Endangered Species UPDATE

September/October 2000
Vol. 17 No. 5
pages 93-116

School of Natural Resources and Environment
THE UNIVERSITY OF MICHIGAN

Opinion

Update on Endangered Species Protection in Canada

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Abstract
The Canadian government introduced the Species at Risk Act in April 2000. In its current form, the legislation is weak and will do little to halt the slide towards extinction of many Canadian species. Unlike the U.S. Endangered Species Act, which contains clear prohibitions against the harming of species and their habitats wherever they reside, many of the provisions in the Canadian Act rely on the discretion of politicians to act in a manner which is beneficial to species at risk. The legislation contains no automatic protection for the habitat of species at risk (loss of habitat is the primary cause of species endangerment) and the scope of the prohibitions against harming of individual species at risk and their residences is limited to federal lands (excluding the three northern territories which are under federal authority), some migratory birds, and some aquatic species. Species that migrate across the Canada-U.S. border are not specifically addressed by the legislation. Final decisions about which species will be listed, and therefore receive legal protection, will be left up to politicians, not scientists. The current Act does not fulfill all of Canada's commitments under international and national agreements, nor does it live up to the government's own promises or meet the expectations of the majority of Canadians who believe that the federal government should take the lead role in protecting species at risk.

Introduction
Canada is home to some 57,000 identified species (Canadian Wildlife Service 1995). Of these, 353 are on the national list of species at risk. Twenty-seven species are already gone from the Canadian wild, and another 326 will meet the same fate unless factors affecting their well-being are reversed. Some species like the Vancouver Island marmot (*Marmota vancouverensis*), the Newfoundland population of the American marten (*Martes americana atrata*), and the copper redhorse (*Moxostoma hubbsi*) are found only in Canada. Others, like the grizzly bear (*Ursus arctos*) and woodland Caribou (*Rangifer tarandus caribou*), refuse to recognize international boundaries and range freely between Canada and the U.S. While American laws protect them in the U.S., the absence of similar legislation in Canada and many of its provinces means that these species can be legally hunted in some jurisdictions.

Because of its decentralized power structures, passing endangered species legislation in Canada is considerably more cumbersome than in the U.S. Under the Constitution Act of 1867, much of the control over natural resources was devolved to the provinces. The federal government retained control over its lands, which include national parks, military sites, and some agricultural lands, inland fisheries and the seacoast, and "Indian lands" (this includes the three northern territories). Because the Constitution Act granted Parliament the power to implement Imperial treaties such as the Migratory Birds Convention Act (MBCA) signed by England (on behalf of Canada) and the United States, the Canadian government also has authority over birds covered by this convention. Matters of exclusive provincial authority include provincial public lands and their forest resources, civil and property rights, and other matters of a purely local concern. The Constitution Act was amended in 1982 when the Constitution was repatriated from England to grant the provinces exclusive authority over non-renewable natural resources, forestry resources and electrical production facilities.

Authority over natural resources is jealously guarded by the provinces and any "interference" by the federal government in what is perceived to be provincial jurisdiction would further destabilize sensitive federal-provin-

cial relations. Because not all provinces and territories have passed stand-alone endangered species legislation, many of Canada's species at risk may fall through the cracks due to jurisdictional wrangling.

Provincial legislation

In 1996, the provincial, territorial and federal governments of Canada signed the National Accord for the Protection of Species at Risk (Accord); an agreement that committed them to developing complementary endangered species legislation of their own. To date, only half (7 of 14) of these governments have passed such legislation, and for those jurisdictions that do have legislation, the laws are generally weak. Listing of species is usually at the discretion of provincial cabinets and only four of the provincial laws provide automatic protection of habitat for listed species. Habitat degradation and loss is considered to be the most significant cause of species endangerment worldwide (Wilson 1992), and in Canada, it is thought to account for at least 75% of the species on the national list.

Federal legislation

In 1992, Canada was the first Western nation to sign the Convention on Biological Diversity. The convention required signatories to pass legislation to protect endangered species and their habitats. Four years later, the year that all Canadian governments agreed in principal to the Accord, the Canadian government introduced legislation aimed at protecting endangered species (Bill C-65). This bill died on the Order Paper six months later when Parliament was dissolved for elections.

In April 2000, the federal government introduced the Species at Risk Act, SARA, which is currently working its way through the legislative process in the House of Commons. SARA strives to avoid conflicts between land users and the government by striking the right balance between voluntary stewardship and legislative measures. Many Canadians believe such conflicts to be a significant problem in the U.S. Endangered Species Act where some landowners have developed a "shoot, shovel and shut up" approach to avoid being subject to what they perceive as heavy-handed federal legislation.

Instead of building consensus between stakeholders, SARA has failed to gain the support of most resource users or of a single major environmental group. In fact, several key natural resource industry groups such as the Mining Association of Canada and the Canadian Pulp and Paper Association teamed up with environmental groups such as the Sierra Club of Canada, the Canadian Nature Federation, and the Canadian Wildlife Federation to press for significant improvements to the bill that would strengthen protective measures and encourage landowners and industries to protect species at risk.

The species-based approach to conservation of endangered species in SARA is similar to that of the U.S. Endangered Species Act. Little is done to prevent species from getting on the list in the first place, since conservation efforts are triggered by the listing process. This approach has been criticized as being ineffective and expensive since conservation programs that target entire ecosystems, rather than each of the constituent species individually, are

Endangered Species UPDATE

A forum for information exchange on endangered species issues

September/October 2000 Vol. 17 No. 5

Instructions for Authors: The *Endangered Species UPDATE* welcomes articles, editorial comments, and announcements related to species protection.

Subscription Information: The *Endangered Species UPDATE* is published six times per year by the School of Natural Resources and Environment at The University of Michigan. Annual rates are $28 for regular subscriptions, and $23 for students and senior citizens (add $5 for postage outside the US). Send check or money order (payable to The University of Michigan) to:

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Cover: *Puma concolor* with cubs. Photo courtesy of Jim Dutcher Productions.

The views expressed in the *Endangered Species UPDATE* may not necessarily reflect those of the U.S. Fish and Wildlife Service or The University of Michigan.

The *Endangered Species UPDATE* was made possible in part by the David and Lucile Packard Foundation, Turner Foundation, Boone and Crockett Club, Chevron Corporation, and the U.S. FWS Division of Endangered Species Region 3.

thought to be more effective. In SARA, it is possible for non-threatened species to benefit from the listing of another species, since a multi-species or an ecosystem approach may be adopted when preparing a recovery strategy for a species. However, since this is left to the discretion of the Minister, this approach may rarely be used.

Federal powers and the need for a strong national law

Species under federal authority (those on federal lands, birds covered under the MBCA, and aquatic species covered by the Fisheries Act) need a strong federal law to protect them. Development of an effective network of provincial and territorial laws can only be attained through strong federal leadership. Until the federal government meets its commitments under the Accord, there will be no impetus for the provinces to meet theirs.

Canadian species will continue to be at risk until a comprehensive federal-provincial network of laws is in place. For example, the province of British Columbia, with its temperate climate, and varied geography, is home to at least 70% of Canada's birds and mammals, half of which are found exclusively in this province. British Columbia has no endangered species law. Until legislative gaps such as this are plugged, it will be up to the federal government to bring these species under its umbrella of protection. There are some tools that may provide the federal government with the legal authority to do this.

In addition to authority over federal lands and aquatic and migratory bird species, the Constitution Act also granted the federal government several broader powers over matters not clearly within provincial authority: Peace Order and Good Government (POGG) and the Criminal Law Power. POGG gives the federal government authority in three areas: national emergencies, in matters having a "national dimension," and over non-local matters on which the Constitution is silent. Of these, the "national concern" category is most relevant to species at risk. To be considered a "national concern" the scope must be national and the concern must be one that cannot be addressed provincially. It is not difficult to demonstrate that the scope of endangered species is national. Many range across provincial and even international boundaries. Species restricted to a single province present some difficulties for POGG, but it can be argued that even these are of concern to all Canadians. For example, organizations like the Vancouver Island Marmot Recovery Foundation receive donations from individuals across Canada to protect a species that most Canadians will never encounter (the Vancouver Island marmot-*Marmota vancouverensis*, is found only on an island off the coast of the province of British Columbia). Surveys have repeatedly demonstrated the importance of preserving Canadian biodiversity to Canadians, and it is obvious from the profusion of national and provincial symbols depicting wildlife, that wildlife is highly valued by Canadians. While it may be difficult to persuade the courts that legislation aimed at preserving species that reside within a single province has a national dimension, endangered species legislation would have as its goal the protection of all Canadian species at risk. Surely, the loss of Canadian biodiversity stemming from numerous species extinctions across the country would be of "national concern."

It is also reasonably easy to demonstrate that protecting endangered species cannot be done on an ad hoc, provincial basis since most of them range across provincial and or national borders. Protecting these transboundary species is necessarily a federal obligation, since provincial jurisdiction does not extend beyond provincial territory.

While the argument for the use of POGG to regulate species that move across provincial and international boundaries is likely a winning one, it is less clear how a court would rule on intra-provincial species. The federal government's ability to use its Criminal Law Power in areas of provincial jurisdiction is less contentious. It is generally accepted, though not tested in court, that this power provides the authority to prohibit and punish conduct considered harmful to endangered species. As this power already prohibits cruelty to individual animals, it is not a stretch to apply it to an entire species. The Supreme Court of Canada, in a case involving Hydro-Québec (*R. v. Hydro-Québec*, 1997 3 S.C.R. 213), has already ruled that the federal government can use its Criminal Law Power to prohibit environmental harm.

Many legal experts, and the government of Canada, believe that the Criminal Law Power can be used to protect "critical habitat" even if it is outside of federal jurisdiction. Critical habitat is defined in SARA as that part of a species' habitat that is nec-

essary for the survival or recovery of the species. However, the issue of whether this power can be used to protect the "habitat" of an endangered species in areas of traditional provincial authority is far murkier. SARA defines habitat (aquatic species excepted) as the area or type of site where an individual naturally occurs or formerly occurred and has the potential to be reintroduced. The greater the impact of legislation on provincial jurisdiction, the greater the risk of the legislation being found unconstitutional. If you consider that the habitat needs of a large mammal like a grizzly bear can be enormous, the duty imposed on a province to protect that habitat can be quite onerous, as compared to the duty to protect only the individual or its residence. Further, because it is based on prohibitions punished by penalties, offences under the Criminal Law Power must be clearly defined. Such precision is not available for habitat, particularly at the time a species is listed, which is when the prohibitions would come into play. Under SARA, habitat is defined on a species-by-species basis during the recovery stage—a process that may not happen for some time after listing. For an enforcement officer to be able to specify that a violation has occurred under SARA, he/she would need to be able to determine that something has been harmed. Though reasonably straightforward in the case of an individual of a species, and in some cases, for its residence, it is generally not obvious when habitat has been harmed.

The Species at Risk Act

In several key areas such as habitat protection, SARA is weaker than the government's previous attempt at endangered species legislation (Bill C-65) and it is certainly weaker than the U.S. Endangered Species Act. The key features of SARA are considered briefly below.

Listing

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has been responsible for listing endangered species in Canada for close to 25 years, though this listing process has carried no legal weight. COSEWIC consists of scientists from federal and provincial governments, non-governmental conservation organizations and from academia.

Under SARA, COSEWIC will be given the legal authority to determine which species are at risk, but the federal Cabinet will have final listing authority. This means that biological factors will not be the only considerations determining whether species such as the Peary (*Rangifer tarandus pearyi*) and woodland Caribou and the bowhead whale (*Balaena mysticetus*), species that are an important part of aboriginal hunting traditions in northern Canada, and marine species such as the Atlantic salmon (*Salmo salar*) and the Atlantic cod (*Gadus morhua*) which are economically important to the people of eastern Canada, are listed. While such socio-economic considerations should not be ignored in determining how scarce resources are allocated for species recovery, they have no role to play in determining whether a species gets listed. Such decisions should be based entirely on scientific considerations. Socio-economic factors should be considered at the protection stage when all concerned stakeholders are at the table and requirements such as habitat have been considered.

Six Canadian provinces have opted for a political listing system in their own legislation, but only Nova Scotia allows scientists to determine the legal list of species at risk. When listing is left to political discretion, most species in need of protection do not make the legal list. In the provinces that have political listing, only about 30% of the COSEWIC-listed species have been listed by the provinces. If species are left off the legal list, they receive no protection against killing, no recovery plans are written, and there is no support for landowners who voluntarily opt to protect them.

SARA contains no provisions to roll over COSEWIC's existing list of 353 species. When it receives Royal Assent, the new legislation will apply to no species. Cabinet would have 30 days to decide which of the current endangered or threatened COSEWIC species would be on the list. No time limit is specified for the listing of species of "special concern." There are no guarantees that any of the currently listed species will get protection under SARA.

Prohibitions

SARA includes hefty fines for harming endangered and threatened species or their residences. However, the scope of application is limited. The law applies automatically only to species on some federal lands, aquatic species protected under the Fisheries Act and migratory birds protected under the MBCA. The prohibitions do not apply automatically on territorial lands that are under federal control. Without the territories, federal lands make up only about

4% of Canada's landmass. This abdication of federal authority over territorial lands places territorial governments in an untenable position. None have standalone endangered species legislation—likely because they have been waiting for the federal government to clarify its position on territorial lands. The territories do not have the authority to make laws governing species under federal control. Under SARA, northern species such as the grizzly bear, polar bear (*Ursus maritimus*), woodland caribou and Peary caribou, wolverine (*Gulo gulo*), and wood bison (*Bison bison athabascae*) will fall through the gaps in federal-territorial jurisdiction. Territorial Wildlife Acts allow hunting of these COSEWIC-listed species.

For the remaining lands—the vast majority of Canada—SARA stipulates that when the provinces fail to protect a species at risk, the federal government may use its "safety net" provisions to protect the species. Given the long history of federal-provincial tensions in Canada, it is highly unlikely that federal discretionary powers will ever be exercised. The federal government has had discretionary powers allowing it to regulate environmental practices in place for nearly 30 years. These powers have never been used in provincial jurisdiction. A rarely, if ever, utilized power will be unlikely to provide a true "safety net" for species that fall through gaps in provincial laws.

The federal government has the authority through its Criminal Law Power to prohibit the harming of an individual species at risk or its residence. However, the government's use of this power in SARA is puzzling. By providing automatic protection only to species under federal jurisdiction and discretionary protection to those that are not, the legislation suggests a regulatory approach, rather than one based on prohibitions. This undermines the Criminal Law Power—the federal government either has the authority to protect individuals and their residences anywhere in Canada or not. It is inconsistent for the government to maintain that it has this power, but will use it only when it sees fit.

Habitat

Critical habitat protection measures are not mandated under SARA, even in areas of clear federal jurisdiction. Such measures are left up to the discretion of the Minister. The fact that there is no requirement to protect the habitat of a single species, even those found within Canada's national parks, provides a clear indication of the government's lack of commitment to protecting endangered species. It also violates the government's own promises. In the 1999 Throne speech, Prime Minister Jean Chrétien promised to introduce legislation that will ensure that species at risk and their critical habitat are protected. On the same occasion, the Environment Minister, David Anderson, noted that "...any species protection legislation must include provisions for the protection of critical habitat of endangered species. This is fundamental. No habitat, no species."

The government's rational for failing to automatically protect the habitat of species that fall within federal jurisdiction in SARA is not clear. The province of Québec provides us with an example of what is likely to happen when decisions about whether to protect habitat are left up to politicians. In Québec, protection of the habitat of animal species is decided after a species is listed on a case-by-case basis. To date, seven animals have been listed; none have received habitat protection measures.

The discretionary federal habitat "safety net" in SARA is puzzling for the same reasons noted above for the discretionary measures in place to protect individual species and their residences beyond federal jurisdiction. If the federal government has the authority to protect critical habitat under its Criminal Law Power when the provinces fail to do so, then this power should be exercised consistently, not on a discretionary ad hoc basis.

Recovery

SARA incorporates a two-stage recovery planning process. A recovery strategy must be prepared for all endangered and threatened species if recovery is deemed to be feasible. It is here that critical habitat is identified for each species. Once this is done, an action plan is prepared. There are no time limits imposed on the completion of such plans and there is no obligation on the part of government to implement any of them.

Compensation and stewardship

The preamble to SARA notes that voluntary stewardship initiatives should be supported. However, SARA does little to promote "volunteerism." Should the federal "safety net" be invoked on private lands, there is compensation for extraordinary losses due to measures put in place to protect endangered species. However, the details are not spelled out in the legislation. It is not clear who will be eligible for

compensation, that is, whether it will extend beyond private landowners to include individuals, corporations and communities who may be economically disadvantaged by measures put in place to protect species at risk.

Along with SARA, the government introduced a promising new stewardship tool that will allow Canadians to benefit from tax concessions by donating land or through easements that restrict development on lands considered by the government to be "ecologically sensitive." Such stewardship tools could complement legislative measures, but it remains to be seen how many Canadians will successfully navigate the bureaucratic process required to meet government requirements.

No matter how effective the tools, success will ultimately be determined by funding considerations. Budget 2000 announced a fund of $90 million (Canadian dollars) to be spent over 3 years for endangered species. Although this is a significantly greater investment in species at risk than has been made in the past, it includes costs for the administration of the new Act and for the operation of COSEWIC, not just species recovery. The Canadian Wildlife Service believes that at least $100 million (Candian) is needed per year just to fund recovery activities for the currently listed species.

Canadians and species at risk

If passed in its current form, SARA will fall short of the Canadian public's desire for effective legislation to protect Canada's biodiversity. National polls have repeatedly demonstrated overwhelming public support for strong endangered species legislation. A poll conducted by POLLARA in August 2000, commissioned by the International Fund for Animal Welfare, found that nearly two-thirds of Canadians believe that the federal government is not doing enough to protect plant and animal species at risk of extinction. More than three-fifths (62%) of respondents felt that scientists should take the lead role in determining which species are protected versus 18% who thought that government should take the lead in listing species. The vast majority of those asked (81%) believed that that laws protecting endangered species should also make it mandatory to protect the species' habitat. A clear majority (85%) felt that federal laws should protect species not just on federal lands, but also those on provincial and private lands.

With the majority of Canadians, key natural resource industries, and environmental groups calling for stronger and more effective endangered species legislation, it is difficult to understand why the federal government has introduced legislation that will do little to ensure the protection of Canadian biodiversity.

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FOCUS ON NATURE ™ *by Rochelle Mason*

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Introgression Level Achieved through Florida Panther Genetic Restoration

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Abstract

Florida panthers (Puma concolor coryi) exist today as a small isolated population of 60 to 70 individuals in southern Florida after two centuries of habitat loss and persecution eliminated them from much of the southeastern United States. Many observed phenotypic traits such as cryptorchidism, kinked tails, cowlicks, and atrial septal defects are assumed to be manifestations of inbreeding. Dispersal mechanisms can no longer function to maintain genetic diversity within the small population. A plan to restore genetic diversity within the panther population to levels comparable to western puma was initiated with the release of eight Texas puma (P. c. stanleyana) in 1995. The goal was to achieve a 20% representation of Texas puma genes in the panther population. To date, four of the eight Texas pumas are still alive and have produced a minimum of 36 descendants, 25 of which are thought to still be alive. Based on our pedigree knowledge, we calculate that the panther population has 18% to 22% representation of Texas puma genes as the result of genetic restoration.

Introduction

Florida panthers (*Puma concolor coryi*) are endangered by a combination of population and habitat factors (USFWS 1987). Loss and fragmentation of habitat and unregulated killing over the past two centuries have reduced and isolated *Puma* populations in the eastern United States to the point where only one population estimated to number between 60 to 70 individuals exists on approximately 8,810 square kilometers (2.2 million acres) of habitat in south Florida (Maehr 1990). Small population size and geographic isolation increase the chance for extinction of Florida panthers due to demographic instability inherent in small numbers and erosion of genetic diversity from restricted gene flow and inbreeding. Maintaining genetic diversity is key for production of fit individuals as well as providing population elasticity in order to respond to changing environmental and habitat conditions.

Genetic diversity within the panther population would have been maintained at higher levels when the population was greater in size. Furthermore, natural exchange of genetic material occurred historically among the Florida panther population in the southeastern United States and contiguous populations of *P. c. cougar* to the north, *P. c. hippolestes* to the northwest and *P. c. stanleyana* to the west (Young & Goldman 1946). Gene flow occurred as individuals dispersed widely and bred, however, human settlement of the eastern United States resulted in local extirpations of *Puma*, thereby eliminating this exchange. With limits to dispersal and decreasing population size, breeding among close relatives occurs and can lead to inbreeding depression, loss of genetic variation, declining health, reduced survivability, and eventual extinction (Gilpin & Soulé 1986). Even with adequate habitat protection, these genetic concerns could lead to panther extinction.

Florida panthers exhibit reduced genetic variability when compared to western pumas (Roelke et al. 1993), and panther traits such as kinked tails, cowlicks, atrial septal defects, cryptorchidism, and poor sperm characteristics may be manifestations of inbreeding. Concern that the predicted downward trend in panther population viability may have begun led to the development and implementation of a "Plan for Genetic Restoration and Management of Florida Panthers"

(Seal 1994). This plan called for the release of eight female Texas pumas into areas occupied by Florida panthers to mimic the former natural exchange of individuals among these populations. The resultant *Puma* population in Florida after several generations of intercrossed offspring have been assimilated was expected to trace 20% of its genome to material from the Texas population. This level of genetic restoration was deemed adequate to forestall negative impacts of inbreeding and to raise the panther population genetic diversity to levels documented in western North American *Puma* populations. Periodic releases of *Puma* into Florida would be necessary to maintain the desired levels of genetic variation within the panther population over time.

The objectives of this study are to document the productivity of the Texas pumas that were released in 1995 and their subsequent offspring and to calculate the percentage of the panther population's genome that originated from these translocated Texas (TX) cats.

Methods

The study area encompassed most of interior Florida south of Orlando (28.3°N), extending to southern Everglades National Park. Approximately 50% of panther habitat is in public ownership and includes areas such as Big Cypress National Preserve, Florida Panther National Wildlife Refuge, Fakahatchee Strand State Preserve, and Everglades National Park. Major vegetation communities are pine forests and savannas, cypress and mixed hardwood swamps, hardwood hammocks, and open marshlands (Davis 1943). Climate is subtropical with average annual temperature and precipitation of 74° F (23 C) and 137 centimeters respectively (Henry et al. 1994). The TX pumas used for genetic restoration originated from west Texas, primarily in Pecos, Presidio, and Brewster counties.

Florida panthers (FP) and TX pumas were captured using trained hounds, anesthetized following McCown et. al (1990), and fitted with radiocollars. Vital signs were monitored during anesthesia and all animals underwent a complete physical examination to assess general health condition. Samples taken included whole blood and skin biopsies, and *Puma* greater than four months of age were vaccinated for feline viral rhinotracheitis, feline calicivirus, feline panleukopenia, and rabies. All animals were tattooed on the ear and had subcutaneous transponder chips implanted between the shoulder blades. Neonate kittens were handled following Land et al. (1998).

Criteria for selecting appropriate TX pumas for release in Florida were identified by Seal (1994). The 8 pumas were quarantined for a minimum of 30 days to screen for possible pathogens and were released at five sites throughout areas occupied by Florida panthers (Johnson et al. 1998).

All radiocollared *Puma* were monitored from fixed-winged aircraft three times weekly and locations plotted on 1:24000 USGS Topological Maps. Associations among radiocollared cats were noted during each flight. Universal Transverse Mercator coordinates were obtained from the maps and stored in electronic databases. Radiocollars were equipped with mortality sensors and all carcasses detected were recovered and subjected to full necropsies by certified pathologists typically within 24 hours.

Panther population size was estimated at 60 to 70 individuals based on the sum of all extant radio-collared panthers (35), plus their known offspring (12) and all known uncollared panthers detected through intensive capture and survey efforts over the past year (nine) (D. Land, unpublished data). In addition to these known animals, we added five to ten individuals to our estimate to reflect the percentage of the population that remains undetected. Each year we encounter previously unknown individuals that are discovered through collisions with motor vehicles or are captured during routine surveys.

Results

Thirty-six intercross animals are known to have been produced, and 25 of these may still survive in the south Florida population (see Appendix). Two were recovered after colliding with vehicles, one died of unknown causes, and eight are strongly suspected of dying based either on tracking evidence or their dams' behavior. Evidence of the fates for another three intercross offspring has not been found subsequent to independence from their dams. Thus, probably 22 to 25 intercross cats exist presently within a total population of about 70 *Puma concolor*.

Table 1 shows the known contributions of each TX female to the south Florida population of *Puma concolor* as of August 2000. The numbers of descendants of each TX female are tallied by the type of intercross, with a dashed line separating each female's own offspring from her

Table 1. Known contributions of Texas pumas to the population of *Puma concolor* in south Florida as of May 2000.

Identification	Maximum Descendants[a]	Contribution, less known deaths	Contribution, less likely deaths	Contribution, less unknown fates	Potential future contribution
TX101 (deceased)	4 F_1 (-0)[b] 10 B-FP (-6)[b] 3 B-TX (-1)[b] 7 F_2 (-1)[b]	6.25	5.00	4.75	+0.0
TX105	2 F_1 (-0)[b]	1.00	1.00	0.50	+1.0[d]
TX106	4 F_1 (-2)[b]	2.00	1.00	0.50	+1.0
TX107	2 F_1 (-0)[b] 3 B-TX (-1)[b] 7 F_2 (-1)[b]	4.25	3.50	3.50	+0.0
TX108	3 F_1 (-1)[b] 1 B-FP (-0)[b]	1.75	1.25	1.25	+1.0[c,d]
Total	36 (-11)[b]	15.25	11.75	10.50	+3.0
% of living population	37.1%	21.8%	16.8%	15.0%	+4.3%

Notes:
[a] Some descendants show up under two TX females from which they descend
[b] Known or suspected deaths
[c] Has recently shown denning behavior, but no litter has been found
[d] No males known to be in area currently

Generations:
TX = female translocated from Texas
F_1 = intercross between TX female and FP male
F_2 = progeny of F_1 x F_1 mating
B-TX = progeny of F_1 male x TX backcross
B-FP = progeny of F_1 x FP backcross

grand-offspring. The genetic contribution of a TX female is expressed as the number of copies of her genome that are represented in her descendants. Thus, each offspring contributes 0.5, and each grand-offspring contributes 0.25. The contributions of each female are given first for all descendants not known to have died. Subsequent columns show the reduced contributions obtained after omitting all animals that are likely to have died ('d' status animals in the Appendix), and then after omitting also the animals whose present status is unknown ('?' status animals in the Appendix). The last column shows additional contributions that may be likely if the TX females are allowed to continue breeding. TX101 was contracepted with melanogesterol acetate for two years prior to her death in March 2000 and TX107 was contracepted in April 2000. The other TX females are all eight or nine years old, and each may be expected to produce about one more litter. The last column of the table assumes that each of three TX females will produce two more offspring. At the bottom of the table are the total contributions of the TX lineages to the south Florida population and the percent contributions out of an assumed population of 70 animals for the subset of intercross descendants defined for each column.

It is possible that there were some undocumented intercross animals in addition to those listed in the Appendix and tallied in Table 1. FP74 and FP84 were discovered as presumed offspring of F_1 female FP73 at ages that allow for the possibility that unobserved littermates could have already dispersed. TX105 exhibited denning behavior in August 1999, but no litter was found. In May 2000, we captured a female kitten from this litter (FP94) and found no sign of other littermates. The two male F_1 cats that are old enough to reproduce may have mated with unknown females: FP79 is suspected of siring four litters and other uncollared females are known to occur in his home range; FP65 was not the most mature, resident male in the

vicinity of any known breeding females, but he too may have sired unobserved litters. F_1 females K23 and K34 have not been observed since they would have become independent from their dams, but they may be alive and would be old enough to be breeding. One of TX108's litter of K45 and K46 is believed to have lived to at least the time of independence from its dam. If it is still alive, it would be old enough to have recently produced a litter. Other than these cases, it is unlikely that any undocumented intercross litters survive. The other TX and intercross cats have all been monitored sufficiently closely so that rearing of an unobserved litter would be unlikely, have had known litters at intervals that make it unlikely that additional litters could have been produced, or are still too young to have reared a litter.

Recognizing the above possibilities of undocumented intercross cats, it is likely that at least a few additional intercross cats exist. However, it would be unlikely that more than about four F_1 cats and perhaps four second-generation intercross cats evaded detection.

Discussion

The number of *Puma concolor* in Florida containing some Texas puma ancestry is not precisely known. However, the tabulation presented here is probably fairly complete, with perhaps several F_1, F_2, or backcross litters having been undetected. Similarly, it is not known precisely how many total *Puma concolor* are presently in the population. Assuming that most of the population is collared or otherwise known (such as kittens observed recently), it is likely that the total population size is approximately 70 cats.

The likely representation of Texas puma genes in the south Florida population is about 15% to 16.8% if the aging Texas puma females are excluded, or about 19.6% to 21.3% if those TX females are included. With a projection of three more F_1 litters to be produced in the next few years before all the TX females become post-reproductive, we estimate that the ultimate representation of TX genes in the population would be 19.3% (15.0% now, plus 4.3% in future progeny of TX cats). This is perhaps fortuitously close to the original genetic restoration program goal of 20% representation.

It is possible that an additional one or two F_1 litters and perhaps up to 6 backcross (B-FP) litters were undetected. If these litters do exist, and each produced two surviving kittens, the TX contribution could be as much as 5.0 higher. In this case, representation would be increased by up to 7.1%. Thus, accounting for these possible intercross litters, the plausible range of current representation of TX puma genes in the population is from 15.0% to 28.9%.

If there are no further genetic manipulations, and if future breeding success is unrelated to the ancestry of cats, then the expectation is that the percent of TX genes in the population would remain near the current level. If animals containing more TX ancestry are more successful as breeders, then the representation of TX genes will gradually increase. The reverse will occur if natural selection favors the ancestral FP genes in the population. Most likely, however, change in the frequency of TX genes will occur primarily due to chance, at least during the early generations of intercrossing. After a few more generations, almost all animals will likely contain representation from both ancestral sources, and the range of TX representation among animals will narrow.

Although the average representation of Texas puma genes is probably close to the 20% goal of genetic restoration, most of the TX genes are derived from only a few of the Texas cats. More than 40% of the TX genes are derived from TX101, and much of the remaining TX genes come from TX107. The unequal representations of the Texas pumas in the intercross descendants reduce the genetic diversity inserted into the population. Although five

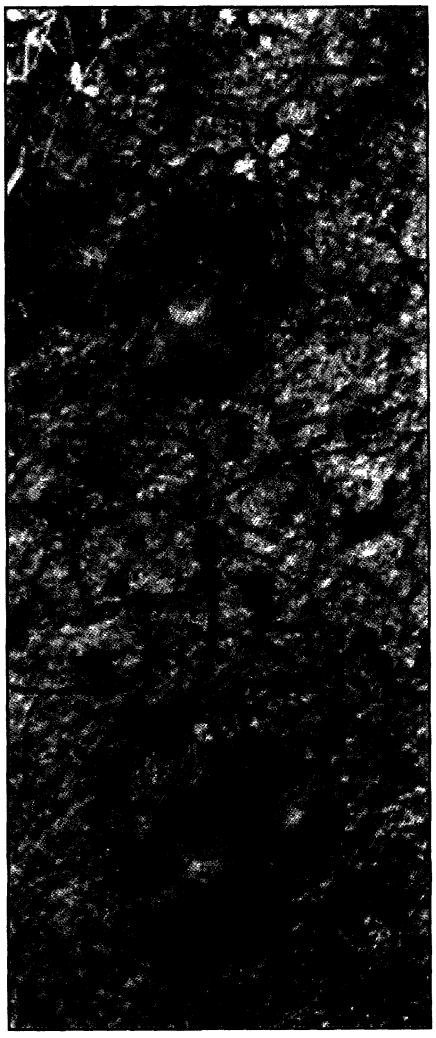

Figure 1. Florida panther prints. Photo courtesy of Friends of the Florida Panther Refuge.

Texas pumas have contributed some descendants, the diversity contributed by those five is the equivalent of about three "effective founders" (founders that have contributed equally to the population: Lacy 1989). As a result, while the genetic restoration will have considerably reversed prior inbreeding, that may be a relatively short-term benefit.

The population of *Puma concolor* in south Florida is still so small that inbreeding will likely become common again among the intercrossed descendants within the next few generations. Already, one intercross animal (FP85) is thought be an inbred offspring of a mating of an F_1 female to her FP father. Although there are an estimated 70 animals in the population, perhaps only half are breeders of the current generation. (Many are still kittens, and some females and many males may not be successful breeders.) The genetically effective population size would be still smaller. To counter a resumption of inbreeding and loss of genetic diversity, further releases of non-local cats may be considered as part of ongoing management of the genetic restoration. The effects of any future releases on the representation of TX ancestry achieved in this initial genetic restoration will need to be assessed.

Our analysis of the representation of Texas puma genes that has been achieved in the genetic restoration program for the Florida panther has been based on the pedigree as it is known from field observations through August 2000, about five years after the release of eight Texas females. This pedigree analysis will need to be regularly updated and refined as field monitoring continues. In addition, molecular genetic analyses are underway that will likely provide confirmation and/or refinement of the pedigree, as well as information about the likely ancestry of previously unknown cats. These data on the ancestry of the cats in the population will then allow analysis of the effects of the genetic restoration on the morphological traits (including cowlicks, kinked tails, cryptorchidism, and atrial-septal defects), reproductive performance, survivorship, and population viability.

Figure 2. Florida panther kitten. Photo courtesy of Friends of the Florida Panther Refuge.

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Table 2. Texas pumas and known intercross *Puma concolor* in the south Florida population.

ID	Sex	Dam	Sire[1]	Birth	Gen.	Status[2]	Notes
TX101	F			1991±2y	TX	D	contracepted 11/97
FP65	M	TX101	FP45	12/96	F_1	A	
FP66	F	TX101	FP45	12/96	F_1	A	With 2 kittens
K52	M	FP66	FP54	9/98	B-FP	d	Not oberved after handled at den,
K53	F	FP66	FP54	9/98	B-FP	d	dam re-bred early
K54	M	FP66	FP54	9/98	B-FP	d	
K76	M	FP66	FP60	12/99	B-FP	D	Roadkill (2/00)
K77	F	FP66	FP60	12/99	B-FP	a	Still with dam
K78	F	FP66	FP60	12/99	B-FP	a	
FP73	F	TX101	FPX	9/95	F_1	A	Litters in 98 and 99
FP74	M	FP73	FPX	6/97	B-FP	D	Roadkill (9/99). May have lttermates.
FP84	M	FP73	FPX	2/99	B-FP	D	Death by unknown causes (4/00). May have littermates
FP79[3]	M	TX101	FPX	9/95	F_1	A	Sired 12 known offspring
FP87	F	FP55	FP79	4/99	B-FP	A	Independent from dam
K61	M	FP55	FP79	4/99	B-FP	?	Not observed after independence
TX102	F			1991±2y	TX	D	Pregnant when hit by car (9/95)
TX103	F			1991±2y	TX	D	Pregnant when died (8/99)
TX104	F			1991±2y	TX	D	Not known to have bred. Died 4/98
TX105	F			1991±2y	TX	A	Radiocollar failed 8/2000
K34	F	TX105	FP16	9/96	F_1	?	Not observed after independence
FP94	F	TX105	FP16	8/99	F_1	A	May have had littermates
TX106	F			1991±2y	TX	A	With 1 kitten
K23	F	TX106	FP51	11/95	F_1	?	Not observed after independence
K47	M	TX106	FP51	2/98	F_1	d	Disappeared after male entered area
K62	F	TX106	FP54	6/99	F_1	d	No longer with dam
FP83	F	TX106	FP54	6/99	F_1	A	Still with dam
TX107	F			1991±2y	TX	A	Contracepted 4/00
FP70	F	TX107	FPX	5/97	F_1	A	With 3 kittens, radiocollar failed 1/2000
FP88	F	FP70	FP79	6/99	F_2	A	Still with dam
FP91	F	FP70	FP79	3/99	F_2	A	
FP92	M	FP70	FP79	3/99	F_2	A	
FP71	F	TX107	FPX	5/97	F_1	A	With 3 kittens, radiocollar failed 7/2000
K69	M	FP71	FP79	6/99	F_2	a/d	Still with dam, either k69 or k70 presumed dead
K70	F	FP71	FP79	6/99	F_2	a/d	based on field sign
FP86	F	FP71	FP79	6/99	F_2	A	
FP90	M	FP71	FP79	6/99	F_2	A	
K56	F	TX107	FP79	2/99	B-TX	d	Monitoring hampered by failure of dam's collar; FP93
K57	M	TX107	FP79	2/99	B-TX	a	captured 4/00
FP93	F	TX107	FP79	2/99	B-TX	A	
TX108	F			1992±2y	TX	A	
FP61	F	TX108	FP16	7/96	F_1	A	With 1 kitten
FP85	M	FP61	FP16	3/99	B-FP	A	Inbred
K45	F	TX108	FP16	1/98	F_1	a/d	One of K45 and K46 with dam prior to independence;
K46	M	TX108	FP16	1/98	F_1	a/d	other likely dead

Notes

[1]**FP_x indicates that the sire was unknown, but temporal and/or spatial circumstances make it likely that it was a FP male, rather than F_1 or other intercross.**

[2]**Status codes:**

A = radio-collared; monitored regularly

a = presumed alive; observed recently or signs of continued presence with dam

? = fate unknown; not collared and not recently observed

d = presumed dead; disappeared under circumstances that suggest mortality is likely

D = known to be dead

[3]**Also has offspring listed under dams FP70, FP71, and TX107**

Marine Matters

Status and Conservation Efforts of Ashy Storm on the Farallon Islands

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Abstract
*The Ashy Storm-Petrel (*Oceanodroma homochroa*) is one of the least known seabird species because of its crevice-nesting and nocturnal habits. The Farallon National Wildlife Refuge supports the largest population of Ashy Storm-Petrels. Results from a capture-recapture study indicate that the population of Ashy storm-petrels on the Farallon Islands has declined almost 40% in 20 years and predicts that the population will continue to decline at a rate of almost 3% per year. Reasons for this decline include predation by gulls, mice, and owls. Current conservation efforts include studies to better document predation on Ashys, efforts to exclude gulls from Ashy nesting habitat, and a combination of artificial nesting boxes and playback systems to promote the recovery of this seabird species.*

Introduction
The Ashy storm-petrel (*Oceanodroma homochroa*) is a small seabird, weighing approximately 42 grams and just over seven inches in length. This species belongs to the order Procellariiformes, the same group as albatrosses, shearwaters, and fulmars. Storm-petrels are the smallest members of this group, and because they are mostly nocturnal in their breeding activities, are amongst some of the least known seabird species. Ashy storm-petrels nest in rock walls and crevices and have a limited breeding range, primarily on islands off the coast of central and southern California, and in smaller numbers on Islas Los Coronados, Mexico. The Farallon Islands, located 27 miles west of San Francisco, hosts the most significant proportion of this seabird population. Ashy storm-petrels have an extended breeding season, lasting six months or more, during which time a single chick is raised.

The Farallon National Wildlife Refuge supports the largest breeding population for the Ashy Storm-Petrel and its native predator, the Western Gull. Ten additional seabird species breed on the Farallon Islands, totaling approximately 200,000 nesting seabirds. Such a large assemblage is remarkable for this small group of islands, which together comprise approximately 120 acres. Since its declaration as a National Wildlife Refuge in 1909, the U.S. Fish and Wildlife Service have managed the Farallon Islands.

Population in decline
It is believed that the Southeast Farallon Islands supports between 50 – 70% of the world population of Ashys. Under a cooperative agreement with USFWS since 1969, Point Reyes Bird Observatory (PRBO) has been conducting long-term monitoring of this population. Results from capture-recapture studies indicates that the population has declined almost 40% in 20 years from an estimated 3,500 – 4,000 breeding birds in 1972 to approximately 2,000 – 2,400 birds in 1992. Furthermore, demographic modeling predicts that the Ashy population will continue to decline at a rate of almost 3% per year. Currently, there is no official listing for the Ashy storm-petrel under the Endangered Species Act, although it has been designated a species of special concern by the State of California and species of management concern by the U.S. Fish and Wildlife Service.

Threats to reproduction
Several possible explanations exist for the population decline of Ashy storm-petrels on the

Figure 1. Ashy chick on the Farallon Islands. Photo courtesy of the Point Reyes Bird Observatory.

Farallon Islands. One of the largest densities of Ashy storm-petrels on the Farallon Islands is on the south-facing slope of the hill where the lighthouse is located. Until recently, Western Gulls did not nest in these areas. In the 1980s however, gulls expanded their breeding range to include this prime petrel habitat. As a result, petrel remains are commonly encountered on the slopes of this hill. Although Western Gulls are native on the island, their population has been increasing as a result of the activities of man. In an attempt to discourage gulls from nesting in areas important for Ashy storm-petrels, USFWS constructed gull exclosures consisting of a system of cables strung between poles. Other avian predators of Ashys include Burrowing Owls, which are resident on the island in the fall, winter, and spring.

Another possible threat to the breeding Ashy population is the presence of the introduced House mouse (*Mus musculus*), which is capable of entering crevices and taking eggs and even small chicks. On other islands, introduced animals have had devastating effects on seabird populations. Currently, it is unknown what impact mice have on the Ashy population, although plans to document mouse and gull predation on Ashys are underway.

Conservation efforts

Artificial nesting boxes have been successfully used as tools for aiding in the restoration of seabird populations on the Farallones and elsewhere for seabirds such as Cassin's Auklets, Rhinoceros Auklets, Tufted Puffins, and Pigeon Guillemots. Social attraction is based on vocalization playback of the species that is being attracted and has also been a successful tool for bringing seabirds to nesting areas. To increase good "Ashy habitat" on the Farallones and to promote the recovery of this species, a combination of nesting boxes and vocalization playback has been implemented. Future plans include continuing to develop effective methods of decreasing gull densities in areas of important Ashy habitat, as well as better documentation of Ashy storm-petrel predation and predators, in an attempt to preserve this unique and beautiful seabird species.

Figure 2. Ashy chicks have benefited from habitat improvement effots such as nesting boxes. Photo courtesy Point Reyes Bird Observatory.

The Return of the Great Plains Puma

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Abstract
With the advent of European settlement over a century ago, the northern Great Plains became the site of extremely rapid landscape change. Most large mammals, including the wapiti or elk (Cervus elephas), bison (Bison bison), wolf (Canis lupus), puma (Puma concolor), grizzly bear (Ursus arctos horribilus), and black bear (Ursus americanus), were almost completely extirpated from wooded "island-like" habitats such as the Black Hills, the Pine Ridge Escarpment, and also from the mixed-grass prairies. Pumas likely persisted in very low densities within the Black Hills, which now constitutes the core breeding and dispersal ecoregion into adjacent biotically similar environments, including the Pine Ridge Escarpment, the Rawhide Buttes, and the Wildcat Hills. Limiting factors on puma numbers include fluctuating white-tailed deer (Odocoileus virginianus) and mule deer (Odocoileus hemionus) populations, and human and road densities. Rural landowners within the Greater Black Hills ecosystem may increasingly face the dilemma of balancing economic interests with federal and state laws designed to protect and reestablish these native carnivores. How farmers and ranchers resolve these land use issues has implications for other Great Plains states where carnivore dispersion is also taking place. If the Black Hills, the core habitat for the Great Plains puma can be preserved, along with riparian patch and peninsula corridors to adjacent forested buttes, the puma will once again take its place as a dominant carnivore in the Great Plains.

Habitats, history, and limiting factors of the plains puma

Since European settlement commenced over one hundred and thirty years ago, the northern Great Plains has witnessed the extirpation of nearly all large mammalian carnivores, including the gray wolf (*Canis lupus*), the black bear (*Ursus americanus*) the grizzly bear (*Ursus arctos horribilus*), and the puma (*Puma concolor*). By 1900, only a few individuals of *Puma concolor* and *Canis lupus* hung on in remote ecologically distinct forested "island" habitats.

At the present time these habitats in a "sea" of agriculture are proving to be natural recovery zones for residual populations of pumas, also called mountain lions, cougars, or panthers. Such a natural recovery balanced with essential economic interests may prove to be a model for other Great Plains states facing similar issues. One such island habitat is the Greater Black Hills Ecosystem. The Black Hills proper of southwestern South Dakota and eastern Wyoming rise over 2,300 meters and extend across 10,000 square kilometers, with similar biotic communities lying adjacent to these mountains. Geologically speaking, the Black Hills is an eroded semi-circular "geologic dome" structure. Ecologically speaking, several thousand square kilometers of similar habitat ring the Black Hills.

Three such hilly ecosystems, the Rawhide Buttes of eastern Wyoming, along with the Wildcat Hills and the Pine Ridge Escarpment of western Nebraska, lie south and southwest of the Black Hills (see Figure 1). The Wildcat Hills run in a northwest-southwest track south of Scottsbluff, with peaks reaching 1,600 meters. The Pine Ridge is a range of bluffs and buttes rising to nearly 1,600 meters, and stretches in a ragged "boomerang-shaped" arc approximately 166 kilometers from the South Dakota border north of Chadron, Nebraska, and west just past the Wyoming border. This rugged pine-covered landscape with white cliffs is thirty-three kilometers wide in places (Dawes County Travel Board). 19,240 hectares of this woodland is included within the Nebraska National Forest, covered with mature stands of ponderosa pine (*pinus ponderosa*) along the ridges with deciduous forests of cottonwood (*Populus angustifolia*), green ash (*Fraxinus* sp.), box elder (*Acer negundo*), and willow (*Salix* sp.)in the riparian areas (United States Dept. of Agriculture, Forest Service 1999).

The Rawhide Buttes lie south and

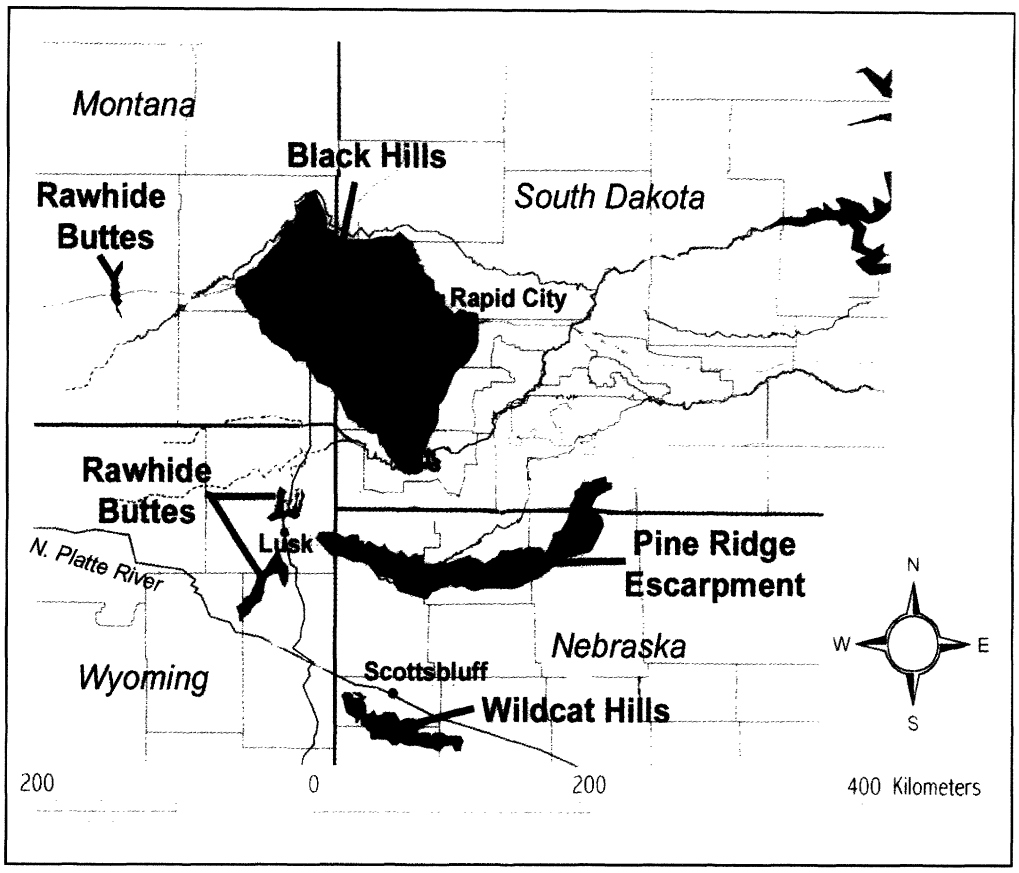

Figure 1. Location and boundaries of the greater Black Hills ecosystem (map by Kirk Johnson, 2000).

west of the town of Lusk, along Highway 85. They include several isolated "islands" of eroded clay and sandstone remnants, some rising several hundred feet above the surrounding prairie in places. These bluffs are also covered with conifers.

The primary flora of all four habitats is ponderosa pine. Ponderosa pine covers over 90 percent of the Black Hills, along with pockets of white spruce, aspen and bur oak (Black Hills National Forest Land and Resource Management Plan Map: no date given). Aspen groves are interspersed throughout these mountains. The white spruce is located at higher elevations in the western portion of the Hills, while the bur oak communities are mostly in the northern and eastern region of the Black Hills, and also within the Black Hills National Forest in Wyoming (Black Hills National Forest Land and Resource Management Plan Map: no date given).

The Black Hills National Forest covers 480,000 hectares, approximately 73 percent of the total forest acreage of the Black Hills (Inner Voice 1999). Due to decades of fire suppression, the ponderosa pine has developed thick stands that have encroached into grassy meadows, creating poor habitat for mule and white-tailed deer (Benzon 2000). The pine encroachment is due to fire suppression over the past few decades— originally the Hills had many more open grassy meadows interspersed with conifers and aspen (Benzon 2000).

Throughout South Dakota, the deer population is slowly increasing, and may number 250,000 animals (Hauk 2000). One-third of this number are mule deer, located in the western part of the state (Hauk 2000). In the Black Hills, however, the deer population has declined from an estimated high of 90,000 in 1991 to around 42,000 in 2000 (Benzon 2000). Both species of deer are represented in the Black Hills. Until the recent drop in population, white-tailed deer appeared to be increasing in range and numbers (Jenks 1996).

The thick ponderosa pine overstory limits the growth of grasses, herbs and shrubs, causing deer to seek forage in areas with less forest cover and more shrubs (DePerno et al. 1995). Such areas often lie on the fringes of the Black Hills. Decreasing numbers of deer may well prove to be an inhibiting factor on the puma population in the Black Hills—estimates range from 15-75 scattered throughout the mountains and adjacent badlands (Benzon 1995). A few hundred elk, however, could continue to prop up the big cat's numbers. There have been several verified elk kills in the Hills (Jenks 2000).

Road densities, too, have been shown to be a limiting factor on puma populations (Van Dyke, et al. 1986). Road densities in the South Dakota counties within the Black Hills are approximately 0.8 kilometers/square kilometer (Johnson 1998). This is much less than the 1.0 kilometers/square kilometer demonstrated to be an inhibiting factor for other large carnivores with small isolated populations (Light and Fritts 1994).

It is likely that pumas were never entirely extirpated from South Dakota. Prior to increased reports over the last two decades, there were two cougars "officially" killed in the 1900s in the Black Hills. A man with trained hounds tracked and killed a puma near the

head of Stockade Creek in the 1930s and one 63-kg male was killed in December of 1957 on Elk Mountain (Mann 1959). This indicates that a small residual population of the big cats persisted in the Black Hills long after other Great Plains populations had died out.

Ungulate and puma proximity analysis

In 1996, a proximity analysis correlating puma sightings/sign with deer and elk winter study ranges was undertaken using "Geographic Information Systems" (GIS) software (Johnson 1996). This class study utilized research from deer and elk wintering sites centered around five stream drainages studied by South Dakota State University (SDSU) doctoral students in the central Black Hills: Slate Creek, Burnt Fork, Horse Spring Creek, Gordon Gulch, and East China Gulch (DePerno 1996—see Figure 2).

For several years in the 1990s, the doctoral research was undertaken to determine the extent of white-tailed deer, mule deer and elk winter ranges and forage utilization. Research revealed that these ungulates migrated from higher elevations in the Black Hills to lower stream drainages during most winters (Jenks 1996). Such ungulate migrations may signal a need for better cover from winter storms, plus a more abundant food supply. It is hypothesized that pumas likely follow deer and elk to their wintering sites in the Black Hills, as they have been reported to do in other locations, depending in winter severity (Ross and Jalkotzy 1992).

The proximity study covered 556 square kilometers, and incorporated these five wintering ranges into a GIS basemap, overlaying the ranges with verified reports of cougar sightings or sign (Johnson 1996). The South

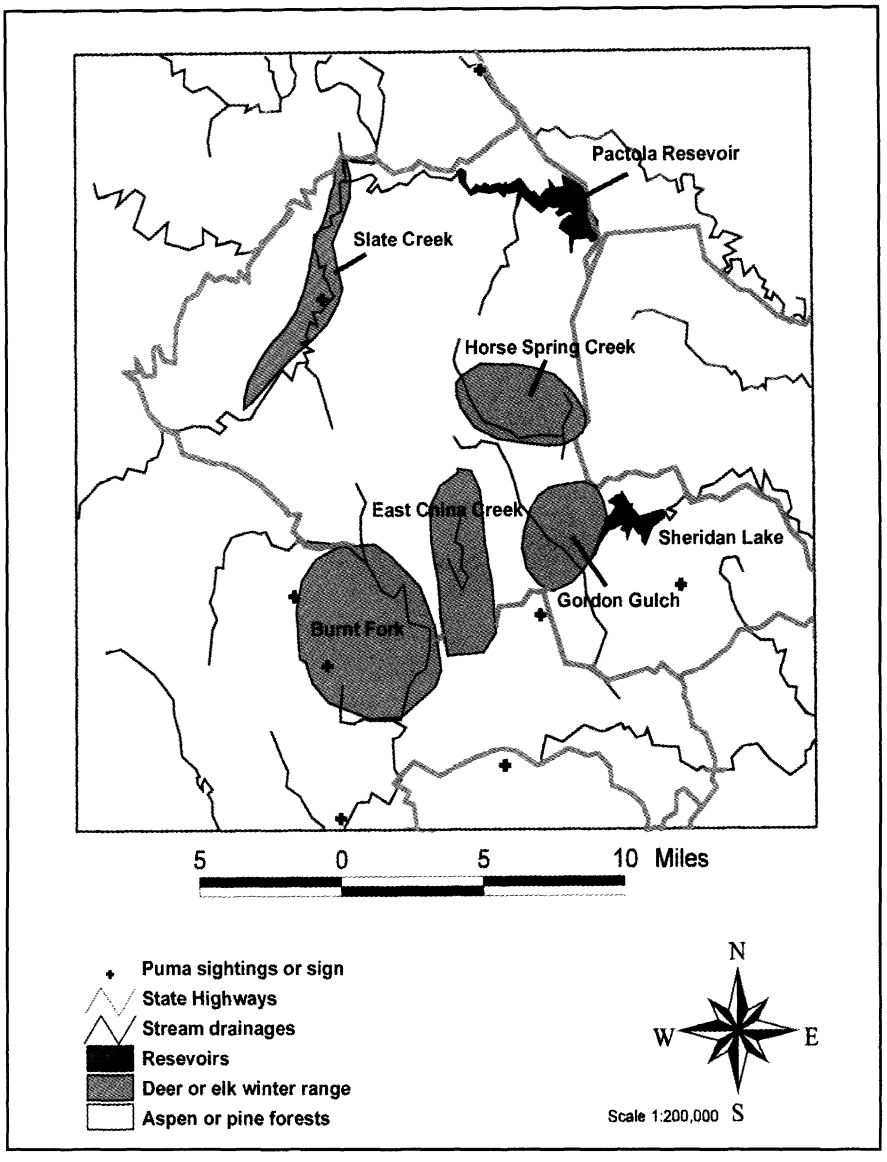

Figure 2. Puma reports in deer/elk study ranges in the Black Hills. Deer/elk data courtesy South Dakota State University, puma data courtesy South Dakota Department of Game, Fish, and Parks. Map by Kirk Johnson, June 1996.

Dakota Department of Game, Fish and Parks had earlier developed a dot map of the distribution of the puma throughout the Black Hills based on verified sightings, or sign (e.g. feces, signs of wildlife/livestock kills) between the years 1987-1995 (Benzon 1995). This map revealed cougar reports from all over the Black Hills, with dot densities predominating in the center of the mountains.

A "Nearest Neighbor" analysis was conducted to determine the extent of clustering regularity or randomness of the puma sighting dot data with the ungulate wintering ranges (Johnson 1996). The cougar reports came from the winter season (Benzon 1996), which may correlate with deer and elk migrations. The results of the Nearest Neighbor analysis indicated the eight puma dot locations within the 556-km^2 study area were more random than regular (Johnson 1996; see Figure 2).

One implication of the proximity study is that pumas in the Black Hills do not concentrate more of their hunting activities upon elk and deer wintering drainages than other areas of their range. The size of the study region chosen, however, may be too small to adequately correlate puma dot data with all ungulate wintering ranges (Johnson 1996). It

is possible that if elk and deer congregate by streams, a larger Nearest Neighbor analysis incorporating all of the Black Hills would show a correlation between puma sightings/sign along such streams and ungulate winter usage (Johnson 1996).

Puma reports in the Black Hills

Verifiable reports of pumas in the Black Hills remain consistent. There were a total of 54 sightings of mountain lions in South Dakota in 1999, and between January to June 2000, twenty-seven reports were received (Hauk 2000). There have been a few cases of interaction between humans, livestock and pumas. In 1998, a man in Custer State Park reportedly got between a mother puma and her cub and was charged three times by the cat, but was unharmed (Benzon 1998). On another occasion, a few packhorses were injured from an attack within the state park (Hauk 2000). On average, 5-6 complaints of cougar depredation on livestock are received each year, including attacks on adult horses, colts, cattle, and one mule (Waite 1996). In 1999, a cougar killed a radio-collared bighorn sheep in the Hills, and the remains of other bighorns have been found (Waite 2000). Bighorn sheep are a favored prey of the big cats, along with deer and elk.

Several cougars have been found dead in the Hills, most apparently of natural causes, including starvation (Jenks 2000). In one case approximately two years ago the decomposed body of a female puma that had been shot was found, along with her two cubs that apparently stayed with her body and starved to death (Benzon 2000). Since 1998 there have been two roadkills reported, one between the towns of Hill City and Custer, and one by Tilford along Interstate 90 near Sturgis (Hauk 2000).

On another occasion, three brothers were out hunting in late November of 1999 when they encountered and killed a young female cougar near Deerfield Reservoir, in the center of the Black Hills (Buchholz 1999). Killing the big cats in South Dakota is a Class 2 misdemeanor punishable by up to 30 days in jail and a $100 fine unless there is a threat to humans or livestock. Judges also can assess a $5,000 civil penalty if conditions warrant (Buchholz 1999).

Pumas in prairie riparian habitats east of the Black Hills

In addition to the Black Hills, a dozen or more cougars may roam the Cheyenne River, Bad River, White River and West River riparian "breaks" country east of the mountains (Benzon 1995). Ranchers southeast of the capital city of Pierre in south-central South Dakota have reported cougars causing cattle to stampede through fences (Lewis 1999). This area lies within the breaks of the Missouri Valley, in the northeastern corner of Fort Pierre National Grasslands.

While Fort Pierre consists of public land interspersed with cultivated private inholdings, it does contain the 3,492-hectare "Cedar Creek Roadless Area," potentially good habitat for deer, elk and pumas (U.S. Department of Agriculture, Forest Service 1999). Another promising grassland site lies west of Badlands National Park, within the Buffalo Gap National Grassland. Within these rolling plains and badlands lies the 7,328-hectare "Red Shirt Roadless Area," home to two large prairie dog colonies, with an abundant deer and raptor population (U.S. Dept. of Agriculture, Forest Service 2000). Red Shirt is a mixed-grass prairie ecosystem, dominated by western wheatgrass, buffalo grass, and blue grama. It contains gently sloping grasslands with Rocky Mountain juniper in the dissected badland slopes (U.S. Dept. of Agriculture, Forest Service 2000). Such isolated Badlands terrain with few roads may provide the best habitat for the big cats in the future.

South of the Badlands lies the 6,564-hectare LaCreek National Wildlife Refuge, a few miles from the Nebraska border within the northern limits of Nebraska's Sand Hills. There are 1-2 reports a year of cougars on or near the refuge, mostly within the Lake Creek Valley or the Little White River (Bousquet 2000). LaCreek is home to some of the densest concentrations of avian life in the nation, including thousands of sandhill cranes, dozens of species of water birds, golden and bald eagles, and mammals such as the rare kit fox and beavers. Many of these animals are part of the prey base for cougars.

About thirty-five kilometers west of the refuge lies the town of Martin, a few kilometers north of the Little White River in Bennett County. A resident female with kittens that has been spotted repeatedly in canyon country approximately thirty-five kilometers northeast of Martin (Beck 2000). This would likely be within the Lodge Creek Valley. Within the past 3-4 years, the lion population has expanded into the refuge area, with sightings occurring on a regular basis around Martin. A younger male has been regularly seen about ten kilometers east of Martin, and its territory may include part of the LaCreek Refuge (Beck 2000). Several reports have come from the tiny town of Wanblee, in Washabaugh County, on the Pine Ridge Indian

Reservation fifty kilometers north of Martin (Beck 2000).

The Black Hills is not the only habitat where the big cats have been found dead due to human or natural causes. Wilder wooded sections of the Missouri River Valley may harbor a few of these carnivores. In the late 1990s the decomposed carcass of a male puma was found south of the town of Chamberlain (Benzon 2000), just east of the Missouri River in Brule County in southeastern South Dakota. Another dead cougar was reportedly discovered in Charles Mix County, along the Missouri River southeast of Brule (Morgan 2000). There are even unverified reports from Watertown, in eastern South Dakota (Hauk 2000).

East of Chamberlain is the town of Alexandria, along Interstate 90. It is here that the most conclusive report of pumas west of the Black Hills has occurred. On September 14, 2000, a farmer reported two mountain lions were spotted near a 600-pound colt that had been killed two days previously (Petersen 2000). Alexandria lies on the eastern edge of the woody draws of the James River Valley. A farmer was combining his cornfield, and he spooked out two separate cats in the field on separate occasions, about 100 yards from the kill. Wildlife personnel concurred the colt was likely killed by felids, due to the nature of the kill (Petersen 2000).

The bluffs of the Missouri Valley near the town of Selby in Walworth County east of Oahe were where a 36-kg male puma was captured alive in a coyote trap in 1990 (Waite 2000). At the time the male's age was estimated at almost two years. "George," as he was soon nicknamed, led a colorful life after he was translocated and released into the Black Hills. George was briefly radio-collared by Department personnel, but the tracking was soon discontinued due to fears of legal repercussions if any attacks on humans or livestock were to occur (Lewis 2000). George was destroyed in April, 1996, due to fears of possible dangers to humans and livestock and poor eyesight (Waite 2000).

Other "prairie lions" are wanderers in the rugged breaks on the western side of the Missouri. Near the town of Philip in southern Haakon County east of the Black Hills, ranchers have also spotted cougars. One cat was even seen by conductors loping alongside a train near the Bad River (Benzon 2000). The Bad River in southern Haakon County is a tributary of the Missouri, and contains extensive intact stands of cottonwood and willow (Benzon 2000).

Historically, east of the Black Hills prairie lions inhabited the riparian bottomland forests of larger rivers and the surrounding bluffs in what is now South Dakota. There are confirmed sightings of mountain lions in the 266-square kilometer Badlands National Park, about sixty-six kilometers east of the Black Hills (Benzon 2000). The rugged clay and sandstone buttes of the park lie within two heavily dissected river valleys, the Cheyenne and the White. The Bad River Valley lies only thirty-three kilometers north of the White River.

There are recurring reports of a puma living near the little town of Kyle, in Shannon County on the Pine Ridge Indian Reservation, a few miles southeast of Badlands National Park (Beck 2000). The large felids also have a growing prey base on the Pine Ridge Reservation, including an increasing population of several hundred elk that call the "checkerboard" of public and private land home (Beck 2000).

Current puma field research

The 29,200-hectare Custer State Park lies within a first-ever Black Hills cougar study area, stretching from the town of Hot Springs in the southern mountains, north to Pactola Reservoir, and west to Wyoming (Secske 2000). The study, conducted by a doctoral candidate from South Dakota State University in cooperation with the Department of Game, Fish & Parks, commenced in July of 1998 (Secske 2000). In January 1999, the first cats were radio-collared (Jenks 2000). There have been a few setbacks. A large adult male killed one of the radio-collared juvenile males in 1999, southwest of Custer Park near the town of Pringle (Lewis 1999). In addition, a thirty-two kilogram radio-collared female lion was shot and killed illegally by a poacher in December of 1999, and its collar was tossed into the Cheyenne River (Jenks 2000). In September 2000, the poacher turned himself in. Currently, nine cats are radio-collared to monitor their movements, including one male kitten and one female kitten. The cubs had ear tags placed on them (Jenks 2000). The research continues through 2000.

Juvenile riparian dispersal to the Rawhide Buttes of Wyoming

The Cheyenne and White Rivers likely act as "migratory conduits" for juvenile pumas on the move from their mothers' territories in the southern Black Hills and the Badlands. Research in the Santa Ana Mountains of southern California, demonstrated that juvenile felids move to new territories along river routes that have sufficient cover (Beier 1995). Pumas in the Santa Anas live in a 3,300-square kilometer mountain island habitat surrounded by the "urban sea" of southern California with patch and edge corridors to surrounding smaller hilly environments. The

best routes for pumas to move through populated areas were along streams that had a forest or shrub cover at least 400 meters wide over a distance of one kilometer or more (Beier 1995). Some juveniles successfully moved from the Santa Anas to nearby smaller ranges.

Like the Santa Ana Mountains, the Black Hills are surrounded by smaller ranges of buttes and hills, including the Pine Ridge, Wildcat Hills and the Rawhides Buttes. Intermittent tributaries of the Cheyenne River begin down in the hilly Rawhide Buttes. One such tributary is Old Woman Creek. Old Woman Creek is an intermittent stream that runs north along Highway 85, with its origins in the Rawhide Buttes. The creek still contains mature stands of cottonwood trees covering a floodplain nearly a kilometer wide in places—the remnants of a once lush riparian forest. The stream flows north and joins Lightning Creek, a tributary of the Cheyenne in Wyoming.

Old Woman Creek still contains sufficient cover to allow for the movement of cougars migrating from the Black Hills into the Cheyenne River Valley, and then south along Woman Creek to the Rawhide Buttes. Mountain lions are being spotted in the ponderosa pine-covered Rawhide Butte country south and west of Lusk (Anon. 1998). Some similar habitat pockets also lie north of town. The state transplanted elk into the nearby buttes, and people report not only increasing numbers of lions, but some elk predation (Anon. 1998).

The Buttes lie only around sixty-five kilometers east of the resident lion population within the Laramie Mountains, the easternmost range of the Rocky Mountains in Wyoming. It is possible that some juvenile cougars are following streams east out of the Laramies onto the Great Plains east of I-25, not far from Rawhide Buttes. While the rocky Buttes extend over 45 kilometers north to south, they only slightly over a kilometer wide in places—a true island habitat in a "sea" of short-grass prairie.

Puma reports in the Pine Ridge and southern Nebraska

A likely riparian corridor through sixty kilometers of prairie from the Black Hills to the Pine Ridge is Hat Creek. Hat Creek originates in the Pine Ridge west of Nebraska's Fort Robinson State Park, and flows north, joining the Cheyenne just west of Angostura Reservoir along the southern edge of the Hills. Hat Creek also flows through Buffalo Gap National Grassland in South Dakota and Oglala National Grassland in Nebraska, just north of the Pine Ridge, and a few kilometers east of Harrison.

Harrison is where an injured young male puma met its demise in May 1999. The 55-kg felid evidently had been hit by a passing car in the Pine Ridge, and suffered internal bleeding due to broken ribs and a punctured lung (*The Crawford Clipper* 1999). This likely disoriented the cat, and it wandered right into town, where a conservation officer with the Nebraska Game and Parks Commission dispatched it (Murphy 1999). This male is one of four mountain lions killed in Nebraska in the 1990s, with two mortalities in 1999 alone. Prior to the 1990s, there were no officially recorded cougar deaths in Nebraska in the 20th century (Hammel 1999). There is evidence, though, that pumas existed in the Pine Ridge in the 1960s (Brashears 2000). At that time Brashears and his father owned raccoon hounds and hunted in the Pine Ridge. On one occasion the hounds pursued a puma, whose existence was confirmed by clear tracks in mud (Brashears 2000).

In recent years, a young female cougar was shot on private property in the Pine Ridge near Crawford in 1991 (Andelt 1998). Two recent deaths were south of the Pine Ridge, along the western edge of the much larger "Sand Hills" ecoregion. In Sept. 1999, a landowner shot a 34-kg juvenile male cougar on his property near the town of Berea (Hammel 1999). Since 1995, pumas have been legally protected in Nebraska, and it is illegal to shoot these cats unless they pose a clear menace to humans, livestock or pets (Hammel 1999). The fourth fatality involved a passing freight train near the tiny town of Angora in April of 1996 that ended the life of a young male cougar (Andelt 1998).

Credible sightings of pumas within the past 4-5 years are also being received from southern Nebraska east of the Panhandle. Several large canyons, including Deer Creek, Well and Cottonwood Canyons lie 35-50 kilometers south of the Platte River, near the town of Curtis (Brashears 2000). Red cedar, an invasive exotic, has spread rapidly through these canyons on private ranchlands, providing thick cover for pumas. There are also signs of elk reestablishing themselves in the canyons (Brashears 2000). It seems likely that juvenile mountain lions follow the rugged bluffs of the North Platte River and tributaries southeast from the Pine Ridge and Sand Hills.

Conclusion

Field studies of pumas in the Black Hills confirm the big cats roam huge territories. As their population grows in the greater Black Hills ecosystem, rural landowners will increasingly face the dilemma of juggling their economic interests with state and federal laws designed

to restore protected predator populations. Since the carnivore was elevated from "varmint" status and granted full protection in the 1990s, habitat loss on private land ringing these Great Plains environments remains their greatest threat. If that can be protected, so, ultimately, can the puma.

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Line art by Robert Savannah, courtesy U. S. Fish and Wildlife Service.

News From Zoos

Zoological Society of San Diego Receives $6.6 Million Gift

The Zoological Society of San Diego recently received a $6.6 million dollar donation from San Diego Padres majority owner John Moores. This gift, the largest the society has ever received from an individual, is to be used for the conservation of endangered animals. Approximately $4 million will be spent on expanding the two-acre panda enclosure, and the remainder will be used to help build the new $20 million home for the Center for Reproduction of Endangered Species (CRES), which is the research branch of the zoo.

"We're absolutely thrilled with the gift," Douglas G. Myers, the society's executive director, said. "It sends a message out to the rest of the world that we're serious about pandas." Home to three of the five giant pandas currently in the United States, the San Diego Zoo has been active in panda behavior and reproduction research. Recently at the zoo, Hua Mei, the first North American-born panda to survive more than several days, celebrated her first birthday. Her birth was due largely to artificial insemination techniques developed at the CRES. Researchers at the CRES have not only had success with pandas, but also with breeding other high-profile species such as cheetahs and the California condor, to name just a few. In addition, the Society is involved in many *in situ* projects, both in this country and overseas. [Adapted from an article by James Steinberg, *San Diego Union-Tribune*]

Cincinnati Zoo's Ocelot Birth a First

An ocelot kitten produced by embryo transfer was recently born at the Cincinnati Zoo and Botanical Garden. Named Sihil, a Mayan word meaning "to be born again," the kitten was born through a procedure that may assist in increasing the genetic diversity of these medium-sized cats.

As Ken Kaemmerer of the Dallas Zoo says "Embryo transfer is still a fledgling science and any success is reason for celebration." Kaemmerer is the coordinator of the Ocelot Species Survival Plan – a cooperative effort of American Zoo and Aquarium Association (AZA)-accredited institutions whose goal is to save endangered species through captive breeding, habitat preservation, public education, and supportive research.

The zoo's Center for Research of Endangered Wildlife (CREW) has been working in Brazil to produce and freeze Brazilian ocelot embryos. After being transferred to the United States, the embryos will be implanted into a generic ocelot, resulting in a purebred Brazilian kitten.

Ocelots have been on the endangered species list of the U.S. Fish and Wildlife Service since 1972, after being hunted to near-extinction for their spotted coats. Most of the 120 ocelots that are currently housed in North American zoos are "generic," meaning that they are of unknown ancestry, and the ability to transfer embryos is expected to increase the genetically defined population. [Adapted from an article by Christine Oliva, *Cincinnati Enquirer*]

AZA Institutions Receive IMLS Grants

Two AZA-accredited institutions recently received grants from the Institute of Museum and Library Services (IMLS). The National Aviary in Pittsburgh was recently awarded a $40,000 competitive matching grant to develop early detection and identification of the bacteria that causes avian tuberculosis (mycobacteriosis) . Avian TB can be a significant problem in avian collections because the disease is difficult to diagnose and treat. IMLS funds for the two-year research project will provide support for a laboratory technician as well as money for new equipment. The research will be conducted under the direction of Dave Zaitlin, Ph.D., the National Aviary's geneticist and Dr. Robert Wagner, V.M.D., consulting avian veterinarian. Research will employ polymerase chain reaction (PCR) and DNA sequencing techniques to detect mycobacteria in living birds before they show clinical signs of disease.

The Cincinnati Zoo was also the recipient of a $3,785 grant from IMLS to further research conducted at the zoo's Center for Research and Endangered Wildlife (CREW). The grant will aid in reviving populations and provide materials for research and germ plasm storage by addressing reproductive and conservation problems of 23 highly endangered plant species. This collaborative effort between the Zoo, the Center for Plant Conservation (CPC) and nine gardens within the CPC network has broad applications within the field of plant conservation.

Information for News from Zoos *is provided by the American Zoo and Aquarium Association.*

News and Events

On-line species database

The Biological Resources Research Center of the University of Nevada at Reno provides a resource on the Animals of the Great Basin, found on the internet at www.brrc.unr.edu/data/animals/index.html. The site offers state species lists, distribution maps, and photos. An annotated bibliography on Trout directs users to in-depth information on that taxa. Although thorough, not all fauna are represented.

Handbook for Landscape-scale Planning

The Nature Conservancy announces the release of the second edition of *Geography of Hope: a Practitioner's Handbook for Ecoregional Conservation Planning*. This new edition expands on the experience accrued by TNC and other organizations. It discusses identifying conservation targets at multiple scales, setting goals for communities and ecological systems, conceptualizing functional sites and landscapes, selecting conservation targets in freshwater systems, and the site selection or assembly process. The handbook is available at www.consci.org/forum/front.asp. CD-ROM format is also available; contact Monica Perez, FAX (703) 525-8024, mperez@tnc.org.

Wildlife Conservation Conference

The 2001 annual meeting of the Western Section of The Wildlife Society, entitled "Conserving Wildlife at the Start of the 21st Century: Politics and Realities," will be held 22-24 February 2001 in Sacramento, California. Workshop topics include habitat mapping, sage grouse, declining amphibians, and media relations. Technical sessions include seabirds, large mammals, wetlands and waterfowl, habitat restoration, and reptiles and amphibians. For more information see http://www.tws-west.org or contact Barry Garrison, California Department of Fish and Game, FAX (916) 653-1019, bagarris@dfg.ca.gov.

Regional Conservation Assessment

The Conservation Biology Institute (CBI) recently launched the Pacific Northwest Conservation Assessment at www.consbio.org/cbi/assess/assess-main.htm. It includes information about 40 terrestrial ecoregions of the Pacific Northwest region. Information includes historic and current natural and cultural conditions, political influences on conservation, threats, and current research and planning. For more information, please contact Nick Slosser, nslosser@consbio.org.

Announcements for the Bulletin Board are welcomed. Some items have been provided by the Smithsonian Institution's Biological Conservation Newsletter or found in the August 2000 Society for Conservation Biology Newsletter.

Endangered Species UPDATE

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