

**Jaguar Collaring and Monitoring in the Arizona-New Mexico Borderlands with Mexico
February 2, 2009**

Border-related infrastructure projects and patrol activities may affect movement patterns of jaguars in the borderlands region of Arizona/New Mexico and Sonora/Chihuahua. Specifically, fences and barriers placed along the border may impede jaguar movement across the International Border. Installation of fences and barriers may also cause increases in illegal traffic and pursuant law enforcement activities in areas where fences do not exist. Increased activities in these areas may also affect jaguar movement across the border. Maintaining connectivity between Arizona/New Mexico and Sonora/Chihuahua is critical to continued survival of jaguars in Arizona/New Mexico. Should all jaguar movement corridors be severed, it is highly likely that the jaguar will become extirpated from Arizona/New Mexico, as we believe persistence of jaguars in Arizona/New Mexico is dependent on immigration from Sonora/Chihuahua.

To better understand movement and habitat use patterns of jaguars in the border region of Arizona and New Mexico, the Arizona Game and Fish Department, New Mexico Department of Game and Fish, and U.S. Fish and Wildlife Service, in conjunction with key partners from the Arizona-New Mexico Jaguar Conservation Team, propose to capture, collar (with GPS and satellite technology), and monitor jaguars in this region.

To start, likely a jaguar referred to as Macho B would be selected for monitoring because he has been detected (through use of remote-sensing cameras) repeatedly from 1996 through 2008 in three mountain range complexes in south-central Arizona. Furthermore, he was detected in areas where vehicle barriers were placed (detection was made before the barrier placement) and near areas where pedestrian fences are under construction. Though monitoring only one jaguar will not allow us to formulate conclusions about all jaguar movements in the region, it will significantly increase our current level of knowledge.

As additional jaguars are detected in the borderlands region through the use of passive survey techniques (see proposal below), they would, as determined appropriate, be captured and collared to gather further information on jaguar dispersion patterns and habitat use. Results obtained from this effort may help identify important jaguar travel corridors and use areas and better understand how border infrastructure projects affect cross-border jaguar movements.

Estimated Budget to Capture, Collar, and Monitor Jaguars in the Borderlands Region of Arizona and New Mexico for Five Years¹:

Cost of Collar and One Capture Effort	Number of Collar and Capture Efforts	Subtotal	Cost of One Year of Monitoring ¹	Proposed Number of Years	Subtotal	Total ²
\$30,000	5	\$150,000	\$70,000	5	\$350,000	\$500,000

¹ Cost of monitoring includes annual satellite uplink fee, as well as personnel and transportation expenses.

² Total cost may vary depending on the number of jaguars successfully detected, captured, and collared. There may be overlap in the cost of annual monitoring and annual survey work described below (i.e. depending on the success of detecting, capturing, and collaring jaguars, some of personnel and transportation needs for monitoring may be met by those covered in the survey proposal). The total annual partner contribution and additional requested contribution are yet to be determined for this effort.

DRAFT Jaguar Survey Proposal (Additional Array for One Year and Additional Arrays for Multiple Years)

Jaguars have been surveyed in select areas in Arizona and New Mexico using remote-sensing cameras since 1997. In 2001, the Borderland Jaguar Detection Project was formed in cooperation with the Arizona-New Mexico Jaguar Conservation Team. This project expanded jaguar survey efforts (including the use of remote-sensing cameras, as well as track and scat transects) to various mountain range complexes in south-central Arizona. The project was designed to detect presence of jaguars in the area and movement of jaguars crossing the border between Sonora and Arizona. Survey work has resulted in the detection of at least two male jaguars, as well as many other species. Additionally, one of the jaguars, Macho B, was detected and tracked crossing the international border. Repeat detections of Macho B in different mountain range complexes have allowed researchers to estimate a minimum observed range for him.

The Arizona Game and Fish Department, New Mexico Department of Game and Fish, and U.S. Fish and Wildlife Service, in conjunction with key partners from the Jaguar Conservation Team, particularly the Borderland Jaguar Detection Project, propose to expand this survey effort (both remote-sensing cameras and track and scat transects) to other mountain range complexes in the border region of Arizona and New Mexico with the goals of: 1) detecting the presence of jaguars in mountain ranges that have not been previously surveyed, and 2) identifying jaguar habitat in Arizona/New Mexico and potential travel corridors into Arizona/New Mexico from Sonora/Chihuahua. Information gathered through this effort may assist land managers and users in making more informed decisions regarding jaguar management and conservation efforts in the borderlands region.

Estimated Budget to Expand Jaguars Survey Efforts to Five Additional Mountain Ranges in the Borderlands Region of Arizona and New Mexico for Five Years:

Cost of one Camera and Associated Equipment and Supplies	Number of Cameras	Subtotal	Cost of One Year of Surveys ¹	Proposed Number of Years	Subtotal	Total
\$700	250	\$175,000	\$250,000	5	\$1,250,000	\$1,425,000

¹Cost of surveys includes personnel (one full-time supervisor and six full-time assistants) and transportation expenses.

²The total annual partner contribution and additional requested contribution are yet to be determined for this effort.

Note: All cost estimates in the proposals do not include overhead expenses.

Jaguar Conservation in the Arizona-New Mexico/Mexico Borderlands
Arizona Game and Fish Department (on behalf of the
Arizona-New Mexico Jaguar Conservation Team)
February 2, 2009

The jaguar (*Panthera onca*) has been known from the Arizona-New Mexico/Mexico borderlands since pre-settlement times. Never known to be common in the area, it was believed extirpated from the United States and northern Mexico by humans in the 1900s. However, in 1996 jaguars were documented photographically in Arizona and New Mexico. Since then, a low level of at least occasional, perhaps seasonal, presence has been documented along the International Border and a core (northern-most) population has been documented about 140 miles south of the border. Habitat connectivity and jaguar movement between these two areas is largely speculative, although logical ecological corridors exist.

In 1997, the Arizona Game and Fish Department (AGFD) and the New Mexico Game and Fish Department (NMDGF) initiated and eventually formed, in cooperation with the U.S. Fish and Wildlife Service [USFWS] an Arizona-New Mexico Jaguar Conservation Team (JAGCT) to carry out jaguar conservation in the borderlands (Johnson and Van Pelt 1997). Several other state, federal, and local government entities participate in this ongoing effort as signatories to (or informal cooperators under) a Memorandum of Understanding between AGFD and NMDGF for jaguar conservation and a *Jaguar Conservation Framework for Arizona, New Mexico, and Northern Mexico* (AGFD and NMDGF 2007).

Nongovernmental organizations (NGOs), private individuals, and Mexico also are among the JAGCT's informal cooperators. Particularly notable among the NGOs is the Borderland Jaguar Detection Project (BDP), which was formed in 1997, in conjunction with the JAGCT, to detect presence of jaguars and movement of jaguars across the border between Sonora and Arizona. With minimal financial support from JAGCT cooperators and other entities, BDP has expanded its survey efforts (including use of remote-sensing cameras and track/scat transects) to various mountain range complexes in south-central Arizona. This work has resulted in detection of at least two male jaguars, as well as many other species of wildlife. One of these jaguars, Macho B, has been tracked crossing the International Border.

Much like the United States, Mexico considers the jaguar a national priority species for conservation. Mexico has convened two national symposia on jaguar conservation and has initiated a national and regional conservation planning process for the species. The JAGCT has been an invited, active participant in these efforts, which include a third national symposium in Mexico in mid to late 2009 (contingent upon securing funding).

Mexico's conservation strategies are known as PREPs (Proyectos de Recuperación de Especies Prioritarias). The jaguar PREP was completed in 2006 by a *National Technical Consultants Subcommittee for Conservation and Management of the Jaguar*. Direct actions carried out under the PREP would include protection, management, and restoration of the species and its habitat. Indirect actions would include information dissemination, integrating jaguar conservation into the existing fabric of local cultures, and administration, all in an Action Plan covering a five-year period. JAGCT participation in these efforts has furthered coordination and cooperation between the two countries at a variety of levels.

Needs and Proposed Activities

Scarcity of funds has significantly hindered progress in four primary activities of the collaborative jaguar conservation effort in the United States and Mexico: conservation planning; outreach (dissemination of information and education materials in printed, Web-based, and other mediums); survey and monitoring; and (in Mexico) management of jaguar habitat in protected areas. These activities are crucial to identifying and addressing concerns about factors known to affect continued presence of jaguars in the U.S.-Mexico borderlands. These factors include: unlawful killing, movement-corridor disruption, and habitat protection and management in the Mexican portion of the range. The JAGCT and its cooperators and colleagues in Mexico have also identified a need for extensive research into jaguar habitat use and behavior in these northernmost parts of the current and historic range.

Conservation Coordination, Planning, and Outreach. Fundamental to furthering jaguar conservation in the AZ-NM/Mexico borderlands is providing support for the JAGCT to engage fully in ongoing planning and outreach efforts in Arizona and New Mexico and in collaboration with Mexico. The requested funds (see Table 1) would be administered by AGFD and expended by the appropriate cooperating agencies (including AGFD) in the United States and Mexico (subject to the requisite financial agreements). The JAGCT meets at least twice annually in Arizona or New Mexico, and increased funding would enable it to participate in the next jaguar symposium in Mexico and in bi-national jaguar conservation planning over the next five years.

Habitat Protection and Management. Several NGOs in Mexico and the United States are cooperating with the federal government and private landholders in Mexico to voluntarily manage key areas for jaguar conservation. These ongoing protection and management activities are in dire need of funding if they are to be continued (see Table 2). AGFD again proposes that it act in an administrative capacity for such funds, conveying them to the appropriate cooperator(s) in Mexico, subject to prior approval by the Mexican federal government and completion of the requisite financial agreements.

Monitoring and Surveys. JAGCT monitoring and survey efforts must be stepped up over the next five years in conjunction with Department of Homeland Security activities in the AZ-NM/Mexico borderlands. Border-related infrastructure projects and patrol activities may affect movement patterns of jaguars in the borderlands region of Arizona/New Mexico and Sonora/Chihuahua. Specifically, fences and barriers placed along the border may impede jaguar movement across the International Border. Installation of fences and barriers may also cause increases in illegal traffic and pursuant law enforcement activities in areas where fences do not exist. Increased activities in these areas may also affect jaguar movement across the border. Maintaining connectivity between Arizona/New Mexico and Sonora/Chihuahua is critical to continued survival of jaguars in Arizona/New Mexico. Should all jaguar movement corridors be severed, it is highly likely that the jaguar will become extirpated from Arizona/New Mexico because the best available science indicates persistence of jaguars there is dependent on immigration from Sonora/Chihuahua.

To better understand movement and habitat use patterns of jaguars in the border region of Arizona and New Mexico, AGFD, NMDGF, and USFWS, in conjunction with key partners from the JAGCT (i.e. Borderland Detection Project), propose to capture, collar (with GPS and satellite technology), and monitor jaguars in the Arizona-New Mexico and Mexico portions of the

borderlands (see Table 3). In the Mexico portion of the borderlands these efforts would be carried out under AGFD agreement(s) with one or more entities approved by the federal government of Mexico.

To start GPS monitoring, likely the jaguar known as Macho B would be captured and collared, because he has been detected (through use of remote-sensing cameras) repeatedly from 1996 through 2008 in three mountain range complexes in south-central Arizona. Furthermore, he was detected in areas where vehicle barriers have been placed (detection occurred prior to barrier placement) and near areas where pedestrian fences are under construction. Although monitoring a single jaguar will not allow formulation of definitive conclusions about jaguar movements in the region, even that level would significantly increase available knowledge.

With regard to surveys, due to lack of funding jaguar survey work is currently restricted to a relatively small area in south-central Arizona. This effort needs to be expanded to cover areas of previous and/or potential jaguar occurrence in southeastern Arizona, southwestern New Mexico, and the northern portions of Chihuahua and Sonora (see Tables 4 and 5). As additional jaguars are detected through use of passive survey techniques, they would, as determined appropriate, be captured and collared to gather further information on jaguar dispersion patterns and habitat use. Information gathered through this effort would greatly assist land managers in making more informed decisions regarding jaguar management and conservation efforts in the borderlands region and better enable them to understand how border infrastructure projects affect jaguar movements across the International Border and persistence in the borderlands.

Proposed Project Budgets

Table 1. Estimated budget for JAGCT conservation coordination, planning, and outreach in collaboration with governmental and nongovernmental cooperators in the United States and Mexico.

Coordination	Planning	Outreach	Annual Total	Five-Year Total
\$60,000	\$60,000	\$80,000	\$200,000	\$600,000

Table 2. Estimated budget for habitat protection and management in Mexico in accordance with priorities established by the Mexican federal government.

Habitat protection and management	Annual Total	Five-Year Total
\$250,000	\$250,000	\$1,250,000

Table 3. Estimated budget to capture, collar, and monitor jaguars in the borderlands region of Arizona, New Mexico, and Mexico for five years.

Cost of Each Capture and Collaring Effort	Number of Capture and Collaring Efforts	Subtotal	Annual Cost of Monitoring (personnel and satellite uplink)	Proposed Number of Years	Subtotal	Five-Year Total
\$30,000	5	\$150,000	\$70,000	5	\$350,000	\$500,000

Table 4. Estimated budget to expand jaguar survey efforts to at least five additional mountain ranges in the borderlands region of Arizona and New Mexico for five years.

Cost per Camera (including associated equipment, supplies)	Number of Cameras	Subtotal	Survey Cost Per Year	Proposed Number of Years	Subtotal	Total
\$700	250	\$175,000	\$250,000	5	\$1,250,000	\$1,425,000

Table 5. Estimated budget for jaguar survey in Mexico (northern Chihuahua and Sonora) for five years.

Cost Per Camera (including associated equipment, supplies)	Number of Cameras	Subtotal	Survey Cost Per Year	Proposed Number of Years	Subtotal	Total
\$700	250	\$175,000	\$250,000	5	\$1,250,000	\$1,425,000

Note: All cost estimates in the proposals do not include indirect costs.

September 14, 2007

DRAFT Jaguar Collaring and Monitoring (One year)

Border-related infrastructure projects and patrol activities may affect movement patterns of jaguars in the borderlands region of Arizona/New Mexico and Sonora/Chihuahua. Specifically, fences and barriers placed along the border may impede jaguar movement across the international border. Installation of fences and barriers may also cause an increase in illegal traffic and pursuant law enforcement activities in areas where fences do not exist. Increased activities in these areas may also affect jaguar movement across the border. Maintaining connectivity between Arizona/New Mexico and Sonora/Chihuahua is critical to the continued survival of jaguars in Arizona/New Mexico. Should all jaguar movement corridors be severed, it is highly likely that the jaguar will become extirpated from Arizona/New Mexico, as we believe the persistence of the jaguar population in Arizona/New Mexico is dependent upon immigration from Sonora/Chihuahua.

To better understand movement and habitat use patterns of jaguars in the border region of Arizona and New Mexico, the Arizona Game and Fish Department, New Mexico Department of Game and Fish, and U.S. Fish and Wildlife Service, in conjunction with key partners from the Jaguar Conservation Team, propose to capture, collar (with GPS and satellite technology), and monitor jaguars in this region.

To start, likely a jaguar, referred to as Macho B, would be selected for monitoring because he has been detected repeatedly and recently (through the use of remote-sensing cameras) in three mountain range complexes in south-central Arizona (by the Borderlands Jaguar Detection Project). Furthermore, he was detected in areas where vehicle barriers were placed (detection was made before the barrier placement) and near areas where pedestrian fences are under construction. Though monitoring only one jaguar will not allow us to formulate conclusions about all jaguar movements in the region, it will significantly increase our current level of knowledge.

Estimated Budget to Capture, Collar, and Monitor a Jaguar in the Borderlands Region of Arizona and New Mexico for One Year:

Cost of Collar and One Capture Effort	Cost of One Year of Monitoring ¹	Total ²	Total to be Contributed by Other Partners	Total Additional Requested Contribution
\$30,000.00	\$70,000.00	\$100,000.00	\$40,000.00	\$60,000.00

¹ Cost of monitoring includes annual satellite uplink fee, as well as personnel and transportation expenses.

² There may be overlap in the cost of annual monitoring and annual survey work described below (i.e., some of the personnel and transportation needs for monitoring may be met by those covered in the survey proposal).

DRAFT Jaguar Collaring and Monitoring Proposal (Multiple Jaguars and Years)

As additional jaguars are detected in the borderlands region through the use of passive survey techniques (see proposal below), they would, as determined appropriate, be captured and collared to gather further information on jaguar dispersion patterns and habitat use. Results obtained from this effort may help us identify important jaguar travel corridors and use areas and better understand how border infrastructure projects affect cross-border jaguar movements.

Estimated Budget to Capture, Collar, and Monitor Jaguars in the Borderlands Region of Arizona and New Mexico for Five Years¹:

Cost of Collar and One Capture Effort	Number of Collar and Capture Efforts	Subtotal	Cost of One Year of Monitoring ¹	Proposed Number of Years	Subtotal	Total ²
\$30,000.00	5	\$150,000.00	\$70,000.00	5	\$350,000.00	\$500,000.00

¹ Cost of monitoring includes annual satellite uplink fee, as well as personnel and transportation expenses.

² Total cost may vary depending on the number of jaguars successfully detected, captured, and collared. There may be overlap in the cost of annual monitoring and annual survey work described below (i.e., depending on the success of detecting, capturing, and collaring jaguars, some of personnel and transportation needs for monitoring may be met by those covered in the survey proposal). The total annual partner contribution and additional requested contribution are yet to be determined for this effort.

DRAFT Jaguar Survey Proposal (Additional Array for One Year and Additional Arrays for Multiple Years)

Jaguars have been surveyed in select areas in Arizona and New Mexico using remote-sensing cameras since 1997. In 2001, the Borderland Jaguar Detection Project was formed. This project expanded jaguar survey efforts (including the use of remote-sensing cameras, as well as track and scat transects) to various mountain range complexes in south-central Arizona. The project was designed to detect not only the presence of jaguars in the area, but also the movement of jaguars crossing the border between Sonora and Arizona. Survey work has resulted in the detection of at least two male jaguars, as well as many other species. Additionally, one of the jaguars, Macho B, was detected and tracked crossing the international border, and repeat detections of Macho B in different mountain range complexes have allowed researchers to estimate a minimum observed range for him.

The Arizona Game and Fish Department, New Mexico Department of Game and Fish, and U.S. Fish and Wildlife Service, in conjunction with key partners from the Jaguar Conservation Team, particularly the Borderland Jaguar Detection Project, propose to expand this survey effort (both remote-sensing cameras and track and scat transects) to other mountain range complexes in the border region of Arizona and New Mexico with the goals of: 1) detecting the presence of jaguars in mountain ranges that have not been previously surveyed, and 2) identifying jaguar habitat in Arizona/New Mexico and potential travel corridors into Arizona/New Mexico from Sonora/Chihuahua. Information gathered through this effort may assist land managers and users in making more informed decisions regarding jaguar management and conservation efforts in the borderlands region.

Estimated Budget to Expand Jaguar Survey Effort to an Additional Mountain Range in the Borderlands Region of Arizona for One Year:

Cost of one Camera and Associated Equipment and Supplies	Number of Cameras	Subtotal	Cost of One Year of Surveys ¹	Total	Total to be Contributed by Other Partners	Total Additional Requested Contribution
\$700.00	50	\$35,000.00	\$50,000.00	\$85,000.00	\$35,000.00	\$50,000.00

¹Cost of surveys includes personnel (one full-time supervisor and six full-time assistants) and transportation expenses.

Estimated Budget to Expand Jaguar Survey Effort to an Additional Mountain Range in the Borderlands Region of Arizona for Five Years:

Cost of one Camera and Associated Equipment and Supplies	Number of Cameras	Subtotal	Cost of One Year of Surveys ¹	Proposed Number of Years	Subtotal	Total ²
\$700.00	50	\$35,000.00	\$50,000.00	5	\$250,000.00	\$285,000.00

¹Cost of surveys includes personnel (one full-time supervisor and six full-time assistants) and transportation expenses.

²The total annual partner contribution and additional requested contribution are yet to be determined for this effort.

Estimated Budget to Expand Jaguars Survey Efforts to Five Additional Mountain Ranges in the Borderlands Region of Arizona and New Mexico for One Year:

Cost of one Camera and Associated Equipment and Supplies	Number of Cameras	Subtotal	Cost of One Year of Surveys ¹	Total
\$700.00	250	\$175,000.00	\$250,000.00	\$425,000.00

¹Cost of surveys includes personnel (one full-time supervisor and six full-time assistants) and transportation expenses.

²The total annual partner contribution and additional requested contribution are yet to be determined for this effort.

Estimated Budget to Expand Jaguars Survey Efforts to Five Additional Mountain Ranges in the Borderlands Region of Arizona and New Mexico for Five Years:

Cost of one Camera and Associated Equipment and Supplies	Number of Cameras	Subtotal	Cost of One Year of Surveys ¹	Proposed Number of Years	Subtotal	Total
\$700.00	250	\$175,000.00	\$250,000.00	5	\$1,250,000.00	\$1,425,000.00

¹Cost of surveys includes personnel (one full-time supervisor and six full-time assistants) and transportation expenses.

²The total annual partner contribution and additional requested contribution are yet to be determined for this effort.

Note: All cost estimates in the proposals do not include overhead expenses.

Memorandum of Understanding
between the
Arizona Game and Fish Department
and the
New Mexico Department of Game and Fish
for
Jaguar Conservation

Introduction

This Memorandum of Understanding (MOU) for a state-led jaguar (*Panthera onca*) conservation program is made and entered into by and among the Arizona Game and Fish Department (AGFD), the State of New Mexico Department of Game and Fish (NMDGF), and various government agencies that become signatories as described below. AGFD is authorized to enter into this MOU by A.R.S. § 17-231.B.7. NMDGF is authorized to enter into this MOU by New Mexico Statutes Annotated, Chapter 17 Game and Fish; NMSA 1978. The U.S. Fish and Wildlife Service (USFWS) has the authority to enter into this MOU through the Endangered Species Act of 1973, as amended; the Fish and Wildlife Act of 1956, as amended; the Fish and Wildlife Coordination Act, as amended; and 43 CFR part 24, U.S. Department of Interior's fish and wildlife policy on state and federal relationships.

The primary emphasis area for conservation action under this MOU is defined as (see also Fig. 1): Arizona, including all or parts of Santa Cruz, Pima, Pinal, Graham, Greenlee, and Cochise counties; and New Mexico, including all or parts of Catron, Sierra, Luna, Grant, and Hidalgo counties. However, outreach and other conservation-related activities may take place over a broader area, including outlying areas of Arizona, New Mexico, and northern Mexico.

Collectively, AGFD and NMDGF are referred to herein as the Lead Agencies for this MOU, and are jointly responsible for leading this conservation effort.

Collectively, all other signatories to this MOU are referred to herein as Cooperators. Entities that AGFD and NMDGF invite to participate as Cooperators include the following government agencies: state and federal wildlife and/or land management agencies with statewide responsibilities in Arizona and/or New Mexico; tribal wildlife agencies and county governments with management responsibilities within the primary emphasis area defined above for this MOU; the Natural Resource Conservation Districts (NRCs) of Arizona and Soil and Water Conservation Districts (SWCDs) of New Mexico that lie within the primary emphasis areas defined above; and state and federal wildlife management agencies in Mexico that have responsibilities within the area of northern Mexico in which jaguars are known to occur (i.e. Chihuahua and Sonora).

Purpose

The purpose of this MOU is to further jaguar conservation through cooperation among government agencies and the public by implementing the *Conservation Assessment and Strategy for the Jaguar in Arizona and New Mexico* (Johnson and Van Pelt. 1997. Arizona Game and Fish

Department Nongame and Endangered Wildlife Program Technical Report 105. Phoenix, Arizona). The intent is to provide for broad, voluntary participation in the conservation effort, with the Lead Agencies and Cooperators carrying the principal administrative and financial burdens for implementation. [Note: the aforementioned conservation assessment and strategy is being revised to become a *Jaguar Conservation Framework for Arizona, New Mexico, and Northern Mexico*, which AGFD and NMDGF will approve and submit to USFWS for acceptance. USFWS will recuse itself from any vote within JAGCT on the Framework, due to its responsibility for determining adequacy of the Framework after submittal by the Lead Agencies.]

Witnesseth

WHEREAS, (a) the jaguar historically occurred in the Arizona-New Mexico/Mexico borderlands, and continues to occur as a resident (breeding) population in northern Mexico and at least occasionally in Arizona and New Mexico (only males have been documented in AZ-NM since the mid-1900s); (b) the jaguar's current population status throughout the borderlands is not well known, (c) unlawful killing of borderlands jaguars is an ongoing concern, (d) public education, protection from unlawful take, minimal restriction of natural movement, and presence of a healthy core population in northern Mexico are thought to be keys to continued jaguar presence in the AZ-NM/Mexico borderlands, (e) jaguar management in the borderlands would be improved by better information about jaguar movements, food habits, habitat use, and general behavior in that area, and (f) a voluntary partnership among parties responsible for and/or interested in the jaguar can be an effective means of conserving the species.

WHEREAS, the Arizona Game and Fish Department, a State resource agency, has determined that conservation of the jaguar is consistent with (a) its statewide program to manage nongame and endangered wildlife, and (b) its "Cooperative Agreement for Conservation of Endangered Species" with the U.S. Fish and Wildlife Service pursuant to Section 6 of the Endangered Species Act of 1973, as amended.

WHEREAS, the New Mexico Department of Game and Fish, a State resource agency, has determined that conservation of the jaguar is consistent with (a) its mission to maintain and, to the extent possible, enhance the numbers of wildlife indigenous to the state, within the carrying capacity of the habitat, and (b) its "Cooperative Agreement for Conservation of Endangered Species" with the U.S. Fish and Wildlife Service pursuant to Section 6 of the Endangered Species Act of 1973, as amended.

NOW THEREFORE, in consideration of the above premises, the signatories enter into this MOU as partners to accomplish its purpose.

All Signatories to this MOU agree to:

1. Recognize AGFD and NMDGF as the Lead Agencies for this MOU. As such, AGFD and NMDGF will provide the primary administrative and logistical support for this MOU.

2. Participate in a Jaguar Conservation Team (JAGCT), established to implement this MOU and composed of the Lead Agencies and signatory Cooperators. The JACGT shall meet in public session not less than once each year, rotating meetings geographically through the primary emphasis areas of Arizona and New Mexico as necessary to facilitate broad public participation. Except as noted below, each Lead Agency and Cooperator shall designate one voting representative to the JAGCT. Signatories may not vote by proxy assigned to another Signatory. Exceptions: (a) the Bureau of Land Management may (if it so desires) designate one voting representative for Arizona and another for New Mexico; (b) the NRCs in the primary emphasis area of Arizona are treated under this MOU as a single voting Cooperator, but may (if they so desire) collectively designate two voting representatives to represent all the NRCs in that area; and (c) the SWCDs in the primary emphasis area of New Mexico are treated under this MOU as a single voting Cooperator but may (if they so desire) collectively designate two voting representatives to represent all the SWCDs in that area.
3. Recognize AGFD or NMDGF as Chair of the state-convened JAGCT. By mutual agreement, AGFD and NMDGF will determine which of them will serve as Chair.
4. Assist in developing, and if it is approved, implementing (and updating, as necessary) the *Jaguar Conservation Assessment and Framework for Arizona, New Mexico, and Northern Mexico* (AGFD and NMDGF 2007).
5. Provide, subject to availability, funding, facilities, equipment, logistical and staff support, and access to lands under their control, as necessary to implement this MOU.
6. Participate regularly in JAGCT meetings to enhance communication and cooperation among all interested and affected parties; help accomplish agreed-upon tasks; develop plans, reports, recommend actions, and public information and educational materials; provide ongoing review of, and feedback on, this conservation effort; cooperate in development of major media releases and outreach efforts; keep state and local governments, communities, the conservation community, citizens, and other interested and affected parties informed, and solicit their input on issues and actions of concern or interest to them; develop voluntary opportunities and incentives for local communities and private landowners to participate in this conservation effort, including ways that might provide local economic benefits; and assist in securing the funds necessary to implement this conservation effort.

The Arizona Game and Fish Department agrees to:

1. Facilitate issuance of necessary authorizations and State permits pursuant to Title 17, Arizona Revised Statutes, to NMDGF and other Cooperators on a timely basis as sanctioned under the relevant State laws and rules.
2. Carry-out administrative and field actions as necessary to support this conservation effort.

The New Mexico Department of Game and Fish agrees to:

1. Facilitate issuance of necessary authorizations and State permits pursuant to the New Mexico Wildlife Conservation Act, New Mexico Revised Statutes, to AGFD and other Cooperators on a timely basis as sanctioned under the relevant State laws and rules.
2. Carry-out administrative and field actions as necessary to support this conservation effort.

The U.S. Fish and Wildlife Service agrees to:

1. Recognize this conservation effort as a state-led conservation program for the jaguar, in accordance with the Endangered Species Act of 1973, as amended.
2. Carry-out administrative and field actions as necessary to support this conservation effort.

It is Further Mutually Agreed and Understood by and among all Signatories that:

1. Specific work projects or activities that involve transfer of funds, services, or property among signatories to this MOU may require execution of separate agreements or contracts.
2. JAGCT is an advisory body to the Lead Agencies, and does not of itself own, manage, or otherwise control any land, water, or wildlife. Thus, actions proposed or recommended by JAGCT may require amendments to existing land use or other plans, and environmental analysis, or undergo other acceptance or review processes within individual agencies, before an action agency determines whether to approve and/or implement them.
3. Nothing in this MOU shall obligate the signatories to expend appropriations or to enter into any contract or other obligations.
4. This MOU may be substantively modified or amended on written request by any signatory, subject to written concurrence by all signatories. However, signatories may be added to this MOU on their written request and subsequent concurrence by both Lead Agencies and by concurrence (as indicated by voice vote) of a majority of the Cooperators present at a public meeting of the JAGCT where such requests are considered.

5. Signatory participation in this MOU is voluntary, and any signatory may terminate its participation by providing 60-days written notice to the JAGCT Chair.
6. This MOU shall have a term of five (5) years from the date of the last signature of approval by a Lead Agency. At the end of this period, this MOU will expire unless it has been canceled, extended, or renewed by the Lead Agencies.
7. Conflicts between or among signatories concerning procedures or actions under this MOU that cannot be resolved by signatory representatives to the JAGCT shall, as necessary, be referred to the next higher level within each signatory agency for resolution.
8. The State of Arizona Required Provisions (Appendix A) are hereby made part of this MOU.

In Witness Whereof:

The Lead Agency signatories hereto have executed this MOU as of the date for each signature below.

Duane L. Shroufe
Duane L. Shroufe, Director
Arizona Game and Fish Department

3-22-07
Date

Bruce C. Thompson
Bruce C. Thompson, Director
New Mexico Department of Game and Fish

3-22-07
Date

Additional signatories (Cooperators) will be added as they declare their desire to sign onto this MOU and they are accepted per the guidelines above. A separate signature page will be used for each Cooperator, to facilitate execution of this document and to record the date on which that agency became signatory to the MOU. The signatory Cooperators to date are also listed below, for convenience:

Cooperator

Date of Signature

Benjamin N. Tuggle
Benjamin N. Tuggle, Regional Director
U.S. Fish and Wildlife Service, Region 2

3-22-07
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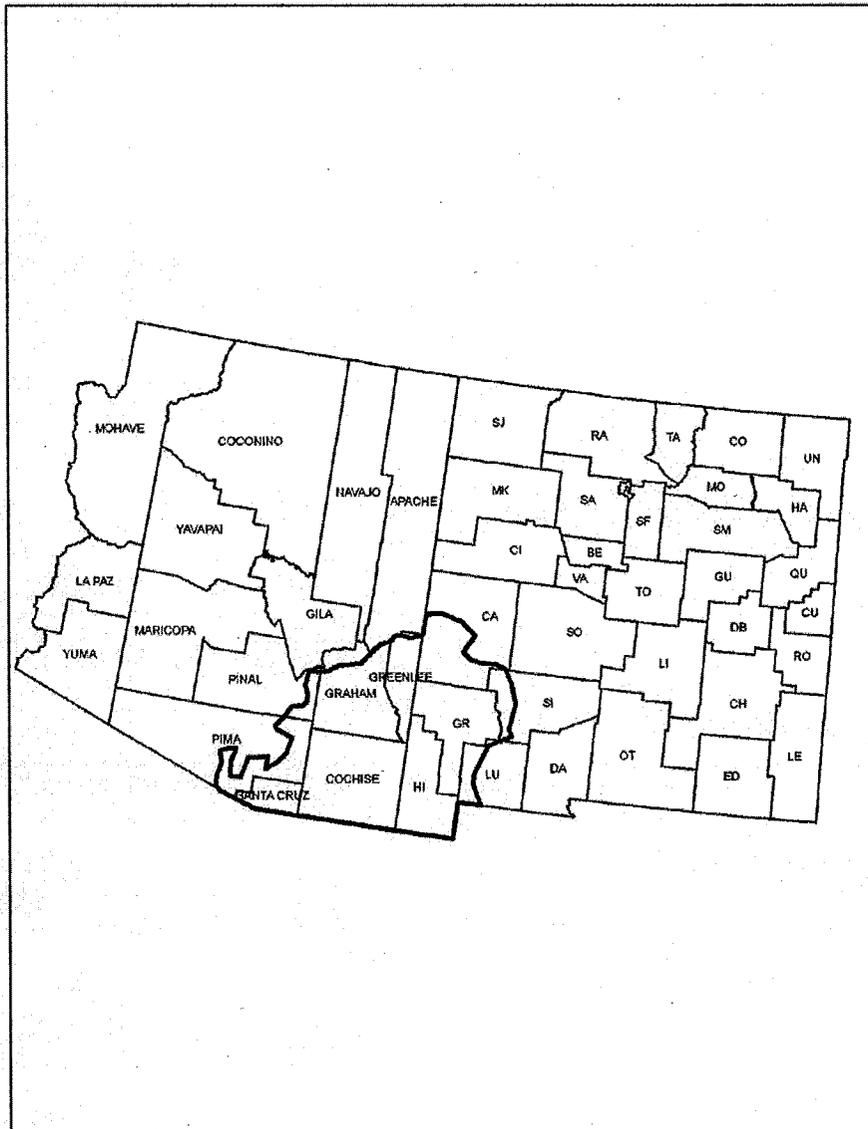


Figure 1. Emphasis area for conservation action under the Memorandum of Understanding between the Arizona Game and Fish Department and the New Mexico Department of Game and Fish for jaguar conservation. In Arizona, the area consists of all or parts of Pima, Santa Cruz, Graham, Greenlee, and Cochise counties. In New Mexico, the area consists of all or parts of Hidalgo, Grant, Luna, Sierra, and Catron counties.

Appendix A

State of Arizona Required Provisions

1. Non-discrimination. In carrying out the terms of this agreement, the Parties agree to comply with Executive Order 99-4 prohibiting discrimination in employment, the provisions of which are incorporated herein by reference.
2. Records Retention and Audit. Pursuant to A.R.S. § 35-214, all books, accounts, reports, files, electronic data, and other records relating to this agreement shall be subject at all reasonable times to inspection and audit by the State of Arizona for five (5) years after completion of this agreement.
3. Arbitration. The parties agree to engage in any alternative dispute resolution procedures authorized by their statutes, regulations and court rules, including, but not limited to, 5 U.S.C. § 575 and A.R.S. § 12-1518.
4. Termination for conflict of interest. This agreement is subject to termination pursuant to A.R.S. § 38-511.
5. Termination for Non-Availability of Funds. Every obligation of the Parties under this agreement is conditioned upon the availability of funds appropriated or allocated for the payment of such obligation. If funds for the continuance of this agreement are not allocated or are not available, this agreement shall terminate automatically on the date of expiration of funding. In the event of such termination, the Parties shall incur no further obligation or liability under this agreement other than for payment of services rendered prior to the expiration of funding.
6. Illegal Immigration. The Parties agree to comply with Executive Order 2005-30, "Ensuring Compliance with Federal Immigration Laws by State Employers and Contractors," the provisions of which are hereby incorporated by reference.

:tj

JAGUAR CONSERVATION ASSESSMENT
FOR
ARIZONA, NEW MEXICO AND NORTHERN MÉXICO

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Final: January 31, 2011

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ACKNOWLEDGMENTS

This document reflects a lot of work by a lot of people. We particularly thank the following:

- For insightful comment on this Assessment: the Arizona-New Mexico Jaguar Conservation Team (JAGCT) and its Scientific Advisory Group (especially Alan Rabinowitz, Howard Quigley, Eric Gese, Brian Miller, Raul Valdez and Emil McCain); Jack Childs; Warner and Wendy Glenn; Steve Spangle, Sherry Barrett, Erin Fernandez, Mark Crites and Sarah Rinkevich; Steve Ferrell, Ron Thompson, Mike Senn and Gary D. Hovatter; David E. Brown; Anthony Giordano; Tim Snow; and Craig Miller.
- For providing website descriptions of their organizations: the Malpai Borderlands Group, Sky Island Alliance and Wildlands Project (now the Wildlands Network).
- For providing a Wildlands Project map of jaguar movement corridors: Kim Vacariu.
- For relentless effort to conserve jaguars: Warner and Wendy Glenn, Kelly Glenn-Kimbrow and Jack Childs.
- For sharing a wealth of jaguar and other wildlife information: the Borderlands Jaguar Detection Project (Jack Childs and Emil McCain).
- For persistent engagement in JAGCT: Judy Keeler and Sue Krentz.
- For advising the borderlands effort on key issues at key times: Alan Rabinowitz.
- For sharing insights gained from jaguar work in Brazil: Sandra Cavalcanti.
- For help whenever it was needed: David L. Bergman.
- For helping shape JAGCT efforts, through workshops and Trilateral Committee meetings, to complement jaguar conservation in México: Ernesto Enkerlin, Oscar Ramirez, Rodrigo Medellin, Gerardo Ceballos, Heliot Zarza Villanueva and other colleagues in México.
- For providing support for JAGCT meetings and other work: Tim Snow.
- For finding publications in obscure places and always on short notice: Melissa Swain.
- For supporting JAGCT by committing resources beyond convenient availability: former Arizona Game and Fish Director Duane Shroufe and current Director Larry Voyles.

We also acknowledge receiving comment from: Chris Hass, formerly with the Appleton-Whittell Research Ranch (National Audubon Society); Dennis Parker, Jim Chilton and the Arizona Cattle Growers' Association; Leoncio A. Garza-Valdes, M.D.; Melanie Emerson, Sky Island Alliance; and Sergio Avila, Sky Island Alliance and formerly associated with the Northern Jaguar Project.

ABOUT THIS ASSESSMENT AND THE JAGUAR KNOWN AS MACHO B

The primary target audience for this Assessment is member agencies and stakeholders in the Arizona-New Mexico Jaguar Conservation Team (JAGCT). Our intent is to provide them with an assessment of the physical and human landscapes on which borderlands jaguar conservation is shaped and delivered. We believe this makes it incumbent on us to explain why this Assessment is being released almost two years after final public review.

Between March 16 and April 17, 2009, a final draft of this document was available for a last round of public review. Few comments were received, perhaps because several previous drafts had been available for review. Or, perhaps it was because of issues discussed below, which clearly affected the nature and tone of a few comments. Regardless, all comments received were considered very carefully as final revision began in April-May 2009.

In June 2009, we had to postpone release of the “final” Assessment because of extraordinary events in borderlands jaguar conservation. The events began on February 18, 2009 when two Arizona Game and Fish Department (AGFD) research biologists discovered an adult male jaguar in a foot-hold snare, southwest of Tucson (AZ). The snare had been set to capture a mountain lion for an AGFD study. The world soon learned the snared jaguar had first been observed in Arizona on August 31, 1996. Gaining fame as “Macho B,” the cat was recorded by trail cameras in southcentral Arizona many times between 1996 and 2009.

Before being released at the capture site, Macho B was equipped with a satellite-telemetry collar to enable remote monitoring around-the-clock. Data began to flow immediately, as did briefings for JAGCT and the media. The demand for news was unprecedented but so was live capture and release of a telemetry-collared jaguar in the United States.

Several days after being released, the estimated 15-16 year-old jaguar began to show signs of possible debilitation. AGFD and U.S. Fish and Wildlife Service (USFWS) recaptured Macho B on March 2 for helicopter-evacuation to Phoenix for veterinary diagnosis. That same afternoon, veterinarians confirmed irreversible renal failure and recommended immediate euthanasia. With USFWS approval, Macho B was euthanized at 5:15 pm on March 2.

This remarkable chain of events precipitated formal investigations into the capture and death of Macho B that held up release of this document. Even today, the federal criminal investigation is ongoing and, consequently, so is the state investigation. This limits the information available to anyone, including us (see <http://azgfd.gov/jaguar>), and affects this Assessment in three ways:

1. A deletion. We have deleted an extended passage about the Macho B capture that was included in the March 16 - April 17, 2009 public review draft. The original passage was crafted to address speculation and allegations about the capture that began before the public comment period opened. It accurately reflected what AGFD and USFWS “knew” in mid-March about the February capture. However, the two agencies subsequently learned the key element in what they originally “knew” about the capture of Macho B was not true: on the part of at least one person (see below), it was in fact intentional, not accidental. Because of the ongoing investigations, we still cannot address details of

capture-related issues or speculation and allegations about the capture, so the simplest solution for us was to delete the Macho B passage. And that is what we have done.

2. The delay. The lengthy period between final public review and this release has “dated” some material in this final Assessment. However, at this point it seems better to release an incompletely updated Assessment with that caveat clearly stated than to discard it – or spend another year or more waiting to update it more thoroughly, when (if?) the ongoing investigations are closed. So, we have updated as much content as possible, particularly regarding federal decisions about recovery planning and critical habitat designation for the jaguar. To do more updating, we would need to have discussions in JAGCT and that is still not possible. It would have been informative, though, to add more about:
 - The human dimensions of borderlands conservation issues, which continue to change, especially due to impacts of unlawful drug trafficking and immigration.
 - Mitigation (conservation) projects stemming from federal interagency consultations on the impacts of borderlands security measures.
 - Jaguar occurrence in the borderlands. No new occurrences north of the border have been recorded since March 2009 but questions have been raised about whether scat or other attractants might have influenced persistent occurrence of Macho B in Arizona as it was reported by the Borderlands Jaguar Detection Project (BJDP), which monitored occurrence in southcentral Arizona for JAGCT.¹
 - Future JAGCT monitoring for borderlands jaguars. BJDP principal Jack Childs has, acting on his own volition, shut BJDP down for the indefinite future, although his work with other aspects of wildlife conservation continues unabated (J. Childs personal communication). Whether and how JAGCT activities pertaining to jaguar detection and monitoring will be resumed remains to be seen.

¹ T.B. Johnson: Macho B was euthanized on March 2, 2009. A few weeks later, allegations were made that scat from a captive female jaguar had been deployed near the snare set in which he was trapped on February 18 and at nearby camera sets. Ongoing federal criminal investigation of the capture precludes discussion needed to determine the full extent to which jaguar scat was used at camera traps and the extent to which such use might have influenced recent occurrences in southcentral Arizona. As noted by Harmsen and others (2010; see also Gorman and Trowbridge 1989), “Solitary felids communicate indirectly by leaving olfactory signals for conspecifics.” Some people contend that camera and snare sets baited with jaguar scat might have induced “residency” by Macho B. Others contend that (especially in arid habitats) scat or other scents might help position a passing jaguar at a set but would not draw one in from miles away or induce persistence (residency) in a given locale. Use of scents as a camera-trap attractant for jaguars is being tested in zoos (see WCS 2010) but it has not been tested scientifically in the field. R. Thompson (personal communication) believes jaguars and mountain lions differ in regard to use of scat stations (piles). He has never found a jaguar scat station during years of jaguar work in México but mountain lion scat stations are common (e.g. at canyon confluences), providing visual and olfactory clues to occurrence. Regardless, use of jaguar scat as a positioning agent or attractant is, in hindsight, conspicuously absent in papers authored by Childs and others (2007) and McCain and Childs (2008, 2009). Note, however, that neither Silver and others (2004) nor Wallace and others (2003) mentioned use of scat or other attractants in seminal camera-trapping studies of jaguar populations in Central and South America. See Long and others (2008) for further discussion of possible effects of attractant use in noninvasive population sampling of carnivores and MacKenzie and others (2006) and Thompson (2004) for discussion of sampling design for estimating or modeling occupancy or population parameters.

- JAGCT stakeholder perspectives on borderlands jaguar conservation. Again due to the ongoing investigations, JAGCT has not met since February 19, 2009. A few comments on the public review draft of this Assessment even “requested” the JAGCT effort be abandoned.² Discussions about such issues and decisions about the future of JAGCT belong to JAGCT, not to us.
 - México. Our valued colleagues to the south continue to move forward on developing jaguar conservation strategies and implementing on-the-ground actions. They are doing some wonderful things. It would be nice to update those activities herein, especially to highlight the most recent rangewide hemispheric jaguar conservation workshop, in México in November 2009. AGFD is proud to have been an invited participant and to have represented JAGCT in all four rangewide conservation workshops held in México and in other important jaguar workshops that have been held “south of the border” over the past 12 or so years.
3. Closure. Although the investigations continue, some pieces of the puzzle are known. On May 14, 2010, Emil McCain plea-bargained in federal court to misdemeanor criminal charges, acknowledging he was guilty of prohibited take of an endangered species in that, on or about February 4, 2009, he “did knowingly attempt to trap, capture and collect without lawful permit or authority a jaguar” and that he had:

“placed jaguar scat or directed a female person to place jaguar scat at three (3) snare sites in an attempt to capture and trap an endangered species, to wit, a jaguar (*Panthera onca*). McCain knew that there had been recent evidence of a jaguar in the area of the snares. The snares had been set solely for the purpose of capturing and placing tracking collars on mountain lions and bears; there was no authorization to intentionally capture a jaguar. A jaguar known as Macho B was caught at one of those snares on February 18, 2009.”

U.S. Attorney Dennis K. Burke and Federal District Court Magistrate Judge Bernardo P. Velasco accepted McCain’s plea the same day McCain signed it, attaching penalties that included a fine of \$1000, a special assessment of \$25 and five years probation.

Ms. Janay M. Brun, McCain’s primary field assistant, has also been charged in the capture of Macho B. Her trial on federal criminal misdemeanor charges of conspiracy and prohibited take of an endangered species has been postponed to April 12, 2011. Continuances were also granted for her previously-scheduled trial dates, so prospects for April 2011 closure do not seem all that bright, which is another reason to release this Assessment rather than continue waiting.

² Sky Island Alliance (2009): [Due to the U.S. District Court decision in March 2009 requiring USFWS to reconsider a jaguar Recovery Plan] Sky Island Alliance “requests the withdrawal and cancelation of the non-binding Jaguar Conservation Assessment for Arizona, New Mexico and Northern Mexico. ... We call on the Arizona Game and Fish Department to halt this process immediately and to support efforts by the U.S. Fish and Wildlife Service to create a true Recovery Plan for the jaguar. ... Continuing to support the Jaguar Conservation Team as a parallel process to a recovery team is not only unnecessary but costly.”

As for AGFD, no AGFD employee has been charged with a federal or state crime related to the Macho B events. However, on March 19, 2010, AGFD terminated an employee who admitted to AGFD investigators in July 2009 that he had lied to federal investigators about his involvement in some of Emil McCain's post-capture actions. This constituted misconduct and grounds for dismissal under state personnel rules but it is important to note that:

- The terminated AGFD employee denied participating in McCain's plan to capture a jaguar.
- McCain's plea bargain did not implicate any AGFD employees. Rather, it clearly stated that his knowing attempt to capture a jaguar was unauthorized. Only AGFD and USFWS could have authorized such an action and they did not authorize it.
- Federal criminal charges have only been filed against McCain and Brun
- State criminal charges have not been filed against anyone but in August 2010 the Arizona Game and Fish Commission levied a civil assessment of \$8000 against Emil McCain for prohibited take of a jaguar. The Commission indicated the amount of the assessment could be revisited and potentially increased in the future if the Game and Fish Department can establish a greater value for the animal or identify additional recoverable costs. The Commission also revoked McCain's Arizona hunting, fishing and trapping privileges for five years. Arizona is part of the Interstate Wildlife Violator Compact, which means that McCain's hunting, fishing and trapping privileges will be revoked in all the member compact states, which includes most of the western United States.
- AGFD has taken other internal disciplinary actions but state personnel rules prohibit disclosing the nature of those actions and the name(s) of the employee(s). However, those actions were not related to employee involvement in the capture, recapture or death of Macho B.

The ongoing investigations and court proceedings might eventually reveal new information that will call into question some of our current understandings about these unparalleled events. If so, we or someone else can reassess the implications, if any. Meanwhile, in this document we have done the best we could to address relevant issues by relying on the "facts" available to us now.

Terry B. Johnson
January 20, 2011

JAGUAR INFORMATION: A NOTE TO READERS

José Ignacio Borrero H. (1967) lamented about the jaguar, “possibly no other animal has been more persecuted by humans,³ nevertheless it is not the best known species with respect to its habits.” Borrero, a respected scientist in his native Colombia (South America), recognized that science rather than perception should drive conservation. Although there is now an extensive, rapidly-growing scientific literature on the jaguar and its conservation in other regions, Borrero’s contention about the lack of knowledge still applies to the AZ-NM borderlands. To help fill that gap, some borderlands stakeholders wanted us to incorporate all available literature into this document. We understand their desire but neither time nor space allowed us to cite or even provide a bibliography of all published jaguar works. Instead, we have incorporated and cited those that seemed most relevant to AZ-NM borderlands issues.

Excellent sources of jaguar information include the following: Cavalcanti (2008), Chávez and Ceballos (2006), Brown and López-González (2001), Medellín and others (2002), Nowell and Jackson (1996), Rabinowitz and Nottingham (1986); Seymour (1989); Tewes and Schmidly (1987); and Valdez (2000). Notably, Childs (1998), Childs and Childs (2008), Glenn (1996), McCain and Childs (2008) and Rabinowitz (1986a) have special relevance to this document because those authors have played important roles in AZ-NM borderlands jaguar conservation. See also Mahler (2009). All these references are cited herein.

Finally, meriting special attention in terms of jaguar knowledge and sharing it freely is Alan Rabinowitz. Since the early 1980s, he has been the central figure in jaguar conservation and it is not possible for us to acknowledge sufficiently his countless contributions. Indeed, in 1996 he played the pivotal role in guiding Warner and Wendy Glenn and the Malpai Borderlands Group toward reasoned jaguar conservation, after Warner and his daughter, Kelly Glenn-Kimbro, discovered and photographed a male jaguar in southwestern New Mexico in March 1996. Alan has authored, co-authored, edited and inspired a plethora of publications that provide entry into the world of jaguar ecology and conservation. Perhaps even more important is his rangewide jaguar work in the field, which has inspired and involved innumerable colleagues, students and other conservationists. The work he started in Belize (Central America) in the 1980s continues now virtually throughout Mesoamerica, most often involving his new organization, Panthera (<http://panthera.org>) and/or the Wildlife Conservation Society (his previous employer; see “Save the Jaguar,” <http://www.savethejaguar.com>). Start at either of those websites and the jaguar world will rapidly come into focus.

Alan Rabinowitz’ note that this Assessment is a valuable contribution to jaguar conservation and equally appreciative words from JAGCT mainstays Warner and Wendy Glenn, Jack Childs and Judy Keeler mean more to us than we can say.

³ For a contemporary perspective on human-felid conflicts, see Inskip and others (2009), who claim that on a world-wide basis such conflict affects more than 75 percent of the species of wild cats (particularly large, wide-ranging species). They list the jaguar in the “High” conflict category, with its conflicts being “well documented.”

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ABBREVIATIONS AND ACRONYMS⁴

For reader convenience, we list below names that are repeatedly abbreviated in this document.

AGFD	Arizona Game and Fish Department
AZ	Arizona
BJDP	Borderlands Jaguar Detection Project
BLM	Bureau of Land Management
CITES	Convention for International Trade in Endangered Species of Wild Fauna and Flora and Fauna (1973, as amended in 1979)
CONANP	Comisión Nacional de Áreas Naturales Protegidas (México's National Commission for Protected Natural Areas)
DHS	Department of Homeland Security
DNA	Deoxyribonucleic acid
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended (Public Law 93-205, 7 U.S.C. §136, 16 U.S.C. §1531-1544, 87 Stat. 884)
HSA	Homeland Security Act
IUCN	The World Conservation Union (previously known as International Union for Conservation of Nature)
JAGCT	Jaguar Conservation Team
JAGSAG	Jaguar Scientific Advisory Group
MBG	Malpai Borderlands Group
MOU	Memorandum of Understanding
MX	México
NEPA	National Environmental Policy Act of 1969 (Public Law 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended)
NGO	Non-Governmental Organization
NM	New Mexico
NMDGF	New Mexico Department of Game and Fish
PHVA	Population and Habitat Viability Analysis
PROFEPA	Procuraduría Federal de Protección al Ambiente (México: Federal Ministry for Environmental Protection)
SEDESOL	Secretaría de Desarrollo Social (México: Secretariat of Social Development)
SEDUE	Secretaría de Desarrollo Urbano y Ecología (México: Secretariat of Urban Development and Ecology)
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (México: Secretariat of Environment and Natural Resources)
US or USA	United States of America
USCBP	U.S. Customs and Border Protection Agency
USFWS	U.S. Fish and Wildlife Service
WCS	Wildlife Conservation Society
WP	Wildlands Project (now known as Wildlands Network)

⁴ Several JAGCT stakeholders who commented on drafts of this Assessment requested a list of abbreviations and acronyms.

GLOSSARY⁵

The definitions below, with two exceptions, are largely derived from Allaby (1994), Begon and others (1996), Hanski and Simberloff (1997), Meffe and others (1997), Morrison and others (2006), Ricklefs and Miller (1999) or the Merriam-Webster Dictionary Collegiate Dictionary (2003, Eleventh Edition).

The first exception is “adaptive management,” the definition of which is taken from the British Columbia Forest Service (BCFS) (see <http://www.for.gov.bc.ca/hfp/amhome/amhome.htm>). The BCFS website also defines other terms used by workers in the field of adaptive management.

The second exception is Part D of “conservation biology,” which is taken from Western (1989). Terms included in this Glossary are also in **bold** typeface the first time they appear in the body of this Assessment.

Adaptive management: a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Some of the differentiating characteristics of adaptive management are: (a) acknowledgement of uncertainty about what policy or practice is “best” for the particular management issue; (b) thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle); (c) careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking; (d) monitoring of key response indicators; (e) analysis of the management outcomes in consideration of the original objectives; and (f) incorporation of the results into future decisions.

Colonization: the entry and spread of a species (or genes) into an area, habitat or population from which it was absent.

Conservation: (1) the principles and practices of the science of preventing extinction. (2) in modern scientific usage, conservation implies sound biosphere management within given social and economic constraints, producing goods and services for humans without depleting natural ecosystem diversity and acknowledging the naturally dynamic character of biological systems.

Conservation biology: (1) a field of study involving the application of genetics, population ecology and community ecology to problems of biodiversity loss. (2) an integrative approach to protection and management of biological diversity that uses appropriate principles and experiences from basic biological fields such as genetics and ecology; from natural resource management fields such as fisheries and wildlife; and from social sciences such as anthropology, sociology, philosophy and economics. (3) the branch of biological sciences that deals with the effects of humans on the environment and with conservation of biological diversity. It uses principles, experiences and information (e.g. data) from the biological sciences, natural resource management and the social sciences, oftentimes including economics. The aims of conservation biology are to: (a) provide scientific conservation principles; (b) identify conservation problems; (c) establish corrective procedures; and (d) bridge science and management by making scientists responsive to the conservation problems and managers responsive to biological issues.

⁵ Several JAGCT stakeholders who commented on drafts of this Assessment requested a Glossary.

Dispersal: the spreading of individuals away from each other, e.g. offspring from their parents and from regions of high density to regions of lower density.

Habitat: (1) the place where an animal or plant normally lives, often characterized by a dominant plant form or physical characteristic (e.g. the stream habitat, the forest habitat). (2) the particular place or environment in which an organism (e.g. an animal or plant) occurs. (3) an area with the combination of resources (e.g. food, water and cover or shelter) and environmental conditions that promotes occupancy by individuals of a given species and which allows those individuals to survive and sometimes to reproduce.

Examples of habitat: a species of bat might occupy a maternity roost in a cave but have its late summer roost (post breeding) in the attic of a building or an underpass on a roadway. Its winter roost might be a cave in a different (perhaps more southerly) country. In summer its foraging habitat might be pine forests in the United States, while in winter it might forage in elfin woodland in central México. In short, a species' "habitat" can and often does vary seasonally, in different phases of the life cycle (juvenile, young adult, adult, senescent), in response to changing weather conditions, drought, prey abundance, or competition with or pressure from other animals. Some species have narrow habitat preferences or tolerances (e.g. talussnails). Others have relatively broad habitat preferences or tolerances (e.g. jaguars and humans).

Habitat patch: an area of habitat that contains the necessary resources and conditions for a population (or species or individual) to persist.

Historical range: where a species used to occur, long ago. Oftentimes the historical range is larger than the currently occupied range, perhaps (for example) because something caused a population decline, or rendered a portion inhospitable to that species.

Inhabit: to live somewhere, whether seasonally, year-round, at a specific stage of a life-cycle, etc.

Metapopulation: (1) a set of con-specific populations occupying an array of habitat patches within a larger area, in which local populations that are lost (reach zero) are recolonized through migration from another local population within the set. (2) a network of semi-isolated populations with some level of regular or intermittent migration and gene flow among them, in which individual populations may go extinct but can later be recolonized (through dispersal) from other populations within the network.

Niche: (1) the ecological role of a species in the community; the many ranges of conditions and resource qualities within which the organism or species can persist, often conceived as a multi-dimensional space. (2) the limits, for all important environmental features, within which individuals of a species can survive, grow and reproduce. (3) in ecology, "niche" describes the relational position of a species or population in an ecosystem.

The description of a niche may include descriptions of the organism's life history, habitat and place in the food chain. According to the competitive exclusion principle, no two species can occupy the same niche in the same environment for a long time. The full range of environmental

conditions (biological and physical) under which an organism can exist describes its fundamental niche. Pressure from and interactions with other organisms (e.g. superior competitors) can force species to occupy a niche that is narrower than this and to which they are mostly highly adapted. This is termed the realized niche. Different species can hold similar niches in different locations and the same species may occupy different niches in different locations. If a niche is left vacant, perhaps by extinction or disease, other organisms can fill that position. When organisms are introduced into a new environment, they can occupy new niches or the niches of native organisms, out-compete the indigenous species and become serious pests.

Occupied range: the portion of a species' historical or recent range that it now inhabits. "Occupied range" implies that a portion of the species' historical range is unoccupied, perhaps (for example) because of population declines or habitat changes.

Occupied habitat: the habitats within an area that a species actually inhabits.

Population: (1) those organisms of the same species living in the same place and time. (2) a group of individuals of one species in an area, although the size and nature of the area is defined, often arbitrarily, for the purposes of the study being undertaken. (3) a group of organisms of the same kind, usually the same species, inhabiting a given area.

Population [and Habitat] Viability Analysis: (1) a PVA is a quantitative assessment of the probability of species viability or vulnerability under defined sets of assumptions and circumstances. (2) a PHVA is collaborative workshop approach to species conservation that centers on, but encompasses more than, a PVA. The workshop process brings to bear the knowledge of many people (particularly an array of experts who have knowledge of the species or problem) on species conservation, eliciting and assessing multiple options for conservation action, principally by using the tool of the PVA as a way to evaluate present threats to population persistence and likely fates under various possible scenarios. PHVA encompasses two different but closely related tools for analyzing the conservation status and needs of a species. A PHV Analysis usually refers to computer modeling of biological processes, whereas a PHV Assessment is an in-depth examination and synthesis of the species' life history, ecology, management and other factors to determine courses of action to manage for viable populations. Assessments include consideration of model analysis, habitat management, captive breeding (if appropriate), genetic tracking (if appropriate), life history, status, threats, geographic distribution, education and information, other conservation efforts, human demography/dimensions, research and any other component that is deemed necessary. By itself, model analysis would have little real world utility without considering the context in which a species lives. Habitat management, human influences and other components are therefore assessed and added into the conservation/recovery equation, at least in a qualitative way. PHV Assessments can be thought of as a tool to compile, evaluate and synthesize data and build a framework for conservation action.

Population dynamics: the variations in time and space in the size and densities of populations.

Scientific method: the body of techniques for investigation of natural or other phenomena and acquisition of new knowledge of the natural world, as well as correction and integration of previous knowledge, typically based on observable, empirical, measurable evidence and subject

to the laws of reasoning. The scientific method generally involves observation, formulation of a hypothesis, experimentation (data gathering), analysis and conclusion that validates or modifies the hypothesis.

Sink population: a population in a low-quality habitat in which the birth rate is generally lower than the death rate and population density is maintained by immigrants from source populations.

Source population: a population in a high-quality habitat in which the birth rate is greatly exceeds the death rate and the excess individuals leave as emigrants.

Suitable habitat: an area of habitat that contains the necessary resources and conditions for a population (or species or individual) to persist, but which may or may not be occupied at a given time, presently, historically or in the future.

JAGUAR CONSERVATION ASSESSMENT
FOR
ARIZONA, NEW MEXICO AND NORTHERN MÉXICO

This assessment of jaguar (*Panthera onca*)⁶ **conservation** in the borderlands shared by Arizona, New Mexico and México was developed to replace a *Conservation Assessment and Strategy for the Jaguar in Arizona and New Mexico* (Johnson and Van Pelt 1997). The Arizona Game and Fish Department (AGFD) and New Mexico Department of Game and Fish (NMDGF) also used it a draft to develop a *Jaguar Conservation Framework for Arizona, New Mexico, and Northern Mexico* (AGFD and NMDGF 2007). The Framework, this Assessment and a 2007 Memorandum of Understanding (MOU) between AGFD and NMDGF provide an **adaptive management** umbrella under which AGFD and NMDGF lead government cooperators and nongovernmental stakeholders known collectively as the AZ-NM Jaguar Conservation Team (JAGCT).

1. Introduction

Jaguar conservation in the AZ-NM borderlands began in 1969, when John P. Russo, AGFD Chief of Game Management, recommended and the Arizona Game and Fish Commission approved making the jaguar a protected (closed season) animal. The staff recommendation leading to Russo's advocacy was precipitated in part by a 1965 hunter take of a jaguar in the Patagonia Mountains, east of Nogales AZ (D.E. Brown personal communication)

Aside from law enforcement activities associated with two more jaguar killings in Arizona in 1971 and 1986, not much more conservation work happened until 1996. Then, Warner Glenn photographed a jaguar in New Mexico on March 7 and Jack Childs photographed a different one in Arizona on August 31 (Glenn 1996; Childs 1998). By April 1997, their sightings and their interest in doing something positive for jaguars in the AZ-NM borderlands had spurred AGFD and NMDGF to: (a) complete a jaguar conservation assessment and strategy for the two states (Johnson and Van Pelt 1997); (b) execute a companion interagency agreement; and (c) establish the JAGCT to guide borderlands jaguar conservation (Van Pelt and Johnson 2002).

To appreciate borderlands jaguar conservation, one thing must be understood: most, perhaps all, JAGCT participants have something in common – a profound interest in jaguar conservation. Many also agree on most of the underlying philosophical aspects, as well as specific elements, of the conservation effort. These commonalities are crucially important but they are easily lost in the conspicuous reality that, typical of diverse groups, JAGCT participants (including signatory agencies) sometimes disagree with each other on issues, such as:

- Historical presence of the jaguar in Arizona and New Mexico. For example, is jaguar presence in this area natural or anthropogenic (e.g. historical translocation by European explorers or by releases in conjunction with “canned” hunts during the 1900s)?

⁶ *Panthera* is used herein as the genus for the jaguar, per Nowak (1999), Pocock (1939), Seymour (1989) and others. Various earlier publications, including some referenced herein, referred it to the genus *Felis*.

- Status. Are jaguars resident or transient in the AZ-NM borderlands? Is presence here reflective of a discrete **population** or are AZ-NM jaguars peripheral occurrences that are part of a larger population centered in México?
- Approaches to conservation. Some stakeholders prefer regulation-driven actions; others prefer voluntary actions.
- Approaches to wildlife management. Some stakeholders prefer “hands on” management; others prefer “hands off” management or no management at all.
- A host of other issues, including: the legal implications of technical terms like **inhabit, scientific method, habitat (including occupied, potential, suitable and unsuitable habitat) and range (including current [= occupied] and historical range)**; preferences for and legitimacy of various uses of public lands (e.g. ranching vs. recreation; multiple-use vs. wilderness designation); private property rights; state vs. federal authorities and responsibilities for wildlife conservation; and issues pertaining to illegal immigration and national security needs along the U.S.-México border.

Honest disagreement is expected but sometimes it seems that JAGCT participants reject an idea simply because of how (or by whom) it is presented. Disagreement can also stem less from the issue on the table than from concern about where it might lead (e.g. will identifying suitable habitat lead to designation of critical habitat?). Although JAGCT discourse is typically courteous and respectful, at times distrust is obvious. Extended argument can limit productive discussion and impede progress. Frankly, some topics seem as contentious now as they were in 1997. This makes it all the more remarkable that so many stakeholders have engaged in JAGCT for a decade or more and continue to work – much more often cooperatively than not – toward a better tomorrow for borderlands jaguars.

Given persistent “bones of contention,” perhaps JAGCT has not focused enough on the human dimension on which conservation success ultimately depends. More focused attention to that aspect might enable greater progress. Thus, we will use this Assessment to acknowledge and address some of the more important “bones” that have not been buried by a decade of JAGCT discussion or, in some cases, even by peer-reviewed publication. Our intent is to help “close the circle” of science, social issues and commitment to public process and fair play in JAGCT (see Bormann and Kellert 1991). Our approach makes this document different than “typical” agency status assessments, a fact noted by a few reviewers – with varying degrees of comfort.

2. Species Biology

The jaguar is the largest wild cat native to the Western Hemisphere and the only one that roars. Its activity patterns vary widely across its range. It is mostly nocturnal but much of its activity occurs in early-morning and late-evening hours (some authors include those two periods in nocturnal but others do not). Sometimes, jaguars are also active in daylight hours, though presumably less so in hotter, drier environments, including the AZ-NM/México borderlands. Physical attributes of the species are well known, as are its food habits. Relatively recently, its movement, habitat use and reproductive behavior have begun to be understood but accurate information about social relationships and **population dynamics** remains scarce. As will become clear below, by far most of the available information on all aspects of jaguar biology comes from portions of the **historical and occupied range** south of the AZ-NM/México borderlands. This is

largely a reflection of sample size; areas of relative jaguar abundance can much more easily be mined for data. These disparities are important; insights drawn from statistically-valid samples (and research) are more robust than inferences based on one individual or even a few.

2.1. Taxonomy

Linnaeus (1758) originally described the jaguar as *Felis onca* (see also Nelson and Goldman 1933). However, *Panthera onca*, first used in 1869, is now the accepted scientific name (Nowak 1999; Pocock 1939; Seymour 1989). Five subspecies were recognized by Hall (1981) but eight by Pocock (1939) and Seymour (1989); all three publications recognized two subspecies with historical range extending into the United States: Arizona jaguar (*P.o. arizonensis*) and northeastern jaguar (*P.o. veraecrucis*). Specimens from Arizona and New Mexico have been attributed to *P.o. arizonensis*, the type specimen of which was collected in 1924 near Cibique, Navajo County AZ (Goldman 1932).

More recent works suggest recognition of subspecies in *Panthera onca* might not be warranted. Larson (1997) used 11 skull characters and multivariate statistics to evaluate 170 skulls of known origin. He re-evaluated morphologies that led some predecessors to assign jaguars to as many as eight subspecies and found that variation in skull characteristics within the previously-recognized subspecies exceeded variation between the subspecies. Larson concluded subspecies recognition was not warranted. Molecular genetics subsequently supported his conclusion (Eizirik and others 2001; Johnson and others 2006), which is consistent with current treatment in *Walker's Mammals of the World* (Nowak 1999): *Panthera onca* is monotypic, i.e. a species without subspecies.

Others have come to different conclusions about how many jaguar subspecies warrant recognition. Johnson and others (2002) found that mitochondrial DNA analysis only weakly supported two phylogeographic groups of jaguars, one north and one south of the Amazon River (South America), although there was evidence of continued gene flow between the two groups (but see Haag and others 2010). Wozencraft (2005) recognized nine subspecies of jaguar rangewide, including *P.o. arizonensis*. Ruiz-Garcia and others (2006) reported that DNA microsatellite analysis indicated the jaguar population in Colombia (South America) included individuals from two subspecies (*P.o. centralis* and *P.o. onca*). As investigative techniques evolve, work will no doubt continue on jaguar systematics and taxonomy, perhaps someday producing a definitive decision on which (if any) subspecies should be recognized within *Panthera onca*.

2.2. Description

The jaguar, a member of the cat family (Felidae), is allied with the “roaring” cats and most closely related to the African lion (*P. leo*), leopard (*P. pardus*), tiger (*P. tigris*), snow leopard (*P. uncia*) and clouded leopard (*Neofelis nebulosa*) (Johnson and others 2006; Nowak 1999). It is the largest species of cat native to the Western Hemisphere and the third largest in the world (Nowak 1999; Seymour 1989). It is also the only “roaring” cat in the New World (Nowell and Jackson 1996; Tewes and Schmidly 1987).

The predominant English common name, “jaguar,” might be derived from an Amazon Basin Indian word meaning “carnivore that overcomes its prey at a single bound” (Liais 1872) or “wild

beast that dominates its prey in one jump” (Rosa and Nocke 2000). Another possible derivation is offered by Merriam-Webster (2007): “jaguar etymology – Portuguese, from Tupi *jawará* large carnivore.” However, the origin and meaning of “jaguar” have been challenged. A non-refereed etymological website asserts, “Tupi-Guarani ... scholars indicate ... *jaguara* was originally a word that referred to all carnivorous animals. ... The Tupi-Guarani word for *Felis onca* is *jaguareté*, where *eté* means ‘true’” (see: <http://www.takeourword.com/tow198/page2.html>).

Origin of the predominant Spanish common name, “el tigre,” is not disputed: it refers to the largest, fiercest cat of all, the tiger. While describing his travels in Sonora (México) from 1756 to 1767, the Jesuit missionary Father Ignaz Pfefferkorn (1795) mentioned the “tigers” (jaguars) of the area. “El tigre” is still commonly used by Spanish-speaking peoples in México.

Rangewide, jaguars measure about 5 to 8 feet from nose to tip of tail and weigh about 80 to 348 lb (Nowak 1999; Nowell and Jackson 1996; Seymour 1989). Males are typically 10 to 25 percent larger than females (Emmons 1999; Rich 1976; WCS 2007) or perhaps 20 to 30 percent larger (Sunquist and Sunquist 2002; Sunquist and Sunquist 2007). In the southern part of the range, females tend toward 100 to 150 lb and males toward 170 to 220 lb. In Central America and southern México, both sexes trend slightly larger than to the north or south. Leopold (1959) listed a range in México of 140 to 250 lb for males and 100 to 180 lb for females. Reliable data are still scarce (many published weights are estimates) but jaguars from northern México and the southern United States tend to weigh about the same as mountain lions (*Puma concolor*): males average about 120 lb and females about 80 lb (see Brown and López-González 2001).

Jaguars have a relatively robust head, compact but muscular body, short limbs and tail and a powerfully-built chest and forelegs (Leopold 1959; Nowak 1999; Rosa and Nocke 2000; Tewes and Schmidly 1987; WCS 2007). Their short, muscular limbs are well suited to climbing, swimming and crawling (Nowell and Jackson 1996; WCS 2007). They have the strongest teeth and jaws of any New World cat and their skull is more massive than that of a mountain lion (Brown and López-González 2001). Their canines are well developed (Seymour 1989).

A jaguar’s coat is typically pale yellow, tan or reddish yellow above and generally whitish on the throat, belly, insides of the limbs and underside of the tail, with prominent dark spots or blotches throughout (Seymour 1989). Jaguars of any age are easily distinguished from adult mountain lions, the only other large cats native within their range. Both juvenile and adult jaguars have distinctive dark spots that have small dots or irregular shapes within larger rosettes (Nowak 1999). Young mountain lions also have black-spotted coats but their spots occur in three irregular dorsal lines and transverse rows that persist only up to the third year of life (Currier 1983).

Every jaguar has unique coloration and a unique black or blackish-spotted rosette pattern that might act as camouflage (Brown and López-González 2001). Color and spotting patterns differ even from one side of a jaguar to the other (Nelson and Goldman 1933), enabling identification of specific individuals (Maffei and others 2004; McCain and Childs 2008; Silver 2004; Silver and others 2004; Wallace and others 2003).

Black or blackish (melanistic) jaguars occur naturally – but not in the United States or northern México. The jaguar is among the few species of wild cats in which melanism occurs (the leopard

is another) but even in melanistic jaguars the underlying rosettes are evident. Melanistic jaguars occur naturally in the Amazon Basin, comprising about six percent of the population (Brown and López-González 2001). Unsubstantiated reports exist for Central America, north to Belize (see Meyer 1994) but no naturally occurring black jaguars have been confirmed north of México's Isthmus of Tehuantepec (Brown and López-González (2001). Dinets and Polechla Jr. (2005) published a photograph of a melanistic jaguar from northwestern México but the publication was not peer reviewed and jaguar experts in México question validity of the photograph (B. Van Pelt personal communication). Melanism in jaguars is caused by a dominant mutation of a single gene (Eizirik and others 2003; Kitchener 1991; Sunquist and Sunquist 2002).

Although the best available science does not support occurrence of a black jaguar in the AZ-NM/México borderlands, or black mountain lions anywhere, black jaguars and other "big black cats" have long been and probably always will be reported from both states (AGFD and NMDGF unpublished data). These reports, particularly one in 1910 near Silver City in southwestern New Mexico (McKenna 1969),⁷ typically generate considerable discussion in JAGCT meetings so we will address the possible explanations in some detail in hopes of putting the subject to rest.

As with most sightings of typical jaguars, those of black jaguars are often too old or the location too poorly described to warrant follow-up. When investigated, they most often can be attributed to anything from a black dog to a bobcat to a feral housecat. Escape of a captive black jaguar (or leopard) might explain such sightings but that seems unlikely to occur, especially repeatedly and in widely-separated locations. Moreover, if such an escape occurred, one might reasonably expect considerable media coverage and a spate of sightings before the animal was captured, died or disappeared. In contrast, most "big black cat" reports received by AGFD and NMDGF are of a single animal seen once by one (typically inexperienced) person. A notable exception occurred in southern Arizona: multiple people, including local government employees, reported repeatedly and with great certainty that a big black cat was leaving very large tracks in and around a rural residential area south of Tucson. Investigation found the "big black cat" to be a large black Labrador retriever (AGFD unpublished data).

What is the origin of reports of black jaguars in the AZ-NM borderlands? Perhaps it is just the power of suggestion. For years, news stories about jaguars in the Southwest tended to be illustrated by file photos of live captives. The most readily available photos were of melanistic animals that were and still are prevalent in zoos. Such captives are striking in appearance and easily photographed. Sighting reports often followed close behind media coverage of jaguar issues. When a black jaguar photograph appeared in the news, agencies could expect another spate of sightings of big black cats. Fortunately, remote-camera work by Jack Childs and Emil McCain in southern Arizona since 1997 yielded photographs of a real Arizona jaguar that have largely replaced black jaguars of unknown origin in more recent media coverage. Photographs taken by AGFD research biologists who discovered the jaguar known as Macho B in a foot-hold snare on February 18, 2009 are also prominently featured in the news now.

Bad lighting is another possible explanation, one that probably results in more of such sightings than anything else. In low light and when facing or quartering away, typical jaguars appear very

⁷ In a March 2010 re-compilation of all "reliable," "less reliable" and "least reliable" jaguar reports for New Mexico, NMDGF (unpublished data) did not even mention the reported sighting in 1910 near Silver City.

dark, sometimes appearing black even to an experienced observer (E. McCain personal communication). However, both the number and the widespread locations of “black jaguar” sightings suggest another “bad lighting” explanation, one that does not even involve jaguars and is not unique to AZ-NM.

Although jaguars once occurred in Texas, the last documented occurrences were of single animals killed in 1946 and 1948 (USFWS 1993). But, Texas does have abundant mountain lions and an abundance of “black panther” sightings. Texas Parks and Wildlife Department (TPWD 2007) offers a simple explanation for these sightings on its website: “[mountain lion] fur is a light, tawny brown color which can appear gray or almost black, depending on light conditions. Contrary to popular belief, there are no black panthers in North America; no one has ever captured or killed a black Mountain Lion.” Indeed, Currier’s (1983) exhaustive mountain lion account for The American Society of Mammalogists (TASM) does not list melanism as occurring in that species. When melanism occurs in other species covered in the TASM series, the species account addresses it (e.g. the jaguar; Seymour 1989).

So, a mountain lion, seen by a casual observer, perhaps even by a skilled observer, especially if seen briefly and unexpectedly in poor lighting (as might occur at dawn or dusk) or an angle, could easily become a “black jaguar” report. Most people would be thrilled to see a wild mountain lion but a wild jaguar would likely be even more exciting. If a “black jaguar” is what they have seen in the newspaper or in a zoo, it seems all the more likely that is what they will “see” in the field. As George (1995) succinctly stated: “People surely perceive what they want to, whether they’re reading patterns in inkblots, seeing ‘the man in the moon,’ or hearing messages in shower spray hitting against the curtain.” Or seeing a black jaguar where there is none.

2.3. Distribution and Abundance

The distribution and abundance of any species of wildlife should be straightforward, a matter of verifiable fact, but often they are not, especially when the animal is secretive, rare, nocturnal or another species can be mistaken for it. Reports and records, whether historical or recent, often vary considerably in quality (and accuracy). So do observers. Also, humans can affect distribution and abundance in many ways, some intentional and some not. These factors can give rise to doubts. For example, some JAGCT stakeholders still question whether jaguars are native to the Southwest, speculating that early European explorers might have brought them here or hunters have released them. Such speculation is definitively refuted by both cultural and fossil records.

The jaguar was prominent in New World art, myth, folklore and religion long before Hernán Cortés and his *conquistadores* arrived on México’s east coast in 1519 and completed the Spanish conquest in 1521. Indeed, the jaguar’s “most honored status ... was achieved during the reign of the great Native American civilizations that occupied Mesoamerica”⁸ (Brown and López-González 2001), long before Cortés arrived. Baldwin (1998), Carmony (1995), Coe (1992), Covarrubias (1954, 1957), Daggett and Henning (1984), Plotkin (1993), Shele and Miller (1986), Smith (2003) and Weaver (1993) are among the authors detailing that reign, summarized as follows:

⁸ In this context, ancient Mesoamerica is roughly equivalent to what is now central Mexico, Belize, Guatemala and western Honduras and El Salvador.

For 2000 to perhaps more than 3000 years, jaguars served Mesoamerican cultures as icons of great importance, symbols of power and ferocity. They were prominent in ancient architecture and in the costumes of royalty and warriors. Alive they were thought to possess the ability to move between the living world and the spirit world, which was probably important for cultures that featured were-jaguars, rebirthing of royalty as a means of immortality and human sacrifice. The Maya word “*balam*” held two meanings: jaguar and priest. The Jaguar Knight (*Ocelotl*) was one of the Aztec Empire’s two highest military ranks of professional soldiers. Popocatepetl, Jaguar Knight hero of an ancient Aztec legend (a tragedy that unfolds like Shakespeare’s *Romeo and Juliet*), lives on today 45 mi southeast of México City, in the form of México’s most active volcano, the smoke from which drifts across his lover, Iztaccihuatl, now a nearby volcano.

The linkage between jaguars and humans continues throughout Mesoamerica today, where Mayans and other descendants of the Aztec Empire still live. Jaguar icons are still culturally prominent throughout México, as witnessed in most *mercados* or artisan stores that sell masks for decorative, festive or ceremonial use and in fabulous collections in the Museo Rafael Coronel (Zacatecas, Zacatecas), Museo Nacional de la Máscara (San Luis Potosí, San Luis Potosí) and Museo Nacional de Antropología (México City, Distrito Federal). Jaguar masks are also very well represented in Mauldin’s (1999) *Masks of México: tigers, devils, and the dance of life*.

The jaguar’s relative but not complete absence as a cultural icon in the American Southwest suggests it was probably less common in that area than in Mesoamerica in recent history (B. Miller, A. Rabinowitz and C. López personal communication). However, “less common” is not the same as “absent” (E. McCain personal communication). Pavlik (2003) underscored that perspective in an inferential assessment of relationships between rock paintings, oral history and documented occurrences of extinct and extant forms of “jaguar” throughout the American Southwest. He concluded (2003:170):

“The type of evidence I have presented, especially rock art and oral tradition, is generally ignored because it does not constitute ‘hard scientific fact. ... To know more about these animals requires a sincere commitment on the part of non-Indians to keep an open mind to the possibilities that exist.”

Small wonder that jaguars were well known to natives in what is now México and the surrounding region (including the American Southwest) long before *conquistadores* arrived; they had been there for millennia. Ancestors of the modern jaguar arrived in North America from the Old World, presumably via the Bering Strait land bridge, in the early Pleistocene Epoch (Arroyo-Cabrales 2002). The Pleistocene extended from about 1.8 million to 10,000 years Before Present (BP) (GSA 1999). The epoch included cycles of continental glaciation world-wide, the last glacial maximum occurring about 18,000 radiocarbon years BP (Thompson and Anderson 2005). The glacial and interglacial periods were accompanied by great changes in climate and in floral and faunal composition (Betancourt and others 1990; Martin 2005; Martin and Klein 1984; Ramamoorthy and others 1993). The jaguar was among the many species affected.

The fossil record documents pre-historical distribution of the jaguar throughout much of what is now the United States, although most remains belong to an extinct race (Daggett and Henning 1984;

Simpson 1941). After the Pleistocene ended, another interglacial period began (it continues today) and the climate trended warmer and drier. As with other cool-adapted species, the jaguar's range retracted to the south (Kurtén and Anderson 1980; Seymour 1989). Today, the jaguar occurs locally from (occasionally) the southwestern United States (Arizona and New Mexico) to (commonly) Brazil and Argentina (Chávez and Ceballos 2006; McCain and Childs 2008; Nowak 1999; Nowell and Jackson 1996; Seymour 1989).

As for abundance, nowhere is the jaguar truly common but it is relatively much more common in parts of South America, Central America and central to southern México than in northern México or the borderlands shared by the United States and México. C. Miller and M. Kelly (personal communication referenced in Meerman 2005) provided survey data indicating jaguar densities in three discrete study areas in Belize (Central America) were as follows: 6.8⁹ in Chiquibul; 8.8 in Cockscomb Basin; and 11.3 in Gallon Jug. Camera-trapping¹⁰ in two reserves in Belize and three in Bolivia (South America) yielded density estimates ranging from 2.84 in Bolivia to a high of 8.8 in Belize (Silver and others 2004). In the southern Pantanal (Brazil), Soisalo and Cavalcanti (2006) used camera-trapping and Global Positioning System (GPS) telemetry to estimate jaguar densities that ranged from 6.6 to 10.3. Ceballos and others (2002) reported that jaguar density in the Calakmul Biosphere Reserve of southern México was 6.67 (Note: the Calakmul density was converted from the authors' 1 per 15 km²).

Jaguar density in the U.S.-México borderlands is poorly known. Grigione and others (2001) reported that preliminary evidence indicated jaguar density in three **metapopulations** in northern México was 1.3 to 1.5. Rosas-Rosas (2006) reported a conservative approximation of jaguar density of 0.01 for the Nácori Chico area, northern Sonora (México). Because of low numbers of documented jaguar occurrences and vast areas that lack organized survey or monitoring effort, neither a current nor a historical density estimate is possible for the borderlands north of the U.S.-México International Border.

United States – The jaguar's recent (roughly post-1600) historical range in the United States included parts of Arizona, New Mexico and Texas and might also have included California and Louisiana (Bailey 1905; Brown 1983; Davis 1982; Goldman 1932; Hall 1981; Hoffmeister 1986; Lowery 1974; Swank and Teer 1987, 1989; USFWS 1980, 1994, 1997). Nelson and Goldman (1933) described the range of *arizonensis* as “the mountainous parts of eastern Arizona north to the Grand Canyon; southwestern New Mexico; northeastern Sonora; and southeastern California.”

Jaguars probably were uncommon residents in the southwestern United States in recent history (e.g. Rabinowitz 1999; Seymour 1989) but whether that description is best applied to individual occurrences or in a population sense remains conjectural (see below). Brown and López-González (2000, 2001) published the most comprehensive occurrence information for the United States, noting that virtually every published jaguar distribution map includes parts of New Mexico and Arizona in historical range. Records from Arizona and New Mexico for 1900 to 2000 ranged from the Grand Canyon (AZ) and the Datil Mountains (NM) south to the U.S.-México border (Brown and López-González 2000, 2001). The veracity of some mid-1900s

⁹ All densities reported herein are presented as jaguars per 39 mi² (100 km²).

¹⁰ See: Gese 2001; Rosas-Rosas 2006; Silver 2004; Silver and others 2004; Soisalo and Cavalcanti 2006; Wallace and others 2003).

records has been questioned because they might have resulted from jaguars being imported into AZ or NM and released, in some instances for “canned” hunts or for other reasons.^{11,12,13} Also, Hill (1942) indicated a jaguar was reported to have been killed “some years ago” near Springer, in northeastern New Mexico, but (Brown and López-González (2001:41) cast doubt on the record because the area is predominantly grassland. NMDGF does not consider the Springer report a reliable occurrence record.¹⁴

Goldman (1932) and Hoffmeister (1986) both reported the jaguar as having been a regular but not an abundant resident in southeastern Arizona. Although lone jaguars were killed in Arizona in 1971 and 1986 (see: Brown 1991, 1997; Brown and López-González 2000, 2001; Valdez 2000), the species was widely considered to have been extirpated from the United States (Brown and Davis 1995; Nowak 1999).

¹¹ In the White Mountains of east-central AZ, in 1963 a hunter (T. Penrod) killed a small female jaguar and in 1964 a federal government trapper (R. Culbreath) killed a male (Brown and López-González 2001). AGFD law enforcement officers speculated one or both of the jaguars had been imported for “canned hunts” (hunts involving release of captive animals) by C.J. Prock, a guide who was investigated for canned hunts involving other species of wildlife. The premise was that the Penrod and Culbreath jaguars had escaped from Prock hunts but the jaguar case could not be made (R. Kohls personal communication; R. Thompson personal communication). Prock, who did not guide Penrod or Culbreath, later asserted he had “never let a jaguar get away in Arizona and that is the whole truth” (Brown and Thompson 2010). However, Prock did lead three successful jaguar hunts in southern AZ in 1958-59 and was fined in 1964 in U.S. District Court in Phoenix AZ for violating the Lacey Act by importing mountain lions into AZ and turning them loose for canned hunts (see: Dean 1974; Jones 1974; W. Swank personal communication). Because of the circumstances, all jaguars taken on hunts guided by C.J. Prock were dropped from the occurrence record for AZ years ago (AGFD unpublished data; Brown and López-Gonzalez 2001).

¹² T.B. Johnson: In a January 2008 email, D. Robertson said that world-famous lion and jaguar hunter Dale Lee had confided to him long ago over a campfire in the Chiricahua Mountains (southeastern AZ) that Lee and his brother [Clell] had “gone down to Guatemala for the Guatemalan government ... and brought back a litter of jungle cats [jaguars], nurtured them to a survivable state, and turned them loose in that area. (Twixt Wilcox [sic] and the Chiracahuas [sic].)” Robertson said Lee had sworn him to secrecy and he was only making a “public statement” because Lee “passed in the 1980s” and, now that he was in his own “twilight years,” he “felt it was time to say something.” To date, I have not found corroborating evidence for Robertson’s statements.

¹³ In comment submitted to USFWS on proposed designation of critical habitat for the jaguar in the United States, D. Parker (2010) referenced canned hunts (among other things) as discrediting the proposal. Parker also addressed the 1963-64 Arizona jaguar records mentioned above and “guaranteed” jaguar hunts in NM in 1972-73. According to Jones (1974), in 1972-73 nine jaguars were imported and released by C.J. Prock before being killed on guaranteed guided hunts near Apache Creek NM (i.e. less than 50 mi east of the 1963-64 AZ records). According to Jones (1974), in December 1973 Prock pleaded *nolo contendere* in U.S. District Court to conspiracy, one of six counts on which he was indicted by a NM grand jury. Parker referenced an August 5, 2010 personal communication from Prock from which Parker inferred that a small female jaguar (and perhaps others) released in the 1972-73 NM hunts had not been killed. Based on Prock’s comments, Parker asserted the 1963-64 AZ jaguars taken by Penrod and Culbreath should be rejected as legitimate records. At one point, Parker seemed to imply that a small female jaguar Prock released in the 1972-73 New Mexico hunts escaped and might be the 78 lb female that Penrod killed in AZ in 1963. USFWS has not responded to Parker’s letter and his supporting “documentation” is not available to us, so it remains unclear how a jaguar released in New Mexico in 1972-73 could have been killed in Arizona in 1963. We do not consider Parker’s comment a sufficient basis for rejecting the Penrod and Culbreath jaguar records.

¹⁴ NMDGF unpublished data: As of March 17, 2010, NMDGF recognizes six reliable jaguar records for NM since 1900: 1900, 1902, 1902, 1995, 1996 and 2006. Reliable means physical evidence substantiates the report. NMDGF did not mention jaguars taken during C.J. Prock “guaranteed hunts” in 1972-73 (see Footnote 13).

Thoughts about extirpation changed in 1996, when two separate groups of mountain lion hunters independently confirmed that jaguars were still, or were again, present in the AZ-NM/México borderlands. The first group, led by rancher-guides Warner Glenn and his daughter Kelly Glenn-Kimbro, photographed an adult male jaguar running before their hounds on March 7, in the Peloncillo Mountains, in extreme southwestern New Mexico (Glenn 1996). The other group, led by Jack Childs and houndsman Matt Colvin, was in the Baboquivari Mountains of southcentral Arizona when, on August 31, they photographed and videotaped a male jaguar treed by their hounds (Childs 1998; Childs and Childs 2008).

At least four (possibly five) different jaguars (all males) have been photographed in the AZ-NM borderlands since 1996. In southcentral Arizona, near the México border, McCain and Childs (2008) documented repeated occurrences of two and perhaps three different individuals from 2001 through March 2007. One of those animals was the 1996 Childs jaguar; it was also documented in August 2008 (possibly also in July 2008) and January 2009 (McCain and Childs 2009), and in 2009 on February 4 and from February 18 through March 2 (AGFD unpublished data). In New Mexico, Warner Glenn observed and photographed an adult male jaguar on February 20, 2006 in Hidalgo County that was not the one he had documented in 1996 (W. Glenn personal communication). The occurrence total is given as four or possibly five because one jaguar was only photographed from the left side and another only from the right side (McCain and Childs 2008). The photographs could thus be of one individual or two.

From some perspectives, occurrence information accumulating since 1996 suggests persistence, if not residency. McCain and Childs (2008) argued an adult jaguar might be resident in the AZ-NM borderlands shared with México. Their inference was based on records indicating one of the four (perhaps five) jaguars documented in AZ-NM since March 1996 was recorded many times over a period of more than 10 years (Childs and Childs 2008; Childs and others 2007; McCain and Childs 2008). That male jaguar is now known to have occurred there at least sporadically, sometimes for several consecutive months, for almost 13 years (but not in all years), from August 31, 1996 through March 2, 2009 (AGFD unpublished data; McCain and Childs 2009).

Contrary to some inferences within JAGCT and among other interested parties, McCain and Childs (2008) did not make a case for occurrence of a resident jaguar “population” in the AZ-NM borderlands. Their focus was on persistence and possible residency of one male, not a population (albeit, the title of their publication suggests broader implications). After considering the McCain and Childs publication, Rabinowitz (personal communication) commented that one persistent (perhaps even resident) individual or a few individuals does not constitute a resident population. Earlier, Rabinowitz (1997, 1999, personal communication) suggested the available evidence does not support a conclusion that the United States has **suitable habitat** for jaguars (i.e. habitat of sufficient quality to sustain a population that is continually present or at least seasonally but regularly present and which consists of more than a few isolated individuals).

Northern México - Swank and Teer (1987, 1989) described jaguar distribution in México as a broad belt from central México to Central America. Anderson (1972) considered the jaguar a “species of postulated occurrence” in Chihuahua, referencing “infrequent reports of wandering” individuals that “enter the state from the west [Sonora] and presumably do not remain long.” Although jaguars had been considered relatively common in Sonora in the 1930s and 1940s, by

the late 1900s the population in southern Sinaloa and Tamaulipas, about 800 miles south of the U.S.-México border, was the most northern population reported by Mexican officials (Brown 1991; Swank and Teer 1987, 1989). However, Brown (1991), based on discussions with rural residents during the 1980s, speculated jaguars had not been extirpated from northern México and might be more persistent in Sonora than had been reported. He mentioned hearing about two jaguars killed in central Sonora around 1970 and assertions by local Indians that male and female jaguars still occurred in the Sierra Bacatete of Sonora, about 200 miles south of Arizona. Brown thought a resident population of jaguars in those mountains could be the **source population** for individuals travelling northward through the Sierra Libre and Sierra Madera toward Arizona.

Chávez and Ceballos (2006), drawing on Aranda (1998), Chávez and others (2005) and Monroy-Vilchis and others (2005) (see also Monroy-Vilchis and others 2008) depicted the distribution of jaguars in México as continuous from north of the Isthmus of Tehuantepec along both the east and west coasts north to the United States. However, the northernmost breeding population in México is now known to be centered about 140 miles south of the U.S.-México border in (but not restricted to) eastcentral Sonora, around Huasabas, Sahuaripa and Nácori Chico, (Brown and López-González 2001; López-González and Brown 2002; Rosas-Rosas and others 2008; Valdez 2000; see also Rosas-Rosas 2006). The Huasabas-Sahuaripa area was well known to American sport hunters and guides decades ago; legendary houndsmen-guides Dale and Clell Lee helped clients kill eight jaguars there between 1935 and 1937 (Brown and López-González 2001). The Huasabas-Sahuaripa population is the northernmost of three extant metapopulations in Sonora identified by Grigione and others (2001) and López-González and Brown (2001), the more southerly two being the Sierra Bacatete and Quiriego-Sinaloa.

The four (or five) jaguars documented in AZ-NM from 1996 through 2009 almost certainly belong to the Huasabas-Sahuaripa population. No physical evidence (e.g. DNA, spot-pattern matches) of such a linkage has been confirmed to date but the logic is compelling. Thus, for purposes of this Assessment (consistent with JAGCT discussion), the range of the “northern jaguar population” is considered to extend from Alamos (Sonora, México) north through the Sierra Madre Occidental of Chihuahua and Sonora and the river valleys, foothills and scrublands of central Sonora into southcentral and southeastern Arizona and southwestern New Mexico. Jaguars seem to be distributed unevenly (in a temporal as well as a spatial sense) across that region, reflecting their territorial nature and the variety of conditions present. The quality of any given habitat patch could change seasonally or from year to year, because of prey base dynamics or other factors (e.g. temperature and availability of water; see Section 2.5).

2.4. Reproduction, Lifespan and Mortality

Jaguar breeding has been documented year-round in the tropics and captivity but females breed only every two or three years if they have cubs (Carrillo and others 2009; Ewer 1973; Gomes de Oliveira 1994; Mondolfi and Hoogesteijn 1986). In Belize, wild jaguars usually bear young during the rainy season, when native prey animals are more abundant (Rabinowitz 1986b; Rabinowitz and Nottingham 1986). In northerly and southerly parts of the range (i.e. temperate zones), breeding tends to occur in spring (Nowak 1999).

Cavalcanti (2008) reported GPS-telemetry monitored jaguars in the southern Pantanal (Brazil) lacked an established breeding season. She also found that males did not retain exclusive home ranges, instead “overlapping extensively year round,” and that females overlapped 64.4 percent of their home range with a male’s home range. Contrary to Rabinowitz and Nottingham (1986) and Schaller and Crawshaw (1980), this suggested individual females did not restrict their movement to within the home range of individual males. Cavalcanti concluded, “we suggest the mating system in jaguars may be one of a polygynous and promiscuous nature; a male likely mates with several females and a female likely mates with several males.” Such a system might be particularly advantageous in the periphery of the range, where co-occurrence of males and females might be highly sporadic.

Male and female jaguars might only come into contact during the breeding season (Crawshaw and Quigley 1984). Copulation lasts an average of nine seconds (range 2-35 s; Stehlik 1971) but occurs as many as 100 times per day over a few days (Eaton 1978). Gestation is about 93-105 days and litters average 1-4 young (Carrillo and others 2009; Nowak 1999). Offspring are born in sheltered sites, such as caves, under fallen trees and among rocks (Mondolfi and Hoogesteijn 1986). They suckle for 5-6 months but stay with the mother for up to 2 years (Nowak 1999; Quigley and Crawshaw 2002). Sexual maturity begins at about 2-3 (females) or 3-4 (males) years of age (Mondolfi and Hoogesteijn 1986; Tewes and Schmidly 1987).

Although young and other jaguars succumb to a variety of natural causes, rangewide the major cause of adult mortality is killing by humans (see: Chávez and Ceballos 2006; Rabinowitz 2006; Seymour 1989; Sunquist and Sunquist 2002; Sunquist and Sunquist 2007; Tewes and Schmidly 1987). The maximum known longevity for jaguars in the wild was thought to be no more than 11 years (Rabinowitz cited in Tewes and Schmidly 1987) but that has been surpassed. Macho B was photographed in southern Arizona at an estimated 2-3 years of age in August 1996 (McCain and Childs 2008, 2009), which means he was at least 15-16 years old when he died in March 2009.

2.5. Food Habits

Jaguars are “top carnivores,” capable of killing almost anything they encounter (see: Rabinowitz and Nottingham 1986; Sunquist and Sunquist 2002). They also scavenge (Cavalcanti 2008; López-González and Piña 2002). They may hunt at any time day or night (Cavalcanti 2008; Emmons 1990), taking live prey by ambush or by stalking and then making a short rush-attack. They swim well and readily take to water to capture prey (e.g. turtles and caimans). Their kill technique varies with the prey. Jaguars kill capybaras by biting the throat or puncturing the back of the skull (Tewes and Schmidly 1987) but kill caimans by pouncing on them and biting through the back of the neck to sever the cervical vertebrae (Almeida 1976). According to Rosa and Nocke (2000), jaguars are the only American cats that routinely kill prey with a single piercing bite to the skull. Jaguars typically do not cover kills as mountain lions do but often drag a carcass (sometimes 100 yd or more) to dense cover in a more secluded spot to feed on it over several days (Sunquist and Sunquist 2002; Tewes and Schmidly 1987).

Rabinowitz (1986a, 1986b) and Rabinowitz and Nottingham (1986) considered the jaguar an opportunistic predator that takes a wide variety of primarily medium and large-sized prey, generally in relation to prey density and ease of capture. The list of prey rangewide underscores

the opportunistic tendencies, including livestock and more than 85 species of native wildlife, such as collared peccaries (javelina), capybara, paca, armadillos, caimans, turtles, cattle and various birds and fish (Seymour 1989; see also: Aranda 1994; Da Silveira and others 2010; Garla and others 2001; Harmsen and others in press; Núñez and others 2000; Reyna-Hurtado 2002; Rosas-Rosas 2006; Rosas-Rosas and others 2008; Tewes and Schmidly 1987).

López-González and Miller (2002) concluded, “jaguars are equally using medium- and large-sized prey, with a trend toward use of larger prey as distance increases from the equator.” Cavalcanti (2008), using GPS-telemetry collars on 10 jaguars, documented 438 prey items at 415 kill sites in the southern Pantanal (Brazil). She found that individual jaguars differed in selection of species they killed (and in the proportion of native prey vs. cattle) but cattle (31.7%), caimans (24.4%) and peccaries (21.0%) were the most frequent prey items.

Dietary overlap and the possible effects of dietary competition between jaguars and mountain lions occurring in the same area has been discussed by several authors (e.g. Iriarte and others 1990; Emmons 1987; Haemig 2006; Rabinowitz and Nottingham 1986; Schaller and Crawshaw 1980; and Taber and others 1997). However, Aranda and Sánchez-Cordero (1996) concluded that jaguars and pumas coexist in Calakmul Biosphere Reserve (Campeche, México) by consuming different prey.

Although javelina and deer are likely mainstays in jaguar diets in the U.S.-México borderlands, other available prey, including livestock, are no doubt also taken. Since 1996, only one jaguar depredation on livestock has been confirmed in AZ-NM (in 2007: McCain and Childs 2008; E. McCain and W. Glenn personal communications). It was probably not the only depredation, since jaguars take livestock in virtually all parts of their range (e.g. Crawshaw and Quigley 2002; Hoogesteijn and others 2002; Núñez and others 2000; Quigley 1987; Rabinowitz 1986a, 1986b; Renata and others 2002; Rosas-Rosas 2006; Rosas-Rosas and others 2008; Schaller and Crawshaw 1980; Valdez and others 2002; Wittmer and others 1995). Jaguars in the Pantanal (Brazil) probably take about three head of cattle for every carcass found (E. Gese personal communication). Jaguar predation on livestock is a learned behavior and injury, lack of natural prey, livestock husbandry practices and other factors can exacerbate it (Rabinowitz 1986a, 1986b; Rabinowitz and Nottingham 1986).

Cavalcanti (2008) reported that in the southern Pantanal (Brazil) GPS-collared jaguars showed individual preferences for preying on cattle. Although >50 percent of the kills for some jaguars consisted of cattle, for others the rate was <10 percent. Much of the annual variability in cattle depredation was driven by rainfall-induced exposure (encounter rates) of cattle to jaguars. All 10 of Cavalcanti’s GPS-collared jaguars were in excellent physical condition when captured for collaring. Cavalcanti also noted that “older and more debilitated individuals seemed to have no problem killing ‘dangerous’ native prey.” However, Cavalcanti found that during an intense drought period “climatic conditions played a stronger role in jaguar prey selection than individual preference or propensity to kill livestock ... prey switching was common.”

Nevertheless, when jaguars are known to occur in an area they tend to be credited with causing more of the livestock losses that occur in that area than studies indicate they should (see: Rabinowitz 1986b; Rabinowitz and Nottingham 1986; Rosas-Rosas 2006; Rosas-Rosas and others 2008). Leopold (1959) noted that a local resident in México advised him “only certain

animals form the habit of killing stock and when these individuals are killed, losses cease even though there are other jaguars in the area.” Cavalcanti (2008) found no such “certain animals” in the southern Pantanal; all 10 jaguars she monitored with GPS telemetry over a 30-month period killed cattle but at varying rates seasonally, annually and individually.

2.6. Home Range

Like most large carnivores, jaguars have relatively large home ranges that are highly variable, depending on topography, available prey and population dynamics (Brown and López-González 2001). However, little information is available on this subject outside tropical America, where several studies of jaguar ecology have been conducted.

Quigley and Crawshaw (1992) estimated that in Brazil a minimum of 772 to 1160 mi² was needed to support 30 to 50 adult jaguars; the actual size depended on prey density, habitat composition and human exploitation. Individual jaguar home ranges varied from 11 to 16 mi² in Belize (Rabinowitz and Nottingham 1986) and 10 to 20 mi² in Jalisco, México (B. Miller personal communication). In Jalisco, home ranges tended to be smaller in the dry season than in the wet season and females with young kittens tended to have smaller home ranges than those with older kittens (Núñez and others 2002). However, B. Miller (personal communication) noted that individual jaguars recorded at the same location on consecutive days traveled up to nine miles overnight before returning to that location.

Relationships between home ranges of males and females in the same general area are not well understood but telemetry is providing new insights. Cascelli de Azevedo and Murray (2007) reported that in a floodplain jaguar population in the southern Pantanal (Brazil), home range sizes were comparable between sexes and overlapped little at the core area. They used ground and fixed-wing radiotelemetry to monitor eight collared jaguars (3 males, 5 females). They concluded that spacing patterns in local jaguar populations were likely based on exclusion through territoriality rather than food limitation.

Cavalcanti (2008), also working in the southern Pantanal, used GPS collars to monitor 10 jaguars (6 males, 4 females) – three to five simultaneously and independent of weather, time of day or season. Cavalcanti concluded that home ranges varied among animals and seasons from 34.1 to 262.9 km². Sizes of core areas for both sexes did not vary seasonally but home ranges were generally larger in dry than in wet seasons. Cavalcanti noted apparent spatial avoidance among females during the wet season but extensive overlap among males in dry and wet seasons. Once, she found two adult males sharing a feral hog carcass. On three occasions, two male jaguars were less than 200 m from each other; Cavalcanti was unable to find any prey carcasses in the area. Twice, two males occurred within 30 m of each other; one was monitored for three months before being found dead, apparently due to an aggressive encounter with another male (or more than one). Cavalcanti concluded that jaguars appeared to be more social than previously believed, with males and females interacting at higher frequency than anticipated based on previous literature.

2.7. Habitat¹⁵

As noted earlier, “habitat” is a contentious discussion topic in JAGCT. Mere mention of the word invites debate over what is and is not habitat. The ecological fluidity or variability of habitat quality and jaguar occupancy across seasons and years is at the center of many discussions about past, current and future jaguar status in the United States. Fueling the contentious discussion is the fact that many JAGCT participants have little background in science and some who do have such background tend not to present their opinions in ways that enhance understanding.

Unquestionably, however, the most contentious element of JAGCT habitat-related discussions has been whether mapping or otherwise identifying suitable or even potential jaguar habitat will lead to critical habitat designation under the ESA of 1973. A primary concern among critical habitat opponents within JAGCT is that designation would inevitably move conservation from voluntary to regulatory approaches (i.e. from the actual landscape to federal courtrooms). To many stakeholders, but definitely not all, it makes little or no conservation sense to represent such a small portion of the jaguar’s total range as critically important to recovery of the species.¹⁶

Conversely, proponents argue designation is needed to address threats to jaguar occurrence in the United States and is required by the ESA (see Section 3.1, below). These arguments tend to miss the fact that critical habitat designation could be an oxymoron not unlike the legal fiction that Arizona created by severing (in a legal sense) the relationship between surface water and ground water. In other words, critical habitat may be legally appropriate (even required) under the ESA and still be illogical (even groundless) from a science or common sense perspective. Even so, regardless of whether the preferred approach to conservation is regulatory or voluntary, or a combination thereof, habitat issues must be dealt with to assess the status of borderlands jaguars.

In considering jaguar habitat attributes, it is particularly important to remember that vegetation is only one component of habitat for this species (indeed, for any species). A. Rabinowitz (personal communication) remarked about the jaguar that:

“the term 'habitat' is defined by all those factors that make an area livable to a species, and I am completely convinced that the one overwhelming determinant of where big cats reside is prey availability and [abundance].”

Elsewhere, Rabinowitz (1999) stated, “the more open, dry habitats of the southwest are marginal for the jaguar in terms of water, cover, and prey density.” Rabinowitz (2006) later identified the following landscape features as those that most affect jaguar presence and movement rangewide: (1) habitat type [vegetation and topography], (2) percent of tree and shrub cover, (3) elevation, (4) human densities, (5) human settlements and (6) roads. He also commented:

“We know what jaguars need: occasional access to water, some degree of forest cover, and prey species that can range from peccaries to armadillos. We also know that jaguars

¹⁵ See Brown (1994) for discussion of biotic communities and vegetation types mentioned in this section.

¹⁶ Whether considered from the historical or recent occurrence perspective, jaguar distribution in the United States represents far less than 1% (closer to 0.001%) of the total occupied range. When numbers of animals are considered, virtually the same relationship exists (1:30,000 [AZ-NM:rangewide] = 0.003%).

can live close to people, but they generally avoid large open areas and sites of high human density.”

Rangewide, jaguars occupy a variety of habitats but generally occur in well vegetated areas (Seymour 1989). Habitat “generalism” is typical of wide-ranging “top carnivores,” which tend to have broader habitat tolerances than many other species and which have considerable effect on the ecosystems of which they are a part (see: Foreman 2004; Gittleman 1996; Mayr 1970; Miller and others 2001; Soulé and Terborgh 1999; Terborgh and others 1999).

In Central and South America, jaguars show a high affinity for lowland wet communities (jungles), typically mangrove swamps, swampy savannas and tropical rain forests, but they also occur in upland habitats with temperate climates (Cavalcanti 2008; Sanderson and others 2002a, 2002b; Seymour 1989; Tewes and Schmidly 1987). The highest densities that Leopold (1959) noted in México were in “heavily forested flatlands and foothills of southern Sinaloa, the swamps of coastal Nayarit, the remaining uncut forests along the Gulf coast as far east as central Campeche, and the great rain forests of northern Chiapas.” Swank and Teer (1987, 1989) opined that jaguars prefer a warm, tropical climate, usually associated with water and are rarely found in extensive arid areas. However, jaguars occur in seasonally-arid tropical scrub throughout the Chaco region of Paraguay, Bolivia and Argentina (A. Giordano personal communication). They also occur in dry tropical forest in Jalisco, México (Núñez and others 2002) and as recently as 1991 local residents thought they were “not unusual” (and still hunted) in the arid thornscrub-covered Sierra del Bacatete of Sonora, México (D.E. Brown and T.B. Johnson personal communications; see also Grigione and others 2001 and Brown and López-González 2001). Further, Sheldon (1921) reported that during a visit to Tiburón Island (off the coast of Sonora, México) the Seri Indians told him jaguars were rare residents of the scrub and chaparral covered, mountainous island.

Jaguars reach their northernmost distribution in relatively arid habitats in northwestern México and the southwestern United States, across a broad elevation belt (Brown and López-González 2000, 2001; Chávez and Ceballos 2006; Nowak 1994, 1999; Sanderson and others 2002a; Seymour 1989; Valdez and others 2002). Brown and López-González (2000) observed that kill-location elevations for 62 jaguars killed in the American Southwest since 1900 ranged from 500 m (1649 ft) to more than 3000 m (9843 ft) – most were above 1500 m (4921 ft) in mountains. Kill records from Arizona, New Mexico and Texas indicated jaguars had occurred there in habitats ranging from low-elevation thornscrub and desertscrub to montane conifer forests (Brown 1991). Most Arizona records to date have been from Madrean evergreen-woodland, shrub-invaded semidesert grassland and along rivers (Hatten and others 2003, 2005). Notably, the jaguar observed in southern Arizona woodlands in 1996 (Childs 1998) was repeatedly documented in arid scrub and desert grasslands in southcentral Arizona from September 2006 through January 2009 (McCain and Childs 2008, 2009) and in February-March 2009 (AGFD unpublished data).

As Rabinowitz (1999) stated, “The fact that the southwestern United States is the northern limit of the modern jaguar’s range is not by chance. The more open, dry habitats of the southwest are marginal for the jaguar in terms of water, cover and prey density.” Rabinowitz (personal communication) also commented, regarding habitat aspects of jaguar conservation in the AZ-NM borderlands, that prey availability and abundance are “the one overwhelming determinant of where big cats reside” and cautioned that “if you take this out of the equation [in describing

jaguar habitat], then you are not looking at jaguar habitat or potential habitat. You are simply looking at land suitability characteristics for jaguars.” Rabinowitz added that concerns about prey base in the presumed core area of the northern jaguar population [in México] are sufficient to warrant concern about long-term viability of the population. When native prey populations have been depleted, or jaguars are old or disabled, jaguars tend to turn to livestock as prey (B. Hassan personal communication cited in Brown 1991; Rabinowitz 1986b; Rabinowitz and Nottingham 1986). The switch to livestock inevitably leads to killed jaguars (see Section 3.1). Notably, Rosas-Rosas (2006) and Rosas-Rosas and others (2008) reported that cattle are now the major food item for the northern jaguar population in México.

Several recent studies have refined understanding of habitats that have been or might be used by jaguars in Arizona and New Mexico: Boydston and López-González (2005); Hatten and others (2003, 2005); Menke 2004; Menke and Hayes (2003); Robinson (2006); and Sierra Institute (2000). The habitat types (dominant plant communities) named in those studies range from thornscrub and desertscrub to woodland communities, including riparian and montane settings (for biotic community nomenclature, see Brown 1994). However, any conclusions about the conservation importance of the habitat types in which jaguars have occurred or might occur in AZ-NM are preliminary and can vary widely, depending on what assumptions are factored into the analyses, including the number and reliability of jaguar occurrence records and the significance of single “point in time” occurrence observations as predictors of habitat use by jaguars.¹⁷ Some **habitat patches** are clearly suitable for jaguars because they are persistently occupied by jaguars. Others are clearly not suitable for jaguar occupancy. Still other habitats are probably best described as marginal, i.e. possibly capable of sustaining jaguars occasionally (e.g. during dispersal or other movements for any purpose) but probably not for longer periods.

3. Species Status

3.1. Threats

Relevant Types of Threats. Two kinds of threats are relevant to assessing the status of borderlands jaguars: (a) threats that contributed historically, and which continue to contribute, to rangewide imperilment of the jaguar; and (b) threats that are relevant to current and future jaguar occupancy of the AZ-NM borderlands. The former must be addressed rangewide, which is beyond the scope of authorities for AGFD, NMDGF and USFWS. Only the latter (local) threats are within the scope of the AZ-NM conservation effort.

¹⁷ T.B. Johnson: This is probably the crux of criticisms within JAGCT and elsewhere of jaguar habitat mapping that is based entirely on point-in-time occurrences, especially across decades if not centuries, whether those occurrences are valid (documented) or speculative. Such maps imply that habitats around such occurrences are “jaguar habitat.” And they are, in the sense that a jaguar, at least apparently, “once” (literally) occurred in them or somewhere in the vicinity. But, whether those habitats are capable of sustaining jaguars over a longer period is, from a conservation perspective, quite a different matter. Connecting isolated dots is an essential tool in jaguar conservation (see Rabinowitz 2006) but when doing so one must never lose touch with the perhaps unintended consequences (i.e. impacts on pre-existing land uses) of connecting dots by sequestering (protecting) blocks of habitat that in reality have little or no value relative to the intended conservation purpose. One need only compare the inference-based conclusions drawn by Sierra Institute (2000) and Robinson (2006) against those drawn by Hatten and others (2003, 2005), Menke (2004) and Menke and Hayes (2003) to see how differently the same occurrence information can be used (or not used) in mapping “jaguar habitat.” Note that of these jaguar-related papers only the Hatten and others (2005) publication was peer reviewed.

In listing determinations, the ESA obligates USFWS to analyze five factors in terms of their effects on (i.e. threats to) species: (A) the present or threatened destruction, modification or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. The USFWS (1997) notice extending endangered status to the jaguar throughout its range (i.e. adding the U.S. portion of historical range to the previously-listed portion from México south to Brazil-Argentina) summarizes the five-factors analysis. It indicates the primary reasons for listing were: loss and modification of habitat; historical legal or illegal killing and commercial trade; insufficiency of state regulations protecting free-ranging borderlands jaguars from harm; and possible harm from M-44 ejector devices (with cyanide capsules) that are sometimes used in predator control actions. Collectively, these four factors frame the “threat” that USFWS found sufficient to warrant extending endangered status to the U.S.-portion of the range.

Although USFWS (1997) did not identify disease or predation as a significant threat to the jaguar, Furtado and Filoni (2008) advised:

“it is widely accepted that surveillances and monitoring programs are required for an adequate understanding of disease dynamics in wild jaguar. ... Diseases should always be considered as an important factor in **conservation biology**.”

In regard to violations of law, USFWS (1997) stipulated, based on the best available information, that the following actions (potentially perceived as threats) will not result in a violation of ESA Section 9 (Prohibited Acts), provided these activities are carried out in accordance with any existing regulations and permit requirements:

- a. Normal ranching activities, except predator control targeting large cats that result in inadvertent trapping or mortality of a jaguar.
- b. Habitat clearing, except in areas where jaguars are known to exist or have been known to exist.
- c. Fencing or other property delineation.
- d. If, when using dogs, a jaguar is inadvertently chased and/or treed by the dogs, so long as the dogs are called off upon realization that a jaguar is being chased.

USFWS (1997) also noted that take of jaguars by any of the following activities would likely violate ESA Section 9 (Prohibited Acts; i.e. they might cause harm):

- 1) Any activity specifically prohibited by ESA (e.g. shooting, hunting, trapping, etc.).
- 2) Intentional clearing or destruction of habitat known to be occupied by jaguars.
- 3) Any activities that fall within the definition of harass and harm. USFWS defines the terms harass and harm as follows: Harass means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm has been defined as

an act which actually kills or injures wildlife. Such acts may include significant habitat modifications or degradation when it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding or sheltering.

- 4) Predator control activities targeting large cats that trap, kill, or otherwise injure jaguars.

Threats Within vs. Outside the United States. The identified threats to jaguars outside the United States are of quite different significance than those within the United States. Southward, jaguar population declines since the late 1800s have been attributed primarily to causes that still exist today: habitat destruction, modification and fragmentation (especially forests and grasslands and savannahs); unregulated or insufficiently regulated hunting (or lack of enforcement of regulations); illegal and legal killing to obtain skins, skulls, teeth and other parts or to prevent or control depredation on livestock; and, in some areas, population declines in prey species (see: Chávez and Ceballos 2006; Seymour 1989; Swank and Teer 1987, 1989; Valdez 2000, 2002). In México, habitat destruction remains a significant threat (Chávez and Ceballos 2006; Sanderson and others 2002a, 2002b; Sanderson and others 2002c; Valdez 2000; Valdez and others 2002) and illegal killing of jaguars still occurs, principally due to conflicts with the livestock industry (Ceballos and Navarro-L. 1991; López-González 2004; Martínez-Mendoza 2000; Rosas-Rosas 2006; Rosas-Rosas and others 2008; R. Thompson personal communication).

These rangewide threats are the primary reasons why jaguars are less common and widely distributed than they once were. Jaguars now occupy only 46 percent of their historical (pre-1900) range (Sanderson and others 2002b). Most extant populations occur in isolated protected areas or in remote areas that are inhospitable to humans (Woodroffe 2001; Hoogesteijn and others 2002). But, are the threats the same in the United States? If so, can they be mitigated here?

The jaguar's historical decline in the United States (see Fig. 1) was concurrent with widespread predator control that was primarily associated with the cattle industry (Brown 1983; USFWS 1990). Shooting accounted for most documented mortalities in the United States before jaguars were protected by state law or the ESA (see: Brown 1983; Brown 1991; Brown and López-González 2001). The only two jaguars documented in the United States from 1969 through 1995 (1971 and 1986) were killed (Brown 1991, 1997; Brown and López-González 2001). In contrast, no jaguar documented in the United States from 1996 through 2009 was killed here, although one of the jaguars that Warner Glenn photographed here was almost certainly killed later in México (a hide matching its spot pattern was displayed there; PROFEPA unpublished data).

One element of predator control programs that could result in jaguar mortality is use of sodium fluoride in M-44 devices.¹⁸ Pursuant to the 1997 *Conservation Assessment and Strategy for the Jaguar in Arizona and New Mexico* (Johnson and Van Pelt 1997), JAGCT asked USDA-APHIS Animal Damage Control (now known as USDA-APHIS Wildlife Services) to assess the risk of

¹⁸ The M-44 device is a spring-loaded cyanide ejector mechanism anchored in the ground and which uses a fetid bait to attract coyotes. When a coyote pulls up on the baited top of the device, the spring-loaded plunger is triggered so it pops upward, through a small plastic capsule containing a small (0.8 g) amount of powdered/granular sodium cyanide, into the coyote's mouth. The coyote is generally killed within seconds.

accidental killing of a jaguar in Arizona and New Mexico by use of M-44 devices (Van Pelt 2004). These devices are used routinely to take coyotes suspected of preying on livestock. They are registered for use by ADC personnel in Arizona and New Mexico and by private applicators in New Mexico; private applicator use in New Mexico is regulated by the New Mexico Department of Agriculture. Since Arizona Proposition 201 (prohibition of trapping on public lands) became effective July 1, 1995, M-44 use in Arizona has been prohibited on public land.

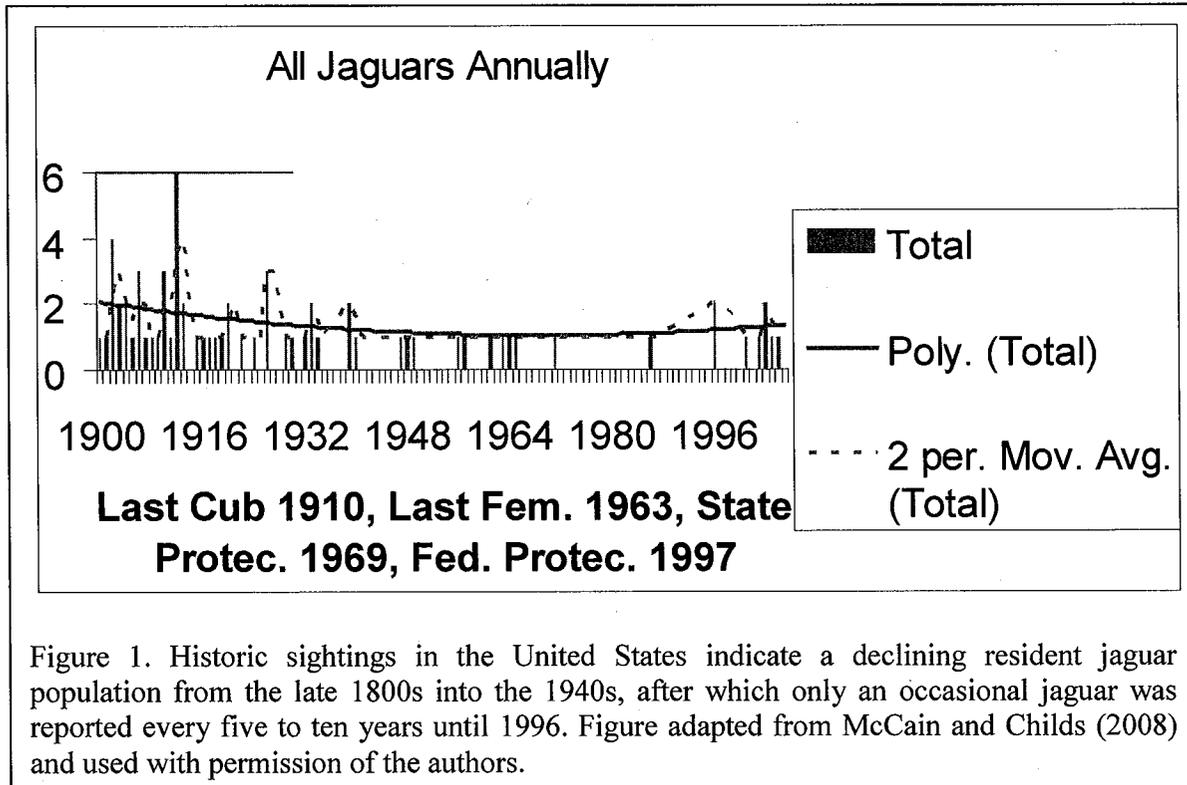


Figure 1. Historic sightings in the United States indicate a declining resident jaguar population from the late 1800s into the 1940s, after which only an occasional jaguar was reported every five to ten years until 1996. Figure adapted from McCain and Childs (2008) and used with permission of the authors.

JAGCT asked Wildlife Services to analyze M-44 use in Cochise, Pima and Santa Cruz counties in Arizona and Hidalgo County in New Mexico for the previous five years, including determination of: (1) the number and species of felids taken by such methods; (2) the amount of area worked in the above counties; and (3) expert opinion on baits that would be least likely to attract jaguars while still allowing for effective M-44 use. Wildlife Services completed the risk assessment for JAGCT in 1997 (see Van Pelt 2004), concluding that:

“M-44 devices have not resulted in the mortality of any felids in the affected area in the last five years despite use of these devices by ADC personnel in Arizona and New Mexico and by private applicators in Hidalgo County, New Mexico. ADC M-44 use has not been widespread in the area. It is estimated the areas with M-44 use totaled no more than about one-half of 1% of the area of the four counties in any one year. No use has occurred on National Forest lands which are presumed to encompass the majority of the habitat most likely to be used by jaguars. Although M-44 use on the New Mexico portion of the Coronado National Forest could occur, it is expected to be relatively infrequent and of low intensity. M-44 use in Arizona is only allowed on private land. In general, M-44

devices are not attractive to felids because fetid or rotten scented bait materials and, in many cases, canid-specific gland lures, are used as the attractive agents. Cats generally prefer fresh meat and are not generally attracted to bait materials that are composed of animal flesh that is in an advanced state of decomposition, and are not generally attracted to coyote pheromone. This assessment indicates accidental or incidental take of a jaguar by M-44 use is highly unlikely to occur.”

USFS Southwestern Regional Forester Corbin L. Newman, Jr. (USFS 2009) clarified M-44 use on the Coronado National Forest (which occurs in Arizona and New Mexico) as follows:

“Although M-44 use on public lands in New Mexico is not prohibited by law, as it is in Arizona, the current Coronado National Forest Plan Land Resource Management Plan does not authorize this activity. Any proposed M-44 use on the New Mexico portion of the Coronado National Forest would require both the requisite National Environmental Policy Act analysis and a plan amendment. Therefore, M-44 use on the Coronado National Forest would be an extraordinarily remote possibility and not just infrequent and of low intensity. Additionally, APHIS Wildlife Services has NEPA and ESA consultation on this tool that may address this species further.”

The 2007 AGFD-NMDGF Jaguar Conservation Framework addresses predator control activities (including use of M-44s) at Section 4.5.1, which states:

“Predator control activities by signatories to the MOU will not be purposefully directed at jaguars. Such activities are subject to a variety of federal, state, and tribal laws, local ordinances, and oversight by various federal, state, and tribal land management, wildlife management, and agricultural agencies or programs. Thus, any JAGCT discussions or recommendations regarding possible effects of area-specific predator control activities on jaguars, and measures to avoid harm to jaguars in such areas, will be carefully coordinated with the appropriate entities.”

As requested by JAGCT and in accordance with the 2007 Framework, Wildlife Services will instruct personnel who are working in areas suspected to be inhabited by one or more jaguars to avoid using M-44 baits that have fresh meat or fish or anise oil as ingredients (D.L. Bergman personal communication).

As summarized by EPA (2009), in January 2007 Sinapu (now known as WildEarth Guardians (<http://www.wildearthguardians.org>) and 10 other environmental groups petitioned to (among other things) cancel registrations for use of sodium cyanide and Compound 1080 (sodium fluoroacetate) in predator control and to cancel registrations for all pesticide products used in predator control that contain either compound. The petitioned actions would have terminated use of sodium cyanide in M-44 devices and sodium fluoroacetate in predator-attractant baits and in livestock protection collars. The petition (and three addenda filed in 1997) alleged the compounds cause unreasonable adverse effects on public health, the environment and species' populations (including threatened or endangered species). EPA (2009) responded as follows:

“For the reasons set forth in the attached response, EPA is denying the first five elements of the petition. In regards to the sixth element (a request for EPA to reinitiate consultation with USFWS on the two compounds when used for registered lethal predator control so that more threatened and endangered species are not harmed), EPA is granting the petition inasmuch as the Agency plans to reinitiate consultation with FWS on these pesticides.”

As EPA and USFWS re-consult on this issue, JAGCT will need to stay apprised of the findings with regard to possible effects on or implications for jaguar conservation in the borderlands.

Commercial trade as a threat to jaguars is evident historically but less clear cut today. Killing of jaguars for commercial sale of their fur was a factor in exterminating a substantial resident population in central Texas in the late 1800s (Nowak 1975). Prior to the 1980s, commercial trade in jaguar hides was substantial and unsustainable in the long term, as discussed by Nowell and Jackson (1996; Part II, Chapter 4), Payán and Trujillo (2006), Redford and Robinson (1991) and Swank and Teer (1987, 1989). According to Chadwick (2001): Iquitos (Peru) shipped 12,700 jaguar pelts between 1946 and 1966; Brazil sold more than 6000 hides each year through the late 1960s; and between 1968 and 1970 the United States imported 31,104 jaguar hides. However, Nowell and Jackson (1996) reported that killing of jaguars for their pelts declined drastically after the mid-1970s, when anti-fur campaigns gathered momentum and CITES¹⁹ progressively shut down international markets. Similarly, Swank and Teer (1989) commented that, by the time they conducted a rangewide jaguar status assessment in 1987, organized poaching rings supporting the pelt trade had already disappeared. Koford (1973) noted that, in addition to the new conservation treaty, depletion of accessible populations probably contributed to the end of the boom years in hide traffic. In short, although illegal trade in jaguar hides and other parts no doubt still exists and might at times involve jaguars (see: Roe and others 2002; Rosenberg 2009; TRAFFIC at <http://www.traffic.org/home.action>), CITES and other factors (e.g. social pressure) appear to be sufficient now to ensure that commercial trade is not and will not again become a significant threat to rangewide existence of the jaguar and it would certainly not be a significant threat to jaguars in the United States.

The primary concern now with regard to jaguar conservation in the U.S.-México borderlands is potential for future loss, fragmentation and modification of habitat. These factors have already contributed to population declines throughout much of the historical range, including northern México (see: Medellín and others 2002; Swank and Teer 1987, 1989; Valdez 2000). Although jaguars in eastcentral Sonora occur in a very rugged area, habitat loss and road development are potential threats (López-González 2004). In contrast, with the possible exception of the effects of “Border Security” projects and large-scale “back-country” human traffic across the International Border (see below), habitats within the JAGCT primary emphasis area for jaguar conservation in the United States are managed in ways that are largely conducive to jaguar occurrence. They have healthy populations of native prey, relatively dispersed human occupancy and they include extensive tracts of public lands used primarily for outdoor recreation and/or ranching.

¹⁹ Although the United States signed CITES (Convention for International Trade in Endangered Species of Wild Fauna and Flora) on March 3, 1973, the convention was not ratified by Congress until September 13, 1973 and it did not “enter into force” (take effect) until July 1, 1975 (see: CITES 2007 and <http://www.cites.org/>).

As noted above, illegal human traffic across the U.S.-México border and the resultant “Border Security” activities are a substantial concern for borderlands jaguar conservation. From the 1980s through today, drug trafficking and illegal immigration have increased tremendously along the border, with consequent impacts on wildlife and habitat. In 1971, the U.S. government spent less than \$71 million on border enforcement in the Southwest but in 1997 spending on drug enforcement alone reached \$1.7 billion (Andreas 1999). According to the Public Lands Foundation (PLF 2005), Arizona’s 374 miles of International Border comprise only about 19 percent of the 1952-mile U.S.-México border. However, PLF (2005) reports that: in FY2004, more than 52 percent of all arrests of illegal immigrants along the Southwest border were in Arizona; and in Arizona in FY2005, U.S. Border Patrol made more than 575,000 arrests of illegal immigrants, seized more than 500,000 pounds of marijuana (estimated value of more than \$400 million) and seized 8750 vehicles (many of which were stolen).

The impacts these problems have on wildlife and wildlife habitat are significant. A decade ago, Operation Gatekeeper on the U.S. side of the California-México border was already pushing illegal immigration operations from traditional entry points into “the most inaccessible zones where the danger is greatest,” even though such areas are also less accessible for law enforcement officers (Ackerman 1998). The plan worked, for California. Ackerman noted that apprehensions of undocumented migrants had fallen 46 percent in San Diego (to an 18-year low) since Gatekeeper started in 1994 but rose by 88 percent along the Texas and Arizona borders. The increase in the Tucson sector was actually 194 percent from FY1993 to FY1997.

Today, it seems no area along the Arizona-Sonora border, no matter how isolated, rugged or devoid of water, is untouched by illegal immigration, drug traffic and law enforcement activities. The affected area includes habitats occupied and possibly occupied by jaguars since 1996 and the impacts of illegal activities have become increasingly conspicuous in recent years. In addition to habitat impacts such as widening existing trails and creating new ones (both of which exacerbate erosion problems and loss of vegetation; see BLM 2006a, 2006b, 2006c), illegal border crossers obtain subsistence food by poaching wildlife, including animals that are commonly known prey of jaguars (e.g. deer and javelina) and destroy wildlife habitat as they build primitive camps and fuel campfires with trees and shrubs (G. Perry personal communication). As law enforcement impedes illegal human traffic in one area, the traffic shifts to others that are more isolated and more difficult for law enforcement agents to monitor. Until recently, many of these areas had relatively little human disturbance and some are the same areas in which jaguars occurred between 1996 and 2009. Nocturnal movements of illegal immigrants and smugglers and of those who are trying to intercept them are more likely to affect jaguars, which in this arid environment are almost exclusively nocturnal, than are daytime activities by hikers, ranchers and hunters (E. McCain personal communication). More than two dozen BJDTP trap-cameras set in remote places have been destroyed or taken and it has become unsafe for biologists to work (especially at night) in key areas along the AZ-NM/México borderlands (E. McCain personal communication).

The scale of impact by illegal immigrants and smugglers in the borderlands is both astounding and costly. Since FY2003, the BLM has maintained a project to mitigate damage in southern Arizona from illegal immigration and smuggling (BLM 2006a, 2006b, 2006c). Project funds have come from base annual appropriations, totaling \$4,404,000 as of FY2006 (BLM 2006c). These funds have been used by BLM across jurisdictional boundaries to cooperate with various

government agencies, private organizations, youth groups and the Tohono O'odham Nation to, among other things: remove more than 590 tons of trash and human waste; remove 130 abandoned vehicles and 1937 abandoned bicycles; repair or rehabilitate hundreds of miles of illegal roads and trails and damaged washes; repair cut fences; replace destroyed gates with cattle guards; install vehicle barriers; clean up graffiti; and plant native trees and re-seed ground cover. Notably, the Malpai Borderlands Group (MBG), an active JAGCT participant, has been among the BLM cooperators, traveling 19,744 miles and working year-round to repair damaged roads, remove trash, repair fences, etc.

A new and significant threat to borderlands jaguar conservation emerged after the tragic events of September 11, 2001, when the United States recognized a much-heightened need for terrorist detection and interdiction at its borders and beyond. The Homeland Security Act (HSA) of 2002 (Public Law No. 107-296, 116 Stat. 2135), enacted on November 25, 2002, created a Department of Homeland Security (DHS), which includes the U.S. Customs and Border Protection Agency (USCBP). On March 16, 2004, DHS announced the Arizona Border Control Initiative, a multi-agency effort to provide additional resources to "detect and deter terrorist activities and cross-border illegal trafficking of people and drugs" (DHS 2004).

Long-term plans for securing the border were addressed in the USCBP 2005-2010 Strategic Plan (USCBP 2005; see also USCBP 2006). Security measures identified for the U.S.-México border that might influence jaguar presence and conservation include (but are not limited to): lighting; fencing and other physical barriers, road and bridge construction and maintenance; surveillance of pedestrian and vehicle traffic; other security activities and habitat alteration to facilitate law enforcement (Segee and Neeley 2006).

Bies (2007) summarized, largely from a wildlife perspective, the current border security situation in the Southwest and possible impacts of fencing and barriers^{20,21} as follows:

"In 2005 and early 2006, Congress failed to find common ground between the Senate and House on comprehensive immigration law reform to address, among other things, national security concerns about the U.S.-México International Border. However, Congress subsequently passed the Secure Fence Act of 2006 (SFA; Public Law 109-367), which President Bush signed into law on October 26, 2006. The intent of the law is to 'establish operational control over the international land and maritime borders of the United States,' through surveillance (e.g. unmanned aerial vehicles, ground-based sensors, satellites, radar coverage and cameras) and physical infrastructure enhancements (e.g. additional checkpoints, all weather access roads and vehicle barriers). The SFA includes southern border fencing provisions from the December 2005 House version of comprehensive immigration reform legislation, including 'at least 2 layers of reinforced

²⁰ For a binational perspective on potential environmental consequences of the International Border fence (which will actually be a discontinuous series of fences), see Córdova and de la Parra (2007).

²¹ "Fence" is typically used alone hereafter when referring to border security measures that DHS will use to establish "operational control." However, in such use "fence" will always include, in addition to actual fencing of various dimensions, the full suite of physical and electronic security measures and activities that DHS has been authorized to implement.

fencing ... from 10 miles west of Calexico [CA] to 5 miles east of Douglas [AZ].’
Notably, the SFA did not provide funds for the fencing.”

Uncertainties about what might be done to secure the U.S.-México International Border, where and how construction might occur and impacts of such actions on humans and wildlife generate a lot of public concern. During workshops in 2005 and 2006, stakeholders in Arizona identified recommendations for addressing impacts (particularly those of physical barriers and fences) to wildlife and wildlife habitat along the AZ/México border (Defenders and Wildlands Project 2007). AGFD and USFWS were among the workshop participants. In New Mexico, a gathering of stakeholders similar to the Arizona workshops was convened on July 8, 2008 to discuss concerns about the NM/México borderlands (R. Held personal communication). The workshop was sponsored by the New Mexico Chapter of the Wildlife Society and the New Mexico Farm and Ranch Heritage Museum (Las Cruces). NMDGF and USFWS also participated.

In 2007, the Good Neighbor Environmental Board (GNEB) provided a border-long perspective in its 10th Annual Report (GNEB 2007). GNEB is an independent U.S. Presidential advisory committee that was established to advise the President and Congress of the United States on “good neighbor” environmental and infrastructure practices along the U.S. border with México (see <http://www.epa.gov/ocem/gneb/index.html>). In its 2007 report to the President and Congress, the Board reported (in part):

“Undocumented Human Crossings. To address problems associated with unauthorized flows of people across rural areas of the U.S.-Mexico border, and also continue to protect the environmental quality of the region ... the [GNEB] recommends:

Strengthen communication and collaboration between security agencies and environmental protection agencies, including land management agencies, on both sides of the border. Early and ongoing cooperation and participation in the cross-agency dialogue will contribute to effective solutions that serve the core agency missions of homeland security and environmental protection, while also addressing quality of life concerns of border communities.

Strategically employ a mix of technology and personnel to meet the security and environmental need of the border region. Vehicle barriers and sensor technology along the boundary that permit habitat connectivity and migration of important species can serve well in rural areas characterized by fragile habitats.”

In the same report, GNEB noted that:

“Impenetrable fences may present significant negative consequences to wildlife and the environment. Fences may disrupt hydrologic patterns, causing flooding and erosion. Wildlife migration routes and territories for some species may be truncated, fragmenting habitats and causing declines in regional populations of large animals such as deer, black bear, pronghorn antelope, mountain lions, and jaguar, and small animals such as snakes, lizards, turtles, and foxes. Migratory birds, as well as bird and mammal breeding behavior, will be affected by lights associated with fences in some areas. Border lighting

projects associated with fencing also have been criticized for potential harm to species such as the jaguarundi and ocelot in the Lower Rio Grande Valley. A fence running along large sections of U.S.-Mexico border, with its accompanying roads, would permanently eliminate hundreds of thousands of acres of transboundary wildlife habitat.”

Despite the impacts evaluation and cross-jurisdictional collaboration needs that were so obvious to so many and a variety of initial DHS consultations with USFWS on border fence issues (e.g. USFWS 2007), Congress and the Bush Administration foreclosed requirements for consultation. With regard to construction of barriers and roads for border security, under the HSA the DHS Secretary is exempt, on a case-by-case basis, from ESA and NEPA compliance (see also the REAL ID Act of 2005, Division B of Public Law 109-13, 119 Stat.231, enacted May 11, 2005). On April 1, 2008, after withstanding a variety of protests and legal challenges regarding lack of environmental review of border security measures, DHS Secretary Michael Chertoff invoked his authority under the REAL ID Act to waive 37 applicable federal laws and all state, local and tribal laws to expedite construction of the border fence and related infrastructure (CNN 2008).

Irrespective of DHS Secretary Chertoff’s April 2008 waiver, USFWS and DHS continue to engage in discussions regarding conservation of jaguars and other borderlands species protected under the ESA (S. Spangle and S. Barrett personal communication). These discussions appear to be producing substantive results at a national level. In January 2009, DHS and the Department of Interior (DOI) signed an agreement committing \$50 million from the DHS Fiscal Year 2009 budget for projects intended to mitigate the effects on listed species of barriers and fencing constructed along the International Border (Reese 2009). USFWS is diligently pursuing availability of the appropriated funding so projects can be approved and initiated.²²

The ESA Section 9 “violations” noted above have particular relevance to DHS fencing, barrier and other national security work along the AZ-NM/México border. In mid-2009, a Customs and Border Inspection spokesperson noted that 601 miles of fencing had already been completed, leaving only 69 miles in Texas to be constructed (Sullivan 2009). However, Reese (2009) and Simon (2009) reported that construction of the final segment is being challenged by appeal to the Supreme Court and petition to President Barack Obama. Regardless, the extent to which projects carried out under the DOI-DHS agreement will mitigate impacts on borderlands jaguars is yet to be determined but the impacts are already being witnessed. During remote-camera jaguar monitoring fieldwork in 2007, the BJDPA documented DHS emplacement of steel reinforced barriers at the exact location at which a jaguar tracked through southcentral Arizona crossed the International Border (E. McCain personal communication). Since then, more border-security fencing and barriers have been built in areas that could be valuable corridors for jaguars.

Other threats to jaguars might include introduction of exotic diseases from invasive wildlife or pets (e.g. feline leukemia), reductions in native prey base, climate change and shifts in corridors used by humans moving along the border. As border security measures are implemented, humans

²² S. Sferra personal communication: It may be March 2011 or so before the Request for Proposals (RFP) goes out. USFWS still has a few issues to work out with Department of Homeland Security on use of the jaguar mitigation funding. The Arizona Field Office is also still working out the prioritization and RFP process for all the border mitigation projects with our Regional Office.

crossing the border illegally will probably shift their routes to mountainous corridors, causing more impacts on large carnivores and native prey populations.

3.2. Conventions and Regulatory Protections

International. The World Conservation Union (IUCN) considers the jaguar “near threatened” rangewide (IUCN 2006). In 1973, the jaguar was listed under CITES as an Appendix 1 species (CITES 2007). CITES signatory nations are prohibited from international trade of Appendix 1 species (including trophies, skins and products). The United States and México are both CITES signatories.

México. The jaguar was protected by México in 1986 and hunting was banned in 1987 (SEDUE 1987). It was listed as threatened on May 17, 1991 (SEDUE 1991) and elevated to endangered on May 16, 1994 (SEDESOL 1994). The jaguar now falls under protection of México’s Ley General de Vida Silvestre (General Wildlife Law), enacted in 2000 to provide for wildlife conservation and management (SEMARNAT 2000; see <http://www.semarnat.gob.mx/pages/inicio.aspx>). México now considers the jaguar a priority species (DOF 1999, INE 2000) and an endangered species (Norma Oficial Mexicana NOM-059-SEMARNAT-2001; Ceballos and others 2006). Under current Mexican law, specimens and parts of endangered species cannot be used for commercial purposes. Endangered and threatened species (or any parts thereof) can only be taken for scientific or recovery purposes (e.g. captive propagation) and then only with prior authorization from SEMARNAT. Jaguars may not lawfully be killed simply because they depredate on livestock.

Note: see Simonian (1995) and Valdez and others (2006) for discussion of the evolution and current status of wildlife conservation and management in México, including information on laws and regulatory processes referenced or alluded to above.

United States of America. The jaguar was listed by the United States as an endangered species in 1972, under the Endangered Species Conservation Act of 1969 (ESCA; USFWS 1972). Two lists of endangered wildlife were maintained under ESCA: foreign species; and species native to the United States; the jaguar appeared only on the list of foreign wildlife. The ESCA was superseded by the ESA of 1973 and on September 26, 1975 the two ESCA lists were replaced by a single ESA “List of Endangered and Threatened Wildlife” (Federal Register 40:44412-44429).

The jaguar was included in the ESA list of 1975 but only for its historical range in México and Central and South America. USFWS (1979) considered its failure to include historical range in the United States in the listing an administrative error it would rectify “as soon as possible.” The corrective listing was proposed (USFWS 1980) but then was withdrawn (USFWS 1982). Listing was proposed again on July 13, 1994 (USFWS (1994)). On July 22, 1997 endangered status was finally extended to the jaguar throughout its historical range, from the southern United States (i.e. Arizona, California, Louisiana, New Mexico and Texas) through México, Central America and South America (USFWS 1997). It is important to note the listing addresses the jaguar at the species level (*Panthera onca*); neither the subspecies *P. o. arizonensis* in AZ-NM/México nor the “northern jaguar population” in the AZ-NM/México borderlands was listed.

Designation of critical habitat is also a regulatory action pursuant to the ESA. Initially, USFWS determined it was not prudent to designate critical habitat for the jaguar in the United States (USFWS 1997, 2006). However, that position was recently reversed after another round of litigation by environmentalists (see USFWS 2010b). USFWS now anticipates publishing a proposed rule to designate critical habitat in “spring 2012” (USFWS 2010c, 2010d).

USFWS Recovery Plans are often construed to be regulatory documents. Joint policy guidance issued by the National Marine Fisheries Service and USFWS (2004)²³ clearly affirms they are not, nor does a Recovery Plan ensure on-the-ground conservation actions:

“A Recovery Plan is the road map to recovery ... [but] Recovery plans are guidance documents, not regulatory documents. No agency or entity is required by the ESA to implement the recovery strategy or specific actions in a recovery plan.”

See Section 3.5.1 for further discussion of jaguar recovery planning.

State of Arizona – The Arizona Game and Fish Commission protected the jaguar in 1969, closing the open season that had previously allowed the species to be taken by licensed hunters. Jaguars are now listed as nongame mammals under Arizona Game and Fish Department (AGFD) Commission Order 14, with no open season for legal take by hunting. Violation of this order is a Class 2 misdemeanor. On May 7, 1998, state legislation (Senate Bill 1106) was signed into law that provides, when the jaguar is delisted federally, for imposing a \$2500 criminal penalty (Class 2 Misdemeanor) and up to \$72,500 in civil penalties for unlawful take of a jaguar. The civil fine is commensurate with the current federal fine under the ESA but the criminal penalty is considerably lower than the companion federal fine. The legislature’s intent was to ensure that state penalties would not be additive to current federal penalties and could serve as an inducement to federal delisting.²⁴

State of New Mexico - The State of New Mexico classifies the jaguar as a Restricted species (19.33.6.9 NMAC) because of its status as a CITES Appendix 1 species. In 1999, during the 44th New Mexican Legislative Session, Senate Bill 252 was signed into law, establishing new regulations and penalties for illegally killing a jaguar. The penalties would take effect only if the jaguar were removed from the federal endangered species list. Although this law provided state penalties as high as those for any animal protected by New Mexico, the penalties are not as high as those under the ESA. In the 2006 New Mexico legislative session, House Bill 536 (“Unlawful Trophy Animal Disposition”) was passed and signed into law. It allows the New Mexico Game Commission to establish regulations authorizing higher civil damages than previously allowable for wildlife designated as trophy animals and establishes a minimum \$2000 in civil penalties (without requiring removal from ESA listing to take effect). Thus, higher penalties for illegal jaguar killing may be established through Commission action. As of December 2010, no such action had been initiated.

²³ NMFS and USFWS. 2004 (updated June 2010). Interim endangered and threatened species recovery planning guidance Version 1.3. See page 1.1 Why develop recovery plans? Silver Spring MD (NMFS) and Arlington VA (USFWS).

²⁴ Emil McCain’s fine on May 14, 2010 for prohibited take of a jaguar in 2009 was \$1000 (plus a special assessment of \$25). The case was prosecuted by the federal government in federal court and settled via plea bargain.

3.3. Biological and Ecological Considerations

Habitat Distribution Potential. Boydston and López-González (2005) used Geographic Information Systems (GIS) technology to assess sexual differentiation in distribution potential of northern jaguars, by modeling distributions of males and females (records of occurrence were derived primarily from killed animals). They suggested that eastern Sonora appeared capable of supporting male and female jaguars, with potential range expansion into southeastern Arizona. However, New Mexico and Chihuahua had environmental characteristics primarily limited to the “male niche,” thus they might be areas into which only males occasionally disperse. Boydston and López-González further suggested that environmental requirements for females might be limiting distribution of northern jaguars. These theories merit further investigation, as “ignoring [or misunderstanding] sex-related differences in environmental preferences diminishes the ability of habitat models to inform management of jaguars and other large carnivores” (Conde and others 2010).

Shifts in Distribution. There is little reason to think that jaguar distribution in the Southwest is static. Over the past 100 years, vegetation in the Southwest has changed appreciably (i.e. from more open grassland and woodland to scrub and shrub-invaded grassland and more closed forest) in response to a variety of factors (Hastings and Turner 1965; Turner and others 2003).

EPA (1998) provides relevant information on climate shifts and projects changes for the near-term future: (a) global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996; (b) the nine warmest years in the 1900s – 1995 was the warmest year on record – occurred after 1984; (c) the average temperature in Tucson, Arizona has increased 3.6°F and rainfall has increased by up to 20 percent in many areas over the past century; and (d) by 2100, temperatures in Arizona could increase by 3-4°F in spring and fall and by 5°F in winter and summer, while precipitation could decrease slightly in summer, increase by 30 percent in fall, increase by 60 percent in winter and increase by 20 percent in spring. [Note: see Thompson and Anderson (2005) for concise insight into primary factors involved in climate and vegetation shifts in the southwestern United States. Also see Karl and others (1996) regarding indexes of climate change for the United States; the document was written expressly for comprehension and use by “non-specialists in the field.” For information on the biotic effects of climate in the Southwest, see: <http://www.cpluhna.nau.edu/change/climate.htm>.]

The effects and importance of such climate changes on historical and future jaguar habitat and distribution here at the northern periphery of the range are unknown (although see: Abbitt and others 2000; Brown and Davis 1995) but indirect effects (e.g. changes in prey base abundance and vegetation) might be important. Also, the human footprint on the landscape has become more evident over the past 100 years and seems likely to become even more pronounced. There are more people in the U.S.-México borderlands now than there were 100 years ago and fewer places without people. Moreover, on the AZ-NM side of the border, much of the developed occupancy is dispersed now, rather than concentrated in a few historical mining towns, which further fragments the landscape. This pattern seems unlikely to change in the foreseeable future and consequent effects on the dynamics of jaguar presence seem inevitable.

Importance of Periphery. Arizona and New Mexico are at the northern edge of the northernmost jaguar population known today. Miller and others (1996) established the value of peripheral populations in recovery of the black-footed ferret, as did Schaller (1993) for the giant panda. Ehrlich and Ehrlich (1992) and Garcia-Ramos and Kirkpatrick (1997) affirmed the conservation value of populations at the fringe of the range in a more general sense.

Channell and Lomolino (2000), studying dynamic biogeography and conservation of endangered species, also assessed importance of populations at the edge of a species' range. They suggested populations undergoing dramatic range reductions persist longest at the extremes of their range; accordingly, they postulated such populations might deserve even greater conservation focus than "core" populations. Peterson (2001) discounted the conservation value of peripheral populations, asserting they are often not viable and can be **sink populations** (see: Brown and Kodric-Brown 1977; Pulliam 1988). Nielsen and others (2001) contested Peterson's findings, claiming such populations are "vitally important to a species' past, present, and future existence." The "importance of periphery" is an intriguing concept that needs scrutiny to determine how, if at all, it relates to northern jaguar conservation (see also below).

Habitat and Population Fragmentation and Connectivity. Habitat and population fragmentation and connectivity are probably the most important factors to consider in assessing borderlands jaguar conservation (see Haag and others 2010). The importance of individual (e.g. peripheral) populations, connectivity and the effects of fragmentation is inherent in the metapopulation concept (see: Begon and others 1996; Hanski 1991; Hanski and Gilpin 1991; Levins 1969; McCullough 1996; Meffe and others 1997; Ricklefs and Miller 1999). A metapopulation consists of a group or network of spatially-separated (i.e. semi-isolated) populations of the same species, together with areas of suitable habitat that are currently unoccupied. The overall dynamic for a non-declining metapopulation is a balance of local loss (extinction or extirpation) and local **recolonization**. A crucial element is linkage of semi-isolated populations through **dispersal**, providing for demographically significant genetic exchange (see: Gutierrez and Harrison 1996; Harrison 1991, 1994). In the absence of linkage, an insular (isolated) population, as can result from habitat fragmentation, may represent a nonequilibrium metapopulation (Harrison and Taylor 1997) in which extinction probability increases (see Brown and Kodric-Brown 1977).

In metapopulations, each "linked" individual population cycles (trends) up or down relatively independently of the other populations and eventually is lost (disappears) due to fluctuations caused by random demographic events. The smaller the population, the more prone it is to being lost. As Andrewartha and Birch (1954) stated, "in different localities the [demographic] trends may be going in different directions at the same time ... spots [habitat patches] that are occupied today may become vacant tomorrow and reoccupied next week or next year." Although the individual populations have finite life-spans, the population as a whole (i.e. the metapopulation) tends to be more persistent over time because immigrants from one population (which might be experiencing an increase) are likely to re-colonize habitat that has been left open by loss of another population. They may also immigrate into another small population and in doing so rescue it from extinction (i.e. the "rescue effect" of Brown and Kodric-Brown 1977).

Although no single population might be sufficient to guarantee long-term survival of a given species, the combined effect of many populations might (thus the ecological importance of both

core and peripheral populations). The ecological relationships inherent to metapopulation theory are complex and there is “no single ‘magic’ population size that guarantees the persistence of populations” (Thomas 1990). Nor is there a magic number of peripheral populations interacting with the core. Given the extent to which habitat fragmentation has occurred and continues to occur, it is particularly important that metapopulation models consider spatial dynamics such as patch area size and extent of isolation. For a review of this subject, see Hanski and Ovaskainen (2003).

Rangewide, jaguar habitat is increasingly fragmented; if jaguars are unable to move from one isolated population to another, at least occasionally, gene flow will eventually cease and population viability will be threatened (see: Rabinowitz 2006; Sanderson and others 2002a, 2002b). This concern is consistent with the contention that, in general, connectivity (e.g. linkages or corridors) among large core areas and peripheral habitats is essential to maintaining biological diversity (see: Beatley 1994; Beier and Noss 1998; Bennett 1999; Cody and Diamond 1975; Damschen and others 2006; Groves 2003; Hudson 1991 [especially Part II, Conservation Corridors: Countering Habitat Fragmentation]; Simberloff and others 1992).

The literature on conservation-oriented corridors is rapidly expanding, as the global landscape becomes more fragmented each year. Practical applications and the benefits thereof are capably and appropriately advocated but limitations are also being identified (e.g. Chetkiewicz and others 2006; Hilty and others 2006). Also, long-distance dispersal rates for carnivores “remain largely a black box. ... rarely do we know what habitat factors impede or assist dispersal between isolated populations” (Waser and others 2001). Regardless, the current understanding is that connectivity of large areas is essential to conserving biological diversity at a landscape-level and (see: Foreman 2004; Soulé and Noss 1998; Weber and Rabinowitz 1996)^{25,26} and is particularly important to long-term viability of large-carnivore populations.

Meaningful corridors are, however, neither a panacea nor simple to design and easy to secure. In some cases, the landscape-level concept of connectivity is so sweeping it becomes as threatening to some interests as it is essential to others. This is evident in borderlands jaguar conservation. Some participants in JAGCT are staunch advocates of a connected network of wild, protected places (e.g. Sky Island Alliance and Wildlands Project; see Section 3.5.1). Often, but not always, such advocates are urbanites who value wildlands and connectivity corridors for conservation and recreation purposes but who do not derive livelihoods from them. Other stakeholders, often rural residents with generations invested in the land and their livelihoods, are staunchly opposed to wildlands protections that could restrict access to or multiple-use of such areas. Neither set of values is “better” than the other (in fact, there is substantial overlap between them on such issues as maintaining open space, connectivity and relatively low-levels of human occupancy) but change, even just the possibility of change, can be threatening and the bigger the perceived change the bigger the perceived threat.

²⁵ Whether such areas must be devoid of human habitation (e.g. legally-established “wilderness”) or merely be hospitable to presence of carnivores (i.e. no illegal killing) is widely debated, including within JAGCT. Debate over effects of human presence is largely values-based, a reflection of land-use preferences. Disparities in philosophy do not change the ecological facts regarding the need of wide-ranging carnivores such as jaguars for large areas of suitable habitat, movement corridors between core and peripheral populations and protection from illegal killing.

²⁶ Simberloff and others (1992) discuss potential and realized situations in which restoration of connectivity through terrestrial or aquatic linkages or corridors might be or is detrimental to conservation objectives.

Increasingly, landscape-level conservation proponents within the more traditional conservation community have taken note of the need to address fear of change by directly involving local people who see the potential for being significantly affected by proposed actions. The Wildlife Conservation Society's "Living Landscapes Program" (WCS 2009) is an excellent example:

"The ... Living Landscapes Program is based on a simple reality: animals do not recognize park boundaries, particularly wide-ranging species such as elephants, bears and jaguars. Indeed, while parks are essential for conservation, the larger landscape adjacent to protected areas, with both humans and animals living within it, is often as important as the protected core. To protect these "Living Landscapes," WCS has created an approach that involves not only parks and protected areas, but neighboring people, governments and the private sector.

Today, the Wildlife Conservation Society is using this approach in some 28 land-and-sea scapes across Africa, Asia, Latin America and North America. While creatively resolving threats to wildlife and wild places while minimizing the costs to humans, WCS is creating a landscape that is sustainable for both.

Conservation in the real world is not only about establishing preserves to protect Earth's diversity, but going beyond them to save wildlife on all fronts."

Among the Wildlife Conservation Society's "living landscapes" is the Maya Biosphere Reserve, an area WCS considers the "most important segment of the Mesoamerican Biological Corridor" and which Rabinowitz (2006) considers crucial to jaguar conservation (see Section 3.5.2).

3.4. Population Status and Trends

Much like "habitat," "population" is a contested term within JAGCT. At the core of the debate is whether the collection of jaguar occurrences in the AZ-NM borderlands is a discrete population, or merely dispersing individuals at the edge of a population that is centered elsewhere. To some, acknowledging that a population of any sort exists seems to invite regulatory protective actions. For others, the issue stems from ecological principles, not matters of law.

Estimation of population status and trends for any large carnivore is challenging, particularly when the species is nocturnal, secretive and present in low numbers. Absent a rigorously-gathered, long-term data-set, inferences must be based on available information and conclusions drawn about presence and status must acknowledge information gaps. So it is with the borderlands jaguar. No firm historical population baseline exists but rangewide population decline is evident in recent history, as Rabinowitz (2006) summarized:

"By the 1960s, environmental degradation and decades of harvesting spotted cat skins for the North American and European fashion industries had decimated many jaguar populations. In 1969 alone, nearly 10,000 jaguar skins valued at more than \$1.5 million were imported into the U.S. By the time most of the jaguar range countries outlawed the trade, during the 1970s, sharp declines in jaguar numbers were noted from areas where

the cats had once been abundant. Meanwhile, Latin America's human population was growing faster than that of any other region except Africa.”

Swank and Teer (1989) estimated that as of 1987 the jaguar's range had been reduced by 67 percent in México and Central America and 38 percent in South America. Similarly, Chávez and Ceballos (2006) estimated that: 60 percent of the jaguar's historical range in México had been lost; the nationwide population was less than 5000 individuals; and a variety of threats suggested that, absent effective conservation efforts, jaguar imperilment in México would only worsen. If the core of the northern México population were lost, or if its connectivity with the United States were broken, present understanding suggests there would be little hope that jaguars would persist or even occur again in Arizona or New Mexico.

Although Valdez (2000) asserted the “United States probably had a viable jaguar population early in the 20th century,” the size of the U.S. population and the number of jaguars that have been present in AZ-NM at any given time is unknown. Regardless, the best available information indicates that, until 1996, jaguars in the American Southwest did not survive for long once they were discovered. Between 1885 and 1959 in Arizona and New Mexico, 45 jaguars were killed, six others were sighted and two more were documented by evidence such as tracks and/or droppings (Hock 1955; Lange 1960). Overlapping assessments documented 58 jaguars killed or photographed in Arizona and New Mexico from 1900 to 2000 (Brown and López-González 2000, 2001; Girmendonk 1994). When plotted at 10-year intervals, the records of jaguars reported killed in Arizona and New Mexico between 1900 and 1980 demonstrated decline characteristic of an over-exploited resident population (Brown 1983, 1987). Brown and López-González 2001) reported that over the past 50 years (presumably 1950-2000) the number of jaguars observed in Arizona and New Mexico has been considerably lower than for the previous 50 years (presumably 1900-1949). Current data have not changed that assessment: 1900-1949 = 51 different jaguars (including 2 females with 3 cubs); 1940-2009 = 10 different jaguars (a track recorded in 1995 and a jaguar photographed in 2004 might represent two more individuals) (AGFD unpublished data; Brown and López-González 2001; NMDGF unpublished data).

Another aspect of population status is whether animals are resident year-round, seasonally present or present only occasionally, perhaps as transient dispersers. The documented record for both Arizona and New Mexico since the late 1800s is mostly of males (Brown and López-González 2001). Nine of the 10 jaguars confirmed in Arizona and New Mexico from 1960 through 2009 that were identified to gender were males (the lone female was killed in 1963 near Big Lake, White Mountains, Arizona)²⁷ and all were solitary individuals (AGFD unpublished data; Brown and López-González 2001; McCain and Childs 2007, 2008, 2009). This information has led many to infer that the jaguars present in Arizona and New Mexico historically and in recent years have been dispersing animals, not year-round or seasonal breeding residents.

The contrary case has also been made, however. Although only a few female jaguars have been reported north of México, three historical records from Arizona suggest evidence of breeding: a reported kill of a female with two kittens near the Grand Canyon between 1885 and 1890 (Lange 1960), a reported kill of a female and a cub at the head of Chevelon Creek in 1910 (Brown 1983; Brown and López-González 2000, 2001; Nowak 1975) and a newspaper report of a female killed

²⁷ Validity of record disputed; see Footnotes 11 and 13.

and her two kittens captured in the Chiricahua Mountains in 1906 (Brown 1989, 1991; Brown and López-González 2000, 2001). Thus, Valdez (2000) contends that jaguars probably were breeding residents in Arizona in recent history (no such claim has been made for New Mexico).

In addition to historical aspects, we must consider current jaguar status and trends in the borderlands. From 1996 through 2009, jaguar occurrence was confirmed repeatedly along the U.S.-México border in southern Arizona and New Mexico (Childs 1998; Childs and others 2007; Glenn 1996; McCain and Childs 2008, 2009). Since 1997, when JAGCT monitoring began, through use of remote cameras, presence has been documented in Arizona and/or New Mexico in every calendar month, with one male (Macho B) confirmed in the same area over a period of 13 years (1996-2009) and a second (different) male confirmed in a nearby area over a period of three years (Childs and others 2007; McCain and Childs 2008, 2009). Both of these males were mature adults. Among recent confirmed records are camera-trap photographs from southcentral Arizona in 2007 that document a male engaged in territorial behavior – scent marking (McCain and Childs 2008). Whether the display might have been in response to near-by presence of another male or a female is unknown but McCain and Childs speculated the species (at least one individual) might now (again?) be resident (albeit in low numbers) in the AZ-NM borderlands.²⁸

Status information is increasingly becoming available on the core of the northern jaguar population in México (see Rosas-Rosas 2006) and the BJDJ has provided invaluable information from southcentral Arizona since 1997 (see McCain and Childs 2008). However, monitoring has not been sufficient to conclusively determine (except for Macho B) whether the jaguars observed in Arizona and/or New Mexico since 1996 have been present continuously or even sporadically (perhaps seasonally) in any specific area. Nor has monitoring in Arizona and New Mexico been sufficient in scope and intensity to draw definitive conclusions as to whether all jaguars – male or female – occurring in the area have been found or whether breeding is or is not occurring in Arizona and/or New Mexico. These difficulties are predictable. As Emmons (1999) stated, “Rarely is more than one adult jaguar at a time found in the same geographic area and the number of individuals that can coexist is limited.” With regard to borderlands jaguars, it is crucial to remember that absence of evidence is not evidence of absence.

3.5. Conservation Efforts

The human dimension provides important context for assessing borderlands jaguar conservation effort. In southern Arizona and New Mexico, extensive public lands and rural private and leased ranchlands form a mosaic supporting many species of native wildlife. In northern México (i.e. states of Chihuahua and Sonora), private and communal rural agrarian lands predominate over governmentally-protected areas. This is an area of rugged topography and great natural diversity, used for many purposes and widely appreciated for its immeasurable values. It is a working landscape for many people and a conservation/recreation landscape for many more.

In the face of ever-increasing urban encroachment, collaboration²⁹ among the people who live in, visit or otherwise value these diverse borderlands is essential to conserving a wealth of life forms

²⁸ See Footnote 1.

²⁹ Buck and others (2001), Hargrove (1998) and Wondolleck and Yaffee (2000) are instructive resources regarding “collaboration” as the term is used in this document.

and lifestyles. Among those who have a stake in how these lands are managed are: academics, artists, backpackers, birdwatchers, campers, conservationists, environmentalists, government agencies, hikers, hunters, Native Americans, photographers, ranchers, retirees, school children, urbanites and writers. How these stakeholders work out their differences and cooperate on issues of common concern will greatly influence whether some species thrive or disappear from these borderlands.

From the 1970s into the 1990s, federal environmental laws provided much of the framework for resolving public-lands conflicts in the United States. The concepts of laws such as the ESA were broadly focused on ensuring natural resources were protected for current and future generations. Representative John D. Dingell (Foreword in Rohlf 1989), chairman of the House Committee that introduced the bill that eventually became the ESA, recalled Congressional intent as follows: "When Congress passed the [ESA], it set a clear policy that we would not be indifferent to the destruction of nature's bounty." It was an act of national altruism and set a remarkable foundation for conservation worldwide; the foundation was regulatory protection.

Forced compliance, perhaps even more so the expectation and fear of forced compliance, soon began generating acrimony, distrust and litigation (e.g. Hage 1990; Ray and Guzzo 1994) that even today lie close to and sometimes boil over onto the surface in land-use discussions. In such circumstances, stakeholder opinions too often reflect the strength of absolute conviction that "my position is right" and any conflicting viewpoint is not just wrong but unacceptable.

Finding common ground or at least a reasonable balance of values among such conflicting viewpoints can be difficult but is not impossible. Bean and others (1991), Kohm (1991) and Bowles and Whelan (1994) were among the first to synthesize emerging approaches through which rhetoric, regulatory issues and values roadblocks could be overcome and common ground (workable solutions that protect wildlife values and stakeholder interests) can be found. Clark (1997) provided experience-based insight into how bureaucracy and conflict impede approaches to endangered species conservation that could lead to greater success (e.g. more open collaboration with nongovernmental stakeholders).

One borderlands species that would benefit from collaboration is the jaguar and there is reason for cautious optimism on that count. In northern México, local collaboration has begun emerging through community-based conservation that is using innovative economic incentives to capture private landowner interest (see: Rosas-Rosas 2006; <http://www.northernjaguarproject.org>). Those efforts complement work on the Arizona-New Mexico side of the border by the Malpai Borderlands Group and others. In both areas, the primary focus is on voluntary rather than regulatory approaches to complex land-use and conservation issues.

An abundant literature is emerging on the merits of voluntary, collaborative conservation. One of the more insightful books is Wondolleck and Yaffee (2000). Years earlier, Yaffee (1982) wrote a primer on the ESA of 1973, describing it as prohibitive policy. The more recent book builds on his original premise that the ESA does provide a solid framework for balancing interests through negotiation (collaboration), even though those approaches superficially appear to be prohibited by the statute itself and, for the first 20 years of the ESA, were too little used by practitioners.

The opening passage in Wondolleck and Yaffee (2000) seems particularly relevant to borderlands jaguar conservation:

“A new style of environmental problem solving and management is under development in the United States. Government agencies, communities, and private groups are building bridges between one another that enable them to deal with common problems, work through conflicts, and develop forward-thinking strategies for regional protection and development. From management partnerships and interagency cooperation to educational outreach and collaborative problem solving, this new style of management is developing organically in many places in response to shared problems and the simple need to move forward. In other places, agency initiatives have helped to create opportunities for meaningful involvement that were not possible in the past.”

Sillero-Zubirir and Laurenson (2001) advocate movement toward community-based conservation is “clearly essential for carnivore conservation.” They speak to the futility of seeking solutions that do not involve local communities. Among the problems they recognize as causing conflict between carnivores and local communities are several familiar to borderlands jaguar conservation: attacks on humans (or fear of such), predation on livestock, predation on game species or other endangered wildlife, consumptive use of carnivores, conflict over land [use]. They assert that community tolerance (if not support) can be gained by recognizing these problems, gaining local participation, improving economic benefits to the community and improving the community’s aesthetic and moral benefits. “Each solution must be worked on a case-by-case basis, to fit a unique set of ecological, cultural, and economic circumstances.”

In no small way, finding a balance between the regulatory approach and the voluntary approach to conservation is essential to ensuring the jaguar’s presence in the southwestern landscape. The ESA is what it is and the letter of the law must be obeyed. So, too, should the spirit of the law and both the spirit and the letter of the ESA include leaving “the ecosystems on which they (e.g. jaguars) depend” in better shape than they are now. This theme echoes conceptually through Wallach’s (1991) book, *At Odds with Progress*, as reflected in a telling passage excerpted from an essay by his intellectual mentor, Carl Sauer (1956):

“The prophets of a new world by material progress may be stopped by economic limits of physical matter. They may fail because people grow tired of getting and spending as measure and mode of living. They may be checked because men come to fear the requisite growing power of government over the individual and the community. The high moments of history have come not when man was most concerned with the comforts and displays of the flesh but when his spirit was moved to grow in grace. What we need more perhaps is an ethic and aesthetic under which man, practicing the qualities of prudence and moderation, may indeed pass on to posterity a good earth.”

“Building bridges” among disparate interests, “meaningful involvement” by stakeholders and passing on to posterity “a good earth” are, we believe, at the heart of the borderlands jaguar conservation effort in Arizona and New Mexico and companion efforts in northern México.

3.5.1. Conservation in the United States

Conservation efforts in the United States are ongoing for borderlands jaguars. They include voluntary actions by non-governmental entities and regulatory and other actions by government agencies. Below, we summarize and assess these efforts to define and meet the conservation needs of jaguars within the borderlands.

AGFD, NMDGF and the State-led AZ-NM Jaguar Conservation Team. In March 1996 and August 1996, live jaguars were documented in New Mexico and Arizona (Glenn 1996; Childs 1998; Childs and Childs 2008). In contrast to the previous two jaguar occurrences in Arizona (1971 and 1986; see Brown and López-González 2001), neither of the jaguars observed in 1996 was killed on discovery. Perhaps that is, at least partially, why the 1996 sightings stimulated tremendous public interest in jaguar presence in the borderlands, considerably more interest than the 1971 and 1986 killings did.

Following the second jaguar discovery in AZ-NM, in September 1996 AGFD, NMDGF and Texas Parks and Wildlife Department (TPWD) began discussing a state-led conservation agreement for jaguars as an alternative to federal listing. TPWD soon dropped out, anticipating that if federal listing were extended to the United States it would not include the *veraecrucis* subspecies historically present in Texas. AGFD and NMDGF continued discussions, eventually creating a state-led effort to (a) conserve the jaguar in Arizona and New Mexico through voluntary collaborative-conservation and (b) preclude the need for federal listing of the jaguar north of the U.S.-México border (Johnson and Van Pelt 1997; Van Pelt and Johnson 2002).

On March 24, 1997, AGFD and NMDGF completed a *Conservation Assessment and Strategy for the Jaguar in Arizona and New Mexico* (Johnson and Van Pelt 1997; Van Pelt and Johnson 2002). The assessment portion described jaguar status in the United States and it identified and assessed risks in Arizona and New Mexico. The strategy portion described goals, objectives, strategies and activities intended to conserve jaguars and recognized the need to encourage and support parallel conservation in northern México. A companion Memorandum of Agreement, also executed in 1997, provided for state, federal and county government participation, under auspices of the JAGCT (AZ-NM Jaguar Conservation Team). Collectively, the two documents were known as the AZ-NM Jaguar Conservation Agreement. Although the Agreement was intended in part to preclude the need for federal listing, the borderlands conservation effort continued after USFWS (1997) extended endangered status to the jaguar in the United States and affirmed that the AZ-NM Jaguar Conservation Agreement would serve as a template for protections necessary for conservation of the jaguar.

JAGCT first met on April 30, 1997, in Douglas, Arizona. Until 2009, it met twice or more each year to discuss recent jaguar sightings, management issues, education and outreach opportunities and research efforts. Through that period, each JAGCT meeting was attended by roughly 40 to 75 people, including ranchers, conservationists, academics, researchers, journalists and staff from government agencies. Various committees were formed to address issues and complete tasks.

Prior to this Assessment, three progress reviews were produced for JAGCT (Johnson and Van Pelt 2000; Van Pelt 2004; Van Pelt and Johnson 1998). Povilitis (2002) also critiqued the effort.

As noted by those authors, JAGCT's conservation efforts have had mixed results. Notable accomplishments include: (a) collaboration with México on jaguar conservation; (b) a jaguar-based educational curriculum (in Spanish and English) that meets state and National standards and is in use in area schools; (c) enhanced public awareness of jaguar presence and conservation needs; (d) increased penalties under state law for unlawful killing of jaguars (in AZ these increased penalties apply only if the jaguar is delisted federally); (e) a jaguar detection project (using still and video camera-traps); (f) a system for evaluating and archiving sighting reports; (g) GIS-based evaluations of areas and habitats of historical and recent jaguar occurrence in Arizona and New Mexico for delineation of primary emphasis areas in both states for this conservation effort; (h) delineation of research recommendations intended to guide studies and provide JAGCT with information requisite to science-based conservation efforts; (i) a rural outreach program (see: Rinkevitch and Bashum 2003; Warshall and Bless 2003); and (j) regular public forums in Arizona and New Mexico for discussion of jaguar-related issues. Consistent participation by 40 or more disparate stakeholders in each JAGCT public meeting since 1997 is a particularly outstanding accomplishment and testimony to broadly-shared commitment to finding mutually agreeable ways to conserve borderlands jaguars voluntarily, within the context of existing land-use practices.

The reviews have also noted important impediments to success, including: (a) lack of funding; (b) irregular or inadequate agency resources (e.g. staff time); and (c) repetitive conflict and debate among interest groups and individuals within JAGCT on key issues, including: (i) status of jaguars in the AZ-NM borderlands (resident or transient); (ii) applicability of recovery planning to jaguars in the United States; (iii) what constitutes jaguar habitat (occupied, potential, suitable, etc.); (iv) designation of critical habitat; (v) reintroduction of jaguars; and (vi) live capture of a jaguar for telemetry study. Despite AGFD and NMDGF commitment to voluntary, non-regulatory conservation within JAGCT (specifically opposing reintroduction of jaguars and designation of critical habitat), concerns about those issues frequently re-surface and must be addressed again and again. Frankly, some of the turmoil stems from provocation by proponents of regulatory protection, some of whom have land-management agendas that go considerably beyond jaguar conservation. At the center of this dissonance is disparate opinion as to whether the AZ-NM borderlands ever have been, now are or ever could or should be made a core area of jaguar occurrence, persistence and recovery. Regardless of who is "right" on any aspect of these issues, repetitive resurrection of "resolved" and unresolved issues has caused considerable loss of time and impeded realization of JAGCT's full potential.

In 2006 and 2007, AGFD, NMDGF and JAGCT cooperators and stakeholders again reassessed the AZ-NM borderlands jaguar conservation effort. The process included developing a new Memorandum of Understanding (MOU), which was initially between AGFD and NMDGF, and this Conservation Assessment and Framework as successors to the 1997 agreement. The first JAGCT meeting under the new MOU was held in Douglas AZ on May 2, 2007 and meetings continued through February 19, 2009, with JAGCT remaining the focal point of jaguar conservation in the United States. JAGCT activities have also helped spur companion efforts in northern México, where, over the past several years, considerable progress has been made. Notably, as of February 2009, Warner Glenn, Jack Childs and their families continued to be active participants and leaders in borderlands jaguar conservation.

AGFD has opted to work toward jaguar conservation mainly through JAGCT but also through interagency efforts directed at conservation of habitats known or suspected to be of value to jaguars. Although its efforts are largely addressed in the preceding paragraphs, additional comment on the latter aspect of AGFD's work seems necessary, largely because of comment by Povilitis (2002, 2008). Povilitis criticizes JAGCT and specifically AGFD for what he perceives as failure to identify and protect habitats important as wildlife movement corridors, particularly along the Mexican border and specifically for the jaguar. Given repeated efforts to address his concerns within and outside JAGCT, his persistence seems to reflect willful lack of understanding about: (a) JAGCT's role as opposed to AGFD's role in habitat protection and (b) AGFD's extensive efforts in habitat conservation throughout Arizona.

JAGCT serves a convening purpose, enabling interested agencies and stakeholders to collaborate in gathering and sharing relevant information as mechanisms for jaguar conservation are developed. In essence, JAGCT provides information and sometimes makes recommendations; it does not make land management or regulatory decisions because it has no authority to do so. Each agency that is signatory to the AGFD-NMDGF MOU under which JAGCT operates is responsible for applying JAGCT and other jaguar-related information through its own management framework. Each of those agencies has unique state, federal or other regulations, policies and procedures that exist entirely outside the JAGCT framework. Povilitis perpetuates a misperception that these statutory and other limitations are somehow within JAGCT's power to change or ignore.

Specifically with regard to AGFD, this state wildlife agency applies JAGCT jaguar location information on virtually a daily basis. AGFD's Habitat Program, which includes a robust project-specific (environmental) review component, provides land management agencies and other state and federal agencies in Arizona with information relevant to the full spectrum of wildlife issues of concern. One key facet of this comprehensive effort is an effort to identify and conserve wildlife movement corridors. This project, known as the *Arizona Wildlife Linkages Workgroup*, is an important collaboration among public and private sector organizations working to address habitat connectivity and fragmentation statewide, in a cohesive, systematic approach to maintain wildlife diversity in Arizona. Comprised of representatives from AGFD, the Arizona Department of Transportation, the Federal Highway Administration, U.S. Forest Service, BLM, USFWS, Northern Arizona University, the Wildlands Network and Sky Island Alliance, the Workgroup is developing a statewide map identifying wildlife movement corridors to provide a visual tool to guide planning, engineering and mitigation efforts.

Much of the wildlife information used in the Workgroup's models (GIS layers) is influenced by lists of sensitive species, e.g. *Arizona Species of Greatest Conservation Need* (part of AGFD's Comprehensive Wildlife Conservation Strategy [State Wildlife Action Plan]). The Workgroup's GIS datasets include information specific to suspected and potential jaguar movement corridors and areas of known or potential value in jaguar conservation. Federal grants secured through the Western Governors Association are enabling AGFD and its collaborators to enhance and use the GIS-based information to refine linkage or fracture zones (breaks in connectivity) into more site-specific areas that will help guide future conservation and planning efforts. A pilot project is already underway in northern Arizona to begin using this tool. Information on the interagency Workgroup and its evolving efforts to identify and protect wildlife linkages in Arizona is available at: http://www.azdot.gov/Highways/OES/AZ_Wildlife_Linkages/index.asp.

In the JAGCT meeting on February 19, 2009 (the last meeting before Macho B investigations began), AGFD presented detailed information on the Workgroup and Povilitis' criticisms. AGFD again advised JAGCT that processes comparable to the AGFD approach exist in BLM, NMDGF, U.S. Forest Service and USFWS. They ensure jaguar conservation needs are brought to attention during intra- and inter-agency consideration of issues pertaining to habitat management and protection. Povilitis was notified about the meeting but did not respond or attend.

As noted above, NMDGF is involved in similar interagency habitat connectivity work and has a habitat protection program comparable to that of AGFD. NMDGF was scheduled to make a presentation on its program at the next JAGCT meeting after February 2009 but the ongoing investigations into the capture and death of Macho B have prevented AGFD from convening another meeting. NMDGF, the JAGCT co-lead, has not convened a meeting in AGFD's absence.

USFWS is a signatory cooperator in JAGCT but by agreed-upon design does not lead the effort. However, USFWS application of jaguar-related information generated through JAGCT's efforts probably exceeds that of any other government agency, including AGFD and NMDGF, because of its federal regulatory authorities and responsibilities. See below for discussion of USFWS use of jaguar information in ESA Section 7 consultations and Biological Opinions.

*Borderlands Jaguar Detection Project.*³⁰ In 1997-99, JAGCT relied on work by Warner Glenn, then Chair of the JAGCT Depredation Committee, to detect jaguar presence in the borderlands through use of camera traps. By 2000, Glenn asked to be relieved of the responsibility because the effort was expanding beyond the time he could commit. Jack Childs agreed to replace Glenn as Depredation Committee Chair and soon began building on Glenn's camera-trapping jaguar detection work. As the work progressed, and new jaguar occurrences were recorded, Childs created the BJDP to conduct detection and monitoring efforts. JAGCT began to recognize BJDP as its field arm, asking it to focus first on assessing jaguar presence in southcentral Arizona but eventually (funding permitting) across the length of the AZ-NM/México borderlands. Under Childs' guidance, eventually with Emil McCain and field assistants and volunteers increasingly doing the bulk of the fieldwork, BJDP became the primary mechanism for increasing knowledge of jaguar occurrence in the borderlands. It seems quite possible that, without the JAGCT work by Glenn, Childs and McCain, the most recent known occurrences of jaguars in the United States would be from 1996 (perhaps 2006 in New Mexico). The "brainpower" behind that work came from those three individuals and so did the commitment to do the work for free (Childs and Glenn) and or for next to nothing (McCain).

As of January 2009, BJDP was: maintaining 45-50 remote-camera stations in Pima, Santa Cruz and Cochise counties, Arizona; conducting track and scat surveys opportunistically; and following up on credible sighting reports from other individuals (McCain and Childs 2009). This work (all of which took place in Arizona) produced 85 jaguar photographs representing 74 different occurrence events and 31 sets of jaguar tracks (105 locations total). The BJDP data represented two adult male jaguars and possibly a third jaguar of unknown sex (for details, see: McCain and Childs 2008, 2009).

³⁰ J. Childs personal communication: As of 2010, I have voluntarily shut down the BJDP for the indefinite future, although my work on other aspects of wildlife conservation will continue unabated.

BJDP effectiveness was directly related to cooperative relationships with local interests, including the Altar Valley Conservation Alliance, San Rafael Valley Alliance, Save the Scenic Santa Ritas and individual landowners and public lands ranchers (see McCain and Childs 2009 for a list of cooperators). BJDP also gave more than 100 public presentations, hosted and gave countless interviews to dozens of reporters and writers, and published one peer-reviewed article (McCain and Childs 2008), more than 15 progress reports to JAGCT and a book (Childs and Childs 2008) about its work with jaguars. All the work was done to help JAGCT and to increase public awareness of and support for jaguar conservation.

Malpai Borderlands Group. MBG is a grassroots, landowner-driven non-profit nongovernmental organization (NGO) consisting of private landowners who live in the borderlands of southeastern Arizona and contiguous southwestern New Mexico, within a few miles of the U.S.-México border (<http://www.malpaiborderlandsgroup.org>; also see Sayre 2005). MBG was the first “rural” group in the AZ-NM borderlands to resolve land management issues bridging private and public lands through collaborative, landscape-level planning. MBG lands total about 800,000 acres and include about 30 privately-owned ranches and a mosaic of state and public lands. MBG’s goal is to restore and maintain the natural processes that create and protect a healthy, unfragmented landscape to support a diverse, flourishing community of human, plant and animal life.

Among MBG’s founding members is Warner Glenn. After his 1996 sighting of a jaguar in the Peloncillo Mountains of NM, MBG met with AGFD and NMDGF and the BLM, U.S. Forest Service and USFWS to discuss implications of the event. As a result, MBG established a fund to help compensate its members for livestock confirmed to have been killed by jaguars. A portion of the proceeds from sale of the book in which Warner Glenn described his 1996 sighting (*Eyes of Fire: Encounter with a Borderlands Jaguar*, Glenn 1996) is donated to the Jaguar Fund. Even though a 2007 jaguar depredation on livestock occurred in AZ, about 200 miles west of the MBG focus area, MBG voluntarily used its funds to compensate the rancher for the loss.

Sky Island Alliance. SIA (<http://www.skyislandalliance.org>) is a grassroots NGO dedicated to protection and restoration of the rich natural heritage of native species and habitats in the “Sky Islands” of the southwestern United States and northwestern México. SIA works with volunteers, scientists, land owners, public officials and government agencies to establish protected areas, restore healthy landscapes and promote public appreciation of the region's unique biological diversity. Active in promoting jaguar conservation, SIA believes establishing a Tumacacori Highlands Wilderness Area (ca. 84,000 acres) on the Coronado National Forest in southcentral Arizona, an area of known recent jaguar occurrence, would significantly contribute to jaguar conservation. [Others believe current land uses on the Coronado National Forest do not conflict with jaguar conservation, thus protection under the Wilderness Act of 1964 is not needed.]

Wildlands Project. This NGO (now known as Wildlands Network; <http://www.twp.org>) was founded in 1991 by conservation biologists and wilderness advocates who were and who remain concerned about worldwide extinction rates for plants and animals. WP founders believed the traditional system of protecting wildlife and wildlands was no longer working. Unless protected areas such as parks, wilderness areas and wildlife refuges were linked together, the landscape

would increasingly become islands of habitat surrounded by a sea of development. The long-term survival of many species would continue to become increasingly threatened.

Rather than focus on simply protecting more land, WP asked conservationists to think about innovative ways in which existing islands of protected habitat could be connected by wildlands networks – mosaics of public and private land linked together so wildlife has the room it needs. From this mindset evolved a one hundred year vision: to create a continental-scale network of connected wildlands. It is a bold and sweeping vision from the private sector that most government agencies have not yet embraced and one that causes considerable concern among private individuals who have stakes in the areas that would most likely be affected.

More than a decade later, some of the concepts first proposed by WP are now main-stream. The idea of reconnecting and restoring wildlands on a continental scale has been widely adopted by conservation groups, both large and small. Today, the WP vision can be seen working across North America and around the globe. Dozens of partner groups are developing landscape-scale conservation plans by using cutting-edge science to establish conservation priorities for very large regions and are actively working to turn these hopeful visions of “what could be” into reality on the ground. The science in the WP approach to conservation is evident; its focus on connectivity meshes well with primary jaguar conservation needs in the borderlands. Within the JAGCT, however, WP is not universally embraced. Some stakeholders are concerned its intent is to pursue land protection actions that will conflict with existing local custom and culture. The dichotomy is a familiar one and the jaguar is caught between the two.

Some local resistance is a legacy from the WP’s early rhetoric and stated goals, which evoked perceptions of ecological elitism and change that would result in exclusion of traditional rural land uses, such as ranching, from public lands. However, in recent years the WP approach has shifted toward inclusivity and collaboration (see goals published at <http://www.twp.org>) to work with a broader range of stakeholders, including local communities, landowners and regulatory agencies, in addition to conservation organizations. WP is striving to identify common ground that enables all interest groups to support the organization’s vision for continental conservation (K. Vacariu personal communication). Nevertheless, some JAGCT participants seem not to have recognized (or not to trust) that the leopard has changed its spots. It remains to be seen whether essential common ground can be found among the disparate groups.

To further borderlands jaguar conservation, in 2007 WP identified possible movement corridors within the northern population, connecting areas of recent occurrence in Arizona and New Mexico with the “Nácori Chico” [Sahuaripa-Huasabas] area of Sonora (K. Vacariu personal communication). They used GIS technology and an invitation-only “Jaguar Corridor Mapping Workshop” on April 13, 2007 to produce two versions of a jaguar movement corridor map: a multi-layered, scientifically-defensible GIS corridor base map and a more user-friendly corridor map (see Fig. 2) for general distribution. The WP GIS corridor map was produced from several data layers, including terrain, land cover, roads, population, property and land ownership, The Nature Conservancy’s “Human Footprint” layer and a multiple-layer-based habitat suitability analysis that was funded by WP but produced by Dr. Enrique Martinez of UNAM, in México City. The workshop was the first time all the GIS data were compiled into a single map showing “highly-predictable” jaguar movement corridors.

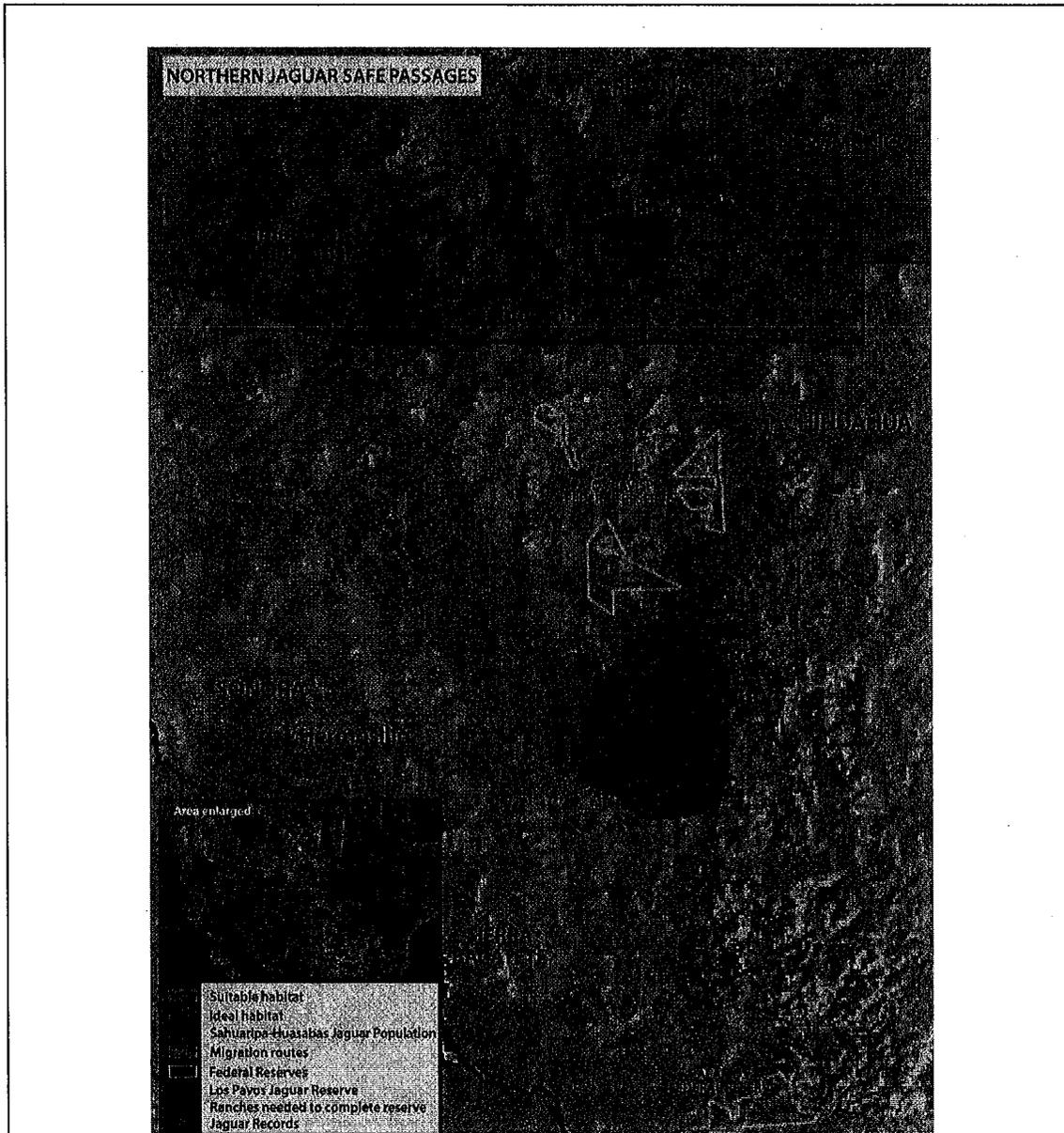


Figure 2. Corridors thought to enable jaguar movement between the United States and México. Map adapted from and provided courtesy of the Wildlands Project (WP 2007). Note: this map is used only to illustrate possible movement corridors. Use does not imply agreement with, or accuracy of, mapped depictions of “safe passages” or “suitable habitat” or “ideal habitat,” nor does it indicate support for advocacy for acquisition of “Ranches needed to complete [a jaguar] reserve” in the United States or México.

The “user-friendly” corridors map (Fig. 2) nicely illustrates JAGCT’s ongoing discussion of routes by which jaguars might move between the United States and México. Except for the San Pedro River corridor (east of the Huachuca Mountains), the map is generally well supported by historical records of jaguars in the United States and México (see Brown and López-González 2001), by BJDJ jaguar monitoring and survey work in southcentral Arizona (see Section 3.5.1) and by recent jaguar research and conservation effort in northern México (see Section 3.5.2). The corridors are also, again except for the San Pedro River corridor, reasonably consistent with various jaguar habitat assessments for the Southwest (e.g. Brown and López-González 2001; Grigione and others 2009; and Hatten and others 2003, 2005).

Regarding the San Pedro River and its watershed, we are not aware of any documented historical or recent jaguar locations along or near that river. Regardless, our use of the Wildlands Project corridors map does not mean we agree with its depictions of “safe passages,” “suitable habitat,” or “ideal habitat,” nor does it indicate that we support advocating for acquisition of “Ranches needed to complete [a jaguar] reserve” in the United States or México. Our use of the predictive map is purely to emphasize an important aspect of jaguar conservation in the borderlands: the need to identify actual movement (connectivity) corridors, based on documented occurrences rather than conjecture.

U.S. Fish and Wildlife Service – USFWS has been active in JAGCT activities since the effort began in 1997, including: participating in and providing briefings at JAGCT meetings; funding BJDJ camera work; cooperating with AGFD and NMDGF to develop documents pertaining to jaguar conservation and to evaluate jaguar sighting reports; and consultation through ESA Section 7 and NEPA environmental review processes.

Section 7 consultations are often complex and time-consuming but they are probably the most direct regulatory mechanism for ensuring that the available information (whether from JAGCT or elsewhere) is applied to benefit jaguar conservation in the United States (e.g. USFWS 2007). Section 7 consultations often result in Biological Opinions that identify conservation measures and other actions to address known or potential impacts. USFWS Biological Opinions on border-fence related issues and other federally funded or permitted activities that are pertinent to jaguar conservation are available at:

<http://www.fws.gov/southwest/es/arizona/biological.htm>)

The *Listed Cats of Texas and Arizona Recovery Plan (With Emphasis on the Ocelot)* (USFWS 1990) addresses the jaguar and jaguarundi but primarily focuses on the ocelot. The plan provides limited information on the jaguar, asserting that the status in northern México needs to be determined before recovery recommendations can be made. The ocelot portion of the plan is undergoing extensive revision to incorporate an innovative approach to establishing recovery objectives but the jaguarundi and jaguar portions have not been re-worked (T.B. Johnson and W.E. Van Pelt personal observation).

From the beginning of JAGCT work in 1997, AGFD, NMDGF and USFWS have committed to emphasizing non-regulatory approaches to jaguar conservation in the AZ-NM borderlands (AGFD and NMDGF 2007). Recent USFWS decisions to develop a northern jaguar Recovery

Plan (USFWS 2010a)³¹ and designate critical habitat (USFWS 2010b) seem likely to polarize stakeholders, at least initially. It remains to be seen whether the new federal approaches will result in greater conservation return for jaguars in the United States or elsewhere.

3.5.2. Conservation in México

México considers the jaguar a national priority species for conservation, elevating it to the highest levels of government when the President of the Republic declared 2005 to be “The Year of the Jaguar” (Ceballos and others 2006; Chávez and Ceballos 2006; Fox-Quesada 2005). On October 12-15, 2005, México, under direction by CONANP and auspices of SEMARNAT, sponsored its first national symposium on jaguar conservation, *El Jaguar Mexicano en el Siglo XXI: Situación Actual y Manejo* (Chávez and Ceballos 2006). JAGCT participation in the symposium furthered coordination and cooperation between the two countries in several ways, including development of national and local jaguar conservation strategies.

Despite a shortage of funding, CONANP recognizes the value of conservation strategies, known in México as PREPs (Proyectos de Recuperación de Especies Prioritarias), for diverse species and the need to identify threats to species and prioritize consensus actions, set specific dates and establish clear goals, indicators of success, responsible parties, resources and follow-up to implement actions for conservation. CONANP’s *National Technical Consultants Subcommittee for Conservation and Management of the Jaguar* completed a PREP in 2006 (Ceballos and others 2006). The PREP identifies on-the-ground conservation actions such as protection, management and restoration of the species and its habitat. It provides for indirect actions such as information dissemination, integrating jaguar conservation into the fabric of local cultures and administration. The intent is to implement the plan over a period of five years.

During “The Year of the Jaguar,” approximately 38,000 ha (93,897 ac) of the Sierra de Vallejo (State of Nayarit) were decreed as State Natural Protected Areas, in cooperation with Hojanay (a Mexican NGO). Banamex and the Fideicomiso Fund for Natural Heritage in México also reached agreement with the Ejido Ursilo Galvan (a local cooperative from the same mountain range) to set aside 1900 ha (4695 ac) as an Ejidal Sanctuary for the jaguar. México also signed a brotherhood pact with Unity for Conservation (another Mexican NGO) to protect areas with Belize and Guatemala to support a biological corridor in this critical area of “Jaguars without Borders” (Rabinowitz 2006).

³¹ T.B. Johnson: On January 7, 2008 USFWS Director H. Dale Hall approved a determination by USFWS Region 2 Director Benjamin N. Tuggle Jr. under 16 USC §1533(f)(1) that development of a federal Recovery Plan for the jaguar would not promote conservation of the species (see USFWS 2007). In January 2010, Hall’s decision was reversed by USFWS Acting Director Rowan W. Gould (see USFWS 2010a). Accordingly, in September 2010 USFWS Region 2 convened a binational Recovery Team for the northern (borderlands) jaguar population. The team is developing a PVA, PHVA and Recovery Outline before beginning work on a Recovery Plan. It is not clear why USFWS is developing a Recovery Plan for a population that is not a federally listed entity (i.e. the jaguar rangewide is the listed entity). Developing a Recovery Plan for an unlisted entity seems to contradict USFWS policy as the policy was explained to me by Gary Frazer (personal communication), the USFWS Assistant Director for its Endangered Species Program, shortly before the jaguar team was convened. Perhaps the federal court directive to undertake recovery planning supersedes USFWS policy. Regardless, whether moving forward with northern jaguar recovery planning for an unlisted entity as opposed to a rangewide plan is consistent with the federal Administrative Procedures Act has, to my knowledge, not been examined.

State-specific jaguar conservation strategies have been produced for Jalisco, Michoacán and Oaxaca. In cooperation with PROFEPA, communities and NGOs have implemented community watch groups in 14 states. All told, 25 or more watch groups have been established (none in Sonora or Chihuahua), involving more than 400 rural community members who protect areas to stop illegal hunting and change land use.

México's national jaguar conservation planning efforts continued with a March 2006 workshop conducted by the National Institute of Ecology (the proceedings are still being completed; G. Ceballos personal communication). The workshop goal was to develop a plan that will lead to recovery of the jaguar in México. Key objectives were to evaluate the current status of the jaguar in México; determine threats to jaguar existence; and determine priority conservation actions at the local, regional and national scale. Subcommittees were established to work at the local level, including one for the northern jaguar population in Chihuahua-Sonora. JAGCT participation provided opportunities for both countries to share experiences and inform development of mutual conservation strategies, including research projects to fill information gaps impeding progress.

On November 21-24, 2006, México hosted an invited-participation jaguar **Population and Habitat Viability Analysis** (PHVA) workshop, in Cuernavaca (the proceedings are still in review). The workshop was the second element of the *Simposio El Jaguar Mexicano en el Siglo XXI*. Again, JAGCT participated and, on JAGCT's behalf, AGFD provided funding to help support the workshop, which was facilitated by the IUCN Conservation Breeding Specialist Group. The overall process is intended to generate (eventually) extinction risk assessments based on information on life history, population dynamics, ecology and history of the populations. The November 2006 workshop underscored the need for regional jaguar management (conservation) plans, including one for Sonora-Sinaloa (which includes the northern jaguar population). Support for the approach was garnered at the May 2007 meeting of the Trilateral Committee.³²

The need for timely, collaborative conservation rangewide was reaffirmed in November 2009, when jaguar conservationists and scientists from throughout the Western Hemisphere convened

³² The Trilateral Committee for Wildlife and Ecosystem Conservation and Management was established in 1996 through a Memorandum of Understanding among Canada, Mexico and the United States. The following description is adapted from the Committee's Web site, at <http://www.trilat.org/index.htm>:

The Committee facilitates and enhances cooperation and coordination among the three nations in projects and programs for conservation and management of wildlife, plants, biological diversity, and ecosystems of mutual interest. The Trilateral also facilitates development of partnerships with other associated and interested entities. Delegations from each country come together annually for discussions on a wide range of topics, including: joint, on-the-ground projects; issues of law enforcement; and development of information databases. Typically, state and provincial wildlife agencies and nongovernmental organizations with an interest in specific topics are invited to attend the annual meetings and are encouraged to work on specific issues.

Trilateral Committee discussions take place under the auspices of working tables that report to an executive body comprising the directors of the lead federal wildlife agencies from the three countries (e.g. USFWS for the United States). Because the issues that are important to the three nations change over time, working tables are established and discontinued as needed. Currently, seven working tables are active: Species of Common Concern, Law Enforcement, Ecosystem Conservation, Migratory Birds, Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and the Executive Committee. Jaguar issues can be (and have been) discussed at several or the working tables.

in Merida México. The invited-participation workshop will result in a book entitled, *Jaguars on the Edge: an assessment and perspectives of jaguar continental conservation.*” The workshop included status assessments from each country in which jaguars occur (e.g. USA: Johnson and Van Pelt in press). More workshops are anticipated, as relevant information is generated through field projects throughout the country. Adequate information is lacking in many key areas but considerable progress has been made in the past few years.

Defenders of Wildlife – Defenders is a U.S.-based NGO with presence in on-the-ground jaguar conservation in México, where it partners with Naturalia and the Northern Jaguar Project (Defenders 2009; see also below). Elements of the joint program include a “camera contest” on cattle ranches surrounding Naturalia’s Northern Jaguar Reserve. The camera contest was funded in 2006 by a grant from the USFWS “Wildlife Without Borders - México” program. The contest uses remote, motion-triggered cameras (re-set monthly) to record pictures of jaguars, pumas, ocelots and bobcats. Project objectives are to: (1) promote the recovery of the jaguar through a significant portion of its historic range by expanding the population in México and preserving habitat connectivity for dispersal and re-colonization into appropriate areas in the United States; (2) implement a jaguar camera survey contest as a vital component of a larger northern jaguar conservation plan; (3) obtain information about population size, spatial distribution and abundance of jaguar and other wildlife; (4) gain access to private lands that are not included in the current research area; (5) provide economic incentives for the continued presence of jaguar and counter local bounties; (6) engage landowners and ranchers in jaguar conservation; (7) build local tolerance for jaguar and a self-policing environment. The camera-contest project awards \$50 to \$500 for each photograph of targeted wildlife (including jaguar). In return, participating ranchers agree to protect all wildlife on their ranches.

Defenders also cooperates with Naturalia and the Northern Jaguar Project in a Jaguar Guardian Program to help stop jaguar killing and to provide field assistance to an on-site research project. The guardians work directly with ranchers to minimize conflicts with livestock and reduce killing of jaguars. They also assist Naturalia with security and stewardship activities on the Northern Jaguar Reserve. The effectiveness of the Northern Jaguar Reserve guardians program has been criticized by other jaguar conservationists working in northern México (R. Thompson personal communication).

Mesoamerican Biological Corridor – The MBC is intended to protect key biodiversity sites in Middle America and ultimately connect the Yucatan Peninsula to other ecologically rich areas in the region (see <http://www.biomeso.net/magazin.asp>) and to the “Paseo Tigre” (Path of the Jaguar; Rabinowitz 2006), which is intended to become a network of corridors connecting jaguar conservation units from México to Brazil. The MBC evolved from the “Paseo Pantera” (Path of the Panther) initiative that the Wildlife Conservation Society and its partners launched in the 1990s (see Carr 1992). The original Paseo concept was initially an unbroken strand of protected and restored forest lands stretching from southern México to Panama, perhaps beyond. Initially, on-the-ground progress foundered due to opposition from indigenous and campesino groups to the perceived likelihood of protecting land for wildlife and thereby excluding people. The multi-nation MBC and Paseo Tigre have tempered that approach to ensure inclusion of local peoples and pre-existing land uses compatible with jaguar conservation. Consequently, the appropriate heads of state have endorsed it and progress is being made (Miller and others 2001).

Naturalia – Founded in 1990, *Naturalia* (<http://www.naturalia.org.mx>; see also Bravo 2006) is one of México's most active and most forward-looking conservation NGOs. In 2003, it purchased Rancho Los Pavos, a 10,000-acre ranch in northern Sonora that has become the core of a protected area, the Northern Jaguar Reserve (Friederici 2006). The Reserve is dedicated to protection of jaguars and all other wildlife species present and to rehabilitation of habitat. It has a small research field station, one of a handful in Sonora. Staffing and operations at the field station are the responsibility of the Northern Jaguar Project. In the Reserve, biologists are working on inventories of birds, mammals, butterflies and plants.

In 2008, *Naturalia* and the Northern Jaguar Project (see below) also completed purchase of the 35,000 acre Ranch Zetasora, bordering the 10,000 acre Northern Jaguar Reserve, bringing the Reserve to ca. 70 square miles, with more expansion anticipated (D. Hadley and O. Moctezuma personal communication). *Naturalia* and the Northern Jaguar Project hired two experienced jaguar guardians trained in biology and a reserve vaquero to conduct basic research, monitor jaguars and maintain a consistent physical presence on the Reserve (NJP 2008).

Naturalia is also working with other collaborators to build capacity in indigenous communities to monitor jaguars, an effort that has already resulted in detections, and to conduct jaguar surveys outside established reserves (E. Fernandez personal communication).

In 2005, *Naturalia* acquired another wildlife reserve, the 10,000-acre Rancho Los Fresnos, by transfer from The Nature Conservancy. Los Fresnos is located in Sonora, near the U.S.-México Border. NJP (2008) suggests the reserve, which primarily includes grassland and riparian habitats in the upper San Pedro River drainage, might someday have value as border-corridor habitat for jaguars. Although the reserve undoubtedly has significant value for a variety of wildlife, as noted previously we are not aware of any recent or historical records documenting jaguar presence in the San Pedro watershed. R. Thompson (personal communication) knows the area very well and is extensively engaged in jaguar conservation in northern México; he described Los Fresnos as “a good beaver preserve, not jaguar habitat.”

Northern Jaguar Project – NJP, an NGO based in Tucson AZ, is dedicated to conservation of jaguar habitat in Sonora and creation of a safe-haven corridor between the northernmost breeding population in Sonora and the U.S. borderlands (see <http://www.northernjaguarproject.org>). NJP promotes conservation ranching, stewardship and increased regional awareness of the value of wildlife, particularly charismatic endangered species like the jaguar. It also works to eliminate conflict between ranchers and wildlife, particularly mountain lions and jaguars. It is partnering with *Naturalia* to create jaguar preserves in México. The two organizations cooperatively operate and manage the Northern Jaguar Reserve, in northern Sonora.

All funding received by the Northern Jaguar Project goes to support protection of habitat and wildlife in the Northern Jaguar Reserve and the surrounding area. The Project operates a small field station and research program on the reserve, in conjunction with *Naturalia*. Researchers are conducting studies related to large carnivores, using trip cameras and hair snares to gather data on population densities, movement, dispersal, diet and habitat needs. Visiting researchers are conducting plant inventories and making preliminary lists of birds and insects. The Project's