.042 (0.180)	0.990	8 (2)	0.354	48
	50	-0.039 (0.170)	0.952	10 (7)	0.544	58
	60	-0.038 (0.165)	0.944	13 (9)	0.573	65
	75	-0.034 (0.157)	0.830	14 (11)	0.590	73
	100	-0.033 (0.150)	0.726	18 (16)	0.608	83
	150	-0.026 (0.131)	0.408	31 (28)	0.729	80
	200	-0.023 (0.123)	0.284	44 (39)	0.780	82
No Road Mortality						

50	30	-0.033 (0.169)	0.958	8 (4)	0.379	50
	40	-0.030 (0.159)	0.902	11 (9)	0.476	61
	50	-0.026 (0.148)	0.780	15 (11)	0.547	79
	60	-0.023 (0.139)	0.650	17 (13)	0.609	73
	75	-0.019 (0.127)	0.414	21 (17)	0.645	76
	100	-0.014 (0.114)	0.262	35 (25)	0.731	81
	150	-0.007 (0.096)	0.070	64 (40)	0.830	87
	200	-0.003 (0.087)	0.018	102 (53)	0.879	92
60	30	-0.011 (0.160)	0.756	11 (7)	0.465	64
	40	-0.002 (0.143)	0.472	20 (11)	0.566	74
	50	0.003 (0.128)	0.264	28 (14)	0.648	77
	60	0.007 (0.117)	0.140	35 (17)	0.693	79
	75	0.014 (0.105)	0.044	52 (21)	0.762	83
	100	0.019 (0.095)	0.008	77 (23)	0.827	81
	150	0.025 (0.087)	0.000	130 (24)	0.888	–
	200	0.028 (0.083)	0.000	180 (25)	0.917	–
70	30	0.013 (0.150)	0.404	18 (8)	0.497	71
	40	0.023 (0.131)	0.156	28 (11)	0.599	77
	50	0.032 (0.115)	0.030	40 (11)	0.684	89
	60	0.036 (0.109)	0.008	50 (12)	0.731	84
	75	0.041 (0.102)	0.004	70 (11)	0.795	74
	100	0.045 (0.095)	0.000	93 (11)	0.838	–
	150	0.050 (0.090)	0.000	144 (10)	0.892	–
	200	0.052 (0.087)	0.000	194 (12)	0.918	–

Figure 4. South Texas / northern Tamaulipas ocelot PVA. 100-year extinction probabilities for simulated populations of different initial sizes in the presence (top panel) and absence (bottom panel) of road mortality and under alternative conditions of adult female reproductive success (indicated by bar shading; see legend in bottom panel). See text for additional model information.

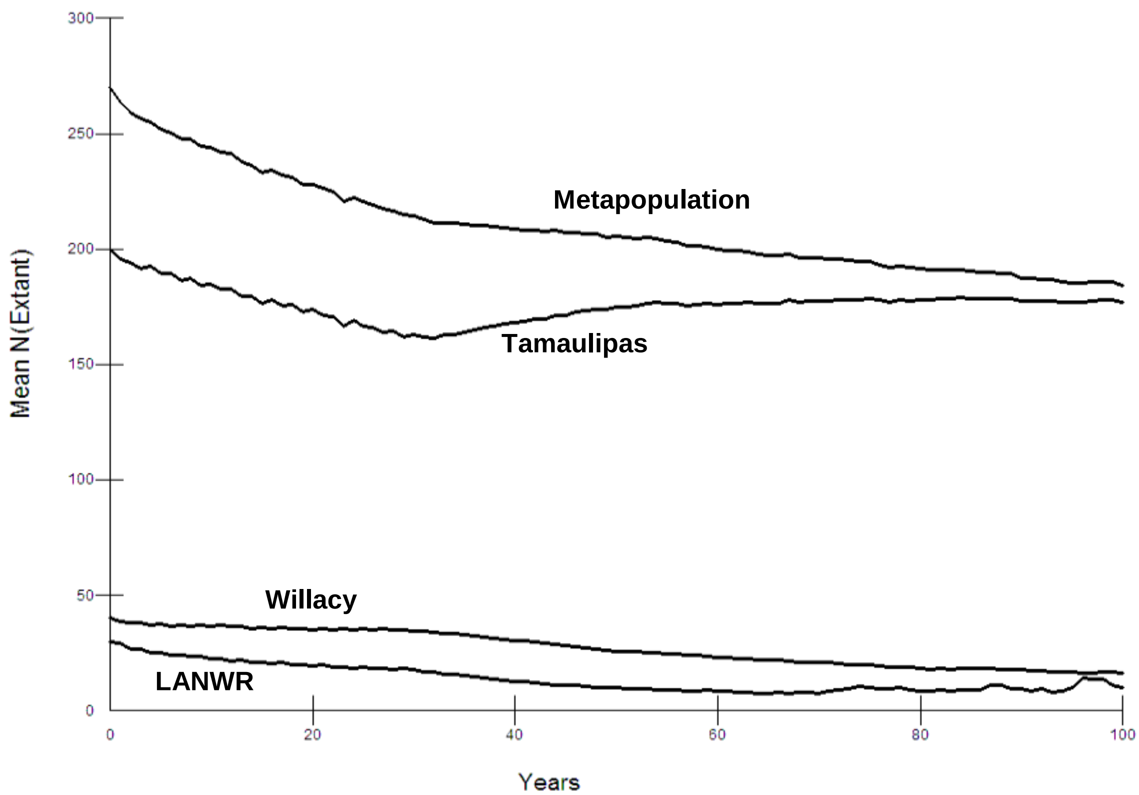


Taken together, these data reinforce the results obtained in our earlier demographic sensitivity analysis: uncertainty in our understanding of intrinsic ocelot breeding rates, and in our understanding of the quantitative impact of road-kill mortality, impairs our ability to make more precise predictions of the fate of ocelot populations subject to human activities. Nevertheless, models like these are invaluable in pointing out the relative importance of these factors in determining the persistence of these populations as humans encroach on their habitat with greater frequency and severity.

Risk Analysis II: Translocation and Metapopulation Viability

A representative population trajectory for each of the metapopulation components is presented in Figure 5, while the full results of the metapopulation analysis are presented in Table 5.

Figure 5. South Texas / northern Tamaulipas ocelot PVA. Representative translocation / metapopulation projection for 100 years, with translocation from Tamaulipas to the two U.S. populations occurring every other year for 30 years. Road mortality is included in this particular model, with a medium level of adult female reproductive success (60% of adult females are assumed to produce a litter each year). See accompanying text for additional model details.



Examination of these data lead us to the following conclusions:

- Even when translocation is used as a conservation strategy, the smaller South Texas populations are at a very high risk of population extinction when road mortality is included in the models. Bi-annual translocations from Tamaulipas are not sufficient to counteract the loss of individuals from vehicle impacts and the population decline resulting from stochastic fluctuations in demographic rates that is characteristic of small populations. When road mortality is removed from the analysis, and we assume a medium level of female reproductive success, all population growth rates are positive and extinction risks are greatly reduced.

Table 5. South Texas / northern Tamaulipas ocelot PVA. Results of metapopulation risk analysis models in the presence (top half) and absence (bottom half) of road mortality and under alternative conditions of underlying female reproductive success. See page 122 for definitions of column headings.

Years	% ♀♀	Population	r_s (Obs) (SD)	$P(E)_{100}$	N_{100} (SD)	GD_{100}	T(E)
30	50	LANWR	-0.048 (0.194)	1.000	–	–	42
		Wilacy	-0.023 (0.154)	0.910	9 (8)	0.487	71
		Tamaulipas	-0.022 (0.109)	0.288	64 (51)	0.796	75
		Metapop	-0.023 (0.099)	0.270	64 (51)	0.798	81
60		LANWR	-0.032 (0.195)	0.994	4 (3)	0.268	56
		Wilacy	-0.011 (0.143)	0.566	13 (8)	0.628	86
		Tamaulipas	-0.054 (0.137)	0.824	24 (26)	0.698	60
		Metapop	-0.034 (0.114)	0.458	18 (19)	0.669	88
30	60	LANWR	-0.033 (0.188)	0.996	10 (8)	0.612	50
		Wilacy	-0.004 (0.145)	0.568	16 (11)	0.578	79
		Tamaulipas	0.018 (0.082)	0.004	177 (33)	0.909	97
		Metapop	0.016 (0.075)	0.004	184 (35)	0.915	97
60		LANWR	-0.022 (0.188)	0.958	7 (4)	0.481	73
		Wilacy	0.012 (0.131)	0.152	20 (11)	0.683	90
		Tamaulipas	0.003 (0.096)	0.112	149 (60)	0.875	66
		Metapop	0.007 (0.080)	0.014	152 (74)	0.883	94
30	70	LANWR	-0.022 (0.183)	0.978	6 (4)	0.340	58
		Wilacy	0.019 (0.135)	0.224	23 (11)	0.614	80
		Tamaulipas	0.046 (0.083)	0.000	194 (10)	0.919	–
		Metapop	0.042 (0.076)	0.000	212 (18)	0.928	–
60		LANWR	-0.009 (0.177)	0.816	10 (6)	0.528	77
		Wilacy	0.034 (0.125)	0.048	28 (10)	0.712	92
		Tamaulipas	0.039 (0.085)	0.000	194 (11)	0.919	–
		Metapop	0.037 (0.075)	0.000	222 (17)	0.933	–
30	50	LANWR	-0.011 (0.163)	0.874	10 (7)	0.473	69
		Wilacy	-0.014	0.772	12 (8)	0.559	74

			(0.151)				
		Tamaulipas	-0.024 (0.116)	0.320	63 (52)	0.795	69
		Metapop	-0.019 (0.099)	0.212	60 (53)	0.781	85
60		LANWR	0.001 (0.153)	0.546	11 (7)	0.598	86
		Wilacy	0.000 (0.139)	0.388	15 (10)	0.665	89
		Tamaulipas	-0.052 (0.140)	0.824	40 (42)	0.750	60
		Metapop	-0.019 (0.101)	0.178	27 (27)	0.746	93
30	60	LANWR	0.008 (0.157)	0.636	13 (8)	0.496	77
		Wilacy	0.010 (0.140)	0.342	21 (11)	0.601	80
		Tamaulipas	0.018 (0.090)	0.008	175 (36)	0.908	61
		Metapop	0.020 (0.079)	0.000	192 (43)	0.918	–
60		LANWR	0.026 (0.147)	0.272	17 (8)	0.636	89
		Wilacy	0.027 (0.127)	0.076	26 (10)	0.706	90
		Tamaulipas	0.005 (0.102)	0.130	155 (57)	0.881	71
		Metapop	0.016 (0.079)	0.002	172 (76)	0.905	93
30	70	LANWR	0.029 (0.150)	0.288	19 (8)	0.540	80
		Wilacy	0.034 (0.131)	0.102	28 (10)	0.642	83
		Tamaulipas	0.046 (0.090)	0.000	194 (12)	0.918	–
		Metapop	0.046 (0.079)	0.000	232 (21)	0.935	–
60		LANWR	0.048 (0.141)	0.088	21 (8)	0.656	91
		Wilacy	0.049 (0.125)	0.014	31 (10)	0.723	94
		Tamaulipas	0.038 (0.092)	0.002	192 (16)	0.916	64
		Metapop	0.043 (0.078)	0.000	241 (24)	0.940	–

- Longer periods of translocation can improve the viability of the south Texas ocelot populations, but at the expense of the Tamaulipas population: longer translocation programs actually *increase* the risk of extinction in the source population. The Tamaulipas population, despite the absence of appreciable mortality from vehicle impacts, is not large enough to demographically withstand the removal of four females bi-annually. This conclusion, however, is dependent on the assumption that the source population in Tamaulipas is just 200 individuals, distributed relatively close to the border with the United States. This assumption may be unrealistic; the source population may in fact be considerably larger – perhaps up to 1,000 individuals – if we base our population size estimate across the entire state. In this case, the removal of a relatively small number of ocelots will have a much smaller demographic impact. Care must be given in determining the total source population size before setting quantitative targets for translocation to smaller population in south Texas.

All in all, a carefully-designed translocation strategy appears to have considerable promise as a means of improving the viability of small remnant populations of ocelots on south Texas. Such a strategy, however, cannot be so aggressive as to compromise the demographic and genetic health of the source population in Tamaulipas. Vigilant monitoring of a program like this would be necessary, combined with improved transport protocols designed to minimize transit mortality, in order for long-term program success to be a realistic goal.

Future Directions for Additional Analysis

Impacts of habitat loss
Our models do not currently include a simulation of gradual erosion – or, for that matter, recovery – of ocelot habitat in south Texas and northern Tamaulipas. This is certainly a real possibility as the burgeoning human population expands into more and more urban areas. We need to better understand the nature of this expansion, and its specific impacts on both quantity and quality of ocelot habitat.

Impacts of disease
Preliminary discussions during baseline model development included the possibility of disease epidemics impacting ocelot populations in this area. While recognizing the potential risks, we were unable to parameterize a disease model with any real confidence at this time. Further discussions would be necessary to understand this process in greater detail.

Density-dependent survival
There was concern among workshop participants that we were not accurately modeling density dependent mortality in ocelot populations. It is quite likely that as population size decreases, rates of fecundity and survival may actually increase as competition for space, food and mates is reduced. This needs to be studied in more detail so that more accurate models can be developed.

Conclusions

We may conclude our preliminary analysis of south Texas/northern Tamaulipas ocelot population viability by returning to the original set of questions that provided the foundation for our study.

- *What is our best estimate of stochastic population dynamics of this species in its current range?*

  Based on our current understanding of the demographics of ocelot populations occupying south Texas and northern Tamaulipas, these populations, particularly those in south Texas, appear to be at a considerable risk of extinction through the action of intrinsic, stochastic fluctuations in demographic rates that are the hallmark of very small, isolated populations of wildlife. Moreover, this risk is directly tied to the activities of humans in the area, namely the construction and use of roads throughout ocelot habitat.

- *What are the primary factors that drive population growth dynamics of ocelots in south Texas and northern Tamaulipas?*

  Our preliminary set of PVA models discussed here show that ocelot growth dynamics is largely driven by adult female reproductive success, defined here as the proportion of adult females successfully producing a litter in a given year. Moreover, the additional levels of mortality brought about by vehicle collisions is a primary factor in determining the future growth dynamics of any given population subjected to such activity.

- *How vulnerable are small, fragmented populations of ocelots in south Texas and northern Tamaulipas to local extinction in the absence of demographic interaction with other populations?*

  Small populations of ocelots, for example, those numbering less than 100 individuals, have an elevated risk of extinction compared to their larger counterparts. When additional anthropogenic mortality is included in our analyses, even larger populations do not appear to be able to tolerate this kind of additional demographic stress.

- *What are the benefits to the ocelot of increasing range and connectivity in the landscape?*

  Because of the risk of extinction through isolation discussed above, range increase through habitat improvements may result in greater levels of ocelot population increase and, as a result, a reduced risk of extinction. This, of course, also depends on the success of mitigating human-mediated processes such as road mortality. As an alternative conservation measure, connecting small ocelot populations through the use of landscape corridors may provide an additional buffer against extinction risk. However, this strategy will meet with the greatest level of success when 1) individual subpopulations are increased in size in a way that approaches some level of viability in the absence of connectivity, 2) dispersal rates, whether natural or artificial, are sufficiently high to maintain a functioning metapopulation, and 3) anthropogenic sources of mortality are reduced to acceptable levels.

- *How successful might translocation be as a conservation management strategy for smaller populations of ocelots in south Texas?*

  Our models indicate that, based on our best understanding of the demographics of ocelots in this portion of their range, the input of a relatively small number of individuals can have a significant positive impact on the viability of endangered recipient populations. Preliminary analyses indicate that just one to two females injected into a population on a bi-annual basis may be enough to compensate for the destabilizing effect of stochastic demography operating on small populations.

- *How many animals could be removed from a given source population such as northern Tamaulipas for augmentation of smaller populations in south Texas at risk of extinction without negatively impacting the persistence of the source?*

  It appears that careful consideration must be given to the extent of removal of ocelots from the source population in Tamaulipas. Removing four subadult females every other year, comprising approximately 4% of the total female population, may put the population at some risk if translocations last longer than 40 to 50 years. A smaller number of individuals could no doubt be removed more easily, but the assumed transit mortality would lead to a greatly reduced demographic benefit to the recipient populations. These conclusions are strongly dependent on our assumptions of overall ocelot population size in the source regions of Tamaulipas; risks to this population may be reduced substantially if our estimates of total population size are increased.

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Appendix III-I

Simulation Modeling and Population Viability Analysis

A model is any simplified representation of a real system. We use models in all aspects of our lives, in order to: (1) extract the important trends from complex processes, (2) permit comparison among systems, (3) facilitate analysis of causes of processes acting on the system, and (4) make predictions about the future. A complete description of a natural system, if it were possible, would often decrease our understanding relative to that provided by a good model, because there is "noise" in the system that is extraneous to the processes we wish to understand. For example, the typical representation of the growth of a wildlife population by an annual percent growth rate is a simplified mathematical model of the much more complex changes in population size. Representing population growth as an annual percent change assumes constant exponential growth, ignoring the irregular fluctuations as individuals are born or immigrate, and die or emigrate. For many purposes, such a simplified model of population growth is very useful, because it captures the essential information we might need regarding the average change in population size, and it allows us to make predictions about the future size of the population. A detailed description of the exact changes in numbers of individuals, while a true description of the population, would often be of much less value because the essential pattern would be obscured, and it would be difficult or impossible to make predictions about the future population size.

In considerations of the vulnerability of a population to extinction, as is so often required for conservation planning and management, the simple model of population growth as a constant annual rate of change is inadequate for our needs. The fluctuations in population size that are omitted from the standard ecological models of population change can cause population extinction, and therefore are often the primary focus of concern. In order to understand and predict the vulnerability of a wildlife population to extinction, we need to use a model which incorporates the processes which cause fluctuations in the population, as well as those which control the long-term trends in population size (Shaffer 1981). Many processes can cause fluctuations in population size: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), decimation of the population or its habitats by humans, the chance results of the probabilistic events in the lives of individuals (sex determination, location of mates, breeding success, survival), and interactions among these factors (Gilpin and Soulé 1986).

Models of population dynamics which incorporate causes of fluctuations in population size in order to predict probabilities of extinction, and to help identify the processes which contribute to a population's vulnerability, are used in "Population Viability Analysis" (PVA) (Lacy 1993/4). For the purpose of predicting vulnerability to extinction, any and all population processes that impact population dynamics can be important. Much analysis of conservation issues is conducted by largely intuitive assessments by biologists with experience with the system. Assessments by experts can be quite valuable, and are often contrasted with "models" used to evaluate population vulnerability to extinction. Such a contrast is not valid, however, as *any* synthesis of facts and understanding of processes constitutes a model, even if it is a mental model within the mind of the expert and perhaps only vaguely specified to others (or even to the expert himself or herself).

A number of properties of the problem of assessing vulnerability of a population to extinction make it difficult to rely on mental or intuitive models. Numerous processes impact population dynamics, and many of the factors interact in complex ways. For example, increased fragmentation of habitat can make it more difficult to locate mates, can lead to greater mortality as individuals disperse greater distances across unsuitable habitat, and can lead to increased inbreeding which in turn can further reduce ability to attract mates and to survive. In addition, many of the processes impacting population dynamics are intrinsically probabilistic, with a random component. Sex determination, disease, predation, mate acquisition -- indeed, almost all events in the life of an individual -- are stochastic events, occurring with certain probabilities rather than with absolute certainty at any given time. The consequences of factors influencing population dynamics are often delayed for years or even generations. With a long-lived species, a population might persist for 20 to 40 years beyond the emergence of factors that ultimately cause extinction. Humans can synthesize mentally only a few factors at a time, most people have difficulty assessing probabilities intuitively, and it is difficult to consider delayed effects. Moreover, the data needed for models of population dynamics are often very uncertain. Optimal decision-making when data are uncertain is difficult, as it involves correct assessment of probabilities that the true values fall within certain ranges, adding yet another probabilistic or chance component to the evaluation of the situation.

The difficulty of incorporating multiple, interacting, probabilistic processes into a model that can utilize uncertain data has prevented (to date) development of analytical models (mathematical equations developed from theory) which encompass more than a small subset of the processes known to affect wildlife population dynamics. It is possible that the mental models of some biologists are sufficiently complex to predict accurately population vulnerabilities to extinction under a range of conditions, but it is not possible to assess objectively the precision of such intuitive assessments, and it is difficult to transfer that knowledge to others who need also to evaluate the situation. Computer simulation models have increasingly been used to assist in PVA. Although rarely as elegant as models framed in analytical equations, computer simulation models can be well suited for the complex task of evaluating risks of extinction. Simulation models can include as many factors that influence population dynamics as the modeler and the user of the model want to assess. Interactions between processes can be modeled, if the nature of those interactions can be specified. Probabilistic events can be easily simulated by computer programs, providing output that gives both the mean expected result and the range or distribution of possible outcomes. In theory, simulation programs can be used to build models of population dynamics that include all the knowledge of the system which is available to experts. In practice, the models will be simpler, because some factors are judged unlikely to be important, and because the persons who developed the model did not have access to the full array of expert knowledge.

Although computer simulation models can be complex and confusing, they are precisely defined and all the assumptions and algorithms can be examined. Therefore, the models are objective, testable, and open to challenge and improvement. PVA models allow use of all available data on the biology of the taxon, facilitate testing of the effects of unknown or uncertain data, and expedite the comparison of the likely results of various possible management options.

PVA models also have weaknesses and limitations. A model of the population dynamics does not define the goals for conservation planning. Goals, in terms of population growth, probability of persistence, number of extant populations, genetic diversity, or other measures of population performance must be defined by the management authorities before the results of population modeling can be used. Because the models incorporate many factors, the number of possibilities to test can seem endless, and it can be difficult to determine which of the factors that were analyzed are most important to the population dynamics. PVA models are necessarily incomplete. We can model only those factors which we understand and for which we can specify the parameters. Therefore, it is important to realize that the models probably underestimate the threats facing the population. Finally, the models are used to predict the long-term effects of the processes presently acting on the population. Many aspects of the situation could change radically within the time span that is modeled. Therefore, it is important to reassess the data and model results periodically, with changes made to the conservation programs as needed.

The *VORTEX* Population Viability Analysis Model

For the analyses presented here, the *VORTEX* computer software (Lacy 1993) for population viability analysis was used. *VORTEX* models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of inbreeding in small populations. *VORTEX* also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations.

Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. The carrying capacity can be specified to change linearly over time, to model losses or gains in the amount or quality of habitat. Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size.

VORTEX models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. During the simulation, *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or “expected heterozygosity”) relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

VORTEX is an *individual-based* model. That is, *VORTEX* creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. *VORTEX* keeps track of the sex, age, and parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modeled by determining for each animal in each year of the simulation whether any of the events occur. (See figure below.) Events occur according to the specified age and sex-specific probabilities. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

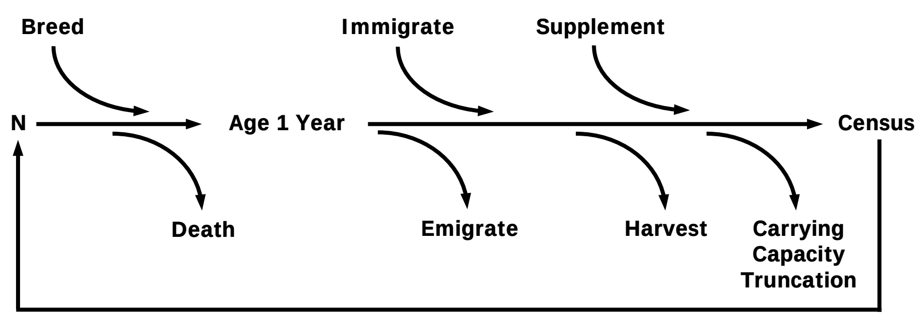
VORTEX requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the catastrophes on survival and reproduction must be specified. Rates of migration (dispersal) between each pair of local populations must be specified. Because *VORTEX* requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

Further information on *VORTEX* is available in Lacy (2000) and Miller and Lacy (2003).

Dealing with Uncertainty

It is important to recognize that uncertainty regarding the biological parameters of a population and its consequent fate occurs at several levels and for independent reasons. Uncertainty can occur because the parameters have never been measured on the population. Uncertainty can occur because limited field data have yielded estimates with potentially large sampling error. Uncertainty can occur because independent studies have generated discordant estimates. Uncertainty can occur because environmental conditions or population status have been changing over time, and field surveys were conducted during periods which may not be

VORTEX Simulation Model Timeline



Events listed above the timeline increase N, while
events listed below the timeline decrease N.

representative of long-term averages. Uncertainty can occur because the environment will change in the future, so that measurements made in the past may not accurately predict future conditions.

Sensitivity testing is necessary to determine the extent to which uncertainty in input parameters results in uncertainty regarding the future fate of the pronghorn population. If alternative plausible parameter values result in divergent predictions for the population, then it is important to try to resolve the uncertainty with better data. Sensitivity of population dynamics to certain parameters also indicates that those parameters describe factors that could be critical determinants of population viability. Such factors are therefore good candidates for efficient management actions designed to ensure the persistence of the population.

The above kinds of uncertainty should be distinguished from several more sources of uncertainty about the future of the population. Even if long-term average demographic rates are known with precision, variation over time caused by fluctuating environmental conditions will cause uncertainty in the fate of the population at any given time in the future. Such environmental variation should be incorporated into the model used to assess population dynamics, and will generate a range of possible outcomes (perhaps represented as a mean and standard deviation) from the model. In addition, most biological processes are inherently stochastic, having a random component. The stochastic or probabilistic nature of survival, sex determination, transmission of genes, acquisition of mates, reproduction, and other processes preclude exact determination of the future state of a population. Such demographic stochasticity should also be incorporated into a population model, because such variability both increases our uncertainty about the future and can also change the expected or mean outcome relative to that which would result if there were no such variation. Finally, there is "uncertainty" which represents the alternative actions or interventions which might be pursued as a management strategy. The likely effectiveness of such management options can be explored by testing alternative scenarios in the model of population dynamics, in much the same way that sensitivity testing is used to explore the effects of uncertain biological parameters.

Demographic Stochasticity

VORTEX models demographic stochasticity by determining the occurrence of probabilistic events such as reproduction, litter size, sex determination, and death with a pseudo-random number generator. For each life event, if the random value sampled from a specified distribution falls above the user-specified probability, the event is deemed to have occurred, thereby simulating a binomial process. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

The source code used to generate random numbers uniformly distributed between 0 and 1 was obtained from Maier (1991), based on the algorithm of Kirkpatrick and Stoll (1981). Random deviates from binomial distributions, with mean p and standard deviation s, are obtained by first determining the integral number of binomial trials, N, that would produce the value of s closest to the specified value, according to:

$$N = \frac{p(1-p)}{s^2}$$

N binomial trials are then simulated by sampling from the uniform 0-1 distribution to obtain the desired result, the frequency or proportion of successes. If the value of N determined for a desired binomial distribution is larger than 25, a normal approximation is used in place of the binomial distribution. This normal approximation must be truncated at 0 and at 1 to allow use in defining probabilities, although, with such large values of N, s is small relative to p and the truncation would be invoked only rarely. To avoid introducing bias with this truncation, the normal approximation to the binomial (when used) is truncated symmetrically around the mean. The algorithm for generating random numbers from a unit normal distribution follows Latour (1986).

Environmental Variation

VORTEX can model annual fluctuations in birth and death rates and in carrying capacity as might result from environmental variation. To model environmental variation, each demographic parameter is assigned a distribution with a mean and standard deviation that is specified by the user. Annual fluctuations in probabilities of reproduction and mortality are modeled as binomial distributions. Environmental variation in carrying capacity is modeled as a normal distribution. Environmental variation in demographic rates can be correlated among populations.

Catastrophes

Catastrophes are modeled in *VORTEX* as random events that occur with specified probabilities. A catastrophe will occur if a randomly generated number between zero and one is less than the probability of occurrence. Following a catastrophic event, the chances of survival and successful breeding for that simulated year are multiplied by severity factors. For example, forest fires might occur once in 50 years, on average, killing 25% of animals, and reducing breeding by survivors 50% for the year. Such a catastrophe would be modeled as a random event with 0.02 probability of occurrence each year, and severity factors of 0.75 for survival and 0.50 for reproduction. Catastrophes can be local (impacting populations independently), or regional (affecting sets of populations simultaneously).

Genetic Processes

VORTEX models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical neutral (non-selected) genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. Each offspring created during the simulation is randomly assigned one of the alleles from each parent. *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or "expected heterozygosity") relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

Inbreeding depression is modeled as a loss of viability of inbred animals during their first year. The severity of inbreeding depression is commonly measured by the number of "lethal equivalents" in a population (Morton *et al.* 1956). The number of lethal equivalents per diploid genome estimates the average number of lethal alleles per individual in the population if all deleterious effects of inbreeding were due entirely to recessive lethal alleles. A population in which inbreeding depression is one lethal equivalent per diploid genome may have one recessive lethal allele per individual, it may have two recessive alleles per individual, each of which confer a 50% decrease in survival, or it may have some other combination of recessive deleterious alleles which equate in effect with one lethal allele per individual.

VORTEX partitions the total effect of inbreeding (the total lethal equivalents) into an effect due to recessive lethal alleles and an effect due to loci at which there is heterozygote advantage (superior fitness of heterozygotes relative to all homozygote genotypes). To model the effects of lethal alleles, each founder starts with a unique recessive lethal allele (and a dominant non-lethal allele) at up to five modeled loci. By virtue of the deaths of individuals that are homozygous for lethal alleles, such alleles can be removed slowly by natural selection during the generations of a simulation. This diminishes the probability that inbred individuals in subsequent generations will be homozygous for a lethal allele.

Heterozygote advantage is modeled by specifying that juvenile survival is related to inbreeding

$$\ln(S) = A - B F$$

according to the logarithmic model: in which *S* is survival, *F* is the inbreeding coefficient, *A* is the logarithm of survival in the absence of inbreeding, and *B* is the portion of the lethal equivalents per haploid genome that is due to heterozygote advantage rather than to recessive lethal alleles. Unlike the situation with fully recessive deleterious alleles, natural selection does not remove deleterious alleles at loci in which the heterozygote has higher fitness than both homozygotes, because all alleles are deleterious when homozygous and beneficial when present in heterozygous combination with other alleles. Thus, under heterozygote advantage, the impact of inbreeding on survival does not diminish during repeated generations of inbreeding. Unfortunately, for relatively few species are data available to allow estimation of the effects of inbreeding, and the magnitude of these effects apparently varies considerably among species (Falconer 1981; Ralls *et al.* 1988; Lacy *et al.* 1992) and even among populations of the same species (Lacy *et al.* 1996). Even without detailed pedigree data from which to estimate the number of lethal equivalents in a population and the underlying nature of the genetic load (recessive alleles or heterozygote advantage), PVAs must make assumptions about the effects of inbreeding on the population being studied. If genetic effects are ignored, the PVA will overestimate the viability of small populations. In some cases, it might be considered appropriate to assume that an inadequately studied species would respond to inbreeding in accord with the median (3.14 lethal equivalents per diploid) reported in the survey by Ralls *et al.* (1988). In other cases, there might be reason to make more optimistic assumptions (perhaps the lower quartile, 0.90 lethal equivalents), or more pessimistic assumptions (perhaps the upper quartile, 5.62 lethal equivalents). In the few species in which inbreeding depression has been studied carefully, about half of the effects of inbreeding are due recessive lethal alleles and about half of the effects are due to heterozygote advantage or other genetic mechanisms that are not diminished by natural selection during generations of inbreeding, although the proportion of the total inbreeding effect can vary substantially among populations (Lacy and Ballou 1998).

A full explanation of the genetic mechanisms of inbreeding depression is beyond the scope of this manual, and interested readers are encouraged to refer to the references cited above.

VORTEX can model monogamous or polygamous mating systems. In a monogamous system, a relative scarcity of breeding males may limit reproduction by females. In polygamous or monogamous models, the user can specify the proportion of the adult males in the breeding pool.

Males are randomly reassigned to the breeding pool each year of the simulation, and all males in the breeding pool have an equal chance of siring offspring.

Deterministic Processes

VORTEX can incorporate several deterministic processes, in addition to mean age-specific birth and death rates. Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. Each animal in the population has an equal probability of being removed by this truncation. The carrying capacity can be specified to change over time, to model losses or gains in the amount or quality of habitat.

Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size. The default functional relationship between breeding and density allows entry of Allee effects (reduction in breeding at low density) and/or reduced breeding at high densities.

Populations can be supplemented or harvested for any number of years in each simulation. Harvest may be culling or removal of animals for translocation to another (unmodeled) population. The numbers of additions and removals are specified according to the age and sex of animals.

Migration Among Populations

VORTEX can model up to 50 populations, with possibly distinct population parameters. Each pairwise migration rate is specified as the probability of an individual moving from one population to another. Migration among populations can be restricted to one sex and/or a limited age cohort. Emigration from a population can be restricted to occur only when the number of animals in the population exceeds a specified proportion of the carrying capacity. Dispersal mortality can be specified as a probability of death for any migrating animal, which is in addition to age-sex specific mortality. Because of between-population migration and managed supplementation, populations can be recolonized. *VORTEX* tracks the dynamics of local extinctions and recolonizations through the simulation.

Output

VORTEX outputs: **(1)** probability of extinction at specified intervals (e.g., every 10 years during a 100 year simulation), **(2)** median time to extinction, if the population went extinct in at least 50% of the simulations, **(3)** mean time to extinction of those simulated populations that became extinct, and **(4)** mean size of, and genetic variation within, extant populations.

Standard deviations across simulations and standard errors of the mean are reported for population size and the measures of genetic variation. Under the assumption that extinction of independently replicated populations is a binomial process, the standard error of the probability

$$SE(p) = \sqrt{\frac{p(1-p)}{n}}$$

of extinction is reported by *VORTEX* as: in which the frequency of extinction was p over n simulated populations. Demographic and genetic statistics are calculated and reported for each subpopulation and for the metapopulation.

Sequence of Program Flow

(1) The seed for the random number generator is initialized with the number of seconds elapsed since the beginning of the 20th century.

(2) The user is prompted for an output file name, duration of the simulation, number of iterations, the size below which a population is considered extinct, and a large number of population parameters.

(3) The maximum allowable population size (necessary for preventing memory overflow) is

$$K_{max} = (K + 3s)(1 + L)$$

calculated as: in which K is the maximum carrying capacity (carrying capacity can be specified to change during a simulation, so the maximum carrying capacity can be greater than the initial carrying capacity), s is the annual environmental variation in the carrying capacity expressed as a standard deviation, and L is the specified maximum litter size.

(4) Memory is allocated for data arrays. If insufficient memory is available for data arrays then N_{max} is adjusted downward to the size that can be accommodated within the available memory and a warning message is given. In this case it is possible that the analysis may have to be terminated because the simulated population exceeds N_{max}. Because N_{max} is often several-fold greater than the likely maximum population size in a simulation, a warning that it has been adjusted downward because of limiting memory often will not hamper the analyses.

(5) The deterministic growth rate of the population is calculated from mean birth and death rates that have been entered. Algorithms follow cohort life-table analyses (Ricklefs 1979). Generation time and the expected stable age distribution are also calculated. Life-table calculations assume constant birth and death rates, no limitation by carrying capacity, no limitation of mates, no loss of fitness due to inbreeding depression, and that the population is at the stable age distribution. The effects of catastrophes are incorporated into the life table analysis by using birth and death rates that are weighted averages of the values in years with and without catastrophes, weighted by the probability of a catastrophe occurring or not occurring.

(6) Iterative simulation of the population proceeds via steps 7 through 26 below.

(7) The starting population is assigned an age and sex structure. The user can specify the exact age-sex structure of the starting population, or can specify an initial population size and request that the population be distributed according to the stable age distribution calculated from the life table. Individuals in the starting population are assumed to be unrelated. Thus, inbreeding can occur only in second and later generations.

(8) Two unique alleles at a hypothetical neutral genetic locus are assigned to each individual in the starting population and to each individual supplemented to the population during the simulation. *VORTEX* therefore uses an infinite alleles model of genetic variation. The subsequent fate of genetic variation is tracked by reporting the number of extant neutral alleles each year, the expected heterozygosity or gene diversity, and the observed

$$H_e = 1 - \sum \left(p_i^2\right)$$

heterozygosity. The expected heterozygosity, derived from the Hardy-Weinberg equilibrium, is given byin which p_i is the frequency of allele *i* in the population. The observed heterozygosity is simply the proportion of the individuals in the simulated population that are heterozygous. Because of the starting assumption of two unique alleles per founder, the initial population has an observed heterozygosity of 1.0 at the hypothetical locus and only inbred animals can become homozygous. Proportional loss of heterozygosity through random genetic drift is independent of the initial heterozygosity and allele frequencies of a population (Crow and Kimura 1970), so the expected heterozygosity remaining in a simulated population is a useful metric of genetic decay for comparison across scenarios and populations. The mean observed heterozygosity reported by *VORTEX* is the mean inbreeding coefficient of the population.

(9) For each of the10 alleles at five non-neutral loci that are used to model inbreeding depression, each founder is assigned a unique lethal allele with probability equal to 0.1 x the mean number of lethal alleles per individual.

(10) Years are iterated via steps 11 through 25 below.

(11) The probabilities of females producing each possible size litter are adjusted to account for density dependence of reproduction (if any).

(12) Birth rate, survival rates, and carrying capacity for the year are adjusted to model environmental variation. Environmental variation is assumed to follow binomial distributions for birth and death rates and a normal distribution for carrying capacity, with mean rates and standard deviations specified by the user. At the outset of each year a random number is drawn from the specified binomial distribution to determine the percent of females producing litters. The distribution of litter sizes among those females that do breed is maintained constant. Another random number is drawn from a specified binomial distribution to model the environmental variation in mortality rates. If environmental variations in reproduction and mortality are chosen to be correlated, the random number used to specify mortality rates for the year is chosen to be the same percentile of its binomial distribution as was the number used to specify reproductive rate. Otherwise, a new random number is drawn to specify the deviation of age- and sex-specific mortality rates from their means. Environmental variation across years in mortality rates is always forced to be correlated among age and sex classes.

The carrying capacity (*K*) for the year is determined by first increasing or decreasing the carrying capacity at year 1 by an amount specified by the user to account for changes over time. Environmental variation in K is then imposed by drawing a random number from a normal distribution with the specified values for mean and standard deviation.

(13) Birth rates and survival rates for the year are adjusted to model any catastrophes determined to have occurred in that year.

(14) Breeding males are selected for the year. A male of breeding age is placed into the pool of potential breeders for that year if a random number drawn for that male is less than the proportion of adult males specified to be breeding. Breeding males are selected independently each year; there is no long-term tenure of breeding males and no long-term pair bonds.

(15) For each female of breeding age, a mate is drawn at random from the pool of breeding males for that year. If the user specifies that the breeding system is monogamous, then each male can only be paired with a single female each year. Males are paired only with those females which have already been selected for breeding that year. Thus, males will not be the limiting sex unless there are insufficient males to pair with the successfully breeding females.

If the breeding system is polygynous, then a male may be selected as the mate for several females. The degree of polygyny is determined by the proportion of males in the pool of potential breeders each year.

The size of the litter produced by that pair is determined by comparing the probabilities of each potential litter size (including litter size of 0, no breeding) to a randomly drawn number. The offspring are produced and assigned a sex by comparison of a random number to the specified birth sex ratio. Offspring are assigned, at random, one allele at the hypothetical genetic locus from each parent.

(16) The genetic kinship of each new offspring to each other living animal in the population is

$$f_{AB} = 0.5(f_{MB} + f_{PB})$$

determined. The kinship between new animal A, and another existing animal, B, is in which f_{ij} is the kinship between animals i and j, M is the mother of A, and P is the father of A. The inbreeding coefficient of each animal is equal to the kinship between its parents, $F = f_{MP}$, and the kinship of an animal to itself is $f_A = 0.5(1 + F)$. (See Ballou 1983 for a detailed description of this method for calculating inbreeding coefficients.)

(17) The survival of each animal is determined by comparing a random number to the survival probability for that animal. In the absence of inbreeding depression, the survival probability is given by the age and sex-specific survival rate for that year. If a newborn individual is homozygous for a lethal allele, it is killed. Otherwise, the survival probability for

$$e^{-b(1-\mathrm{Pr}[Lethal])F}$$

individuals in their first year is multiplied by in which b is the number of lethal equivalents per haploid genome, and Pr[*Lethals*] is the proportion of this inbreeding effect due to lethal alleles.

(18) The age of each animal is incremented by 1.

(19) If more than one population is being modeled, migration among populations occurs stochastically with specified probabilities.

(20) If population harvest is to occur that year, the number of harvested individuals of each age and sex class are chosen at random from those available and removed. If the number to be removed does not exist for an age-sex class, *VORTEX* continues but reports that harvest was incomplete.

(21) Dead animals are removed from the computer memory to make space for future generations.

(22) If population supplementation is to occur in a particular year, new individuals of the specified age-class are created. Each immigrant is assumed to be genetically unrelated to all other individuals in the population, and it carries the number of lethal alleles that was specified for the starting population.

(23) The population growth rate is calculated as the ratio of the population size in the current year to the previous year.

(24) If the population size (N) exceeds the carrying capacity (K) for that year, additional mortality is imposed across all age and sex classes. The probability of each animal dying during this carrying capacity truncation is set to $(N - K)/N$, so that the expected population size after the additional mortality is K.

(25) Summary statistics on population size and genetic variation are tallied and reported.

(26) Final population size and genetic variation are determined for the simulation.

(27) Summary statistics on population size, genetic variation, probability of extinction, and mean population growth rate are calculated across iterations and output.

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Appendix IV – Programs and Resources to Assist Landowners and Partners in Implementing the Ocelot Recovery Plan.

GENERAL INFORMATION ABOUT OCELOTS

Websites

US Fish & Wildlife Service (USFWS):
http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A084

Laguna Atascosa National Wildlife Refuge: http://www.fws.gov/refuge/laguna_atascosa/

Lower Rio Grande Valley National Wildlife Refuge:
http://www.fws.gov/refuge/lower_rio_grande_valley/

Santa Ana National Wildlife Refuge:
http://www.fws.gov/refuge/santa_ana/

Nature Serve:
http://explorer.natureserve.org/servlet/NatureServe?searchSciOrCommonName=ocelot&x=0&y=0

IUCN Red List: http://www.iucnredlist.org/details/11509/0

STATE PROGRAMS

Arizona

Arizona Game and Fish Department (AGFD): http://www.gf.state.az.us/.

Heritage Grants Program (http://www.azgfd.gov/w_c/heritage_program.shtml)
AGFD's Identification, Inventory, Acquisition, Protection and Management of Sensitive Habitats (IIAPM) sub-program provides funds through a competitive process for projects that preserve and enhance Arizona's natural biological diversity. The funding focus is directed toward species and habitat objectives that will give the greatest return for the Heritage funds invested. Contact the Heritage Grants Coordinator (602/789-3530) or visit the website at: http://www.gf.state.az.us/w_c/heritage_apply.shtml

Landowner Incentive Program (LIP)
This program provides funds for on-the-ground activities that enhance habitats or provide other conservation benefits for "at risk" species on private lands. The LIP is a grant program establishing a partnership among Federal/state governments and private landowners. At the Federal level, administrative oversight will be provided by the USFWS. The USFWS will award grants to states for programs that enhance, protect, and/or restore habitats that benefit federally-listed species, proposed or candidate species, or other species at risk on private lands. The

state's role in the implementation of LIP is to provide technical and financial assistance to private landowners for projects that meet the aforementioned criteria. The private landowner role is to provide the habitat necessary to accomplish the objectives of LIP. Additionally, the USFWS requires a 25% non-Federal match, cash or in-kind contribution, to be eligible for these funds. In Arizona, contact: Landowner Relations Program Manager, 2221 W. Greenway Rd., Phoenix, AZ 85023-4312, AGFD's Regional Habitat Program in Tucson (520/628-5376), or visit the website at: http://www.gf.state.az.us/outdoor_recreation/landowner_lip.shtml

State Wildlife Grants Program via Comprehensive Wildlife Conservation Program (CWCP)
This nationwide program is designed to provide financial assistance in response to proposals to research, monitor, or implement conservation measures for threatened or endangered species. For Arizona, information is available at the website: http://www.gf.state.az.us/w_c/cwcs.shtml

Stewardship Program
This program provides technical management assistance, including use of heavy equipment, materials, and labor, or reimbursement of materials and labor, to enhance wildlife habitat and populations. Projects can occur on private or public lands. Contact AGFD's Regional Habitat Programs in Tucson (520/628-5376).

Arizona Department of Water Resources

The Arizona Water Protection Fund Commission
All applicants will be required to demonstrate the direct benefit(s) to rivers, streams, and/or riparian habits in their proposals. Complete information regarding the grant cycle, including workshop times, is posted on the Arizona Water Protection Fund website: http://www.azwpf.gov/

Texas

Texas Parks and Wildlife Department (TPWD): http://www.tpwd.state.tx.us

Landowner Incentive Program (LIP)
http://www.tpwd.state.tx.us/landwater/land/private/lip/
This program encourages creative and effective projects for conserving rare species and provides financial incentives. As most rare species inhabit privately owned and managed lands in Texas, use contacts found on the website to determine which species are found locally (http://www.tpwd.state.tx.us/landwater/land/habitats/). Funds can be used for projects that enhance, restore, or protect habitat. For information, contact: Cecily Warren, Texas Parks & Wildlife Department, 4200 Smith School Road, Austin, Texas 78744 (512/389-4799).

Private Lands and Habitat Management Program
This program provides advice and information specifically tailored to each property and wildlife assemblage therein. The goals are to enhance habitat quality and property values, and conserve wildlife. Devising a management plan specific to each property involves a meeting with a biologist and then the formulation of recommendations that will incorporate the landowner's goals, management of wildlife as a renewable natural resource, and increased ecological

diversity. For more information, visit the website at:
http://www.tpwd.state.tx.us/landwater/land/private/description/

State Wildlife Grants Program via Comprehensive Wildlife Conservation Program (CWCP)
This nationwide program, funded by the USFWS, is designed to provide financial assistance in response to proposals to research, monitor, or implement conservation measures for threatened or endangered species. For Texas, a copy of the program may be reviewed at:
http://www.tpwd.state.tx.us/business/grants/wildlife/cwcs/

Transportation Programs

National Scenic Byways Grants Program
This program provides funds for areas located along a National Scenic Byway, All-American Road, or State Scenic Byway. Corridor management plans, and natural resource protection through acquiring scenic easements are among the eligible projects. See the website at:
http://www.fhwa.dot.gov/hep/scenic_byways/grants/

Transportation Enhancement Program
This program funds a wide range of projects, including those that reduce vehicular collisions with wildlife and maintain habitat connectivity. Funding covers the construction of wildlife underpasses, bridges, or fences. Projects must be financially supported by Federal, state, Tribal, or local governments to receive the reimbursements issued by this program. For Texas, more information is available at the website at: http://www.dot.state.tx.us/des/step/introduction.htm.
In Arizona, see the website at:
http://www.dot.state.az.us/Highways/EEG/enhancement_scenic_roads/enhancement/index.asp.

FEDERAL PROGRAMS

U.S. Fish and Wildlife Service

Conservation Banks
Conservation Banks are lands that are permanently protected and managed as mitigation for the loss elsewhere of listed species and their habitats. Driven by free market demands, Conservation Banks enable landowners with suitable, conserved lands to make money selling mitigation credits to other landowners who need to mitigate their land development impacts on listed species. For more information, see:
http://www.fws.gov/endangered/landowners/conservation-banking.html

Cooperative Endangered Species Conservation Fund
These grants, authorized by section 6 of the Endangered Species Act, enable states to work with private landowners, conservation groups, and other agencies with conservation efforts and acquire and protect habitat for threatened and endangered species.

Endangered Species Act "Traditional" Section 6 Conservation Grants
These are funds provided to AGFD and TPWD to implement recovery actions, survey and monitor sensitive species, perform candidate assessments, and other related actions. The funds

may be used on private, state, or Federal lands. In Arizona, contact the USFWS Traditional section 6 Coordinator. Contact the AGFD Non-game Branch in Phoenix for information concerning section 6 projects. In Texas, see the website at: http://www.fws.gov/endangered/grants/index.html

Endangered Species Act "Non-traditional" Section 6 Funds
Recent initiatives have provided additional Federal funding to AGFD and TPWD for habitat conservation planning and land acquisitions.

> *Habitat Conservation Planning Assistance Grants*
> These grants fund the development of Habitat Conservation Plans (HCPs) through support of baseline surveys and inventories, document preparation, outreach, and similar planning activities.
>
> *HCP Land Acquisition Grants*
> These funds may be used to acquire land associated with approved HCPs. Grants do not fund the mitigation required by an HCP permittee, but rather support conservation actions by the state, local governments, or other entities that complement mitigation.
>
> *Recovery Land Acquisitions Grants*
> These funds may be used for acquisition of habitat to secure long-term protection for a listed species. Land acquisition projects that address high priority recovery plan actions are most competitive.

For information on these grants, contact: AGFD Habitat Branch (602/789-3602), TPWD (512/912-7018). Information is also available through the USFWS and TPWD websites, at:
http://www.fws.gov/endangered/grants/index.html
http://www.tpwd.state.tx.us/business/grants/wildlife/section_6/

Federal Aid in Wildlife Restoration
This program, based on the Federal Aid in Wildlife Restoration Act, popularly known as the Pittman-Robertson Act, provides funding for the selection, restoration, rehabilitation, and improvement of wildlife habitat, wildlife management research, and the distribution of information produced by the projects. The program is a cost-reimbursement program, where the state covers the full amount of an approved project then applies for reimbursement through Federal Aid for up to 75% of project expenses. The state must provide at least 25% of the project costs from a non-Federal source.

Partners for Fish and Wildlife Program
This program provides technical and financial assistance to landowners who want to improve fish and wildlife habitat on their property. The program is open to private individuals, non-governmental organizations, tribes, counties, and state governments. Contact the Partners Program Field Coordinator in Corpus Christi, Texas (361/994-9005) or Phoenix, Arizona (602/670-6150).

State Wildlife Grants

The State Wildlife Grants Program provides Federal funding to every state and territory to support cost effective conservation aimed at keeping wildlife from becoming endangered. This program continues the long history of cooperation between the Federal government and the states for managing and conserving wildlife. A two-thirds or greater non-Federal match is required. State Wildlife Grants are administered by AGFD and TPWD. See information about the program at: www.teaming.com

Tribal Landowner Incentive Program

This is a grants program for actions and activities that protect and restore habitats that benefit federally-listed, proposed, or candidate species, or other at-risk species on Tribal lands. The program is available to federally-recognized Tribes. Tribal landowner incentive program funds can be used for environmental review, habitat evaluation, permit review, and other compliance so long as those activities are directly related to the Tribal landowner incentive program project. A minimum of 25% non-Federal matching funds is required. Contact the USFWS, Albuquerque, New Mexico (505/248-6810) for additional information. Also see the grant application kit at: http://grants.fws.gov

Tribal Wildlife Grants Program

This program is designed to develop and implement programs for the benefit of wildlife and their habitat, including species that are not hunted or fished. Participation is limited to federally-recognized Indian Tribal governments. There is no matching requirement; however, the USFWS will consider matching funds as an indication of Tribal commitment to the program and will encourage partnerships. Matching and cost sharing requirements are discussed in 43 CFR Part 12, section 12.64. Application procedures are spelled out in the "Tribal Wildlife Grant Application Kit" available at: http://www.fws.gov/grants/tribal.html

Environmental Protection Agency (EPA)

The EPA's Catalog of Federal Funding Sources for Watershed Protection (https://www.epa.gov/waterdata/catalog-federal-funding) contains a searchable database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of watershed protection projects. Searches can be limited to those for which "conservation districts" are eligible.

Natural Resource Conservation Service (NRCS)

Conservation Innovation Grants

As a part of the Environmental Quality Incentives Program (EQIP), Conservation Innovation Grants provide 50% of the cost to stimulate the development and adoption of innovative conservation approaches and technologies. National website: http://www.nrcs.usda.gov/programs/cig/

Conservation Reserve Program

This is a voluntary program that offers annual rental payments and cost-share assistance to establish long-term resource conservation. The program provides up to 50% of participant costs to establish target management practices on private lands, and could be used to help establish riparian buffers and cienegas on private lands. In Arizona, contact NRCS, Tucson (520/670-6602).

Grassland Reserve Program

This program serves to restore, enhance, and protect grasslands through conservation easements, while maintaining existing grazing practices. National website: http://www.nrcs.usda.gov/programs/GRP/

Wetlands Reserve Program

This program can be used to purchase conservation easements from willing landowners and to fund restoration of privately-owned wetlands or former wetlands on rangelands or farmlands. In Arizona, contact NRCS, Tucson (520/670-6602).

Wildlife Habitat Incentives Program (WHIP)

This program provides technical assistance and cost-share (up to 75%) to help establish and improve fish and wildlife habitat, primarily on private lands. In Arizona, contact NRCS, Tucson (520/670-6602, ext. 226). In Texas, visit the website at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip/

U.S. Forest Service Programs

Bring Back the Natives

This initiative is a national effort by the Bureau of Land Management and Forest Service in cooperation with the National Fish and Wildlife Foundation to restore health of entire riverine and aquatic systems and their native species. In turn, national, state, and local partners make their own matching contributions to accomplish improved habitat and water quality. Three programs are available through the Forest Service: 1) *Rise to the Future* is a program to enhance fisheries and aquatic resources, 2) *Every Species Counts* conserves sensitive flora and fauna, and helps recover endangered species, and 3) *Get Wild* targets protection and improvement of riparian and wetland habitats and associated species. Forest Service funds must be matched with labor and materials. Contact the Coronado National Forest, Sierra Vista Ranger District, 5990 S. Highway 92, Hereford, Arizona, 85615 (520/378-0311). Bring Back the Natives funds can also be obtained through the National Fish and Wildlife Foundation (see below).

National Association of Conservation Districts

Five-Star Restoration Challenge Grants to Fund Habitat Restoration Projects

The National Association of Counties, the National Fish and Wildlife Foundation, and the Wildlife Habitat Council, in cooperation with the U.S. Environmental Protection Agency, the Community-Based Restoration Program within National Oceanic and Atmospheric Administration's Fisheries Program, and other sponsors of this grant. The program provides modest financial assistance on a competitive basis to support community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach, and training activities. Projects must involve diverse partnerships of, ideally, five organizations that contribute funding, land, technical assistance, workforce support, and/or other in-kind services.

PRIVATE ORGANIZATIONS AND FOUNDATIONS

Many private grants and foundations could provide funding and other resources for recovery action implementation, both national and international. An annual directory, entitled "Environmental Grantmaking Foundations" contains information about 800 foundations. It is available from the Resources for Global Sustainability, Inc., P.O. Box 3665, Cary, NC 27519-3665 (800/724-1857, rgs@environmentalgrants.com). A website (Red Lodge Clearinghouse Funding Search – http://www.redlodgeclearinghouse.org/resources/search.asp) also provides an abundance of information on funding opportunities. Several examples of private grant and foundation programs are listed below:

Environmental Defense (ED)

The Landowner Conservation Assistance Program (LCAP) worked with private landowners in locations that may be used by the ocelot to provide additional habitat or enhance existing habitat. Given that the removal of over 95% of native thornscrub habitat from the Lower Rio Grande Valley and northeastern Mexico is the primary cause for ocelot decline, incentives for restoring and protecting habitat within the ocelot's potential range were provided through the LCAP program.

The Conservation Reserve Program (CRP SAFE) is a collaborative effort among Environmental Defense, the Natural Resource Conservation Service, and the Farm Services Agency to create and implement actions that provide shared costs to landowners for establishing Tamaulipan thornscrub on their land.

In 2003, the Ocelot Nation Program was formed to assist the ocelot spanning the U.S./Mexican border. Environmental Defense (ED) teamed up with both The Nature Conservancy and Pronatura Noreste, a Mexican conservation group, to try to create a 200-km long, cross-border corridor to let the Texas cats breed with their Mexican counterparts. Working with the USFWS, ED began restoration projects with Texas ranchers in Willacy and Cameron counties. Because young cats are capable of swimming the Rio Grande or the Brownsville Ship Channel in search of a home range and breeding partners, ED is also working with Mexican landowners to establish protection for the ocelot. U.S. landowners can consider a suite of tools developed by Environmental Defense. In addition to establishing Safe Harbor Agreements, which guarantee that habitat improvements won't result in added government regulation, ED also helps landowners develop new forms of income like nature tourism.

In Mexico, the situation is more complicated. Pronatura has instituted the country's first conservation easements, but faces difficulties in defining boundaries. Together, incentives are being explored for landowners to help ocelots, particularly along the Gulf Coast, where important potential ocelot habitat is becoming increasingly impacted by human land use patterns.

Friends of the Laguna Atascosa National Wildlife Refuge

This is a non-profit, local group that sponsors the annual Ocelot Festival and the "adopt an ocelot" program. The Friends group raises money and then enhances these funds by partnering with other groups and matching funds for the purchase and restoration of potential ocelot habitat. Laguna Atascosa National Wildlife Refuge, 22817 Ocelot Road, Los Fresnos, Texas, 78566; telephone: 956/748-3607.

National Fish and Wildlife Foundation Grants
Grants from the National Fish and Wildlife Foundation fund projects in two forms: one is through matching grants to projects that conserve and restore wildlife and plants, generally involving government, educational institutions, or non-profit organizations; the other is through the Special Grant Programs which are a collection of at least 42 different funds. Of these, the following 12 funds could support ocelot projects: Acres for America, Bring Back the Natives, Budweiser Conservation Scholarship Program, Coastal Counties Restoration Initiative, Five-Star Restoration Matching Grants Program, Hurricane Wildlife Relief Fund, National Wildlife Refuge Friends Group Grant Program, Native Plant Conservation Initiative, Conservation on Private Lands, Nature of Learning, Pulling Together Initiative, State Comprehensive Wildlife Conservation Support Program. All of these programs have specific information and contacts available on the web page given above.

Feline Conservation Federation

The Feline Conservation Federation has previously worked with the Dallas Zoo to fund wild felid surveys in Mexico. See the website: http://www.thefcf.com/

National Wildlife Federation

The National Wildlife Federation has funded ocelot conservation work in the past. Grants from the National Wildlife Federation periodically are available based on current funding.

The Nature Conservancy (TNC)

The Nature Conservancy is known for its partnerships in conservation efforts and its purchasing of property to preserve habitat. At present, TNC is supporting international and national conservation efforts that will enhance ocelot habitat and is partnering with Pronatura Noreste of Mexico, Environmental Defense, and the USFWS to manage for ocelots along the Mexico-US border.

Toyota TAPESTRY Grants for Teachers

Fifty teachers will be awarded as much as $10,000 and another 20 will receive grants up to $2,500 for innovative science projects in 1 of 3 categories, including environmental science. Projects should demonstrate creativity, model a novel way of presenting science and be implemented in the school district over a one-year period. For general information, tips on applying, or examples of winning projects, visit http://www.nsta.org/programs/tapestry. To download the application or request entry materials, go to: http://www.nsta.org/tapestry/

FINAL NOTE:

Voluntary measures can be taken by landowners that generally enhance the likelihood of obtaining financial assistance from the sources given above. For endangered species, such as the ocelot, these measures include participation in USFWS programs, such as Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs). On the web, please see: http://www.fws.gov/endangered/ and click on the “For Landowners” tab for information.

Habitat Conservation Plans are crafted when a landowner has a proposed project that may affect a threatened or endangered species currently existing on non-Federal lands. Together with the USFWS, the landowner develops an HCP that includes an assessment of likely impacts to the species from the proposed project, the steps that will be taken to minimize and mitigate those impacts, and the funding available to implement the steps. If the HCP meets specific criteria, the USFWS issues an incidental take permit that allows the landowner to incidentally take listed species in the course of proceeding with development or other activities. Programmatic HCPs, that cover an entire county or region, may also be devised or may already exist in an area and willing landowners may be included under a Certificate of Inclusion. Habitat Conservation Plans allow for economic development in conjunction with endangered species conservation.

Safe Harbor Agreements are designed to help participating landowners conserve threatened and endangered species voluntarily. This agreement is made in exchange for legal assurances from the USFWS that new restrictions stemming from the Endangered Species Act will not be placed on the use of their land as a result of their voluntarily providing a net conservation benefit that may attract a threatened or endangered species in the future.

Appendix V – Comments on the Draft Ocelot Recovery Plan and Responses to Comments

Public Review

A draft of this recovery plan (hereafter referred to as "plan") was published and distributed for review to all interested parties. The Service published a notice in the Federal Register on August 26, 2010 (75 FR 52547) to announce that the document was available for public review and comment. The comment period lasted for 60 days and closed on October 25, 2010. An electronic version of the draft plan was also posted on the USFWS's Southwest Region website (http://www.fws.gov/southwest/) and the Species Profile website (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A084).

Peer Review

We asked 13 individuals to serve as peer reviewers of the document. Seven reviewers provided comments. Depending on their expertise, peer reviewers were asked to review and comment on 1) description and taxonomy; 2) life history and demography; 3) captive breeding and management; 4) habitat characteristics and ecosystems; 5) biological constraints to recovery; 6) the recovery criteria and recovery action outline; and 7) the quality and completeness of the data in the draft plan. The qualifications of the peer reviewers are in the administrative record for this plan.

Public Comments Received

We received 1,514 sets of comments from interested parties during the public comment period. These included comments from 1 federal agency, 1 state agency, 8 non-profit organizations, and 1,504 individual citizens. The comments from individual citizens included 790 copies of the same shorter form letter and 711 copies of a longer form letter delivered by electronic mail.

Responses to Comments

The USFWS reviewed all comments received for substantive issues and new information. Within these comments, the USFWS identified 65 substantive comments, which are addressed in the following summary. The USFWS has amended the draft Recovery Plan as appropriate. The USFWS acknowledges the public comments and the great care with which individuals and organizations responded to the draft Recovery Plan. The USFWS recognizes that public participation is essential to the task of protecting the ocelot. The final Recovery Plan is the product of many years of work on the part of the Recovery Team and numerous federal, state, and local organizations, as well as individuals from Texas, Arizona, and Mexico.

Some comments provided were supportive of the recovery plan overall and offered constructive advice that has substantially improved the plan. Some commenters suggested editorial changes to the text of the plan and we have incorporated suggestions as appropriate. Some commenters suggested additions and clarifications, and we tried to clarify the document and have accommodated these suggestions as appropriate. The remaining substantive comments were taken into consideration in this final version of the plan, and specific responses are provided below. Several of the comments were similar in nature and were combined and summarized for brevity. Comments are arranged into eight categories based on the related topics of the comments: (A) recovery criteria, (B) genetics data, (C) research efforts and recovery actions (D) critical habitat, (E) translocation, (F) border infrastructure, (G) Arizona and Sonora management unit, (H) roads and crossings.

A. Recovery Criteria

A.1 Comment: A reviewer suggested that the subspecies *L. p. sonoriensis* and *L. p. albescens* must have the IUCN Least Concern rank and a stable or increasing population trend for the specified time period for either downlisting or delisting to be considered.

A.1 Response: The current IUCN status assessment for ocelot is at the species level. We agree that an evaluation of the status of subspecies may be warranted for ocelot. A review seems particularly justified for *L. p. sonoriensis* and *L. p. albescens* as each subspecies represents individuals adapted to environmental conditions at the northern extremes and to very different habitats from the majority of the range of the ocelot at the species level. An action item is included in the recovery plan to conduct a periodic workshop for the Ocelot Recovery Team to share information with the IUCN Cat Specialist Group. If a subspecific status assessment under the IUCN is determined to be warranted and is completed, the recovery criteria would likely need to be revised to accommodate those assessments.

A.2 Comment: A reviewer stated that the recovery plan's population viability analysis did not suggest that 225 ocelots would constitute a viable population, and that the delisting criteria are not supported by the plan's population viability analysis.

A.2 Response: The PVA analyzed populations consisting of ocelots in the ranges of 30, 40, 50, 60, 75, and so on. There was a misprint on page 38 of the 2010 draft plan ("Rationale for Downlisting Criterion 2") that stated the PVA examined scenarios with populations of 70 ocelots and it has been corrected in the revised plan (see page 48-51 in the revised plan). Population modelling with no road mortality and 60% of adult female ocelots breeding in a population of 75 ocelots produced the first positive, although minimally positive, population growth of all the PVA scenarios. Three populations of 75 individuals (as suggested by the criteria questioned by the reviewer, i.e. 225 individuals) minimize the risk of extinction. Although we are unlikely to completely eliminate the threat of road mortality, we expect that a significant reduction in the level of road mortality is possible given recent partnerships between the Texas Department of Transportation (TXDOT) and the U.S. Fish and Wildlife Service.

A.3 Comment: Did the PVA inform the recovery criteria of 200 ocelots in TX, AZ and the various metapopulation configurations? It is not clear to me because the model seems to indicate a 28-41% extinction risk for a population between 150-200 animals. That seems rather high to me.

A.3 Response: The PVA was used to inform the recovery criteria. The probability of extinction the reviewer mentions are correct under a scenario of continued high road mortality in Texas. Although the USFWS is working diligently to eliminate road mortality, it is likely a minimal amount of road mortality will continue, but not to the degree evaluated in the PVA. If one assumes that the USFWS and its partners in Texas will be able to minimize road mortality, then the results of the PVA that considers the populations to have no risk of road mortality is closer to the expected reality. Under the scenario with no road mortality, the probability of extinction modeled in the PVA was 0.07 for a population of 150, or 0.02 for a population of 200 with 50% of the females breeding. In scenarios with no road mortality and 60-70% of females are breeding, the PVA modeled a probability of extinction of 0 for a starting population of 150-200 individuals.

A.4 Comment: Reevaluate the population targets for downlisting and delisting based on a new PVA that incorporates a reasonable range of potential effects from climate change. Consider what climate change adaptation and mitigation measures may be necessary to ensure recovery of ocelots.

A.4 Response: Conducting a new PVA would require data on parameters explaining the possible effects of climate change. Although the USFWS recognizes that climate change will have a significant impact on many species, little quantifiable data exists beyond what was used in the existing PVA. In 2011, the USFWS began studying the effects of climate change (i.e., drought and varying degrees of salinity) on the dominant woody plants found in Tamaulipan Brushlands of south Texas and northeastern Mexico. The USFWS will develop a strategic adaptation plan for ocelots in south Texas and the information in the study can be used in a new PVA in the future. A new action item (1.2.6), "Consider what climate change adaptation and mitigation measures may be necessary to ensure recovery," was added to the revised plan. Although valuable, PVAs are only models of what is expected to occur given the literature and data available about the species at the time. The models that were used for the development of this plan were intended to be reviewed and refined as new information becomes available. As additional information is gathered regarding female reproductive success under drought conditions in South Texas, and significant physical changes to suitable habitat under different climate scenarios, the model will be refined and recovery strategies and criteria may be adapted. These new models would likely be presented within a peer-reviewed venue with the ability of stakeholders to review, critique, and comment on the models.

A.5 Comment: The draft plan states that the downlisting/delisting target of 200 ocelots in Texas may be met by establishing either (1) a single population of at least 150 ocelots or (2) at least 2 populations of 75 ocelots each. Both scenarios would require sufficient interchange with ocelots in Tamaulipas to maintain genetic variability of the Texas populations. The only rationale provided for the 200, 150, and 75 targets is that the PVA indicates that an initial population size of 70 ocelots reduces the extinction risk compared to an initial size of 50 or 60.

A.5 Response: We have modified our justification of the criteria and we believe that these numbers along with the other criteria would provide a sufficient number of ocelots to ensure viability for the foreseeable future. The draft plan should have been more accurate. The PVA analyzed populations starting at 30, 40, 50, 60, 75, and so on, but not 70. This was a misprint on page 38 of the 2010 draft plan and has been corrected in the revised plan. See also *A.2 Response* above.

A population goal of 200 ocelots functioning as a single large population would require a large contiguous block of habitat that may not ever be achievable in south Texas. Therefore, this particular criterion was written such that smaller interconnected populations would provide the same outcome as a larger, single population by allowing for the same total population number in smaller interconnected segments without requiring such a prohibitively large contiguous habitat block. Some of the input parameters for which there was little information for the PVA can be overcome by requiring sufficient interchange with ocelots in Tamaulipas, and between Texas populations to a lesser degree, to increase genetic variability of the ocelot populations in Texas. Without interventions such as translocation of ocelots from a population(s) with a greater degree of heterogeneity, the effects of continued genetic erosion could result in adults unable to reproduce or higher incidences of diseases in the smaller population. Unfortunately, there is no known threshold of genetic erosion that marks a significantly higher risk of extinction of these small populations.

A.6 Comment: There is no explanation provided for how a single population of 150 ocelots can justify downlisting.

A.6 Response: The ocelot cannot be downlisted when a single population of 150 is known (see pages 48-51). *Downlisting* to threatened status will not be considered until all downlisting criteria are met. These criteria are: 1) ocelots are recognized under a status of "Least Concern" by the IUCN for five years, 2) there are 1,000 ocelots in Tamaulipas and at least 200 ocelots in Texas for at least five years, and 3) at least 1,000 ocelots in the ASMU for at least five years. Delisting requires more significant time frames and population sizes under certain scenarios. The justification for the portion of the second criterion that relates to the single population is given in the response to comment A.3 above.

A.7 Comment: The minimum population target of 1,000 in Tamaulipas lacks an adequate rationale to support that number for downlisting/delisting.

A.7 Response: The PVA utilizes the best science available and strongly supports that a population of 1,000 individuals would be sustainable. Additionally, downlisting and delisting are based on three criteria and are not based on any one criterion having been met, i.e. a population of 1,000 ocelots in Tamaulipas for five years is not sufficient justification for downlisting the ocelot for the U.S.

A.8 Comment: There should be a statement about conducting additional population modeling to estimate extinction risks as updated population size estimates are obtained.

A.8 Response: As suggested by the reviewer, a new action "5.6. Conduct periodic population viability analyses as new significant information is acquired" was added to the revised plan.

A.9 Comment: The collection of data on indicators (such as fertility and infant mortality) of reduced fitness and inbreeding depression should be included and mentioned as an important component of evaluating genetic health. Such data could provide compelling evidence of a need for genetic augmentation.

A.9 Response: This information was added to the plan in Recovery Actions 3.1.1, 3.1.2 and 3.1.3.

A.10 Comment: The draft plan does not explain what risk of extinction over what period of time is acceptable from a policy standpoint.

A.10 Response: The period of time for which a certain degree of risk of extinction is deemed acceptable has not been defined by the USFWS. The available data regarding the interaction of the stochastic factors affecting the changes in ocelot populations are not known well enough to provide such a precise measure. Instead the USFWS relies upon the Recovery Team to provide their expert opinion, based on the best available and current scientific information, to suggest what suites of specific conditions provide for population recovery, for the foreseeable future, such that the ocelot can be downlisted or delisted.

A.11 Comment: One reviewer questioned recovery of the ocelot based on the fact that the majority of the habitat is located in Mexico and that possibly the species is already "recovered" based upon the large number of ocelots suspected to be extant in Mexico.

A.11 Response: Ocelots in these two border regions have conservation value given that these ocelots use different habitats than those in the rest of Mexico. Species on their edge of their range often have genetics not represented in other areas of the species range, an important contribution to overall species' genetic diversity, especially as climate change is predicted to affect range extremes for many species. Texas supports an isolated, highly imperiled population that once was demographically linked to the State of Tamaulipas. Ocelots along the coast and several inland areas of Tamaulipas are in a very similar situation as those in Texas. They are found in highly isolated habitat patches so small that populations are at risk of becoming extinct soon. The Recovery Team believes that the risks to the long-term existence of ocelots is still a concern and that the criteria developed in this plan to meet downlisting and delisting are a better measure of recovery than the supposition that there are enough ocelots in other countries and that they will remain in high numbers for ocelots to be considered recovered.

A.12 Comment: A reviewer commented that it was inappropriate for there to be a recovery criterion that depends on the growth and conservation of populations south of Texas and Arizona, specifically in Mexico, since the maintenance of these populations is beyond the control of the USFWS.

A.12 Response: The long-term recovery of the ocelot in the U.S. is viewed by the USFWS to require recovery criteria that depend upon the growth and protection of populations of ocelots beyond the borders of the U.S. due to the way the ocelot is listed under the ESA (i.e., throughout its range). Regardless, the majority of proposed recovery actions target the Texas and Arizona populations.

A.13 Comment: The minimum population target for the ASMU does not appear to be supported by the best available science or a precautionary approach. The draft plan does not provide an adequate rationale for the proposed minimum population target for the ASMU, and should not be based solely on the López González *et al.* (2003) study. The draft plan also underestimates the potential contribution of southern Arizona to ocelot recovery. Delisting criteria generally set the bar too low for recovery, allowing delisting with only 200 ocelots in Texas, unconnected to those in Mexico, and with a reduction in numbers of the ocelot in Sonora, if the population is 1,350-2,700. It is inappropriate to set target numbers for the Sonora population that allow for a significant decline in the number of ocelots currently in Sonora.

A.13 Response: The range for the 2003 population estimate for Sonora was quite large and was clearly a broadly-applied estimate. The new state population estimate for Sonora (Gómez-Ramírez 2015) is smaller than the 2003 published estimate and we have revised our justification for this criterion to reflect this new information. Additionally, downlisting and delisting of the ocelot are based on three criteria and are not based on any one criterion having been met, i.e. a population of 1,000 ocelots in the ASMU is not sufficient justification for downlisting the ocelot (see pages 52-55).

A.14 Comment: The delisting criterion related to the TTMU is ambiguous about whether the 'additional population of at least 75 ocelots' would be connected to the two core Texas populations. The criterion states that enough habitat protection must be in place to 'connect all core ocelot populations within Texas' but is unclear whether the additional population of 75 is a 'core' population.

A.14 Response: The term "core" has been removed from the revised plan as it was confusing and unneccesary. If natural connectivity is impossible to achieve between Texas and Tamaulipas and a third population of ocelots is established in Texas, connectivity among those three populations in Texas would be required to meet that criterion for delisting. We agree that this was unclear in the draft plan and have attempted to clarify the language in the final plan.

A.15 Comment: The criterion for TTMU is 75 ocelots but the first sentence indicates that there are currently 30 + 40 (=70) in Texas? Are we really only 5 ocelots away from downlisting?

A.15 Response: This criterion states that the ocelot will only be considered for downlisting with a total population of at least 200 ocelots in Texas and that there should be at least two populations of 75 individuals each plus an additional 50 ocelots in Texas.

A.16 Comment: Revise the criterion to state that interchange "shall" be required for delisting. Establishing two core populations of 75 ocelots each in Texas is unlikely to prevent extinction of either population after 100 years. Reasonable precautions should be taken to improve their likelihood of success.

A.16 Response: Although the Recovery Team agrees that a more naturally-functioning landscape would be ideal, the location and size of current cities and the possibility of development expanding beyond the means of conservation to mitigate for habitat and corridor loss may preclude the likelihood of natural connectivity across the landscape of Texas and Tamaulipas. Although we would prefer natural interchange between populations in Texas and Tamaulipas to meet the criteria for consideration of delisting, that may not be achievable. However, recovery of the ocelot in the TTMU is still possible without requiring a physical on-the-ground connection or corridor.

A.17 Comment: The recovery strategy calls for "original research and conservation planning" for each population given the "dramatic climatic and landscape differences" between the ASMU and TTMU. If the USFWS really believes that the circumstances for the ASMU are so different, we do not think it is appropriate to use the same TTMU population goal for recovery without a much clearer explanation of the rationale for doing so.

A.17 Response: We encourage more research to provide better population estimates for the ASMU area to support changes in the downlisting/delisting criteria for the ASMU if they are necessary.

A.18 Comment: Under the 'Current Status of the Species' you discuss the various ocelot subspecies that have been described. Are the Texas or Sonora subspecies the listed entities under the ESA? Are any ocelot subspecies the listed entities under the IUCN? Clarify how the subspecies fits into listing status and subsequent recovery criteria.

A.18 Response: Subspecies of ocelot were not separately-listed entities under the ESA or the IUCN. Because the USFWS's limited resources are better applied to planning and on-the-ground implementation of conservation actions within the boundaries of the U.S. and in partnership with agencies and private individuals in adjacent Mexico, we focused this plan on two management units that cover the range of two subspecies, *L. p. sonoriensis* and *L. p. albescens*. We have attempted to clarify this in the final plan.

A.19 Comment: What would happen if the IUCN delisted the ocelot entirely? Would the U.S. still have a recovery plan/goal specific to our borders?

A.19 Response: The IUCN does not list or delist species in the same way as the ESA. The IUCN assesses the status of species and ranks it into one of eight categories based on various criteria (e.g., rate of decline, size of population, degree of habitat loss and fragmentation). The ocelot was considered a species of least concern at the time of its most recent assessment. The ocelot can only be considered for delisting under the ESA if it meets the 3 criteria stated for delisting in this plan. Only one of the criteria relates to the IUCN's ranking of the ocelot.

B. Genetics

B.1 Comment: The apparent declines in heterozygosity in the Texas populations over the past few decades were not found to be statistically significant. Therefore, they should either not be included here, or a statement about the lack of significance should be added.

B.1 Response: In the final plan, to add clarity, we do state that there was a lack of statistical significance in apparent declines in heterozygosity in the Texas populations. However, Texas ocelot populations exhibit very low effective population, indicating a reduced chance of long-term survival for those same populations. When a population loses genetic diversity, the first losses are the rare alleles which do not contribute much to allelic diversity (since they were rare in the first place), so it is not surprising that those results were not statistically significant.

Heterozygosity is often not affected at first and it may take years before heterozygosity significantly declines, except in the case of a very severe bottleneck.

C. Research Efforts and Recovery Actions

C.1 Comment: We strongly encourage the USFWS to immediately develop robust ocelot research, conservation and recovery strategies to include the "sky island" portion of the ocelot's range in the Arizona-Sonora Management Unit. The Draft Recovery Plan should delineate their plans to coordinate research with Mexican agencies and nongovernmental conservation organizations in order to gain a greater understanding of ocelots and other felids in the border region.

C.1 Response: In 2011 the USFWS awarded a contract to deploy over 100 paired cameras in Arizona and New Mexico to photograph jaguars; in 2012, that effort was expanded to include ocelots. To date, five male ocelots have been photographed in Arizona and their photographs are available for viewing at: (Flicker) http://bit.ly/TapYhK or (Facebook) http://on.fb.me/TazSP9. In addition to the camera traps, a scat-dog trained to detect feline scat has been deployed in the general area around the jaguar and ocelot detections. In 2014, the USFWS began communicating with multiple partners and researchers in the U.S. and Mexico to plan status-update workshops. These workshops would provide a forum for various partners to participate in an open conversation about current ocelot research and conservation needs.

C.2 Comment: We ask the USFWS to explicitly state the desired actions and opportunities to engage and advance goals for its listed partners in ocelot recovery on both sides of the border, and specifically to better utilize data that already exists and is currently being collected.

C.2 Response: In this recovery plan, we have outlined the actions deemed necessary to achieve recovery of the species. The USFWS and the Recovery Team welcome continuing collaboration with various partners and have identified partners that should be involved in those specific actions in the implementation schedule and would welcome additional partners in these efforts.

C.3 Comment: We recommend the USFWS lead a more thorough analysis of the historic and current records of ocelots in the ASMU and also if there was ever a breeding population of ocelots in the ASMU.

C.3 Response: Various partners have provided updated information on ocelot records for Arizona and Sonora. Dr. Carlos López González has provided updated results of field work for Sonora. There are "undocumentable reports of additional ocelots being taken after 1964" according to the first recovery plan in 1990, including one observation of a pelt of a lactating female ocelot from Arizona believed to have been trapped sometime during 1980-1985. We would welcome any additional information regarding current or historical records of ocelots in the ASMU.

C.4 Comment: The USFWS should place more emphasis on identifying potential habitat for ocelot recovery in both Arizona and Sonora. To support the recovery of endangered tropical cats in the sky island region, including their reintroduction, migration corridors that link key habitat cores in Mexico and the United States must be protected. But first, these corridors and habitats must be identified. There are also significant opportunities for habitat protection south of the border, with Sonora being the second largest state in Mexico, and having one of the lowest human population densities in the country (López González *et al.* 2003). Relatively intact patches of continuous habitat therefore make this area a stronghold for rare species such as the ocelot.

C.4 Response: The USFWS recognizes that additional collaboration and support of research in the ASMU is necessary. Recovery action 1.3 is focused on the ASMU and address many of these concerns. Additionally, the USFWS has funded a project to survey the border area for jaguar and ocelots as discussed in C.1 above.

C.5 Comment: In our 2007 comments on the internal version of the Draft Ocelot Recovery Plan (as a member of the Ocelot Recovery Implementation Team), we requested the addition of two recovery actions pertaining to the ASMU. Unfortunately, these suggestions were not incorporated into the public draft. With some minor modifications, we again request that these two actions be added to the Recovery Actions section as follows:
1) Based upon the results of field studies and habitat suitability models, determine if an area for establishing a new ocelot population exists within southern Arizona.
2) If suitable habitat of sufficient size to support an ocelot population is identified, establish a new ocelot population in southern Arizona.

C.5 Response: The Recovery Team will continue to use scientific evidence to guide the development and implementation of recovery actions (e.g. reintroduction, augmentation, and translocation) as suggested by the commenter. Although there have been several confirmed reports of ocelots in Arizona since 1964, the USFWS is not aware of any evidence of a current breeding population of ocelots in Arizona. Rather than encouraging the creation of a breeding population in Arizona, the USFWS and its partners should work to determine if there is a breeding population of ocelots in Arizona and which habitats might be suitable for a population of breeding ocelots in Arizona.

D. Critical Habitat Designation and Mapping Habitat

D.1 Comment: All of the 1,501 form letters received plus three independent comments received suggested that the USFWS designate critical habitat for the ocelot. One reviewer commented that designation of critical habitat would preclude approval of federally permitted or funded projects that would adversely modify designated critical habitat. About half of the form letters justified critical habitat designation by stating the designation would encourage the USFWS to engage in discussions with landowners about ocelot habitat. Of the form letters received by the USFWS, about 790 copies of the same shorter form letter requested the protection of the "wild cats" by designating the refuges in Texas as critical habitat.

D.1 Response: In the 1982 final rule (47 FR 31670), the USFWS made a determination that the designation of critical habitat was not prudent.

D.2 Comment: One reviewer commented that designation and mapping of critical habitat would also delineate areas for priority conservation actions, including the habitat restoration that the recovery plan states is critical.

D.2 Response: Critical habitat designation is not required to map areas for priority conservation actions. The USFWS and independent researchers have already identified areas for priority conservation actions to benefit ocelot and have mapped closed canopy cover in south Texas which are areas that could be suitable habitat.

E. Translocation

E.1 Comment: Several commenters expressed desire that any translocation must not endanger the source population and must preserve the ocelot's full ESA protections.

E.1 Response: The Recovery Team considered the impacts of translocation on the source population. This evaluation was presented in the PVA. The 2009 plan for the translocation of ocelots in Texas and Tamaulipas states that actions must "ensure no adverse impacts to source populations in Mexico result from translocation" (Translocation Working Group 2009). It was not stated in the draft ocelot recovery plan, and an action item has been added to address this important need: 3.1.3. Monitor effects of translocation from the source population(s). Part of this evaluation is to estimate the distribution and population size in Tamaulipas prior to translocation, and monitor population demographics in Mexico after translocation. Ocelots translocated from the wild into current populations would retain their endangered status.

E.2 Comment: There should be more emphasis on translocation versus natural dispersal given fragmentation caused by the border infrastructure and expanding human population.

E.2 Response: The USFWS believes that natural dispersal of ocelots between the U.S. and Mexico is a better alternative to artificial translocation, but recognizes the immense challenges on the landscape and therefore has provided a suite of alternatives to provide an opportunity for recovery of the ocelot that might entail the use of translocations.

E.3 Comment: Reintroduced populations separate from wild populations in the U.S. would be essential to the survival of this species in the wild and therefore must not be designated as "non-essential" under ESA section 10j. Similarly, the reviewer stated that "individuals or populations that augment or are not physically separate from wild individuals or populations must retain their endangered status."

E.3 Response: The 1982 amendments to the Act included the addition of section 10(j), which allows for the designation of reintroduced populations of listed species as experimental populations. Under section 10(j) of the Act and our regulations at 50 CFR 17.81, the USFWS may designate an experimental population as a population of endangered or threatened species that has been or will be released into suitable natural habitat outside the species' current natural range. With the experimental population designation, the relevant population is treated as threatened for purposes of section 9 of the Act, regardless of the species' designation elsewhere in its range. At this time, the USFWS does not anticipate designation of an experimental population of ocelots.

E.4 Comment: Are you trying to assist ocelot recovery range-wide by managing the U.S. population or trying to recover a specific subspecies? Later in the plan, you do reference translocations. How would using a different subspecies be perceived?

E.4 Response: Because the ocelot is listed throughout its range, the USFWS is working toward recovery of the entire listed entity. However, because we have little ability to manage species conservation outside U.S. borders, the USFWS is working with partners to maintain a level of genetic diversity in the species by protecting and maintaining ocelot populations at healthy levels while recovering those populations that are most at risk, namely those of the *sonoriensis* and *albescens* subspecies. At this time, the USFWS does not anticipate translocations across subspecies, but we recognize that if conditions worsen, this may become a potential consideration in the future. Translocations across subspecies would have to be carefully evaluated.

F. Border Infrastructure

F.1 Comment: The recovery plan should explicitly call for modifying or removing the border wall and other border infrastructure in places necessary to establish connectivity between ocelots in the U.S. and in Mexico. The agency must specify realistic mechanisms that can more directly address the profound and vast scale of threats to ocelot recovery presented by border security activities, including how the agency plans to manage border habitat, access roads, artificial night lighting, and other security activities.

F.1 Response: Urbanization and wildlife-limiting infrastructure in the border region of Arizona and Texas are concerns, and the USFWS routinely makes recommendations to avoid and minimize any impacts to this area that would impact habitat from direct loss or reduced connectivity. Modification or removal of existing border infrastructure would create greater connectivity for endangered cats and other wildlife between Mexico and the U.S. However, the Secure Fence Act of 2006 limits the USFWS's ability to affect border infrastructure. The Department of Homeland Security has worked with the Department of the Interior to provide funding to mitigate for habitat loss of the ocelot in Texas. The U.S. Border Patrol has implemented an environmental stewardship training developed by the USFWS and has established Public Lands Liaison Agents to assist with environmental concerns on public lands. Furthermore, the USFWS continues to work with CBP to modify and update best management practices and procedures as needed.

F.2 Comment: The USFWS must put more emphasis on meaningfully addressing the significant threats to ocelot habitat and cross-border connectivity presented by border security activities. The lack of baseline data that informs pre- and post-border wall construction effects from which to compare and monitor environmental impacts is a significant obstacle to the preservation of unique habitats and species. Of special concern is the monitoring of federally protected areas, threatened and endangered species, and cross-border watersheds.

F.2 Response: As mentioned in Response F.1 above, the USFWS is aware of the negative effects on endangered species' survival and recovery due to urbanization and wildlife-limiting infrastructure in the border regions of Arizona and Texas. It is the USFWS's practice to consistently recommend avoidance and minimization measures that favor endangered species survival and recovery when providing input on activities in these areas. However, the speed at which the border infrastructure was planned and built made it impossible to provide pre-construction data to assess the effects of the project. In Texas, the border infrastructure is undoubtedly a significant impediment to the long-term recovery of the ocelot. It fragments at-risk ocelot populations in Texas from populations in Tamaulipas, Mexico. The plan now includes an action (2.2.3) to recommend alternative methods for maintaining national security at the border, other than structures that limit wildlife connectivity.

F.3 Comment: The USFWS must further research the efficacy of "cat doors" for ocelots to determine whether this type of recovery action is even feasible, much less needed or preferred.

F.3 Response: At the request of CBP, the USFWS provided locations for the proposed wildlife openings in the infrastructure. However, fewer wildlife openings were installed than the USFWS recommended and they were not located according to wildlife needs. An unconfirmed observation of a bobcat using a wildlife opening was reported in south Texas, but no photograph has been provided. Even if used by other species, we agree with the reviewer that the efficacy of the openings for use by ocelots should be investigated. Existing wildlife openings have not been maintained and have filled in with silt, such that their utility for wildlife is limited.

F.4 Comment: There are no major habitat threats at present and the biggest limitation on the animal's distribution are highways and industrial developments including the planned completion of a border fence that will restrict any further northward movement of ocelots into Arizona. Are there pipes that would allow ocelots but not people to pass under the border fence?

F.4 Response: Major threats in the U.S. to ocelot recovery are mortalities from vehicle strikes, development, habitat loss and fragmentation. We agree that existing and planned border infrastructure would remove habitat, limit habitat use, and limit dispersal and regular movements of ocelots along the U.S.-Mexico border. It is unlikely that an opening in a barrier intended to curtail illegal immigration could be designed that would allow for the free movement of ocelots and still meet its intended purpose. In Arizona, some segments of the infrastructure are intended to prevent passage of vehicles and are quite permeable by wildlife. Ocelots could potentially pass through these areas of permeable infrastructure if lighting and the traffic from vehicles used by the U.S. Border Patrol were limited.

F.5 Comment: There was no explicit analysis of the location of the fence relative to likely areas of connectivity or any descriptions of whether the fence has – or could be – modified to allow ocelots to pass. Are there existing openings that are of a size that would permit passage by an ocelot? Has this been tested? Is the fence continuous in the regions where connectivity is most crucial?

F.5 Response: The reviewer is correct that there was a paucity of information in the draft plan regarding the infrastructure. More information is included in the final plan, given that the

USFWS now knows the extent and design of the current infrastructure. According to the Secure Fence Act, additional infrastructure may be built and it is not necessary those plans follow standard ESA consultation regulations, and the location and design of these structures could be more detrimental to the long-term recovery and conservation of ocelots.

There are nearly 100 cut-out openings, approximately 21 cm wide by 29 cm tall, in the steel bollard fence design in the 115 km of fence in the Lower Rio Grande Valley of Texas. The distance between openings varies greatly and the openings were not installed according to the recommendations of the USFWS. The openings have not been tested for any wildlife use to the best of our knowledge. Many segments of the fence still have opening for vehicular traffic, although there are plans to install large metal gates in those locations. The USFWS has data of bobcats using these large openings quite extensively.

F.6 Comment: Is there nothing that can be added, in terms of recommendations that can be made now, that will help mitigate the effects of the border fence?

F.6 Response: The recommendations that have been included in the plan include: 1) limit the footprint of any infrastructure that is deemed necessary to maintain homeland security, 2) limit increased human and vehicular disturbance in key areas, as identified by the USFWS, due to increased patrols, 3) seek alternative measures (that can curtail illegal immigration) to physical infrastructure which limits wildlife connectivity (e.g., “smart” infrastructure and airplane drones).

F.7 Comment: We believe the USFWS should discuss the concrete actions it will take to ensure that U.S. (and northern Mexico) ocelot population recovery will occur despite the likely enduring barriers to natural movement and increasing levels of disturbance along most of the border. For example, Congress has appropriated $50 million specifically for endangered species mitigation activities related to the construction and maintenance of border barriers and associated infrastructure, and another $40 million for environmental compliance, monitoring and mitigation projects. The draft plan should describe the numerous projects the USFWS has implemented or will likely implement using this funding.

F.7 Response: In south Texas, the USFWS has stated that all mitigation funds will be used to acquire lands that will make the mission of the Refuges in the area achievable again. In relation to the ocelot, this means acquiring lands that will provide habitat connections between ocelot populations. The USFWS will continue to maintain a land acquisition and land-partnerships program (e.g., easements and agreements) focusing on protecting the riparian corridor along the Rio Grande for literally hundreds of species of trust resources, but projects such as the Border Infrastructure have limited the utility of habitats adjacent to the Rio Grande for land-based migrations and connectivity for wildlife populations.

In Arizona, the USFWS applied funds towards research and monitoring for ocelots and jaguars, as well as building teams of citizen scientists to assist in monitoring for jaguar and ocelots, and developing programs to reach the public about the conservation of these rare native felines.

F.8 Comment: We support Recovery Action 2.2 to identify potential ocelot border crossing of high priority, but we urge the USFWS to be far more specific about how it will seek to manage habitat, roads, and artificial night lighting, all of which could prevent or discourage successful population interchange in these areas.

F.8 Response: The USFWS encourages all federal agencies to follow environmental regulations including following the NEPA process and the consultation process under section 7 of the ESA for federal actions. Best management practices and standard operating procedures have been developed and implemented to some degree by CBP and the USFWS will continue to work with CBP to modify and update best management practices and procedures. The USFWS will continue to work through the appropriate channels, such as at the Borderland Management Task Force Meetings, to address specific issues.

F.9 Comment: We also urge the USFWS to provide maps or otherwise offer precise information about lands the Recovery Team believes are crucial to maintain and enhance.

F.9 Response: Many actions in the plan are aimed at identifying and prioritizing lands for conservation. In particular, recovery actions 1.1.6, 1.1.7 and 1.1.11 address these concerns. Identifying and prioritizing those lands most critical to target for conservation of the ocelot is an ongoing process, as changes in land use outside ocelot habitat can affect ocelot movements. The identification of linkages will be a critical component of a comprehensive habitat conservation model. Priority should be given to areas with minimal need for habitat restoration and a maximum potential for long-term protection as well as proximity to existing ocelot populations.

F.10 Comment: Actions on behalf of the ocelot will need to consider the cumulative impacts of fencing, lighting, highway traffic, and habitat avoidance due to human activities. The plan includes the measure that it will partner with Homeland Security and Border Patrol on these border issues (e.g., 4.1.7 on p. 42), but FWS needs to go further. The agency (and the Ocelot Recovery Plan) must be clear on how and what measures must be taken to protect the ocelot from this threat sufficient to recover it.

F.10 Response: The plan offers a suite of recovery actions that range from relying upon natural dispersal around barriers and across the U.S.-Mexico border to artificial movements (i.e., translocation) to protect the ocelot from the threat of increased patrolling by Border Patrol and increased development of infrastructure in the area. In particular, Recovery Actions 2.2.1, 2.2.2, 2.2.3, and 2.2.4 are specific measures to avoid, reduce, and minimize impacts on ocelot habitat and behavior from U.S.-Mexican border infrastructure, maintenance, and development. These actions have been modified and expanded from the draft plan to better address this ongoing threat. In addition, the USFWS continues to use the appropriate regulatory mechanisms for avoidance and minimization of these threats from human border activity as an ongoing strategy, while working with DHS and CBP to conserve wildlife.

F.11 Comment: The presentation of border issues under threats is incomplete and unbalanced. We are aware of no studies which document that any of the border infrastructure or operational activities have impacted survival and/or recovery of ocelot. For example, while CBP border control activities, including fence construction, have been cited as precluding movement of ocelots between U.S. and Mexico, based on DNA and other evidence as presented in the draft plan, several authors have concluded that movement of ocelots between the two countries has been reduced to insignificant levels for a number of years. Further, even if there were movement of ocelots between the two countries, there is no evidence that the pedestrian fence is impermeable to ocelot. There is photographic evidence that adult bobcats, which are substantially larger than ocelots, are able to fit between the bollards of the pedestrian fence.

F.11 Response: There are studies that document how border infrastructure or operational activities could have an impact on survival and recovery of ocelots. In 2004, Grigione and Mrykalo published a scientific peer-reviewed article indicating that activity patterns for ocelots and their prey would be altered under artificial night lighting conditions, that evening activity levels would either be reduced or redirected towards areas with dense vegetation away from well-lit areas, and that ocelot foraging success would likely be altered in those disturbed areas. The data recently collected by the USFWS (ca. 2006-2015) regarding the strong negative effect of concrete traffic barriers on ocelot dispersal and survivorship when ocelots attempt to cross roads, clearly demonstrates that barriers can be a serious impediment; therefore reduction of barriers, and minimization of impermeable designs should have been a more lengthy negotiation process between agencies.

Conservation genetics indicates that at least one genetic exchange per generation will maintain genetic diversity within a population. Any additional barrier that reduces the probability of genetic exchange is detrimental to recovery. With so few ocelots in the U.S. and the greater genetic diversity of the Tamaulipas population, the movement of any ocelots across the border is significant to the conservation of the species along the border.

Although it might be physically possible for an ocelot to move through wildlife openings installed by CBP, the USFWS knows of no evidence that openings in the border infrastructure make it permeable to ocelots. The USFWS has not been presented with any photographic evidence that bobcats have moved through any wildlife openings in the border infrastructure. Sections of the infrastructure associated with concrete walls, such as the 12-16 foot high walls in Hidalgo County, Texas, do not have wildlife openings and are not permeable to ocelots or any other terrestrial wildlife.

F.12 Comment: Changes are needed to the entire passage on ocelots and border crossings as it was based on speculation as to where and how often ocelots cross the Arizona-Sonora border in either direction. It was very weak on linking actual border obstacles to likely or even suspected suitable ocelot habitat. Much of the obstructed border seems very unlikely to have any value in terms of ocelot movement.

F.12 Response: We agree that little is known about the characteristics of ocelots moving across the Arizona-Sonora border, but additional information about known movements and border infrastructure has been incorporated into this final plan. The wildlife-impermeable border infrastructure in Arizona is located within or immediately adjacent to border cities in the U.S. The vast majority of the fencing in Arizona is permeable to smaller wildlife such as medium-sized carnivores and smaller.

F.13 Comments: Recovery actions will likely have adverse impacts on the CBP mission and will require further evaluation prior to inclusion in the plan.

F.13 Response: The USFWS does not determine whether recovery actions should be included due to impacts on CBP's mission or the mission of any other agency. Instead, recovery actions are developed in accordance with what is needed to achieve recovery of the species. It is unlikely that the issuance of a plan will have any effect on CBP's mission until the recovery actions outlined are implemented. CBP will be able to work with the USFWS to ensure that both agencies' needs are met. CBP should relay any specific issues and concerns about actions implemented by the USFWS through the appropriate channels, such as through the Borderland Management Task Force Meetings.

F.14 Comment: Recovery actions likely to directly impact the CBP mission to secure U.S. borders need further evaluation prior to their inclusion in the plan. There are two recovery actions contained in the draft plan with potential to directly or indirectly impact the CBP border security mission and operations. These actions should be removed from this plan until their impacts on the CBP mission have been fully addressed. In particular, the reviewer suggested removal of the following recovery action: Maintain and enhance thornscrub habitats or similar vegetative structure near the border.

F.14 Response: Thornscrub and structurally similar habitats along border riparian zones are especially important to encourage river crossings by ocelots and other wildlife and also to provide cover for movement to and from water sources for drinking. Human-caused fires can reduce the density of thornscrub cover and encourage establishment of invasive grasses which are even more fire-prone. However, dense thornscrub or structurally similar habitat may be a deterrent to illegal border crossings by humans due to the immense effort required for humans to traverse it, potentially making its maintenance or restoration attractive and beneficial to enforcement authorities. Communication and relationship development with enforcement authorities, as described in Recovery Actions 2.1.4.1, 2.2.2, 2.2.3, 2.2.4 and 2.3 are critical to making progress in this area.

F.15 Comment: Apprehension of individuals entering these dense thornscrub and similar habitat types increases risk to CBP agents. CBP will work with USFWS to determine if suitable areas can be identified for maintenance or restoration of ocelot habitat that would not inhibit the border protection mission, but CBP cannot accept this as a general action under the plan.

F.15 Response: The USFWS will collaborate with CBP and other federal agencies to find ways to recover the ocelot. The USFWS will also continue to share resources such as intelligence gathered during the maintenance of wildlife game cameras that document illegal activities, reporting illegal activities witnessed by USFWS personnel, and continued collaboration between the USFWS dispatch office and the CBP dispatch call centers in the Rio Grande Valley Sector. The USFWS will continue to meet and discuss issues at the Borderlands Management Task Force Meetings or similar groups to work toward a mutually beneficial resolution.

Native thornscrub is exceedingly rare in the LRGV. Where it is found, it provides a very dense layer of thorny brush even at the height of 1-2 feet above the ground. Dense brushlands of this type are the restoration goal of the USFWS for a multitude of species, as this was one of the many native growth forms in the area and this is the growth form that is most suitable for the ocelot. The growth form that is referred to as being used by undocumented immigrants are most likely thornscrub that has been disturbed by humans through burning brush areas, creating roads and trails, grazing of livestock, farming, developing lands, draining nearby wetlands, and other forms of disturbance. These are areas that should be restored to the densest brush type possible, where appropriate. The USFWS would suggest that dense woodlands, as formerly existed in many areas, if restored and maintained, would provide an opportunity to funnel undocumented immigrants into more open areas where they could more easily be detained.

F.16 Comment: The draft plan does not acknowledge that the expanding population, poverty, and high unemployment in the Rio Grande Valley area might be partially due to illegal immigration in the area and that an increase in border security which controls illegal immigration is likely to have an indirect beneficial effect on ocelot habitat.

F.16 Response: Border security infrastructure has led directly to increased roads, additional habitat loss, increased habitat fragmentation, and increased light and noise pollution in ocelot habitat. These impacts clearly have a negative impact on ocelot habitat. The role of illegal immigration as a cause of the development of that infrastructure and the effect of the segments of border infrastructure on limiting the sociological drivers responsible for illegal immigration is well beyond the scope of this plan. Instead, the USFWS has focused on collaborating with other federal agencies, such as CBP, to minimize and mitigate impacts caused by the actions of those federal agencies.

G. Arizona-Sonora Management Unit

G.1 Comment: The Arizona-Sonora ocelot subspecies (*L. p. sonoriensis*) has no known reproducing individuals in the United States.

G.1 Response: Although we do not currently have information that there is an extant, self-sustaining ocelot population in Arizona, ocelots in Sonora near the international border are capable of dispersing into suitable habitat in Arizona, and with appropriate habitat protection and restoration, it may be possible to maintain a self-sustaining population of ocelots in Arizona.

G.2 Comment: Establishment of Recovery Goals for the Arizona-Sonoran Recovery Unit (ASMU) is unwarranted. A more thorough analysis of the historic and current records of ocelots in Arizona needs to be conducted: if there ever was a breeding population in the ASMU, what is the suitable habitat and the current extent of that suitable habitat in the ASMU, and what information is available or needed to determine acceptable downlisting criteria for ocelot as part of the ASMU? We recommend that the analysis needs to take into account the time it takes to propose and make final a reclassification ruling.

G.2 Response: The USFWS agrees that a more thorough evaluation needs to determine if there is an extant breeding population of ocelots in Arizona. Recent data suggest that ocelots found near the Arizona-Sonora border are capable of moving between the two states and data provided from researchers in Sonora demonstrates that there is a viable breeding population in the state of

Sonora. The USFWS supports listing recovery goals for the ASMU, but has updated the quantification of recovery and downlisting criteria based on comments received from other reviewers. We agree that the current extent of suitable habitat in the ASMU should be assessed. As mentioned elsewhere we will continue to encourage the gathering of new information to update the downlisting criteria for ocelot in the ASMU. We have included action items that should result in obtaining this information. Following acquisition of new data, the Recovery Team will re-evaluate recovery needs and downlisting criteria for the ocelot populations in Sonora and Arizona. Updates to downlisting criteria and proposals for reclassification would happen following significant and new data.

G.3 Comment: This recovery plan proposes expenditures of at least $10.4 million for recovery of the Arizona-Sonoran population based on a single, unconfirmed record of the species in the last 46 years and for a recovery unit with no historic record of breeding activity in the U.S. Recovery goals for this recovery unit should reflect the biological relevance of Arizona lands for the survival and recovery of this population.

G.3 Response: There are many confirmed records of ocelots in the Arizona-Sonora Management Unit (ASMU), including many observations consistent with a breeding population in all 5 study areas surveyed in Sonora in 2010-2011. There were 8 confirmed ocelot observations in Arizona between 1964 and 2010. Since 2010, there have been 3 individual males documented multiple times with remote cameras.

G.4 Comment: One reviewer commented that the draft plan implied that predator control and trapping could be a significant source of mortality in Arizona and that it is under-reported by trappers. This reviewer also commented that the statement about 57% of Arizona being public lands is misleading, and that it should be re-calculated for the area south of Globe and east of I-10.

G.4 Response: We revised the plan so that the reference to predator control and fur trapping refers to Texas; the earlier draft erred in generalizing to the U.S. We also added information on the percent of public land in the relevant counties of Arizona, namely Pima (44%), Santa Cruz (62%), Gila (60%), Pinal (55%), and Graham (56%). Tribal lands are not counted as public land in these percentages.

G.5 Comment: One reviewer commented that the 2010 Biological Opinion that was issued to USDA-APHIS Wildlife Services should be included in our discussion of predator control and that we should take special note that there has been an absence of take by predator control since 1983.

G.5 Response: The final plan has been clarified to explain information in the 2010 Biological Opinion referenced by the reviewer.

G.6 Comment: A reviewer stated that all of the ocelots from Arizona for which the sex is known are males, and it would be incorrect to state that Arizona has or had a breeding population of these cats in recent times. Hence, any statements or designations of critical habitat would be premature despite the possibility that this species is extending its range northward similar to the recent expansions of coatis, opossums, and other small mammals into southern Arizona.

G.6 Response: Ongoing monitoring efforts initiated by the University of Arizona and U.S. Geological Survey, funded in part by DHS, continue to sample southern Arizona for ocelot with wildlife cameras. To date, three males and no female ocelots have been documented. However, regarding critical habitat, in the 1982 final rule (47 FR 31670), the USFWS made a determination that the designation of critical habitat was not prudent.

G.7 Comment: We suggest that the USFWS lead a coordinated monitoring effort on public and private lands in southern Arizona and if possible, fund research efforts in northern Sonora. This would allow the USFWS to integrate the documentation and collection of reliable ocelot sightings (Class I and II based on AGFD guidelines), road-kill and photographs, localities, habitat type and other pertinent information, and develop a statistically sound sampling design for ocelots across the recovery planning area, along with a regional predictive model of their distribution.

G.7 Response: We recognize that the USFWS and the states, through section 6 agreements, have responsibilities and authorities for monitoring ocelots. The plan includes a recovery action to develop cooperation among agencies and organizations for data sharing and data repository. This action should encourage regional coordination and sharing of information. There is also another recovery action to promote data collection and sharing among countries with ocelots that intends to provide support for a routine workshop every three to five years to gather ocelot information.

G.8 Comment: Considering Sky Island Alliance's significant research efforts already underway in the region, USFWS should identify opportunities to engage regional partners on both sides of the border in order to advance ocelot recovery. SIA is currently developing a region-wide wildlife monitoring effort in southern Arizona with the use of non-invasive techniques, such as remote cameras and identification of tracks and other sign.

G.8 Response: The USFWS agrees that engaging regional partners in the U.S. and Mexico will advance ocelot recovery. We look forward to collaborating on future research and welcome any new information regarding the ocelot in southern Arizona. In 2014, the USFWS began planning annual workshops with multiple partners and researchers in the U.S. and Mexico. These workshops will provide a forum for various partners to participate in an open conversation about current ocelot research and conservation needs.

G.9 Comment: The localities where SIA has documented ocelots in Sonora are more typical of habitats found in southern Arizona. The contrast between López González *et al.* (2003) documentations and SIA's research reflects the lack of recorded knowledge about northern Sonoran ocelots, and highlights the immediate need to establish research projects in order to gather accurate information. This includes information on the local habitats occupied, the existing vegetation cover, and other preferences by the species.

G.9 Response: We agree that little has been documented and published regarding ocelot habitat use and preference in northern Sonora and we would welcome any new information in this area. Such information would be very valuable to help guide future recovery implementation in the ASMU.

G.10 Comment: The USFWS should place more emphasis on identifying potential habitat for ocelot recovery in both Arizona and Sonora. Migration corridors that link key habitat cores in Mexico and the United States must be identified and protected. Recovery strategies within the ASMU require on-the-ground evaluations of potential habitat and cross-border corridors, and an evaluation of the potential for reintroduction, including land tenure (public or private), area covered, number and sex ratio of animals to reintroduce and monitoring.

G.10 Response: We agree that mapping potential and occupied habitat in Sonora and Arizona, and potential linkages, is important to recovery. The plan contains several specific actions to map these areas. The comment also requests that the plan consider reintroduction of ocelots into Arizona. Any such reintroduction would require a significant amount of surveying to determine if there is already a breeding population in Arizona. Reintroduction is a less desirable strategy than increasing connectivity and creating conditions for natural range expansion of ocelots especially considering that there are natural habitat corridors to build upon and protect in some areas of the ASMU.

G.11 Comment: A captive breeding program would be most unwise in my opinion as the species appears to be doing well in the wild in Sonora.

G.11 Response: The USFWS recognizes a captive breeding program as an option to assist recovery. Such a program must be evaluated for effectiveness and compared to other recovery options based on an analysis of logistics, resources needed, economics, length of time, availability of enough founder animals to start a program, potential for success, and well-defined goals. At present the Recovery Team considers a captive breeding program involving either *L. p. sonoriensis* or *L. p. albescens* as a lesser priority compared to other recovery options.

H. Roads and Crossings

H.1 Comment: There should be a statement about evaluating crossing structures to verify that ocelots will use them and that they do reduce road mortality.

H.1 Response: A statement was added in Section 2.1.3.5.

H.2 Comment: One of the form letters received specifically stated that ocelot crossings should be installed on State Highway 100 as several ocelots have died there from vehicles.

H.2 Response: The USFWS knows of four ocelots that have died from collisions with vehicles on State Highway 100, between Los Fresnos and Laguna Vista, Texas. The USFWS agrees that wildlife crossings are a necessary component of improvements to this roadway in addition to removing the 10.5 km concrete barrier installed in 2007 by Texas Department of Transportation (TXDOT), contrary to USFWS recommendations.

H.3 Comment: Roads present a very real threat to Ocelots. The Recovery Plan provided disturbing numbers on how many Ocelots have died from vehicles. There should be no new road construction on the refuge or on any other Federal lands where Ocelots occur.

H.3 Response: The USFWS concurs that roads represent a major threat to ocelot recovery. All modifications to habitats used by ocelots that occur on federal properties or utilizing federal funds require consultation with the USFWS's regulatory branch, Ecological Services. It is the role of Ecological Services to ensure that federal actions do not have a significant impact on endangered species. Through the consultation process, the Ecological Services branch works with the agency responsible for the action in order to eliminate the "may affect" determination on a project or to require mitigation for any impacts to ocelot habitat. The USFWS proactively meets with consultants and roadway engineers even on projects that do not have a federal nexus. The USFWS has recently developed a plan presenting the needs and priority areas for wildlife crossings in South Texas and similar plans have been developed for Arizona.

H.4 Comment: What would be the impact of a bridge on ocelot mortality? I would think bridges could be assets rather than liabilities.

H.4 Response: The word "bridge" was used many times in the plan to mean international bridges. These international bridge projects often result in the direct removal of vegetation due to the need for construction of pilings and access for heavy equipment, and/or indirectly due to increased foot-traffic activities of undocumented immigrants and constant foot- and vehicle-patrolling by Border Patrol agents under the bridges. However, roadway bridges over drainages, canals, or ocelot habitat may make ideal wildlife crossings if they meet the design requirements to be functional for ocelots. We have clarified some of the language in the final plan to distinguish international bridges from other types of bridges.

H.5 Comment: Perhaps even more crucial than efforts to construct road crossings are efforts to avoid constructing roads in known ocelot habitat. Development, including road construction and its associated threats, represent the primary cause of ocelot endangerment. To forestall the need to construct expensive road crossings – which would only minimize (as opposed to completely avoid) ocelot road mortality – the USFWS should more explicitly discuss steps to avoid road construction in known ocelot habitat. To help implement this goal, the final recovery plan should discuss Section 6001 of the SAFETEA-LU (Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users) and its requirements.

H.5 Response: We agree that any regulations, stipulations, and best management practices for planning, designing, and funding roadway projects should be followed. In an attempt to reduce or eliminate roadway impacts on ocelots, the USFWS and its partners have engaged the transportation industry directly, regularly, and consequently with significant improvements to wildlife with regards to roadways since 2009. The state of Arizona benefits from having a plan for wildlife crossings for several species. Friends groups and other non-profit groups that assist National Wildlife Refuges or affect wildlife conservation in other ways, can greatly assist in these planning and funding processes by, among other things, helping to rally political support for reducing the impacts of roadways on wildlife such as the ocelot.

H.6 Comment: We question why the document fails to mention the efficacy of existing underpasses. Efficacy information could include even anecdotal accounts or data about whether underpasses are located in areas of high priority for ocelot conservation because of their proximity to occupied habitat or to important corridors for ocelots. It is difficult to understand how such a high reliance on underpasses can be justified without monitoring data to suggest that these high cost interventions are effective.

H.6 Response: The mitigation of negative ecological impacts that result from roadways is a relatively new, but well-established science. This body of information supports extensive use of wildlife crossings by carnivores. With the exception of a wildlife crossing under State Highway 48 near Brownsville, Texas, and a bridge near San Benito, Texas, the vast majority of structures installed by TXDOT in conjunction with roadways were designed or located in places primarily to move water rather than to mitigate wildlife-roadway issues. Crossing structures and bridges are being monitored by the USFWS in partnership with TXDOT and many are being used by bobcats, coyotes, raccoons, rabbits, armadillos, opossums, and skunks. The USFWS will continue to monitor these areas and provide insights to partners regarding the effectiveness of these wildlife crossings. When installed properly and in the proper locations, crossings have the potential to be a very effective tool for ocelot recovery, but to date none have been built in an area near a population of ocelots.

Copies may be obtained online (species search: ocelot):
www.fws.gov/endangered

or by contacting:

U.S. Fish and Wildlife Service
Laguna Atascosa National Wildlife Refuge
22817 Ocelot Rd.
Los Fresnos, TX 78566

or

U.S. Fish and Wildlife Service
Southwest Regional Office
P.O. Box 1306
Albuquerque, NM 87103

www.fws.gov/southwest

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