BOB MILLER
Governor

STATE OF NEVADA

CATHERINE BARCOMB
Executive Director

COMMISSION FOR THE PRESERVATION OF WILD HORSES

Stewart Facility
Capitol Complex
Carson City, Nevada 89710
(702) 687-5589

AGENDA FOR WILD HORSE AND BURRO FORUM

Overnight Accomodations at the:
Sands Hotel Casino
345 N. Arlington Ave.
Reno, Nevada 89501
Telephone (800) 648-3553

Forum Location:
Washoe County Commission Chambers
1001 E. 9th St.
Reno, Nevada

SUNDAY MAY 5, 1991

9:00 AM - Palomino Valley Corrals
Fred Wyatt, Palomino Valley Adoption Center
Mary Ann Simonds, Whole Horse Institute

Discussions on Wild Horse Behavior, Selection, and Relationships. Handling Techniques Will be Demonstrated.

7:00 PM - Registration for Speakers and Agency Participants
Sands Hotel and Casino

Naomi Tyler, Boise, Idaho...A Presentation on Mustang Lady, 1990 Endurance Horse of the Year and National Endurance Champion 1990

MONDAY MAY 6, 1991

8:00 AM Opening Remarks, Objectives, Introductions...Dan Keiserman, Las Vegas, Nevada, Chairman, Commission for the Preservation of Wild Horses

Dr. Donald Siniff, Professor, Department of Ecology, Evolution, and Behavior, University of Minnesota...Fertility Control in Wild Horses

Dr. Walt Conley, Professor, Department of Biology, New Mexico State University...Modeling Wild Horse Populations

Dr. John Turner, Associate Professor, Dept. of Physiology and Biophysics, Medical College of Ohio...Immunocontraception

12:00 PM LUNCH

1:00 PM Dr. Richard Sanford, DVM, Reno, Nevada...Tubal Ligation

Dr. Gus Cothran, University of Kentucky... Strategies for Genetic Management of Feral Horse Populations on Public Lands in the United States

Josh Warburton...Managing for Herd Integrity Adaptability VS Adoptability, Herd/Heritage of the Horse

Dr. John Grandy, PhD, Vice-President, Wildlife and Habitat Protection Division, Humane Society of the United States...Criteria for Fertility Control and Wild Horse Management

4:30 PM PANEL DISCUSSION

TUESDAY MAY 7, 1991

8:00 AM Dr. Wayne Burkhart, Associate Professor,University of Nevada-Reno... Historical Perspective of the Range

Floyd Rathbun, SCS Range Conservationist Nature of the Range/Plant Communities ...Overview of Range Health

Brad Hines, Range Program Leader, BLM-Nevada State Office...Review of Decision Making Process through Allotment Evaluation

Nancy Whittaker, Animal Protection Institute ...Interior Board of Land Appeals Decision

Honorable Bruce Harris...Interior Board of Land Appeals

12:00 PM LUNCH

1:00 PM Tom Pogacnik, WH&B Specialist - Tonopah Resource Area - BLM...Managing Wild Horses and Burros in Nevada

Kelly Grissom, WH&B Specialist - Kingman Resource Area - Phoenix, AZ BLM...Slide Presentation/Burros

Bill Phillips, WH&B Specialist, Susanville, CA, BLM, and Tracy Irons, Carson City, NV, BLM, ...Modoc/Washoe Experimental Stewardship Program

Valerie Dobrich, Wild Horse and Burro Specialist, BLM-Battle Mountain District and Fred Reed, Western Air Research...Pioneering Use of the Maule 5 Fixed-Wing for Wild Horse Aerial Surveys

Rick Sorenson, Assistant to the President, Wild Horse Sanctuary, CA

Bob Stager, WH&B Specialist, Las Vegas District, NV,... Perception VS Fact

WEDNESDAY MAY 8, 1991
8:00 AM United States Forest Service

1) Brian Stout, Forest Supervisor, Bridger-Teton National Park..."Wyoming Honor Farm Training Wild Horses for the National Forest"

2) Doug Sorenson, Supervisory Range Conservationist, Ruby Mountains Ranger District, and Mitch Bulthuis, Range Conservationist Humbolt National Forest, CA..."Cherry Springs Wild Horse Territory as a Recreational Opportunity and MORE!"

3) Bill Bramlette, District Ranger, Mono Lake Ranger District, Inyo & Toiyabe National Forests, CA..."Montgomery Pass Wild Horse Territory"

Gordon Olson, Chief of Division of Resources Management, Assateague Island National Seashore, Virginia...Management of Feral Horses on Assateague Island

Robert P. McQuivey, Habitat Division Chief, Nevada Department of Wildlife...Opportunity for Making Wild Horses, Burros, and Wildlife Uses Compatible

Demar Dahl, 1st Vice President... Nevada Cattlemen's Association

John Boyles, Chief, Division of Wild Horses and Burros, BLM, Washington, D.C....Looking at New Horizons

State of Nevada

Commission for the
Preservation of Wild Horses

WILD HORSE AND BURRO FORUM

May 5 - 8, 1991
Reno, Nevada

Dr. Wayne Burkhart, Associate Professor
University of Nevada-Reno

Historical Perspective of the Range

[Presentation not available.]

Floyd Rathbun, SCS Range Conservationist

Nature of the Range/Plant Communities and Overview of Range Health

[Presentation not available.]

Brad Hines, Range Program Leader
Bureau of Land Management - Nevada State Office

Review of Decision Making Process through Allotment Evaluation

The Bureau of Land Management in Nevada is implementing multiple use management on nearly 48,000,000 acres of public land under the directio of fourteen existing Land Use Plans (LUPs) that have been prepared throughout the State. Generally these LUP's correspond to the twelve Resource Area boundaries that occur within the six district offices.

Beginning in the late 1970s and continuing in the late 1980s the BLM in Nevada was in an intensive land use planning phase. The emphasis which began this effort was the court settlement (NRDC v. Morton), agreed to between the National Resource Defense Council, the BLM and Federal Court wherein, the BLM was to prepare 212 Environmental Impact Statements (EISs) to analyze the impacts of grazing domestic livestock on public lands.

The proposed action in the early planning efforts which wre analyzed in the EIS's contained, in part, a forage allocation to livestock, wild horses and burros, and wildlife. These proposed actions used "one point in time range land inventories" as a data base to determine the overall carrying capacity of the range and proposed various allocations of the capacity between varying uses. This policy became controversial and centered around the validity of using "one point in time inventories" as the main criteria for allocations. As a result of this controversy in 1982 the BLM Director issued a new policy that required adequate monitoring data to be required in addition to the "one point in time inventory" data when changes in livestock grazing preferences were implemented.

As a result the 14 LUPs for the State made the following types of decisions:

1. Livestock Grazing
   a. Identified objectives for vegetation goals
   b. Determined where livestock would and would not be allowed
   c. Identified the degree of range improvements deemed to be necessary to meet LUP objectives
   d. Identified kind and class of livestock to be permitted by area
   e. Identified goals for authorized levels of livestock use
   f. Identified "initial levels" of authorized livestock grazing
   g. Identified that "monitoring" would be used to adjust livestock graxing if it was determined that the existing authorizations were not meeting the LUP objectives.
2. Typical Discussions regarding Wild Horse and Burros
   a. Identified Herd Management Areas
   b. Identified "initial levels" of Wild Horse and Burros
   c. Identified that "monitoring" would be used to adjust Wild Horse and Burros levels in order to determine the appropriate management level that would be allowed to graze on public lands.
3. Wildlife
   a. Identified habitat objectives by kind and area of wildlife
   b. Identified "reasonable numbers" of wildlife by kind and area after consultation with the department of wildlife
   c. Identified aquatic habitat objectives for certain fishable streams, etc.

This approach to our LUP decisions was again challenged in Federal District Court (NRDC v Watt) or the Reno Graxing EIS lawsuit. This suit challenged both the National Environmental Policy Act (NEPA), and the Federal Land Policy and Management Act (FLPMA), compliance of BLM LUP/EIS. They also alleged that the BLM policy of not using "inventories" for allocation was illegal. That our LUP decisions were "delaying indefinitely management actions needed to improve unacceptable range conditions."

The Federal Judge ruled that he ". . . refused to become the range manager for the State of Nevada." He also stated the BLM had clearly stated that "monitoring" would be used to determine what changes in existing management of the public lands would be implemented. He "invited" the plaintiffs back into his court room if the BLM did not implement their approved LUPs.

Subsequent to this ruling the BLM Director issued a policy direction which stated that within 5 years of issuance of the Record of Decision-and the Rangeland Program Summary the BLM would do the following on all Intesive (I) and Maintenance (M) category allotments:

1. establish multiple use allotment specific objectives

2. implement a monitoring program to assess the obtainment or lack thereof in meeting the LUP objectives

3. based upon an analysis of the monitoring data either

    a. enter into a livestock use agreement which implements the needed changes in existing management or

    b. issue a grazing decision which implements the needed changes in livestock grazing management or

    c. document the file if monitoring establishes that existing management is meeting the LUP objectives

To meet the goals established by BLM policy the Nevada BLM has implemented an interdisaplinary allotment evaluation policy or affected intersts to become involved in the process.

At the beginning of the fiscal year each resource area sends a listing of the allotment evaluations that they will be working on to their mailing list of interested publics. This letter requests that if you want to become involved or if you want to identify yourself as an affected interest on a particular allotment to notify the authorized office in writing. Additionally the letter requests that if you have information that will assist the BLM in determining if the current management is or is not meeting the LUP objectives to please provide this information.

As this list is developed the area office will then keep you involved in the consultation, cooperation and coordination process on a particular allotment (s).

The allotment evaluation process consists of five basic parts which are:

1. What do you want? (Allotment specific objectives for those LUP objectives that are or may be impacted by grazing animals)

2. Data analysis

3. What's broke (and what broke it) and what's not broke?

4. How do you fix what's broke?

5. Management Decision

At the conclusion of the evaluation process Nevada BLM uses a Multiple Use Decision process to establish:

1. The terms and conditions of the grazing permits

2. The Appropriate Management Level for Wild Horses and Burros that occur within the allotment

3. Any rcommendations for wildlife populations or habitat management actions required if it is determined that these actions are necessary F*

This format addresses the above items in a manner that must be consistent with the LUP for the area.

Should any protests or appeals be initiated as a result of these decisions it is intended that they all be consolidated for the purpose of holding one hearing on the issues. The rationale for this is that the issues of livestock grazing, wild horse and burro management and wildlife issue are all interrelated. The basis of the decision is monitoring information collected on the resources of the allotment. Any adjudication of these decisions should consider all the users of the vegetation resources, rather than seperate forums adjudicating single issues.

The Honorable Bruce Harris, Deputy Chief Administrative Judge
Department of Interior Board of Land Appeals

I. History of the Department of the Interior's Quasi-Judicial Review System

A. Creation of the Department of the Interior — public land adjudications.

B. Evolution of the Administrative Review Process.

1. 1849-1946 Direct Secretarial Review for Appeal.

2. 1947-1970 Delegations-Office of Appeals and Hearings in BLM. Right of appeal to Secretary — delegation to Solicitor.

3. 1970-1991 Office of Hearings and Appeals (OHA) — delegation at 43 CFR 4.1- authorized representative of the Secretary.

II. Organization of OHA

A. Director.

B. Hearings Division, comprised of Administrative Law Judges.

C. Boards of Appeal: IBLA, Interior Board of Indian Appeals (IBIA), Interior Board of Contract Appeals (IBCA), AD Hoc Appeals Boards.

III. IBLA's Jurisdiction.

A. Principal agency reviewed is the Bureau of Land Management.
Decisions commonly appealed involve: Oil and gas leasing, mining claims, grazing, Alaska Native claims, land exchanges, desert land entries, timber sales, color-of-title, rights-of-way, and wild horse and burros.

B. IBLA also has jurisdiction over decisions of the Director, Minerals Management Service (MMS);decisions of the Director of the Office of Surface Mining Reclamation and Enforcement (OSM), and selected decisions of the Bureau of Indian Affairs (BIA).

C. Jurisdictional requirements for a valid appeal of a BLM decision:

1. Under 43 CFR 4.410(a), "Any party to a case who is adversely affected by a decision of an officer of the Bureau of Land Management * * * shall have a right of appeal to the Board * * *. (emphasis added).

2. BLM action not appealable to the Board:

a. A decision approved by the Secretary. 43 CFR 4.410 (a) (3). Approval by the Secretary deprives IBLA of authority to review agency actio regardless of when Secretarial approval occurs.

b. A decision approved by an Assistant Secretary, if such approval occurs prior to the filing of an appeal with the Board. Blue Star, Inc., 41 IBLA 333 (1979).

c. Land classification decisions. 43 CFR 4.410(a) (1).

d. Resource management plans. 43 CFR 1610.5-2(b); see also *Oregon Natural Resources Council,* 78 IBLA 124, 127 (1983). Implementation actions taken under an approved resource management plan are appealable, however.

e. BLM decisions (grazing) which must first be appealed to an administrative alw judge under 43 CFR 4.470 and 43 CFR Part 4100.

IV. IBLA's Internal Procedures.

A. Make-up of IBLA.

1. Board is comprised of 11 members designated as administrative judges, one of whom serves as Chief Administrative Judge and one who serves as Deputy Chief. All judges are attorneys, appointed by the Secretary or the Director, OHA.

2. The Board ahs 15 staff attorneys, whose principal duty is to draft proposed decisions for the Board. Another attorney, James Roberts, srves as the Docket Attorney. He assigns cases, advises the Chief Administrative Judge, and handles procedural questions for the Board. He may be reached at 703-235-3750.

B. Caseloads as of April 1, 1991, was 665.

1. Of those, 7 are wild horse and burro cases.

2. The three largest categories of cases pending before the Board are mining claims (142), mineral royalties (90), oil and gas (83).

3. Average time for disposition is 9.0 months from date ripe for decision. Many cases are handled in a summary manner on procedural grounds.

C. Filing an Appeal.

1. An appeal in a wild horse and burro case is initiated by filing a notice of appeal in the office of the BLM officer who made the decision within 30 days of the date of receipt of the decision. The case file is then forwarded to the Board.

   a. Compare with BLM grazing decision — appeal filed with BLM authorized officer who made decision within 30 days of receipt — appeal fowarded to State Director — State Director has 30 days in which to file a motion on behalf of authorized officer. Appellant has 20 days to file a response to the motion. Case record, appeal, motion and any response forwarded to the Hearings Division, Salt Lake City. 43 CFR 4.470.

2. Under 43 CFR 4.21 (a), the timely filing of notice of appeal stays the effect of a wild horse and burro decision. Exceptions exist in other categories of cases such as oil and gas operations, rights-of-way, and special recreation use permits.

   a. Requests to put decision into effect.

   b. Requests to expedite. There are no regulations that relate to this for wild horse and burro cases.

3. Upon receipt of the case file, the appeal is docketed.

D. Case Assignment.

1. Assigned on a monthly basis to a panel of two judges.
Assignments are purely rotational. Pre-assignment screening.

E. Preparation of Decisions.

1. Special concurrences.

2. Dissents.

3. Ex parte rules — 43 CFR 4.27(b).

F. Circulation of Draft Decision to Entire Board.

1. Holds.

2. Board meetings.

G. Issuance of IBLA Decision.

1. IBLA decisions are precedential. See 5 U.S.C. § 552(a) (2).

V. Post — Decision Review.

A. Reconsideration — 60 day time limit. 43 CFR 4.403.

B. Review by the Director, OHA, or the Secretary. 43 CFR 4.5.

C. Judicial Review.

Nancy Whittaker,
Animal Protection Institute

Interior Board of Land Appeals Decision

I've been asked to explain the significance of API's appeals and the IBLA rulings on roundup policies. In 1988, API charged that BLM's roundups violated four points of law. We said BLM was removing wild horses illegally. Perhaps the most significant thing about those charges is the fact the Department of Solicitors refused to defend BLM.

The June 1989 ruling found that yes, in fact, BLM's removal plans in Nevada did violate the law on all four counts. Forty thousand horses were removed between 1985 and 1988, the majority of those removals violated the law.

The second most significant fact about our appeals is that our arguments came directly out of BLM's own pre-Reagan wild horse program was in line with the law — that program was changed. That change took it out of line with law, the IBLA rulings put it back in.

The most significant fact about that is that no instructional memo has gone to the field to implement the ruling. Two years have gone by and still there is no instructional memo.

What was the change that took the BLM's wild horse policies and their program so off course and how did it come about? An agenda was launched inside BLm during the Reagan years — it was to cut the wild horse population in half before the permit reviews were scheduled to begin at the end of 1988, then cut the remaining population in half again. To carry out this agenda required three things: funds, legal authorization, and kicking Dahl v Vlark under the rug.

Funds were obtained by stalling the appropriations bill in the Senate subcommittee to force the emergency funding measure. This measure was amended in Committee to contain 20 million dollars earmarked for the removal of 34,000 horses in two years time. The emergency measure is not debated on the floor and cannot be amended from the floor. Forcing the continuing resolution by holding up the regular appropriations bill was done three years in a row to provide the money for roundups.

The authorization was provided by proposing a rulemaking to change regulations then allow interim action to be taken on the proposal. By stalling the finalization of the rulemaking for 16 months, some 35,000 horses were removed as interim action. The Proposed rule change was to change the statutory wording of the definition of excess, the justification for the roundups as interim action in 1985 and 1986 used the new definition. When the rulemaking was finalized, BLM was instructed to return to statutory language. Only Congress can change the wording of a law, yet BLM removed some 30,000 horses by doing this. Had Dahl

v Clark been followed, BLM could not have removed 40,000 horses. Is it any wonder the Department of Solicitors refused to defend them?

In the 1987-88 roundups, the justification was to reduce populations to the numbers that were in the land use plans as appropriate management levels. In Nevada, these were set by agreement with ranchers and CRMP groups. The laws require AML be based on monitoring and so these numbers in the land use plans were only starting points to begin monitoring in order to determine appropriate management levels. Since BLM did not do the monitoring, they could not justify a removal based on arbitrary numbers.

The IBLA rulings threw out these arbitrary management levels requiring that appropriate management levels be based on monitoring the actual use by horses, current range conditions.

In the course of this litigation, BLM attempted to put the roundups into full force and effect. Since the Solicitors refused to defend them, BLM then violated its own contract procedures and hired a group of pre-selected individuals to do a spot check evaluation of range conditions in the seveal HMAs involved. their report was submitted to IBLA along with a policy statement claiming the Secretary had the authroity to remove horses at his own discretion. IBLA said No, that the sole and exclusive authority is in the law. In fact it is in the very paragraphs that BLM removal plans deleted by a ". . . misquote of the law." IBLA has listed some 15 or 16 clear findings in the course of their rulings that are directives and guidances for implementing the program and that makes them significant only to the extent they're followed.

Since the 1989 ruling disrupted that original agenda to reduce the population in half before the evaluations, then in half again during the evaluations, BLM was not going to implement that ruling. Instead of the wild horse population being down around 18,000 as listed in the land use plans, headed toward 10,000 during evaluations, which was the plan for Nevada, there were still 27,000 horses out there in 1989. That is not where BLM wanted to be going into those evaluations if they were going to save livestock preference at 1964 levels. And saving 1964 preferences was teh whole point of that mass removal policy.

So instead of issuing an instructional memo to bring the program back into line with law, BLM continued to submit removal plans based on the arbitrary management numbers set in the land use plans by CRMP committees. API appealed the 1989 removals using the same arguments as before and IBLA ruled again in October 1990 reiterated the same rulings as before. Still no instructional memo.

IBLA declared they will affirm a BLM decision to remove horses only where the removal is predicated on an analysis of grazing utilization, trend in range condition, actual use by horses, and other factors that demonstrate the removal is necessary to restore the range and prevent deterioration. The two significant words in this are monitor actual use and remove to restore the range. What this says is that BLM may reduce horses only when horses are shown to be the cause of damage to the range or are the cause of overutilization. Pinpoint cause, remedy damage to the range or are the cause of overutilization, not save 1964 permit levels, is the purpose of monitoring required by Nepa.

So, then, a new head solicitor was named to the Washington office and API was warned from sources inside the Department of Interior that there would be a change in teh rulings from now on and that we needed to be careful because we weren't going to like them. This warning is perhaps one of the more significant facts about the IBLA — they work for the Secretary.

Now Wyoming and Colorado initiated removals in order to cut populations before their allotment evaluations. But unlike Nevada, the other states wrote herd management area plans early and they did set their appropriate management levels based on range monitoring and inventorying information available in the early 1980s. Now the question in these cases is how current is their current assessment of range condition

and is an AML set on monitoring that dates back six or seven years still valid in 1991; and exactly what monitoring and inventorying do they need today to show this in order to reduce the number of horses.

At first glance it looks like the most recent ruling appears to contradict their earlier finding which said you can't restore current range condition by returning to a previously set AML. But they allowed Wyoming and colorado to reduce down to AMLs set in the land use plan six and seven years ago and to remain the appropriate management because these levels were originally established on range monitoring information. the rulings say they will allow it only when there is a program of continued monitoring so that actions are taken only in response to current monitoring data. This circuitous statement amkes little sense to us. Either they reduce horses down to AMLs set in land use plans and throw out the whole idea of monitoring and do it strictly by arbitrary numbers which is a violation of NEPA, FLPMA, and the Wild Horse law or they only reduce horses in response to monitoring current usage and a determination of excess in keeping with law. You cna't have it both ways. But in fact they got it both ways. They put one thing in writing while granting the opposite in actuality.

IBLA's latest ruling also says it's not up to BLM to prove that horses cause overutilization and damage before they can remove them, it's up to the public to provide a preponderance of evidence to show BLM has erred when they declare that excess horses exist in a given area.

Just when IBLA's ruling are getting close to what we would call an erosion of the constraints and restrictions on removals, the American Horse Protection Association's federal court ruling says BLM's collection and analysis of data must <u>clearly show</u> the need for adjustments in the numbers of wild horses. This doesn not say its up to the public to refute BLM but up to BLM to convince the public. We want those words "data must clearly show the need for a removal" in an instructional memo and we want that memo now.

The federal ruling also says when the AML is listed in a land use plan then the plan must be amended with an environmental assessment before that AML can be changed and the reduction made.

And perhaps most important of all that federal ruling says BLM must follow its own policies and procedures. Thus far in our experience we have never seen BLM do that unless it serves a delay tactic contraray to wild horse interests. Both BLM and the public need to recognize that until they follow their own procedures they will continue to have conflicts and controversies and they need to stop blaming the public for their own self imposed problems. The refusal to put court orders and IBLA rulings into field instructions is our major complaint.

The idea of an administrative appeals process is a good one. However, we fear that increased political pressure on IBLA will in fact dictate future ruling and that the warning to us from inside BLM is true.

So in closing I want to say taht the real significance of the IBLA rulings is in the instructional memo that goes to the field and even then that is only part of the picture, these rulings which require monitoring and inventorying based on actual use, current data are significant in the allotment reviews only to the extent that wild horse groups demand they be followe. It is up to wild horse groups to remind BLM, the public, and Congress that 40,000 horses have already been removed during this monitoring period. That is a reduction of some 480,000 AUMs of actual use. Where are the actual use livestock reductions?

Tom Pogacnik, Wild Horse & Burrow Specialist
Bureau of Land Management - Tonopah Resource Area

Managing Wild Horses and Burros in Nevada

[Presentation not available.]

Kelly Grissom, Wild Horse & Burro Specialist
Bureau of Land Management - Kingman Resource Area, Phoenix, AZ

Slide Presentation on Burros

As was said this morning, for example, the genus originated in North America. It's a relatively new species or genus — maybe a million and a half years old. For the last million years we had nine ice ages that opened up a gap between North America and Asia. These animals were able to move across, along with camels, into Asia at the same time. So the genus spread down through Asia as a relatively new species, but earlier fossil evidence they've found so far was about 15,000 years ago and that was in North Africa.

When those species came across into North America, they came with their own predator, and that was homo sapiens, or what people like to talk about as a projectile predator. So there wasn't a structure in the predators that existed here; new predators came and the biggest one was us. So these animals evolved in a North African desert in an environment much more severe than what we have around Yuma, where you have a two- to four-inch rainfall zone and temperatures can run higher than 25 degree. To a wild burro this is still a relatively temperate climate and they're very well adapted to it.

In wild burros you have two main sub-species of the original burros: the grey burro, which is the bigger of the two, but is characterized by leg barring and the Nubian wild ass, or the smaller animal, also is grey but he is characterized by a dorsal stripe along his back. Both of these characteristics show up in our domestic and, hence, our wild burros so both wild sub-species are predecessors to what we have today.

The animals became domesticated about 6,000 years ago. The first equine domesticated was probably the Asian wild ass, about 9,000 years ago, probably initially for meat. Later, they became beasts of burden. About 3,000 years later the African wild ass was domesticated. He was far superior so he just generally replaced the Asian wild ass and then later was replaced by the horse as the domestic animal of choice for power and speed.

The burro was retained because of its docility and its ability to work with humans. It kind of spread with humans along the Mediterranean over into Spain. When they got to Spain, then they were transferred over here with the Spanish invasion. Early on the missionaries used them as beasts of burden. Indians were allowed to ride burros, or use burros, but not horses. It was kind of like a poor man's pick-up. There was a stigma associated with it. Priests could ride them and claim poverty, even though they were really pretty advanced.

Well, then, anything that made a steak at that time was probably consumed by the native Americans. They were still active and, if a burro got off the outfit, he was probably eaten shortly thereafter.

The real introduction of wild burros into the southwest probably came at the discovery of gold. The southwest lends itself to mineralizations because of the high volcanic activity. In about 1852 or so, gold was being discovered along the Colorado River so in came the prospector with his pack burro. The pack burro, being the poor man's pick-up, was also very well adapted to the southwest, much more so than, say, than a horse. He could survive out there. The prospector didn't have to worry about feed or much of anything else. The thing about the burro was that they have very strong personalities. Prospectors became buddies with them. I mean, if you're out in the rocks with an animal for three, four months, he becomes a pretty close social mate.

It's just like being in the mining industry. The mines are discovered, mineral deposits are depleted, they'll eventually run out and the mines are closed. The towns associated with those mines were abandoned and became ghost towns. The burro and other garbage were just left on the site. However, it is very well adapted to the environment and it thrived. Most of the garbage now, bottles and cans, we collect. It seems like burros we do, too. There were no controls. The only natural predator was us. Other than that, there were no predators in the southwest that could handle the population, so the population continued to boom.

Up through about the late 1920s, early 1930s, we're getting into the Depression. Money is low. People would gather up these animals. Even if they'd only bring three cents a pound, if a couple of fellow could put a boxcar load of burros together, they'd end up with $15 or $20. In the Depression, that was quite a bit of money. So there was some sort of control just based on economics. What these animals were turned into was basically the pet food market. They had mink farms, fox farms, etc., and they were a meat source, protein source, for that type of animal. Also, the coat was separated off and you could buy a burro coat out a Sears and Roebuck catalog.

The biggest problem associated with wild burros in the southwest was livestock, and there was a lot of pressure put on burro in livestock areas and they were slowly pushed back out. They were treated as a pest and they were shot on sight. This put them back into more remote, rugged areas and put them more in direct contact with native species, such as the bighorn sheep. But even this more remote, rugged, arid country was still very well suited to wild burros and they continued to thrive and multiply.

In the desert, the most limiting factor we have is water so the largest burro concentrations, especially in Arizona, occurred along perennial waterways, such as the Colorado River and associated rivers like the Santa Maria and the Big Sandy. In areas where you didn't have these rivers, but only the mountains, they associated themselves with perennial springs.

About the 1950s bighorn sheep towns were getting a bit concerned about the burros' ability to out-compete the native species and they started to become concerned about what was happening around the water sources. California was very innovative in trying to deal with it. This was really the first attempt of bureaucracy trying to manage the burros. They put out a hunting season on them but it really did not work that well. The hunting season was called off after several years because of citizens complaining about the number of dead burros lying around in the desert. What was happening is that the hunters, would go out and shoot the burros but they really wouldn't take it as a meat animal and tag it unless the owner just happened to be there and forced them to do it. So that was called off.

They came up with the idea of issuing permits to individuals to go out and collect the animals that they needed or wanted. So the deal was just to zip out there and catch you a burro. Back then, we were still pretty much of a rural country and there were people capable of catching burros but a lot of the city people that wanted burros were incapable of catching one and, once you caught one, what were you going to do with it? There was really kind of a low call for what a burro would do or bring back in the 1950s.

Also at that time there was another movement afoot for the wild horses and burros and Dawn Johnson, Wild Horse Annie, was getting very concerned about getting any treatment about the animals being gathered out on the range and she was successful in getting some federal legislation, at least in part recognizing these animals and limiting the use of mechanized vehicles, including aircraft, in capture of the burros. She continued her effort and was successful in 1971. Even with those very highly emotional charges, she was able to get a protection law for horses and burros passed.

It is an emotional issue. To me, there's nothing better than letting the wild burros go but it still reminds us that there's a biological problem that goes beyond emotion. At that time the BLM was handed the responsibility as the management agency for the wild horses. We didn't know what we were doing. We had no idea. We didn't really want to deal with them, but it was in our laps. We didn't get out the inventory for burro and horse use areas until 1974, identifying areas where they could exist, or did exist. During that time the animals continued to thrive. Our first capture in Arizona didn't come about until 1977 so, it was six years after the law before we ever got a feel for what we were trying to do or where to go.

At the same time research was being put out, a flurry of research cause papers were being put out, trying to give us some information, guidance and answers. Again, the issues really hadn't changed. We were still looking at equines independent of domestic livestock and then the bighorn sheep. Our burros occur in the hot, dry desert below the timer line. It's really not a base livestock operation in these areas, so our biggest conflict then comes with the native bighorn sheep.

The Bighorn Sheep Council is still very concerned about what was happening around the water holes. They put out a flurry of activity trying to design what they considered a sheep protected type water source. They came up with all kinds of ideas about burro-proof fences. A burro-proof fence is two rails that's got a top stand of barbed wire with springs on the inside. What they said would happen is that, with the elimination of that as a water source for the burro, the burros would move on to the next open spring. But this did not happen. What happened is that the water would run underneath the fence and there'd be water available outside. The burros then would have a water source.

As the temperatures climb, they become more restricted to this water source and, the hotter it got, the water would swing back under the fence and there would be no water for them and, by then, they were so heat-stressed that they could not move to the next water source. The first part of the population to suffer would be the foals. The janes would become heat-stressed and water-stressed and they would dry up and the foal was left just to perish and the next group or segment of the population would be those janes that lost their foals or real heavy janes just before birthing. So you've got 400 lb. animals starving to death for lack of water and, just like anything, they're not going to stand there. So they started putting pressure on these burro-proof fences. What happened is they'd get a hole in them and then they'd just kind of crowd in there and then they couldn't see the hole to get back out so these water hole areas became more like holding facilities.

Then they'd have the urge to leave when the feed started running short within these small enclosures, they couldn't find their way out. So what they did was keep putting pressure on the burro-proof fences. Pretty soon you don't have anything that resembles burro-proof any more.

They tried a gap type fencing with multi-trim barbed wire. The animals would try to jump it just like anything else. They'd jump the fence and, every so often, you're going to get one hung up. So, what happens is animals get inside and then they can't get out. So they end up eating everything in sight within that small enclosure. So they're kind of in a dilemma. Outside, they're going to starve to death for lack of water. When they get in, they've got the water to drink but they starve to death for lack of food. And all of this is born on the myth that burros are very dirty around water holes, have very detrimental watering

habits. Common sense will tell you that animals involved in the north African desert would be very clean around a watering hole. If they were polluters of water sources, they would not have lived through this evolutionary track.

For horses a river forms no barrier; they'll swim back and forth. And cows, when they want water, will get in there, but burros won't do that. Burros don't even like to get their feet wet if they have a choice. They'll back off and dig holes in the sand if they have to.

I'm not saying that we don't ahve water source pollution but what will usually happen in water source pollution is there'll be a stream at the bottom. Animals will gather and socialize up above the stream and then you will have organic material in the source of water. When summertime comes along, with the water starts to drop, you will have organic matter and water source pollution. But there's a real easy way around that. And we're just trying to convince the sheep people that we can still have water available on the outside of the fence.

What we do is you go ahead and put your fence up there and just give us water and we can pipe it out to a trough outside. Water's available, the animals aren't pushing on the fence and the area's less pressured.

About the mid-1970s, when all this research was going on, Dr. Gordon Brady did a study on vegetation and burro use south of Lake Havasu City. He used the feed species of white bird sage as his indicator species. What he found was that, about a mile and a half away from water, utilization just kind of dropped off the planet so that gave Arizona BLM the to manage those areas within a mile and a half of water and call them the critical areas. If we can manage those areas within a mile and a half of perennial waters, then we've got the whole area and the water stressed and while the water's freshest there, we can protect the weakest link and that would be the jane and the foals. If she has the nutrients during the critical part of the year, which is the hottest, dryest part (in the middle of May through the middle of July, before we start getting our summer rains).

When you start getting into a heavy burro area, you'll start seeing some browse line. It's a very soft wood tree; the burro's not being destructive by malice, he just starts reaching up and grabbing a mouthful of a very soft wood tree. The branches fall off. Then he goes back and gets another bite. You can see the branches piled up underneath that tree. As soon as we start losing some of the plants that are not typically forage species, we run into very serious ecological problems.

So what we did in the Black Moutains was to establish 23 monitoring sites and we'll use a pace frequency to monitor trends, which just basically lists the frequency of occurrence within a plant, a plant yearly, and ground cover. We'll do a 200 point pace frequency on that. We'll also do our utilization study at the same site. Of course at the time of our maximum population levels, white burr sage flower seems to respond as a key species that will work very well.

I this study we'll also look at seedling regeneration and take a look at ground cover. We'll also try to look at what sign what animal is using it. Is it livestock, is it bighorn sheep? Is it burro or a combination of any two or three? What we have found, using burr sage as a key species (a cool season plant), and a normal year of precipitation, we'll have an abundant production of annuals. The animals present will utilize those annuals heavily and the key species will go fairly untouched. However, if you drop below normal rainfall, then what happens is the animals have to rely more heavily on the perennial plants such as the species brushage or whatever you have out there. So in our management philosphy we came to a point where we're looking at a critical area, a critical time of year. We're looking at key species and we're also looking at good or bad years. We want to have enough in the bank where when you come into a below-average situation that your cattle can carry over your existing populations without putting itself into some jeopardy.

We've got an idea of what the habitat's like. Now we need to look at our animal population. Probably the most important information is how many animals we have out. And what we'll do is we use a Mencken-Peterson index, which is a sight/resight inventory method. We'll make two passes. On the first pass, on a grid type system, we'll go out and we'll paint everything out there. Everything we see we'll mark with an orange paint ball. We try to aim up on them on the left or whatever side we see them on. On the second flight, which may be three to five days later, you're giving that population time to move.

The social organizations change when they come to the water holes and they'll remix and group. So then, three to five days later, you go back out and count everything. You'll count by colors, count by age, and count by sex. And you'll also count what animals are painted. On a hypothetical situation you go out and paint 100 animals. Three to five days later you come back and you count 100 animals. But, of those 100 animals, only 50 of them have orange paint spots which will tell you that your sighting range is 50% or that any time that you're going out there you're only seeing about half the population. So if you're sighting rate's 50% and you're seeing 100 animals, your population, with some degree of probability, is 200 animals.

Our population can sustain reduction and there's two basic methods that we use to capture. One is the bait trap. The first method of this is the water bait trap in areas where we control water so we'll fence out a spring. They don't know what fences are. You've got to give them plenty of time to trust us and try to focus in on a single water source. What will happen is we're changing their water habits. So you've got to be real real easy; don't get in a hurry. You put your trap up in stages. You let them get used to seeing the fences and they don't know you're trying to get them off onto one trail formation so you're changing their whole routine of walks. You've got to be patient with it. When you get them in there and watering comfortably, then you go ahead and set your trap.

When we get into an area where we have livestock, our job is not handling livestock. We're not going to do that but, in some areas, you've got both species occurring so what we'll do is have the rancher come out or have one of his helpers come out and they handle the livestock.

In areas where you have water, on a river or lake, we'll look at a drain trap using feed. We'll select areas that have heavy trails coming in so that you know that the animals are concentrating in that area. We'll start putting hay out. The animals don't know what hay is. It's going to take them a while to adjust, so don't get in a hurry. It might take you three to four weeks driving up and down the lake there, putting feed down and equipment. Once they get on to it, then you know they'll start to come by and take a bite and then, pretty soon, another one will start eating it. You build around them in slow steps and give them plenty of time to adjust to the point where they're comfortably going into that trap to eat.

Now the problems along lakes or rivers is you don't have a lot of access so we came up with using a boat When we first got into the burro boating business, we didn't know how burros were going to respond to water or anything else so we didn't want them jumping off and knocking around and getting hurt so we tied their four feet together, put a halter on them and slide them onto the boat. The animals that are more stressed or pregnant, suffering from malnutrition, you don't want to four-foot them and jerk them down there so you just jump on them and overpower them. It's a 4 x 8 sheet so you've got four foot width on the ground and you can just kind of grab a hold of that animal. You don't want him trying to get off the slide.

When we had them on the boat, we didn't know how they would respond so, initially, we haltered everything in sight. Of course, thinking the last place a burro's going to go is jump over into the river or lake. So they just kind of all cowered in the middle. Now we don't even halter them. We just put a bale of hay back there and send them first class. Stand there and eat while you travel down the river. You get some good looks from people on their water skis and jet skis and stuff, wondering what we're doing with them.

The other main method of capture is using a helicopter as a locater, going out and finding the animals and then driving them in to us. There are two ways of catching them when we get them in there. One is we'll use horses and the old ambush theory and jump out and rope them. What happens is you bring the burros in to you. What happens is you've got to cheat in a deal like this because if these burros get back up to the rocks, their chances of escape have gone up greatly. So you want to get as many things going as you can and if you've got some good roping spots you can do pretty effective job of catching them.

Another method of capture is using a wing truck where you bring them into a colonized area and you slip your cowboys in behind them. The design of the trap is you like to build it along an existing burro trail and have it where it's a nice straight shot where the burros can see out the end of it and they're going to move easily down through it and they won't cramp all up and come back on you. The truck works similar to a series of canals or locks. You've got your whole pen over here. You bring the burros into your catch pen. You open your gates, push them off over and just open the gates and you're ready for another run. It's a very efficient, very effective way. The same with the boat. Burros don't really like getting in horse trailers so sometimes that will get to be a tussle. In Arizona, we use a lot of open top trailers but if you put one burro in a trailer, he'll probably come out on you. So, if we just have one burro, we'll go ahead and hog tie him.

About 90% of the animals we capture are shipped to other adopting sites, satellites, etc. About 6% are adotped out of our facilities and about 1% are released back. Why would a person adopt a wild burro? Maybe it started as a gift for a kid. A major thing going now is sheepherding burros. The burro has the ability to socialize with different animals, become protective of them and to be very adapted to envirionment make them a very good sheepherding animal. They'll keep the predators pushed out and, right now, in Texas and in South Dakota, North Dakoto, there is a very high demand for this type of animal.

In the southwest we don't have much of a predator problem. Coyotes seem to be a predator but we don't really have that many coyote kills. There have been several. We caught one colt that had his ear chewed off but he got away from him. But not very many coyote kill. We also have injuries, mainly due to fighting, falling off rocks, getting hit by cars, something like that, or loco weed. I think the occurrence of infection is very low. I'm not sure how big the problem is but we do have a mortality problem associated with the old projectile predator, human being. He will just slip out there and take a shot.

We have found that a capture method does affect what's happening in the population. In effect, the environment you kind of consider your trap as a random sample because you're not selecting animals when you don't have to go out and find them. You do the selection right off the bat. But in a trap we're catching more studs than jennies. One of the reasons may be that the jennies are a little bit more standoffish. They're either pregnant or have a foal and they're not going to get in a bad situation. On the roping method we find we catch more jennies and, again, it may be because jennies occur in a group, they're going to be a little more social. They're going to have their foals. They're going to be moving a little bit slower and be easier to find and so we found in Arizona that, by using both methods, we've accidently been around 50%. So, if you wanted to alter the sex ratio a little bit, you may be able to do it just by selecting the method that you use to capture.

Now I don't understand why we've got such a large proportion of young studs, yearlings and colts than we do jennies. We're going to have to look at it. I don't understand that very much at all. But, to get back to your trapping method, again, think of it as a random sample. The sex ratio kind of evens out a little bit.

In early research they said there was no normal mortality occurring. I guess they figured burros live forever. But these were short-term research projects and so they did not even discuss mortality but what we've found is that about seven to eight years old we start to get a real severe drop in the animals present in the

population so there is mortality occurring but we have not identified what that mortality is. To back that thought up a little bit, in 1977, 1976, 1977, Dr. Bob Omar did a study on burros in the south end of the Black Mountain. He did some collaring of animals stud. We'd go back out and catch these animals and we'd identify what that animals was. The inside of the collar was not faded out and then we'd return the animals release them back out. We quit seeing these animals about '83, '84, which put them in about the seven to eight year range.

The dominant coloring of the burro population seems to be grey. We had nice light colored jennies. Now when we're roping or wing trapping, about 68% of the animals we capture in that method are grey. Then if we go back and we trap animals and treat them again as a random sampling technique, we find that over 70% of the population is grey. So, we're thinking again our capture technique may have some effect on the drift of the color of the population. Also, the color grey seems to be survival color. You can see the brown and the black ? down here and these two white ones they stand out very well but the two grey ones right above them right here and here are just abuot invisible in the environment. So when we go out catching and counting, there are going to be the ones that you know. Social groupings. With the burros that really is not much of a thing but you put a little pressure on them and it's everybody for themselves. The strongest social bond is between the mother and her foal.

One thing that really hasn't been looked at in the distribution of wild burro population is the need for shade. Of course, we're looking at very top extreme summertime temperatures, there isn't any out there, including any for bighorn sheep. And any animal involved in a desert environment will require shade so that's something that we need to look at for planning what level of population in an area will persist without the shade. In the Black Mountains the waters occur up along where that break is so the sheep habitat is on top and the burro habitat is below that. Still, both species are having to come into those water. That forces them into that critical area during the critical time of the year so there is some overlap around those critical areas.

Now I'm not saying if there's no feed on top that the sheep won't come down to the bottom or if there's no feed on the bottom that the burro won't go on top. They're gonna survive whatever they have to do. Burros prefer the bottom and travel on the bottom. It's not that they're lazy. They're very intelligent, very efficient. They're not going to waste even more energy by cutting over ridges or anything else. They'll take their time and mosey out the easiest way they can get there. They'll water in the late afternoon. Of course, when you start water trapping, they'll alter their habits and water any time of the day that they are allowed to.

Some of them have their own grazing system. They'll get out as far as they can and then start working their way back in toward the water in the evening. By late afternoon they're relatively close to water so that's the time to drink. They don't have far to go.

If you think about the management of two species, such as desert bighorn sheep and wild burros, the question is: is there room for both of them? It's not that there should be a chicken in every pot nor a stud in every main street but they do want to be where they can be without being harassed.

We need to keep going out and keep presenting ourselves and the message that we're conveying to people about the wild burros. Maybe a lot of people that grew up on the old Colorado River days when they sold their beef and ate their burros, those people maybe, their value systems are beyond change but the next generation coming up behind us maybe they can start to understand the beauty and the sensitivity and continue with the the adoption program, keep the animals that have no home on the range but they have a home somewhere.

I'd love to keep herding burros. We're trying to intoduce this wild animal back into being a domestic animal, domestic meaning being in servitude to human beings herding sheep. Now this burro he gets to be in that servitude but at the same time retain a little bit of wildness and I think that's a preety good?

We know that there is an ecological niche in the desert for wild burros. We know. We know that this environment can support those burros and that's the direction that we're moving to, more clearly defined and to allow information out to the other user groups, the bighorn sheep people, desert tortoise people, or the livestock people that these animals can live in a non-threatening manner within the environment. The basic bottom line is we believe that we can get to that happy, healthy environment where that species will exist.

Tracy Irons, Range Conservationist
Burean of Land Management - Carson City District, Nevada

A Comparison of Management Methods for Wild Horses

Very few herd management areas have effective predators to keep wild horses in balance with their habitat and with other legitimate uses such as wildlife and livestock. Also this lack of effective predators eliminates a very crucial element from the natural selection process. If wild horse populations are left for nature to control, the major controlling factors will be a lack of forage and water. Control will be by starvation, dehydration, and malnutrition resulting in lower birth and survival rates as well as lower resistance to disease and parasites. In the process habitats will be degenerated and made less productive for most uses.

Forage production (vegetation available for use by several different kinds of animals) can be determined for an area. However, often three is competition for the same forage between different kinds of animals in the same area. The division of forage between competing uses is not a biological determination but a social decision that needs to be worked out. Do not expect a biological ansewr for this competing use. Often, in the Great Basin and other areas used by wild horses, competition also exists for water. A social decision needs to be worked out to balance conflicting uses for water.

In almost all cases, man must enter the picture to control wild horse populations if healthy, thriving populations of wild horses and their habitats are to be preserved and so that wild horses are in proper balance with other legitimate uses.

The Land Use Plan sets forth the multiple uses for specific areas of land, including wild horse populations. These multiple use decisions are the result of coordination with many publics, in addition to an inventory of what is available for use.

At the present time the Wild Horse and Burro Act does not permit the sale of wild horses and burros. The present policy does not permit the destruction of healthy wild horses and burros. No longer are there large feed lots to hold excess horses that are not adoptable in the regular adoption program.

The fee waiver program, which placed about 20,000 wild horses that were unadoptable in the regular adoption program, has been discontinued. This program was not acceptable to the public.

The existing sanctuaries are at or near capacity and no new sanctuaries are to be added. Sanctuaries are expected to absorb only a very limited number of unadoptable wild horses in the future. The prison program can be expected to continue to make a limited number of excess horses more acceptable in the

regular adoption program but at a high cost. The regular adoption program, at the present time, is the only acceptable means of moving wild horses into the private sector.

If excess wild horses are removed from public land and cannot be adopted, soon all of the wild horse and burro appropriations will be used to hold wild horses at BLM and prison facilities.

In 1983 the Modoc/Washoe Experimental Stewardship Program requested that a management method be devised to reduce the cost of feeding unadoptable horses. They were consuming a large portin of the funds allocated to the Susanville District. From this came a comparison study of the traditional method of removing horses, referred to here as "Gate Cut Mangement." These methods consisted of periodic removal of excess horses by gathering and removing horses that are in excess. All horses gathered are removed without consideration as to their disposal.

Structured Herd Management, as practiced in the Susanville District consisted of gathering the entire herd, to a practical extent. Then horses over five years of age and older were selected for return to the range as the base herd (breeding herd). The size of the base herd is set in the Land Use Plan; horses four years of age and younger were to be placed in the Regular Adoption Program. Gathering occurs every three to four years but every four years is the better choice since it disturbs the horses less often. At each gather older horses that have died since the last gather are replaced with younger animals.

Following is the adoption success comparison between Gate Cut Mangement and Structured Herd Management.

1. Data for 1,106 horses gathered and excessed between 1986 and 1989, from Gate Cut Herds, shows that as of September 1990 50.8% had been adopted in the Regular Adoption Program. On the average these horses were held 223 days before they were adopted. These 1,106 horses came from nine gathers from herds in California and Nevada.

2. The 667 horses from these nine gathers that were four years of age and younger had an adoption rate of 71.3%, with an average holding time of 214 days.

3. The 449 horses that were five years of age and older had an adoption rate of 16.2%, with an average holding time of 290 days. This clearly shows that horses four years of age and younger are more adoptable than are horses five years of age and older. Adoption rates of 657 horses that were four years of age and younger varied from a low of 29.7% for one herd to a high of 95.2% for another herd. This clearly indicates that there is more than just age involved with adoptability in the Regular Adoption Program.

4. Adoption rates for the 449 horses that were five years of age and older varied from a low 0% for one herd to a high of 29.4% for another herd. This again indicates that there is more than just age involved with adoptability in the Regular Adoption Program.

5. This preference for young horses is verified by D.B. Sniff, J.R. Tester, and E.D. Plotka in the BLM Study Contract AA-852-CT5-29, "Fertility Control in Wild Horses," Novenber 30, 1991, which states:

> "A survey of Adopt-A-Horse applicants conducted by Godfrey and Lawson (1986) found that approximately two-thirds of the potential horse adopters preferred a horse no older than 2 years and on 15% of the applicants wanted a horse over 3 years old."

The adoption rate for 95 horses, four years of age and younger, gathered from three structured herds in 1989, had an adoption rate of 98.9% with an average holding time of 109 days. This data shows structured

herd management having a 48.1% higher adoption rate with 114 fewer holding days than for gate cut management.

Structured herd management costs are about 2.4 tiimes as much for management operations (gathering, sorting, etc.) as are gate cut management costs. This point to the need for more than doubling the funding for management operations in the field, for the structured herd management.

Savings to the program are realized by nearly eliminating the cost of feeding unadoptables held off the public land. Some savings may be realized during the fiscal year that the horses are removed. However, most of the savings will be realized during out years.

When the program is considered from gathering through adoptions, feeding unadoptables, etc., indications, from data and using estimates based on experience, are that gate cut management costs about 2.3 times as much as structured herd management. This is with both methods in place.

The cost of moving from gate cut management to structured herd management will vary greatly from her to herd. For many herds the move will cost very little more than structured herd management, in place, even during the year of initial structuring. For other herds the cost will be greater because of unadoptables that need to be removed from the herd. Saving will occur in out years.

In addition to cost, the biological consequences of gate cut management and structured herd managment must be considered. Neither of these methods are random selection. However, structured herd management allows the better chance to maintain herd integrity since selection is by individual from throughout the entire herd. Gate cut management removes entire family groups from that portino of the herd gathered — generally those closest to the trap.

Neither of the methods can duplicate natural selection. However, structured herd management offers the better chance to eliminate visible, undesirable, inherited characteristics from a herd. EXamples are a tendency toward ruptures, the lack of pigment, extreme poor confirmation, etc. Those natural selection factors present remain in effect for those horses left in the base herd, with both methods.

With both methods of management, the actions of man, through removal, is influencing the genetic make up of each herd over time. Structured herd management offers at least the opportunity to maintain a borader based gene pool than does gate cut management. The structured herd management allows the manager to give some thought to what is happening and make at least some minor adjustments.

With structured herd management the negative impression to the public, created by large numbers of wild horses standing in feed lots or being held in sanctuaries off the public land, can be eliminated. A much more positive impression, to the public, is made by keeping wil free-roaming hrses on the public land, as Congress intended. In time the Prison Program can be greatly reduced or eliminated and only very limited sanctuary space will be needed.

Structured herd management requires employees to take on a greater level of responsibility and to have a greater level of knowledge about horses than does gate cut management.

For the BLM to shift from gate cut management to structured herd management, the field operation funding level will need to be more than doubled. This will need to be up-front money since most savings will occur in out years. However, a change to several other possible optioins under consideration will also require very large sums of money to initiate.

It appears that a combination of actions will be needed to solve the wild horse problem. All of these will require large sums of up-front funds.

The Susanville District and parts of Oregon have been working into the structured herd management approach for several years.

Bill Phillips, Range Conservationist
BLM - Susanville District, California

Question & Answer Session

The majority of horses go to California satellite adoption. For the last couple of years, Susanville has run out of horses for adoption. We adopt our horses and then we go to Oregon to get a few horses and come over to Nevada and get a few horses to round out our adoptions. So we have no problems with our younger horses adopting in the State of California. There is no point in shipping them East when we have a market right in the State of California.

We tried trucking horses in California; trucking old horses to adopt and bring them home, truck them, adopt them and bring them home. We have experience trucking horses back and forth and that gets to be a problem. However, these horses did go and spend time in other facilities where they could have been pulled out again and adopted. Sanctuaries offered a lot better place for a horse to take them off the range because it provides a basic kind of natural situation.

They talked about the intensity of management when you look at the total program. Gate cut is by far more intensive management because the horses are in the feed lot and the horses in the sanctuaries are still of the wild horse population and we manage them off the pulic range under very intensive management. So, when you look at the total program, rather than just the little segments of it, that makes a big difference.

I'd like to just clarify that comment Bill. I think you're very correct on that. I think that if we look at the program as it is now, that it's per situation.

First we called it management for improving adoptability. Still we got people who came all unglued. Well we really don't produce horses to satisfy an adoption. However, adoption is a fact of life, whether you want to admit it or not even if you have horses that don't adopt. The fee waiver program got rid of a bunch of those horses, but that didn't have to take place.

Bill, you said you did your gathering every 4 or 5 years in this program and what, can you gather all the horses?

Well, we gather those that we can gather without any stress. We don't go out and try to prove that we can remove every horse from an area. We're 10%, 15%, 20% short sometimes. We're not trying prove that we can take every horse out. There's going to be horses out there we're never going to touch in their full lifetime.

What is the percentage that you gather?

> We don't have a set percentage, we do have a minimum and a maximum management level. So we go out and gather what we can take then count what's left, which brings us down to a little more extra counting but it's a lot easier to count fewer animals. Then we take those horses and count them so we know we have so many females, so many males. Then out of the young we pick horses to go back to bring that up to that minimum management level. Then there is a four-year period during which we keep our hands off of them.

I understand that, but what I was interested in is, can you give me kind of a ball park figure on what percentage of foal population do you remove? The herd will aproximately double. So, instead of 100 you go 200. Now you need to remove 100 animals. What's your maximum?

> 100 dumb horses and then you have this other group over here which represents the vent loss over four years and front the 6%. However that works out that's about what has to go. So it seems to me what that says then is that we do have a removal that can take off a relatively large portion of the population.
>
> In an age plan what that is going to do is change the main structure and the herd is constantly getting older and older; you're changing the age structure and I bet if you keep that program going for ten years you are going to see full production go way down, if they have to take the animals.
>
> About 20% of our two-year-old animals bring foals to the track. That is live foals delivered to the track from three to ten, it's 60 plus from the ten year olds; out to old age those are about 45%. So that, if you keep adding, that percentage will continue. Something above what the gate cut was for that herd when we started.
>
> Now if you look at the foaling of these horses, as you get out to the very older horses, they have a higher foaling rate than horses from ten to that old age. You get to 15 and older, those are the survivors. Our foaling percentage is better than Mexico and this is where they come from, the horses that are tough. They are in good enough shape but when they get to be too old to have foals, if they're not tough they are going to die someplace in between.

I was part of the group that established things to look at as you are aware. Nowhere in those agreements was it determined "acceptable confirmation."

> I'd have to look at the agreement; however, it did say about some different things on there which means the same thing. I think. You have a concern with confirmation?

Yes. I have a concern. The Susanville district is producing domestic horses. You are doing the same thing as the quarter horse industry and the thoroughbred industry are doing — only you're doing it on public land. Never was it intended that there would be acceptable confirmation. These are wild, free-roaming animals, not domestic stock.

> Things we are trying to eliminate, of course, are those extreme faults in confirmation. When we first got into writing the plan, we probably went a little overboard on some things, I agree. I guess I'll have to take a real close look to see what we have left over in

Susanville, on the public range land, to see if it meets the criteria of the domestic horse industry.

When we talk about confirmation, we don't talk about confirmation for a breed or a certain ideal type animal. The main thing we are looking at is that the horse is fairly well put together. In other words, the proportion for what he is, that he doesn't have some kind of a knock-knee or extremely sick.

Or roman-nose, like the pictures she showed?

Yes. Roman-nose is not necessarily reason enough to cut a horse out.

I think one important thing in the Susanville District collection process is that we get in a group of horses from a herd and these horses all have characteristics that are shared. There's something, whatever their historical background is, they all look the same and are pretty much similar. And we are not trying to change those horses, take it from one type to another, we're just selecting those individuals that's in that group that best represent that group.

Some of the horses that come through have light colored hoofs and these horses run in very volcanic areas and we've selected some of these light colored hoof horses out of that population because we don't feel they're as adoptable as the dark colored hooves.

Then I guess the horses that I have in my back yard, I wouldn't have because Susanville doesn't have anything else.

Not to add fuel to the fire but, this is sort of directed both to Dawn and Bill: was color also one of the original considerations in terms of what you removed or not?

The first few herds we did cull for mount color of some. Basically we're trying to preserve what is there. For instance, our main herd consists of beige, blacks, browns, that's what the herd is; we haven't tried to change the color of that herd. Over in the buckfarm herd we know we come with 5% low crop of the year, 10% low crop of the year, 25% low crop of the year, if we manipulate the herds to that point.

What is the rate in production?

The rate in production is what the production is going to be after you remove the young horses. When you have a gate cut herd and put it into a structured herd program it's going to be about some level which is going to be slightly above the gate cut herd. Our herd are basically 50% male and 50% female, which is a natural thing so you have a natural reaction that takes place out there. We pick one of these young studs to put back out there in that herd, we don't know if he's ever going to breed one mare. He has to prove himself or he's not going to make it.

Theoretically we can design the production of a herd and produce whatever annual production. You can remove females out of a herd till you get down to a given level or an age structure. That becomes extremely enhancing and becomes unnatural as far as I'm concerned.

And there's one thing that bothers me about sterilization of horses. We haven't maintained a number yet, but you cut their production capacity way down. You destroy a big piece of that chain in breaking that production down if you've taken the females out of the herd that really could have been left there.

Have you done any studies to project what is going to happen in ten years if we do remove a certain percentage?

You'd loose 6% a year over four years old. I think we have 24% that die during that period as a replacement.

Have you done any studies to determine what your ages will be since, right now, obviously this first year and maybe for three or four years or however long these horses are going to live, you're going to have an older age group. Have you done a projection as to what is going to happen, how many older horses you're going to have out there, except for breeders in ten years, twenty years, thirty years?

No. However, I know some people think these mares stop producing as they get older.

We know that they produce when they get older. What I'm saying is what happens when you keep reducing the animal when this older age group is eventually going to die?

It's all being replaced.

Then you are replacing as you go? Every four years?

Yes, every four years. Whatever died is replaced. So you always have a percentage, once you get going, that are young animals.

Now are you replacing equal numbers of males to equal numbers of females?

Yes.

Is it a possibility you could do this out on the range?

Yes. And I think that's where it should be. We have trucked our horses in because it's cheaper. One problem with bringing horses into the central facility is the fact that they lack immunity.

One thing that I see when you start moving these horses into the facility, is they start to loosing their free-roaming wild status.

I think the point you made about the importance of maintaining the integrity of the horse is a very important one, a very valid one. I think that the Bureau of Land Management has made a statement that one of the goals is to maintain their vital natural balances of wild horse populations. I think fertility control, when done over a number of years where a percentage of the animals are treated and it is reversible, will not affect the presence of those genes in the gene pool over time because if the animal doesn't reproduce one year, it will in another year. However, removing horses from a population is a permanent removal of those genes from the gene pool.

My feeling about that is, if the Bureau of Land Management is interested in producing a horse breed program for feral horses then the type of thing that you are describing would be certainly appropriate. If it's interested in maintaining a vital natural population that is self-selective then that type of program would be detrimental to that goal.

It's not sterilization, it reversible fertility control; there's a very big difference.

> We don't really know, or think we know for sure, that all those mares are going to come back and produce foals. But we hope, as in Mexico, they hold out the animals for show purposes, so that's a possibility. I agree that what you're doing sounds social in preserving the tubal ligation.

Of course the most ideal situation would be to have a true natural setting for horses to run up on the hills with predators or something in control and never catch them and that we have a situation like that on the first range plans.

> We actually have a situation like that in the Montgomery Pass Wild Horse Territory. We will be discussing a little bit tomorrow morning so you can hear about that then.

Valerie Dobrich, Wild Horse and Burro Specialist
Bureau of Land Management, Battle Mountain District

Pioneering Use of the Maule 5 Fixed-Wing for Wild Horse Aerial Surveys

I am going to talk about a wild horse distribution study that I'm in the midst of in my resource area. I will also take this opportunity to introduce the rather innovative airplanes that I'm using to gather the monitoring data for these studies.

Before we get started I want to thank Cathy Barcom and the Nevada Commission for the Preservation of Wild Horses. Cathy and the Commission recently approved my grant proposal and they will be funding the remainder of my 1991 wild horse distribution survey.

The 1971 Wild Horse and Burro Act states that wild horses are to be considered an integral part of the natural system of our public land. To me that says that we recognize that wild horses belong on our public land and, as such, we manage them side by side with the other natural resources.

But before you can manage wild horses, or any animal, you better become familiar with that animal's interactions in their environment and their ecosystems. Because long term wild horse management is only going to be successful if we don't understand the habits and the needs of those bands of wild horses within their individual herd management areas (HMAs).

For me, a direct route to gather this information is by becoming familiar with the seasonal distribution of bands of wild horses and their migration route within their individual areas. To do this I'm in the process of a three-year distribution study within in each of the 12 HMAs in my resource area. Actually this is not truly a seasonal distribution study since it is taking place only three times a year: in the early spring, in the late summer, and in the dead of winter. Available funding was partially responsible for this but the three times a year is going to give me the data that I'm looking for at this point. The spring distribution study,

which I completed the first week of April, is letting me see where wild horses depend on their early spring forage green-up and, associated with that, I'm able to locate spring foaling locations.

The summer survey, which is scheduled to take place in late August, is going to let me document wild horse distribution when it is most widely distributed; when the wild horses are competing the least among themselves for available forage.

And then, finally, the winter schedule, which I have scheduled to take place in mid-January, will allow me to document where wild horses are when forage is their limiting factor and when they are by necessity directly competing with each other the most for available forage.

The entire study is scheduled to take place over a three year time span. The first year, this year, I am gathering the initial data and in 1992, the flights will be scheduled for the same time of year and all of my monitoring procedures will remain the same. The '91 and '92 data can then be looked at for any notable variations. The third year of the study, in 1993, I plan on surveying only those herd management areas which show notable discrepancies between the first two and attempt to clarify any wild horse discrepancies.

Along with the spring, the summer and the winter distribution of the wild horses, the aerial study is letting me gather other information, which is going to be vital to me before I make any long term management decisions. One of them, an example of this which all of us here in Nevada and can relate to at this point in time, is water availability. In low rainfall years, such as the last five or six years, that we've been seeing in Nevada, data is showing the water sources that the wild horses depend on and allows me to foresee and act on any potential water shortage emergency.

Wild horse watering locations in my resource area are in the form of developed or undeveloped springs in which historically you'll see water either year round or just seasonally. Due to the ongoing drought here in the state, those waters are drying up a lot quicker than usual in any given season. The wild horses also depend on trough water, which is controlled by the ranchers or the permittee and which can therefore be shut off by the rancher or the permittee.

Due to the lack of forage, which was caused by the lack of rainfall, some ranchers are either not moving their cattle or their livestock into certain locations or moving them out earlier and behind them, in some cases the water is getting shut off. This obviously has direct impact on the wild horses. With the help of the tracking systems and GPS (which is becoming available to a lot of us), and the on-board computer that the Maule is equipped with, I can record the legal location of any water as I fly over it and enter any notes regarding that water directly into the onboard computer, which is tied into the Loren-C system. This lets me go ahead and research water rights to find out who currently has the water rights of a particular water location, and follow up on that if I want, to find the water rights and then subsequent water development.

Making note of wild horse watering locations is also valuable in helping me identify reasons why horses are drinking outside their herd management area boundaries. There are several reasons why horses are going to leave their HMAs. It can be an increase in mining activities within their herd management area and it can be on a seasonal basis during hunting season or when the permittee has his cattle and sheep in and the horses are more directly competing for forage and water. Ground and aerial monitoring have shown me that another possible reason that wild horses are leaving their HMA boundaries is because of the seasonal lack of water inside the HMA. It stands to reason if there's water available at another location, the wild horses are going to go there. Once I can identify that there's a need for dependable water inside the HMA, then I can act on that.

Wild horse and wildlife and livestock grazing overlaps are also being recorded, using the onboard computer. This information allows me to make recommendations concerning allotment evaluations, subsequent multiple use decisions, and is very important to me when I'm formulating my wild horse management plan, once questions are identified and answered concerning where horses depend on their feed during the spring, the summer and the winter months; where their foaling areas are, what water sources are vital to their uninterrupted habits; and where severe grazing overlaps are occurring. Once I can answer those questions, I can make the wild horse management recommendations and formulate the long term wild horse management plans.

At that point the wild horses within my resource area are being managed as the 1971 Wild Horse and Nurro Act of Congress intended they be managed. Namely, as an integral part of our public land.

Fred Reed
Western Air Research

Pioneering Use of the Maule 5 Fixed-Wing for Wild Horse Aerial Surveys

Western Air Research is a Wyoming company. Our group is located in Alta, Wyoming. Our staff consists of nine highly trained individuals who are dedicated to the wildlife resource community and our philosophy is to provide the safest and most efficient aerial support to the natural resource community that can be found anywhere. We contract to only state and federal agencies or industries involved with natural resource studies, such as EAs or EISs. We currently have five aircraft and work throughout the western United States on wildlife projects ranging from grizzly bears to endangered species to water fowl and other wildlife. We work with law enforcement agencies and provide state of the art support and technology for fire suppression and other forest and range management efforts.

We will show you some of our equipment and tell you a little bit about how we use it and show you how we can help with wild horse management. First, our primary research vehicle, the Maule aircraft. Over the years we have operated many different types of equipment for this type of work: Supercubs, blanket scouts, all of the Cessnas, Bells, Hughs, and other types of helicopters. The one aircraft that we've found that gives us the most flexibility in all around the performance is the Maule. The aircraft is an extremely good product that lends itself very nicely to be modified for wildlife and wild horse work.

We take the basic airplane into our shop for about a month or so and we tear it completely apart, strip it down and then build it back, cutting in large windows, changing some of its landing gear configurations and building in data acquisition equipment, modifying the instrument panel, cabin heating systems, etc. In all we make a couple of dozen modifications and changes to the aircraft. When we're done we feel we have one of the safest and most efficient natural resource aerial platforms that can be found. The aircraft flies fast when necessary to get the job done quickly. It's also capable of very slow speed for best observation and accurate locations. It's engine is powerful and at the same time one most reliable and efficient used in an aircraft. The aircraft's weight-carrying capacity is such that allows for enough fuel to carry a crew of three, all of the electronic data equipment, survival gear, and fly missions four hours and longer with comfortable fuel reserves. Our modified observer windows provide visibility as good or better than some types of helicopters. We have flown them over 12,000 hours in support of natural resources since 1984. Our Maules are the most singularly used aircraft for wildlife work in the states of Idaho and Wyoming.

Now some of the systems that are found in the aircraft. First one being the Loren-C. Loren is a ground-based radio navigation system that has been around since World War II, and it's operated by the Coast

Guard. It was designed initially for ocean navigation, but has also been used in aircraft for many years. We had Loren-Cs in the military. The original systems were very large and heavy, not very efficient, and very expensive, sometimes exceeding $100,000 per unit. The current Loren-C is very small and compact and fits nicely in a standard instrument panel in the aircraft. It wasn't until the advent of the microprocessor that the Loren was made useful to general aviation.

In the early 1980s Cecil Brown, a wildlife biologist, and I were working on an elk study in Idaho and wondered if Loren could be applied to wildlife research. We dedided that if we interface the Loren with a computer we could do all kinds of things with the position locations pertaining to wildlife research. One of the problems we found was that computers don't work very well in aircraft. The hostile environment of G forces, vibrations, voltage fluctuations, temperature extremes, all were problems we were to be encountered. Plus computers sometimes emit radiation and an electronic noise that shut down aircraft navigation systems when they are tied together.

My wife, who teaches adult education computer programming, went to work on the software and an electrical engineer friend and I went to work on the hardware and helped with the software. With the combination of the modified aircraft, Loren computer, and other equipment, and some new techniques, we found that we could reduce flight times on a typical telemetry study by about fifty percent. Using the equipment we developed new survey techniques that changed the way wildlife population trends would be looked at in Idaho and Wyoming forever.

After a three year study with the University of Wyoming Wildlife Research Cooperative Unit, we helped develop another technique for determining wildlife population against the estimates. This technique provides much more reliable results and our aircraft now saves the State of Wyoming tens of thousands of dollars in flight time in antelope surveys each year.

From the period of about 1950 to 1990, we see some different types of changes. The most significant during that time period were more social, political, and economic as oposed to changes in the active range plan. We see an interest in the public being involved in wildlife and wild horse issues, in the NEPA process, and in the 1971 Wild Horse and Burro Act. All these things have really made a big change in the way we do business, not only from a wildlife perspective but the livestock area as well. The public is just really deeply involved in the land use planning process.

I'm now going to briefly focus on the Bureau of Land Management process because they manage most of the land in Nevada. If we look back in the early-to-mid-1970s, the Bureau tried to go with four allocations: wild horses, wildlife, and livestock and geographical area. What that's done is we're using the numbers game when it suits us. We are using the monitoring process and it's created a considerable amount of confusion but, more important than that, is it's putting us back into the mode of looking at court decisions or management as opposed to making decisions based upon resources. I think that a court decision that is based on the legal interpretation of the law often has nothing to do with what is needed from a resource perspective.

I would hope that we could get back into the mode of working together on livestock issues with wildlife interests and wild horse interests working together to make a decision ourselves instead of having judges make those decisions for us. I'd just like to point out three things. Number 1, to continue to jump back and forth on how we are going to make decisions on the type of data we are going to use, will continue to cause confusion. I know, from working with some of the wild horse interest groups and people in Nevada, they were very willing to look at numbers back in the mid '70s and early '80s; numbers with conditions of the wildlife perspective, land management agency perspective, and livestock criteria. I think we've gotten away from that, we've gotten away from looking at what will this particular geographical area hold. Let's establish

some criteria either in numbers, monitoring, or a combination of both, then play by those same rules for a given period of time until we can determine whether or not those objectives are being met.

I want to make just one point about the geological balance, since that seems to be the new management buzz word. Ecology is a branch of science concerned with the inner relationship of organisms and their environment. The definition of balance, however, is done by a different part. To define the threat of ecological balance depends upon who you are and what your interest is. If we are going to use ecological balance in terms of future land management, the first thing we need is an agreed-upon good definition that everybody can abide by. Otherwise, describing ecological balance is not going to mean anything.

Finally I would like to point out the most important thing is that we all be working for the preservation of soil, water and vegetation. Whether we're in the livestock business or the wildlife business or interested in wild horses, I think that's something we should all have in common.

Question & Answer Session

How many acres would be in an area study?

> It would be varied anywhere between half a mile and 1½ miles, depending on visibility and then obviously when we got to some of the steepest stuff we couldn't run the straight east-west transits.

One of the things we do with transits, we fly all of our transits electronically. Instead of having to pick out a point out on the horizon and then the pilot trying to manipulate the aircraft so that it flies a straight line, we set that up with a computer and it automatically tells us what our next line is suppose to be on and we follow it with digitalized information and we can stay precisely on the transits line without drifting off. Especially on antelopes or resource wild horse surveys, when there aren't good geographical points to be able to stay on track, you can wander off your line, count the same group a couple of times or miss large geographical areas that aren't surveyed at all. The electronic transit method eliminates that type of problem.

So crosswinds are not the problem?

> No. It reads out what our heading is suppose to be and we just adjust it and just follow the mountains.

Do you have the capability with this system of a adapting a video camera?

> We mount a video camera in the belly and sometimes we hand-hold the system, depending on what the needs are. We cross-reference the time of the location that's printed on the flight report with the time that is on the video so that always ties it back together.
>
> We do have the hardware, but it's not completely done, that we will be directly interfacing the data acquisition with the video system and will enable printing the data directions on the video. It's all sitting in a box; we haven't put it together yet.
>
> The slide you're looking at down on the lower right hand corner, I didn't use the belly mount. In retrospect, I will next time. The plane can do belly mount video or belly mount still camera. What you're looking at in the bottom right hand corner of the screen there tells you that, April 1, at 13:26, this band of horses was sighted.

Then I cross-reference that 13:26 with that first column you have on your data sheet and that lets me cross-reference exactly what I'm seeing out the window again with what's been entered in the computer. What that also enables is you're still tied back to the slide when you get estimated sizes and herd sizes, and you don't get a real accurate count then you just tie back this photograph after the place and then you can control the sites count.

You mentioned GISs. Do you have anybody now where you've actually got a working interface to do geographical information system if it's overlayed with photographic maps and vegetating maps, all the rest of the stuff. Do you know of anybody in any of these other agencies in the state that actually have one like that?

The Pardee National Forest in Idaho is currently using their GIS. Also, I think the Idaho Falls District BLM is currently using GIS.

Do you think, with the GPS system, that you could acurately map a fence locations? How acurate can you get?

We don't know yet for sure. Our system is capable of 15 meter acuracy by itself. We have the capabilities that we can run 999-way points right now or soon infinite number of way points along a fence line or perimeter of a fire or whatever needs that there is to run continuous survey points.

That's one reason you see the pages that I've handed out. One reason that I have entries in that adult foal column is because I was surprised by the capabilities of the airplane. I didn't intend to do any counts at all, just distribution.

Is there room behind the pilot?

Yes. In fact, if you're sitting in the back seat, you have better visability than if you're sitting right up next to the cockpit there. The way that we can configure the aircraft, we limit it to the pilot plus two observers. Generally that's one on the right front seat, one on left rear.

This is so exciting, what a wonderful technology. And obviously much of what you're doing is really leading edge research type work and I'm looking ahead and certainly not thinking about you loosing money on the prospect, but are you considering selling this technology as you develop it, rather doing it all yourself as a company? So are you planning to enlarge this as a technology sales program, too, with others using your technology and adapting other types of aircraft?

We've made it a phylosophy and a practice that our number one priority is safety and safety for the people in natural resources that have to go do this kind of stuff because that's your job and you are so dependent upon that pilot and that aircraft capability to keep you from getting killed. And if you look at the accident statistic for wild life research in the western states it will clearly demonstrate that high proficiency in aircraft capability is a very crucial thing.

Because of that we realize that there is a market out there and we could build little black boxes and retrofit them on twos and 180's and ship these things all over the world. But because we're so concerned with safety and so concerned with our hand selection of pilots (and only the most experienced who have never had an accident will be considered for a position with us), the last thing we want to do is put some guy who's out of our control in

some far away state with our boxes and have him down there fumbling around trying to figure out what is going on and look up and there be a mountain right in front of him. We plan to stay away from that for now.

GPS will become very widely used within this next decade. Some of the things that we can provide is software that can be used with GPS receivers that are used in other aircraft. We plan on expanding our business in what we call district operations, aviation district operations. We'll base an airplane in a certain geographical area and put a pilot technician there. Some of our pilots have masters degrees in wild life and are highly educated in range and forest background. We'll put that person there and then they can be utilized by agencies within that geographical area. Right now what we do is we'll take off and come down here and spend the week working down here and we'll bring one airplane down or two airplanes or however many it takes to get the job done. Get everything done in a week and then we go on to another area.

Rick Sorenson, Assistant to the President
Wild Horse Sanctuary, California

I've been an advocate of animal rights for the last 60 years. I am co-founder of a magazine called *The Animal's Voice*. A lot of those pictures in it are things that we don't want to look at but there's been so many of them that's true but I'm fighting for humane treatment of all animals. However, I don't think that I can carry the hard line animal rights philosophy as some of the other people do. I believe that I'm an animal just like you're an animal and I won't get into the rights issue so much. But with those standards of *The Animal Voice* magazine, the previous director of the Wild Horse Coalition and most recently assistant to the president of the Wild Horse Sanctuary. I'm a volunteer and not funded in any way; the Sanctuary is not paying for my trip here. The Sanctuary is the living museum for America's free-roaming wild horses and burros.

I'd like to distinguish our sanctuary from other sanctuaries. You're familiar with the sanctuaries in South Dakota and in Oklahoma. We are not that sanctuary. We never have been funded by any government agencies nor have we been given any support from government agencies. Other than one bit of support, which is that most of our horses come from the government. They have been very generous about giving us horses and we do thank them.

I'd like to just briefly give you an overview of the wild horse sanctuary; some of our goals, history, and directions. I know that in the wild horse program there is a lot of conflicting interest and it's sort of an adversarial-type situation we're in in that the humane group seems to be fighting against the agencies and vice-versa. The sanctuary started in 1979 in Alturas, California. It started with 80 head of horses. In 1983 the sanctuary moved to Shingletown, California. Most recently the Sanctuary acquired an additional 150 horses and 30 burros. At the present time there are aproximately 290 horses at the Sanctuary. During the last 11 years, the sanctuary has adopted out approximately 190 horses. The sanctuary began with 550 acres and currently has just under 8,000 acres. This acreage that has been acquired through private donations. Some of the land is leased and some of it has been purchased outright. The Sanctuary is on the foothills of Mount Lassen, about fifty miles east of Red Bluff and about twenty six miles east of Redding.

The yearly budget for the sanctuary is just under $200,000. You might wonder, in light of the possible closing in South Dakota, how we can manage to maintain a sanctuary and why others can't. One of the main reasons is because of the ability of Jim Class to pull the rabbit out of a hat. He has an unusual ability

to create funds. The majority of the funding for the Sanctuary does come from private donations. Through Diane and the board members, they do solicit grant money from various corporations such as Bank of America, Chevron, Rockefeller, and others. They have been very helpful in not only donating actual funds but also purchasing adjacent property and allowing the sanctuary to lease back that property. I don't want to make it sound like the Sanctuary has a great deal of surplus because it doesn't. It is really one of those hand-to-mouth type situations. Almost on a daily or weekly basis, we are looking for where we can get the money to buy the next load of hay.

One of the main purpose of the sanctuary is to create a living museum or it actually gained it's non-profit status as a living museum. It is an educational non-profit organization but in order to make it an educational program we've had to make the sanctuary an enticing place to come. So several ponds were created on the Sanctuary and now are being stocked with bass. The sanctuary is intended to be a location where the public will come and view free-roaming wild horses and burros.

Bob Stager, Wild Horse and Burro Specialist
Bureau of Land Management - Las Vegas District

Perception versus Fact

What I've come to understand, after 15 or 16 years, is what people percieve to be true, or believe to be true is far more important than what the facts or truth are. Do you agree with that? If that's the case then we need perceptions in the wild horse and burro program that aren't based on fact. Wild horse and burro are a problem. They're over-populated. Some people say they're under- populated. How about management hates the wild horses. How about BLM doesn't want to manage wild horses. Well there's a lot of things that I've found that people percieve to be true that aren't true. And I used to approach it idealistically: that's the truth by God and that's what it's going to be and we're going to go down the road.

So, what I think is this agency needs to do is change it's approach. It hasn't worked in the past and it is not working now. That approach has been initiated in California and Arizona and we're trying to get it in Nevada and Vegas. We have been for the past four years and I'll show you some of the successes of that. We didn't start it. And that is to work real hard to bring what is percieved to be true over here to what is really true. As close as possible, to bring those tracks on the same railroad tracks. And people visualize that in the mind you can do that. You've got a tremendous amount of power to manage the public land resources. Tremendous amount of power because all of a sudden the facts and the things that you're using to try to help you as technical person or resource manager become what people believe to be true. And then it's just a matter of compromising the small things.

The military is in the same position I think we are in on how we deal with this perception versus fact. But theirs has to do with warfare. It's every bit as controversial as what I'm going to share with you. In that the military prior to Iraq had a standard approach to warfare and that's they would take position, attach strongholds and the cost of that was people and high risks. But they took it. It's been done for centuries. They still did it, they did it in World War II, they did it in Vietnam. What they used was blitzkrieg, leverage, surprise, and one of the key elements was initiative at the lowest level.

The BLM, in dealing with the media and the public interest groups. The issue that it released and the media is going to show up, right? Channel 3 News, Channel 8 will be there, right? Did they show up every time? Okay does everybody else have that? Issuing a news release is all that it takes for you to get the news media out there? I'll give you some statistics or examples to show you that is not always the case.

If you just issue a news release you don't get the media, in most instances, in the large scale that you want them.

Basically the problems the BLM has had is we collect data and we process the data, we issue decisions and we go through the process; we issue decisions people don't like is more important. What I'm suggesting is the new approach. That approach will be that we package our program in a saleable package. Bring it to the media and we court it. The media simulates information in the public. The facts. Why is that a good idea? Because most of your publics are in the city and they have very little understanding of what wild horses really are and what the grass really is, other than what grows in the yard. The wild horse and burro specialist level needs to get that out to the public. Valeri is doing that in the use of that airplane, that sort of thing is very important. You need to go to rodeos, fairs, things that Arizona and California has been doing for years and get that information out. Schools, Lions Clubs, all of these other different organizations. It becomes kind of a household firm. All the wild horse and burros and what they are. I think that above all else the Bureau of Land Management has to try to remove the number dead genies that we have and show persistence in our approach and don't have any secrets. There's no reason for them.

If we're afraid of the truth, get out of the business. And they need to have managers that set values because when you take that approach we deal with the media. Be open and honest and very vulnerable and you're going to have failures. It doesn't mean your approach is all wrong it just means you can't always go without a little failure. I think the last thing that I want to change is that I think that anything that the BLM does in the wild horse and burro program, the data collections, if they use horses they should be wild horses. If they use burros they should use the wild burros. They shouldn't be using fox trotters and quarter horses if they are out there managing wild horses. If you get that perception to the public that not only are you managing them but you are using them and you have belief in the usefulness of the animals after they get adopted. That's the tail end of the program. Las Vegas is getting ideas. Most people they get, a big old gambling town with a lot of people in it. A lot of tourist come in. We actually manage 20% of the wild horses in the state of Nevada. We manage 55% of the wild burros in the State of Nevada. We have 60% to 70% of the state's population and we're the only place in the state that has large acreages where there is no ranching.

We have a thousand square miles of use area. At Nellis for example, there is no ranching. We have Spring Mountain just west of Las Vegas. There are no ranchers in north park. And we're the only place in the nation who has a large metropolotan area in the state that has a wild horse and burro herd within 15 miles of town — and recieves 500,000 plus visitors a year. We don't even have any signs up until recently. I think the issues that we are facing that make it important for us to try to bring perception versus facts as close together as possible. And the urban areas that are expanding to be larger and the rural areas becomming smaller. And if we are going to manage the horses, the groups that are involved in doing that are comming out of San Francisco and Sacramento, Phoenix; they are coming out of the urban areas and we need to get to them and the way to get to them is back to the media.

Everybody is watching TV at certain times of the day. About four years ago everybody in Clark County had the perception that the desert in Nye and Clark County was designated as over-grazed; an important issue. They no longer have that perception. It took us 2½ years to change that. We used photos on the television, we went on radio talk shows, we were newspaper feature articles. We put it into a saleable package. I can share with you on a personal basis or individaul basis if you like to see how we got people interested in the plans. But we did it. And we were on prime time TV and the 6 p.m. talk shows.

What I want to share with you is the change that occurred between 1972 and 1988. Now the impact of this is the changes over time. It does have an affect when you can get perception versus fact closer together.

It doesn't always go over this your way. But it sure gets closer. And it's certainly a lot more fun than dealing with the facts.

We've got 700 square miles of severly grazed range. A little over half of that is degraded land. I think Kelly in his talk discussed some plants and what happens to them. We can only help raise them for so long and finally they die. There's no place that I know of in the BLM or Forest Service or Park Service that has that large of an area with that severe use. Why is there that severe use? Because we haven't captured for over three years. There are no natural preditors out there to balance those populations. And we go out there and artificially supply water to them because we didn't want them to die. I didn't want to see 200 or 300 dead horses when I come back out there in a week so I captured them. Neither did the military. So if you want to know why you haven't had a nasty drive out to Nellis I can tell you why: they haul water to those spots; they've been doing it for three years. There is no trick to it. The result is 700 square miles of severely damaged range.

We took the media out there. Nellis was concerned enough about it and the media was involved. There's 700 miles of feed lot at Nellis. There's horse droppings, tracks, and horses everywhere. It looks like a big feed lot. And that's what happens. We counted 48 dead before we started hauling water last year. I went out on horseback and counted probably 40 more dead with a little farther distance from the same water sources. Now a herd this size it's normal for the horse to die and I understand that and so I thought it a really big issue.

We spend a lot of time getting it out to the publics. When I'm finished doing that and when I'm finished with the media going out getting involved in it so we can get the truth out and try to get perception versus fact together, maybe we can start managing that herd. And in Wayne Burkhart's talk he discussed the following of green. That herd in Nellis used to follow the green. But with the average preditors, they don't have any more green to follow.

Another example a little less controversial is when I first got to Las Vegas, the horses right outside of Vegas were all considered to be jugheads, over-populated, ugly and there was excessive use everywhere. That sounds like the rest of the state. We went out there and we found about 250 horses over about 400,000 acres. Some of the best country we got in the desert. That's not over-populated. Now this particular horse happens to be a stud horse and another issue in Red Rock. We had five recently killed and to give you that shock that's heard around the world, those five horses, within a day and a half, had $20,000 reward posted on them. And that's primarily due to the three years' previous publicity this herd had. This particular stud horse was probably one of the most, if not the most, photographed horse in the nation before he was killed. They killed his whole band. That's what generated the public anger. The Red Rock Visitors Center gave people of Las Vegas a look at the horses loving; now they don't just like them, they want them there. The wild burros at Red Rock, they want them there. Totally different attitude. They see them as an asset and not a liability. So it works: perception versus facts.

We have recently been working in harvest. We had a drought last year in Vegas and had a bunch of horses die. We had a bunch of horses die right outside of Vegas when the water dries up. We jumped on this immediately. The first thing we did, as soon as we found we had dead horses, was we went out the same day and investigated to be sure there was no foul play. The very next day we called every news station and newspaper in town and the interest groups and got them all out of there. They yelled at us on TV the first day. But after the first day we were on TV for a week and a half and every single day, every single news broadcast on that herd that was at all possible and we came out smelling like a rose. Why? Perception versus fact. We told the truth. We owned up to what we did wrong and took our licking and did something and started hauling water and we did something. It was all right. We didn't try to deceive

anybody. Honesty is getting back to some old stuff. We had captures in all views. We were told unequivicably that capture would be appealed.

We went to perception versus fact, went to media, went to the groups, whoever would listen. We went to schools, to give presentation to the Lion's Club. The bottom line is this: the capture went the indications of the severe use that was occurring out there, heavy trading, heavy dust areas, looks like a big bombing area. The area had never gotten past us before we shared that with the public. Those burros were searching every square inch for something to eat. The adjacent herd area across the river doesn't have that kind of trail. We also showed the severe use of a 53,000 acres, which is nothing compared to what's going on at Nellis and still we showed it.

I get asked all the time, how can you count 3,000 horse one year and only count 2,000 the next? How can you count 500 burros one year and only 200 the next? Well as Kelly mentioned, he gets 50% success ratio using that paint gun routine and we had to somehow do it because we're not allowed use that routine. Yet somehow we get the idea across to public that these animals are hard to see. We went to the media and took them on the capture with us, took them on the census with us, and took them to the areas that were severly grazed and they got to help us count.

Brian Stout, Forest Supervisor
Greater Teton National Park, U.S. Forest Service

I will share with you some of the experiences that we're having on the forest and the wild horse program and in working with the Honor Farm in Riverton, Wyoming.

First let me give you a little background about myself and how I got interested in the wild horse program. Eight years ago, I was on the Potomic in the big teepee with the forest service, on the legislative affairs staff. One of the subject areas that I handled was the range issues. During that time I had the opportunity to get involved with the wild horse and burro legislation and the issues that were surrounding that legislation. I developed somewhat of an understanding and interest in the wild horse program. I left Washington and went to Montana, where I was director of information in the regional office in Mizzoula.

Five years ago was fortunate enough to be selected as the forest supervisor on the Bridger-Teton National Forest in Jackson, Wyoming. It is a 3.4 million acre forest with about 35% in wilderness and much of the rest of it is in back country. Even though it's not wilderness, it's not roaded and the only way we have of managing those areas is through the use of stock. What I found when I arrived in that forest is that much of the skills that we had possessed in the past and relationships to primitive skills, wilderness managing, back country skills, and horsemanship was essentially slipping away from us. We were not really putting the training into our employees and, in many cases, into much of the stock, with one exception. One district had been working hard at keeping their stock up because they were almost entirely wilderness. But much of the rest of it was over 20 years old and really not much of a program in terms of the stock program and the support services that we needed for management of the back country.

We are a large forest. In fact we are the second largest forest in the lower 48 states. But if you look at budget, we are rather a poor forest; we are not a timber producing forest and that's where all the money has been in the past. We really don't contribute a great deal to America's needs for wood fiber so we had to look for a number of alternatives.

The big thing in the forest service was the Missouri fox trotters. We were going back into Missouri and paying fantastic prices and driving the market even higher year to year for those animals and, as the prices went up and the numbers went down. Not only did we have to compete dollar-wise, we were getting animals that were quite green in relationship to being prepared to really work in the back country and in the mountains.

So about three years ago, I wondered if there was an opportunity to work with BLM's wild horse program to meet the needs that we had in terms of management and, at the same time, do something for placement of some of the wild horses that were being captured in Wyoming. We worked with the Rock Springs office and put together a memorandum of understanding whereby the forest service and BLM would work together in placing animals in the forest for use.

The unique thing that was available to us — and one of the reasons we were interested in this — was that BLM had formed a partnership with the Riverton Honor Farm in which they have a group of young men who break wild horses for the adoption program. The horses were pretty green when they went through the adoption program but the young men were developing some rather impressive skills in working with these animals and their facilities were very outstanding.

So, with a three way partnership, we started a process three years ago. My enthusiasm was not shared with the rest of the people on the force. So it took a period of time to demonstrate that these animals can be worked and can be used in a management situation. I had to get one and use it myself to show enough folks on the district that you can work with them.

We started off with three animals that Jack and I had selected. When we ran through a vet check it turned out that two of them had been broke out when they eight years old and one of them developed some ringbone, so we put him out on the sanctuary to live out the rest of his life. I understand that the other one has turned out to be a good ranch horse but he was far too much for my inexperienced summer seasonal. So we took him back and we have been working now with some of the younger animals.

The program is exciting for us and has grown substantially and so I'm going to share with you this morning a few pictures and slides and thoughts about the program that we're working with and where we hope to go with it. The animals we are working with so far are all animals that have been captured in Wyoming, to my knowledge.

The Riverton Honor Farm has a professional staff of horse trainers on that runs this program and they're running about eight to ten students full time. I understand they sign up for the wild horse program for a minimum six months. The other main thing that I've observed in working with some of the enrollies is the enthusiasm and the committment they have developed for the program. Not only are we interested from the standpoint of the opportunity of training the horses and utilizing them in the management situation on the forest, but the really unique thing is the attitude of the young people working in this program and the support they put into it. Frequently you'll find them up after hours continuing to work with the animals, cleaning stalls, etc. My observation is that they really become committed and, in many cases, probably one of the first things that they've ever been able to focus on in their lives and be successful at.

As I said the program started out with a lot of enthusiasm on my and Jack's part but was not necessarily shared by a number of the employees that I had on the forest. Today we have reached a point where we are having difficulty getting enough animals to run through the program. The Shoshone National Forest, the Aspen National Forest, the Boise National Forest, and the Targa National Forest are now in the program and I'm beginning to get requests almost on a daily basis from other forests that are interested in getting involved. We're even looking at an arrangement with the Toiyabe National Forest for a gathering horses

on the national forest system land and running them through the training program for use on the forest afterwards.

We must address the resource management issue and bring wild horse numbers into line with the range caring ability. We plan to accomplish a gather within the next year to 18 months. During this gather selected animals meeting the color and confirmation requirements I mentioned earlier will be turned back onto the range. This will establish the base herd for the territory. From our data we have determined that the pack for the territory will be 58 head. The initial gather will leave only about 40 head on the territory. Our plan will allow the herd to grow to about 68 head and then we will conduct subsequent gathers to keep the herd in balance with the resource.

This summer the district will be constructing a permanent trap. By regulating water troughs, this trap will have the only available water in the southwest pasture and, by using a water trap method, we can capture or release selected animals. By removing a few animals at a time, we can greatly reduce the stress and chance of injury to the horses. In addition, we are planning gathers only once within a three or four year period.

Through years of observation we have identified horse movements. While they are in the pasture, we can select those animals which will be moved into the trap. These movements can easily be facilitated by horse and rider without the need for helicopters. Basically, from the desired horse size, two years of annual herd growth will be subtracted out. This is the number of horses that will remain after the removal. The desired herd size will then be achieved on the second year after removal. One more year of herd growth will be allowed prior to the next removal. We of course will allow all foals under one year of age to remain with the mares and these foals would not count against the herd size.

Once we stabilize the herd and the range begins to recover, the herd size will be based on the utilization of the resource. As you recall our first goal is to maintain a thriving ecological condition. We feel that by keeping the herd to approximately 58 head, that the range should begin to recover. We will continue to monitor transit and conduct utilization studies. If and when the range can support more horses, the herd size will be adjusted to fulfill this resource.

This is a very brief overview of the proposed management of the Cherry Springs Wild Horse Territory. As I mentioned at the beginning, we felt that the area could provide some exceptional recreational opportunities.

Mitch Bulthuis, Range Conservationist
Humbolt National Forest, CA

Cherry Springs Wild Horse Territory as a Recreational Opportunity and MORE!

We have found that people like to see wild horses. Traveling the highways of Nevada, I usually see cars parked alongside the road with passengers taking photos of wild horses and burro. I don't see this happening quite as much with deer, antelope and elk, and I never see this happening with rabbits. People have a curiosity about these horses. They want to see, photograph and learn more about them.

Cherry Springs is more than just a wild horse territory, it is a recreational and educational destination. It is approximately 50 miles from Elko and Interstate 80; about 12 miles from New Ruby Lake; and about 150 miles from Ely, the gateway to the Great Basin National Park.

Now let's look at some of the other recreational resources. This part of Nevada is rich in pioneer history. In 1860 to 1861, the Pony Express ran from St. Louis to San Francisco through the territory across Overland Pass. Fort Ruby, to the east of the territory, was constructed to protect these riders and was soon abandoned after the end of this short period in history. Also the Overland Stage Line ran along the western boundary of the territory. Both the Pony Express and the stage stops are still visible along the roads to the territory. The Donner Party even used these paths on its ill-fated trips to California. The wild horse territory itself is a result of horses released by local ranchers.

Multiple prehistoric people utilized this area for gathering food and hunting. Remnants of these cultures can still be found throughout the territory. This territory also provides a wide range of other resources. Yet area provides excellent mule deer and upland game hunting. Ruby Lake National Wildlife Refuge is to the east and provides exceptional bass and trout fishing along with wildlife viewing for an assortment of water fowl, shore birds, and song birds. The Gallager Fish Hatchery is located near the Refuge.

The territory is rich in geological formation. From the territory you can see the workings of the Bald Mountain Gold Mine to the south. Within the territory we still have exploration recurring for gas and oil and precious metals.

Our primary emphasis will be the ability to view wild horses in their natural environment. In order to create this recreational opportunity, the district has formulated an implementation plan. To begin we will produce the Cherry Spring pamphlet and make it available to the public. The pamphlet will promote the territory and will increase the public interest in viewing wild horses. It would describe the management of wild horses here and the history of wild horses in the west. We view this as an excellent opportunity to educate the public about wild horses and resource management.

We will improve the lower Cherry Spring Road into a three season access to the territory with interpretive signs and viewing area. This road will be expanded into a loop road with additional viewing and interpretive signs. Eventually, self-guided tours would be made available, with road markers that are tied to the pamphlet. Interpretive signs and a low-powered AM radio station would broadcast a pre-recorded message much like those radio stations located along the freeway that announce the weather.

Our primary goal would be to improve range conditions but, by properly locating openings, we will also create viewing areas. These treatments would also be a benefit to wildlife in this territory. Water developments, seedlings, and prescribed burning of sagebrush and pinion juniper will further improve the foraging and viewing potential.

Unfortunately, we cannot do this all ourselves. Due to limited budget and competing programs, internal funding for wild horses is difficult. We need to identify organizations and programs which will help accomplish these projects. We have already submitted a request to the President's National Recreation Initiative called "America's Great Outdoors, the National Forest." We have applied for $67,000 for viewing roads and pamphlets. We meet all the criteria for this grant but one.

We need partners. This is not to say that we haven't been seeking out and receiving other forms of financing. Last year, with the help of the National Mustang Association of the Nevada Division of Forestry, we installed about one-half mile to the dry areas of the territory. This year we are working with the National Mustang Association to install two miles of trench line which will assist in the management of these horses and improve the range.

A valuable resource at our disposal is the Honor Camp Program administered by the Nevada Division of Forestry. This program provides minimum security and provides the opportunity to earn a modest wage

while working on conservation projects. A local outfitter/guide service is interested in horse rides into the area, which will provide the public with viewing experiencing these horses.

These areas will utilize overflow waters from existing troughs and channel it through perforated pipes. We have set our sights slightly high for this territory but we think it's worth it.

There is a need to provide additional recreational opportunities. The population of Elko County and the State of Nevada are growing at a phenomenal rate. We will want to provide a full spectrum of recreation. The Cherry Spring Wild Horse Territory will be a major component of this spectrum.

Bill Bramlette, District Ranger
Inyo & Toiyabe National Forests, California

Montgomery Pass Wild Horse Territory

I think we'll be able to provide maybe a little bit of diversity or another end of the spectrum, as far as what is going on with management and the management of wild horse territories.

I think if you look close enough at just about anything you will find unique and special things going on. This is particularly true with Montgomery Pass Wild Horse Territory. We've got some situations that I think you won't find anywhere else and probably the foremost is the lion credation on the wild horses, although that isn't an area I'll touch on but Dr. Turner will spend time talking about that. The lion situation allows us the opportunity to have management by predators with the least manipulation possible to preserve the integrity of the herds.

Some of the other things with our population that I think are pretty unique, though similar to the Ruby Mountain situation, is that we have a lot of adventurers in the recreational aspect of observing wild horses in their environment. This is probably similar to some of the other areas but at one time the Montgomery Pass Wild Horse Territory was proposed as wilderness and it was not. But the management direction is very similar to managing it as wilderness or at least a very primitive area. I think one other unique aspects of our situation that exists is that we made a commitment to try to base our decisions on resource data. In addition to the uniqueness of the area, our management approach has been fairly unique. But before I get into that, I'd like to give you a little bit of a background about what we have in the Montgomery Pass Wild Horse Territory and what it looks like.

We've got 200,000 acres in both California and Nevada and most of the area is administered by BLM and the Forest Service. We also have scattered parts of private land involved. There are four districts, two Forest Service and two BLM, that are involved in the territory. So there's quite a bit of equal ownership patterns going on. The vegetation of the area is primarily juniper, pinion and Great Basin sage. Water is most from other territories, and is limited in isolated springs scattered throughout the area.

Our herd size ranges from 75 to 380 animals and is a relatively small horse herd. In 1987, after about 1,200 hours of observation, we come up with 184 horses; last year we had 192. Since 1985 we have not done any captures or management or removal of any of those horses. We have a relatively stable population of horses and that's directly related to the predation of the lions.

In about mid-1985, things started to change and probably the biggest thing was the increase in the horse population. The first thing the Forest Service wanted to do was to control the number of horses. So the

Forest Service put together a national plan that called for a management herd of 75 to 90 population and went out and conducted one capture. About the same time there was interest in observing wild horses so the Forest Service authorized two outfitters to conduct observations of the area, which increased interest by the public's exposure to the area.

Previous to that there was very little knowledge of the area or public awareness of the horse population. That was about the time Dr. Turner was aware of what was going on in the Montgomery Pass Wild Horse Territory and the lion, speculating that there was a relationship between the lions and the horses and he got his research started. Our management plan for the area was pretty much blown out of the water. We got together with a few people from Inyo Land Management and the Toiyabe National Forest and started kicking around some ideas about how we might approach herd management. It was pretty obvious that the issues involved and the controversy that we weren't going to continue to do the same old thing. We came up with a modified process of a coordinated resource management planning but we wanted to be sure we were taking advantage of the best information that was available about the territory, the capacity of the range, the animals themselves, their behavior, and their relationship with the lion.

In March 1987 we put together a steering committee representing varied interests. We had California Fish and Game, a lot of horse interest groups, researchers, outfitters and guides, and various agency people who were specialists in the wild horse aspects of this. We also had people who were interested in the off-highway vehicle portion. What we asked for was that the steering committee function as a common ground consensus decision-making body.

With that in place, the first step we took was to identify issues. One of the first issues was the range capacity, taking into consideration wildlife concerns. Another major issue was water and how we were going to deal with the limited amount of water in the territory. Of course, the mountain lion damage to the wild horse population was a big issue that had to be researched. We also had considerable cultural resource historical values throughout the area that were important. The wilderness attributes of that area and the primitive nature needed to be maintained.

We created five task groups who worked on specific aspects of the project. The wild horse committee dealt with technical parts of the data and was headed by Dr. Turner; the financial support committee looked at how we can go about financing all of these things; the wildlife technical committee to deal with a lot of different wildlife concerns, such as mule deer, sage grouse, and animal pre-introduction; and the habitat improvement committee to look at the guidelines for training. The steering committee then got together and tried to set the objectives for the whole management plan. That was a true give-and-take concept, it wasn't just the agency saying this is what the management objectives are going to be for this territory.

Some of the management objectives as provided were to enhance the range land ecological condition; provide water for wild horses; build a better distribution of animals, utilizing the habitat and to insure that the water will be available; consider appropriate habitat improvement from the present ecological age; and manage for a balance of recreation, educational, and research activity, maintaining free roam of behavior and movement of the horses. Then, when it comes down to it, if there's population control required, we would use the information and research that was out there at the time to dictate how we were actually going to remove the animals, or how we were going to deal with the situation. So, with experienced committee guidance and a technical group information they put together some action items to deal with each one of those issues, to meet those objectives.

We had to do a good range analysis and establishg the conditions for determining annual herd relocations. We also were looking at what we needed to do to restrict or control the existing outfitters using the area, as far as the amount of observation that was going on, because there was concern that the behavior of the

horses could be adversely affected by uncontrolled use and recreation. We were concerned about uncontrolled vehicle activity, so we created a number of guidelines for the use and management of the area. Some of these things included information handouts that we had for the few roads that go into the area and encouraging people to observe or treat the country with a minimum impact approach that included how they observed and functioned around the wild horses. It gave them some background and tips about how to do their activity.

We also looked at closing portions of the area but we didn't pressure ourselves into making a lot of decisions that would lock us into anything. We said we were going to provide five years worth of data collection and analysis to be able to continue to refine and fine-tune our decisions. Since the lions were such a critial part of this, we went to an extreme in that we approached both California and Nevada Fish and Game Commissions to request that they not issue permits for taking of the lions from the territory because we felt that any manipulation would adversely affect the study results.

The focus of the five year interim plan is the monitoring and further study of ranch analysis and utilization, mountain lion relations, and the predator-prey relationship, and monitoring the population variables of the horses themselves. We also looked at a profit set up during this five year period. It was also decided that if anything were to happen, for instance, the horse population increased more than about 25% from the 184 horses that we found in 1987, the entire steering committee would reconvene.

In June 1988 we came up with an approved plan. From my standpoint the importance of the plan is not so much what is in this plan as the fact that some 20+ different individuals and representatives of agencies and groups signed their name to it. It shows the amount of commitment and cooperation that is critical to create and implement a plan like this. It is my feeling that this plan is really our testimony to what people can do by working together. Certainly our approach is not the only approach and it's not necessarily the right approach but I think it's a good approach for our situation and an appropriate for our situation.

Dr. John Turner, Associate Professor
Dept. of Physiology and Biophysics, Medical College

Montgomery Pass Wild Horse Territory

I won't take too long to do this but I think it's really kind of valuable at this particular gathering where there are so many people from wild horse backgrounds and management interests to have an opportunity to see a fairly unique sort of situation that wild horses have developed in a predator-prey relationship in the Montgomery Pass Wild Horse Territory.

Horses normally come to the spring area fairly early in the morning and they are gone usually by about 8:00 or 8:30 in the morning. One of the reasons is that this area with all the rocky providence and forestation around it is a very dangerous place for the horses to be because there are a fair number of mountain lions in the area that take foals. The horses come down to water there because they need the water but they don't usually stay for long periods of time.

The herd has a fairly large number of buckskin and very light colored buckskins. This particular coloration of the high percentage of this coloration is kind of unusual.

Contrary to the popular belief about mountain lions, they're extremely shy even when they are treed or put into a corner though they may attack dogs if you have dogs with you. They have never showed any signs

of doing so to any of the lion hunters or myself and the hunters that I work with have about 30 years of experience in tracking lion have said that a lion has never attacked one of them. However, there are a number of things that the lion does when it kills a foal, a number of things you can use as criteria to demonstrate that, in fact, the foal has died by predition rather than just some other cause like natural death or attrition.

The coordinated resource management process that we've been working with was a surprise to me. I didn't realize that it was possible using coordinated resource management with a lot of people working together to actually produce a management plan that would be cohesive and meaningful. I strongly support Bill's position that having communication among the various groups of people interested in a given range area and its capabilities, is fresh. It's very valuable and I've learned a lot from interacting with people from all the areas of wildlife areas, the cattlemen, the Forest Service people, some of the private citizens who were interested in the population of horses and other animals out there, and even range people.

It became very quickly apparent from the beginning that there was a great discrepancy between the number of foals and the number of yearlings. 1986, '87, '88, '89 and '90 that we followed through with these data collections have demonstrated clearly that there are a large number of foals produced but that there are very few yearlings present the next year. So a lot of foals were disappearing. It became clear that there was a consistent agreement that there were mountain lions there, number one, and that there had been incidents of mountain lion killing of horses. This is the basis for the composition data that we see here.

Notice that the overall population size is good from 1987 through 1990. The population size has changed very little in those four years. We have to sort of ignore 1986, in some ways because we don't have nearly the database for that year. But over the last four years, clearly the population size has not varied very much: less than 5% change over the four year period. When we looked at foal survival, what we found was essentially that there were plenty of foals born but few of them survived and during the period from early May when foaling season is underway to the beginning of July when it's about over, we see a fairly significant loss of foals. These are foals that we can document as missing based on that we had seen them earlier and then they were not present by the first of July. The same thing for the period from the first of July to the first of October. There were more foals which we can document as missing although not as many as in the first part of the summer. And finally, if we compare the May to October survival rate for foals with the annual survival rate, we see that there is continued predation after October, but on a smaller level.

The next thing we tried to do was document that the foal loss was actually due to predation. To do that we developed criteria for what predation would consist of and how we could document that it had occurred. The criteria consisted of things like finding clawrake marks on the flesh, puncture marks in the bones of the skull and on the foreleg, and the presence of lion tracks and in the vicinity. Characteristically, Mountain lions cover their prey with brush after they have worked on a them. We would frequently find these foals under piles of brush, so it actually made it very difficult to locate them all on many occasion because they were partially covered. Looking at foal loss, using '87 to '90, the foal loss is approximately 28% to 43%, with an average in the 30s of the foals being killed or at least not being there at yearling. The percentage of the missing foals that were found as carcasses and the percentage of the carcasses which showed lion use according to our criteria, was fairly tied 77% to 100% of the foals showing lion use. The percentage of the carcasses would actually be documented as having been killed by the lion by our criteria range from about 2/3 to 100%.

The next thing we did try to evaluate this situation was to look at the incidents of mountain lions presence in the Montgomery Pass Territory. In 1987 and 1988, when we looked at various months of the year at the frequency of tracks, we found that the frequency of lion tracks are much higher in the winter than it is at

other times of the year. It is actually lowest in the early fall. That meant to us actually, when foals were being born the number of lions present were the lowest or at least lower than in the winter time.

That led us to another question which is what are the lions eating the rest of the year if there are a lot of lions there in January and the foals area already grown up to some extent. I should have mentioned that most of the foals were less than six months of age, by our estimate, when they were killed. Lions have rarely taken any foals over six months. The vast majority of the foals that were taken were less than three months of age. So upon these babies we figured that if there is more lion present in January than in the summer time, when they're taking foals, there must be something else that the lions are eating in the Montgomery Pass Wild Horse Territory.

Based on the lion activity from the tracks and the presence of another prey species, the mule deer, it was clear that when the mule deer come into the Montgomery Pass Wild Horse Territory from the Casa D'Ablo range in the Sierras they winter there. They usually arrive in November and stay until March or early April. During that period of time the lion population is the greatest there. Then it falls off to some extent in the spring, when the deer leave. Our best estimate is that some of the lions are leaving and following the deer back to the Sierras. But there are some lions which have been there year-round, based on this information we have gathered from radio calling and track counts that we've done and track identifications.

What we believe is happening is that these lions that are there year-round are killing and eating foals during the spring and summer and then in the fall and winter, along with other lions that are coming in with the Casa D'Ablo deer herd, these resident lions are killing and eating mule deer. Then when spring comes and the mule deer leave, the resident lions remain and begin killing and eating foals again.

So what we have here is a very very unusual ecosystem in which a prey-switching behavior has evolved with these lions. This is a theory. We don't know this to be a fact but our hypothesis is that this is what is happening. The lions that are living there are switching back and forth from mule deer to horse foals and thereby are able to remain year round. Because they are able to remain year round, they are able to kill fairly large numbers of foals across the three or four month period and thereby significantly the impact the horse population growth. That is the situation as we see it.

As far as the mule deer go, we do have data in that we have located thirty mule deer carcass across the time we've been studying this, since 1986. Of the 30 that we've found, 14 of the carcass (and you'll have to remember that these carcass that we find are usually found in the spring so they've been killed several months before and it's not as easy to document that they were killed by the lions) had shown definitive signs of lion use and 11 of them had definitely been killed by mountain lion. So we know for sure that the lion is also killing mule deer, not just foals.

The only other thing I would like to point out, related to this work we are doing here in the Montgomery Pass, is that if you compare the foaling rate in the Montgomery Pass Wild Horse Territory with other ranges (and of course we know that foaling rates vary across ranges), we find that the foaling rate in the Montgomery Pass Territory tends to be between 30% and 50% higher annually. Likewise, on Assateague Island National Seashore, when we compare the foaling rate on Assateague Island with the foaling rate at Chickatee, where foals are removed annually by the Chickatee volunteer fire department for adoption, we see higher foaling rates among the Chickatee horses than among the Assateague horses. In other words when foals are removed there is a compensatory reproductive response in the rate of productivity as the herd increases and, in our studies with Assateague and with Montgomery Pass, it looks like it can be in the range of anywhere from 30% to 50%.

The reason I bring this up is that in management programs where young animals are to be removed, I think it's important that the young not be removed until they have reached the point where they are close yearling. For example, removals that occur in the fall and foals are born in the spring and the removals occur in the fall after the mating period season is over is probably not much of a problem because the mares will have already conceived or not for that particular year. What we don't know is what the impact is the next spring if those foals are nursing up to being yearlings and we've seen significant amounts of foal nursing as yearlings. Until the new foals are born. So if that happens, then the issue of removing young can perhaps impact the population growth rate. I don't know this to be a fact because I don't have the data, but it is something I bring up to consider, in considering the ages at which animals are removed from the range.

We have been very careful not to advocate the introduction of mountain lions into horse ranges across the country at this point even though it comes much closer to equaling natural ecological balance than either we could create.

We are not doing any killing. The lions are taking care of that very well. We were successful with both California and Nevada studies. They thought this was a very interesting situation and both states were interested in what was going on with the lions so they both cooperated. In California they allowed us to track lions and to collar them if necessary and in Nevada they closed down hunting season in Mineral and Esmeralda counties during the period of time we were doing this. At this point in time we hadn't made a request for continuing the closure of the hunting season and I haven't communicated yet with the Nevada Wildlife Department this year. I don't know what they'll do.

Lions behave very similar with foals as they do with the deer. They usually kill them in one place and then drag them off to someplace that they prefer. They would usually drag them 30 or 40 yards off the horse trail, up into the taller sage brush, but we have actually found foals that have been killed and dragged over a quarter of a mile, up a rocky hillside. It's really impressive to me to think that a 100 pound female lion is able to take a 130 or 140 pound foal and drag it a quarter mile up a hill and through rocks. But we have definitely found, in most of the kills, they tend to go for the neck. It looks like, from the way the claw marks occur on many of the kills, they came up on them and jumped from the side and then bit them in the neck. And we usually find marks on the hind quarters as well, so they're probably doing multiple lacerations with their hind feet while they're biting in the neck. I've seen video tapes of lions in Africa killing Ungulus and what we've seen by the markings it is very similar. Because foals are small and their bones are not hard yet, it's very easy for lions to puncture bones and that has been one of our valuable resources in identifying a kill because we find puncture marks in the skull and in the forelegs.

In over 40 foals that we have found in the past five years, only two of those foals were found near water sites. So, apparently the lion doesn't kill near water or at least in this horse range they are not killing right at the water. Most of the time we find them in areas where there is a trail going along and it is a place where the lion can ambush the animal. But that's not always true because last year we found three of the six foals that had been killed by lions were killed in an open flat sagebrush area. So, I think it may be somewhat lion-dependant: some lions have certain patterns when they pursue them. That's my guess. The people working our research have been struggling with the fact that the mountain lion is a very unusual animal. Lions are so stealthy and secretive it's difficult to work with them.

I guess my perception is with the steering committee we've had work on this, it's never been an issue with the respect to anyone on that committee or part of the public as far as a concern to prevent us from using as, the people look at the alternatives they support the natural non-manipulative, allowing the animals to function in harmony with whatever natural environment they have out there.

One interesting point they didn't mention is that even during the drought conditions we've estimated with our preliminary range analysis work that the herd population is probably closer to 250 animals than it is to around 75 to 90.

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National Park Service
Assateague Island National Seashore, Virginia

Management of Feral Horses on Assateague Island

This morning we've been alluding to stereotypes and I guess I'll continue that somewhat and indicate that, if you want, you can perhaps classify me as an Eastern Yuppie Bureaucrat. I'm coming about as far from the east coast as you can possibly get. I'm a bureaucrat from a different agency, an agency I don't think you folks have addressed yet.

Much to the amazement of many people, the National Park Service is indeed involved in management of horses. However, that management is drastically different than what you've probably been exposed to thus far during this week. We'll get into those differences as my presentation goes on.

I am the sole representative of the Park Service but this doesn't mean I can answer all of the questions about all of the various herds of horses that we are managing. I think I can answer most of them about the Assateague horses but when it comes to other herds I might have to beg off from answering them. To start off then, I am from that other agency, the sister of the Bureau of Land Management and Department of Interior of the National Press Service.

In our agency, our headquarters office is called the public palace. And it is indeed that. Many times, as we see in the parks service, we are very confused and have lots of different directions that we end up going. And it ends up being very much of a puzzle to try to figure out where we are coming from and what we are doing sometimes. Nevertheless, to spite that confusion, there are some very important policy issues that I feel I should bring out in regard to our management of park resources, because it is significantly different than virtually every other land management organization in the United States.

Never mind that the Forest Service emphasizes multiple use and resource utilization. In the National Park Service we do not have that philosophy nor policies that back that up. We are a preservation agency. Now there are exceptions to that. When you look around the agency and various units you'll discover that there is some resource utilization going on. Perhaps some of you are familiar with Death Valley here in this state and the fact that there's mineral extraction that occurs there. In years past there has been grazing that has occurred. There have been attempts at timber resource removal so it's not unheard of; but generally our policies avoid utilization of natural resources and we plan toward preservation of resources.

I am from Assateague Island National Seashore, which was established in 1965. It is a fairly young park, particularly in relation to other federal holdings here in the western United States. In fact, Assateague Island National Seashore, when authorized, was in private ownership and the federal government had to go through a land acquisition process in order to establish parks. This is very different from here in the western United States, where there have always been federal holdings and those holdings have been carved up amongst the various agencies. Plus the fact that we have essentially a foundation coming from private interests influences what we're doing in terms of resource management and, in particular, management of horses.

Assateague Island itself is about 37 miles in length and is split between two states. The Island has roughly 4, 000 acres of islands and in the park also includes about another 20,000 acres of water area, back bays, and ocean. Actually in the park itself there is more water than there is land and few people realize that. It is in the states of Virginia and Maryland. Even though it's shown as a peninsula, there is an inlet, a resource town of Ocean City that splits Assateague Island off as an island. It's not a peninsula.

What we are best known for is our wide open, undeveloped area, despite earlier previous private ownership expanses of beach. Much of the beach is in quasi wilderness condition, not unlike wilderness that you find in the western United States, but much smaller acreage and there is essentially nothing out there. You don't have to go very far to find development but it is very pristine and quite remote unless you have four-wheel-drive or a boat.

A study just came out beginning this week that indicated Assateague Island is the tenth most popular Atlantic coast beach in the United States. It is a recreational area and there's a tremendous amount of emphasis placed on providing recreational opportunities to the visiting public: swimming, surfboarding, surf fishing, canoeing, some hiking, wildlife observation, and things of that sort. What most people don't recognize, oftentimes, is that there's much more than just the beach.

There are significant holdings with salt marsh and back bay areas that are associated with the seashore. T is a very narrow band of beach on the top right hand corner versus the thicket zone and salt marsh area. We literally have the entire length of beach. There's far greater acreage in this kind of vegetation types rather than just the open sand beach. And a lot of people never see it, they never venture out into it. Oftentimes it's very uncomfortable and it's not very easy during green head fly and our mosquito season.

We also have wildlife resources. In fact we a unique situation on Assateague Island regarding our wildlife resources. We have white-tail deer, we have Sica deer (something we don't particularly care for in the park), and we also have the wild horses. I say that this is a unique situation because we three large herbivores in an essentially confined environment. There is a bridge on the north end and a bridge on the south end; otherwise it's an island with no paths to the mainland. None of the agulus utilize the bridges but we have some evidence that indicates some of the deer swim across (the bays are fairly shallow), but they're essentially isolated. And there are no predators, except man.

One of our unusual situations at the seashore where we do have resource consumption is that we have to Congressionally authorize hunting, which occurs and still has results. Sica deer are actively hunted on the island; horses are accidentally hunted. It's during doe season that we end up with a horse or two that's been shot.

The popular belief regarding the origin of horses of Assateague Island is that they came from ship wrecks that occurred offshore. We really think the storage of the horses was an effort on the part of colonists who were residing on the mainland to avoid taxation. They would move their horses onto Assateague Island and permit them to graze freely and, when tax collectors came around and went out and counted acres that were under use by the horses or numbers of head, they weren't around because they were all hidden out on the island. In 1965, the National Seashore was established. There was a population of approximately 20 horses on the island that were loosely owned by one individual. They were not really cared for and just sort of roamed around the islands. Even though there was an individual who laid claim to them, when the Forest Service came in they were just abandoned. We also had feral goats on the island and some individuals let cattle roam freely on the island as well. So, in 1965, the National Park Service inherited a herd of free roaming animals on the island.

There are other national park units that have horses as well, with far different environments. Another national seashore lies off the coast Georgia at Cumberland Island. They have wild and free-roaming horses there as well. Coming up a little further on the coast, Capattern National Seashore, similar situation, except that theirs are much more stringently managed than ours or the ones at Cumberland Island. They literally have their horses corralled and provide care to them. That is the thing we do not do. Their reasoning for that has been essentially the intense development that has occurred on Capattern and the outer banks. That seashore is split up with private in holdings all over and major highways up and down the outer banks, which create problems when you have free- roaming animals in a relatively confined environment. So the management decision was made at Capattern that they would confine their animals and protect them from human use in that manner.

We have a very different situation as much of Assateague Island is essentially a wilderness. We don't have private development although we do have an access road. We can permit our animals to roam free. Cumberland Island is very much the same way. The only way you can get to Cumberland Island is by a boat.

The only other seashore that I'm aware of that has horses is Cape Lookout, which lies south of Capattern, on the North Carolina coast. Again, a very remote situation that is only accessible by boat.

The state line of Maryland and Virginia are in Assategue. There is a fence defining the state line. In Maryland, there are two agencies that manage the island property. There is the National Park Service, the major landholder, and the State of Maryland managing Assateague State Park. They own roughly 600 acres.

In Virginia, the island itself is managed as Chickatee National Wildlife Refuge, managed by the Fish and Wildlife Service. The State Park Service has little interest in managing the horses. As far as they are concerned, they belong to the National Park Service and we're responsible for managing them. In fact we do have operations occur within state park boundaries dealing with the horses.

They are intensely recreation oriented. Virtually all of the state park is developed with bathhouses and campgrounds and there's very little of them in the salt marsh that's undeveloped in the state parks. So we manage the horses in Maryland and in the islands.

In Virginia, we have a different situation in that the Fish and Wildlife Service essentially has nothing to do with the horses that are in Virginia. It is the herd that is owned by the Chickatee Volunteer Fire Department. Chickatee is a small island that resides immediately to west of Assateague Island. For many years the fire department has owned those horses and managed them. Annually they auction off, as a source of income for the fire department, foals and yearlings. They are interested in perpetuating their population as a source of income for them. That's why we have a fence at the state line. They have roughly 150 animals in their herd in Virginia and they don't want their horses intermingled with our horses. They provide veterinary care and have compartmentalized the refuge and split their herd up accordingly. It's relatively easy for them to round up their horses annually. By and large they attempt to keep the horses away from public use areas.

Their herd is managed even though it's not like the domestic horses you have in pasture or in your back yard. There is an intense amount of human intervention to maintain that herd. Our herd in Maryland is different in that we essentially do nothing for them. We do not provide any veterinary care, there's no supplemental feeding that goes on, there are no roundups that go on, essentially a hands-off situation that we deal with, as we would with any other wildlife species within the National Park Service.

I've indicated that our policy was essentially one of preservation. One of the major concerns that we have regarding natural resources in the parks is that they maintain their integrity. Often there are elements that crop up that threaten the integrity of natural resources. One of those might be the introduction of exotic plants. We don't like exotics, we are there to preserve and protect indigident species. Another category that we don't like are exotic and feral animals. In dealing with something like gypsy moss and honeysuckle, it may be next to impossible to get rid of that. There are a number of specific situations where we have deliberately gone about eliminating species, exotic or feral, that are competing with the conditions of wildlife that we are interested in protecting.

Assateague has feral horses that we're permitting them to thrive on the island. But, from a strictly ecological point of view, the best solution for these horses is to get rid of them, one way or another. But the Park Service is more complicated than that. That's probably the easiest solution. There are other elements that enter into decision making regarding our resources.

We now have tremendous cultural resources as well as natural areas: Mesa Verde, the Statue of Liberty, the White House. We are interested in preserving and protecting the nation's history as well. And in some cases we have situations where we are protecting living cultural resources. We manage an interesting little unit in the State of Massachusetts: Frederick Law Homesteads' home. Frederick Law Homesteads was a pioneering landscape architect and his house and the grounds around it are historically significant from a landscape architect's perspective. So we protect the vegetation around his home as a cultural resource. It's living, but it's a cultural resource.

The horses, from our perspective, are a cultural resource. They are living but they are a cultural resource. They are not like Indian ruins like you find at Mesa Verde or an arrowhead or something of that sort; it just happens that they're living. There have been intimate relationships between the history of Assateague Islands and the presence of these horses; a valid human interest relationship that we can't walk away from and, merely for ecological reasons, say we want to get rid of them. Superimposed on top of that is the social influence with obvious interest in protecting them. So socially and politically it would be unacceptable to eliminate them.

We now have evolved into a situation where, scientifically, we're no longer interested in eliminating the horses. When you look at the herd that we have, there is behavior lineage information that is coming up on almost twenty years worth of detailed data. There are virtually no other populations in the world have the kind of lineage information that we have on horses in an essentially closed environment. We know who the mares were and who, in some cases, the sires were and who gave birth to whom for almost twenty years. This is an incredible opportunity, as far as population modeling, that we don't want to loose. The Park Service is interested in these kinds of scientific opportunities.

While we are preservation oriented, there are anomalies in special situations that we deal with and this happens to be one of those, where we accept the feral species. Unfortunately they create problems for us. In fact, they are a threat to the integrity of other natural resources and they're a threat to public enjoyment of the national seashore. In order to address those, our approach to this is a general management plan that outlines basic objectives for management of the park and then we get down to the very specifics about feral horse management. Most of the emphasis in that plan is on human interaction with the horses and how are we going to deal with that. Not much on the side of ecological interaction.

There are tremendous developments in the area. In less than a quarter of a mile we go from heavy development to pristine environment across the inlet. The horses and people are threats to each other on the national seashore. You most generally don't come face to these kinds of population; on a heavy weekend in Ocean City there will be upwards to 300,000 people. Potentially a lot of those visitors can show

up on our doorstep. You don't have to walk for miles across mountain ranges to have interaction with the horses.

They're an attractive nuisance essentially. People like to feed them. Their favorite item is Twinkies. You are familiar with bear jams in some of our national parks like Yellowstone. We get horse jams. Bizarre as this may sound, people stop and photograph them, pet them, and feed them, and even ride them. They have become habituated to our trash and their forage consists of trash cans. We have a number of them that inevitably cause property damage during the course of the summer. Screen tents are very popular because of the bugs. Folks will put their picnic table inside the screened tent and think it's safe. They'll leave all their food out on the table, walk an eighth of a mile over to the beach, and when they come back they'll find their screen tent has been destroyed by the horses.

We have a number of horses that have become quite habituated to using road shoulders because they are mowed and tend to be much more lush and attractive as forage than the remainder of the island. So inevitably we end up with motor vehicle accidents. On an average there are three to four horses that we end up having to put down as a result of motor vehicle accidents. So, it is a serious problem when we're trying to accommodate public use.

We have handouts that we give to the public, we have wayside exhibits to deal with touching of the horses, we have great big obnoxious brown and white signs throughout the parks that tell the public that horses kick and bite. We do have human injuries but they're usually not very serious although the kicks were touch and go. Occasionally kids get kicked and we wonder if it's going to end up being something serious. We have great big signs up and a fairly aggressive law enforcement program to prevent people from stopping along the roadside. We have motor vehicle accidents that occur, not because they hit horses but because people hit cars that have stopped to look at the horses. It is a serious situation. Public education is one of our solutions to try to separate the people from the horses.

I've indicated that we don't manipulate our horses. That is generally the case. We do not feed them, we do not round them up, and there is no veterinary care provided to them unless we've got a particularly difficult situation. Usually about once a year, we end up with two or three horses that are particularly obnoxious. We try negative reinforcement operations. My staff gets out there with whips and airhorns and p.a. systems on patrol cars, trying to get the horses out of public use areas. We inevitably end up with some that are gone for a day and come back the next and so we end up in transfer operations.

We do occasionally, corral and end up having to transfer some of the horses. What we have done in the past is entered into a cooperative agreement with the fire department and give them the horse, no no questions asked, and you can do as you please. Often they'll end up auctioning off that horse. Sometimes they'll just cut them loose. But it gets the horse behind the fence, usually in a remote area away from public use and out of our hair.

However, we have had problems because the refuge managers complain that the horses become problems in refuge. So this opportunity seems to be getting turned off for us and we may not be able to do that any longer. Another thing we've done this past two years is attempted to relocate the horses elsewhere on the national seashore. We have not explored the adopting programs yet, but that's certainly another option. Another option is to destroy animals, which is the least likely thing we'll end up doing. But nevertheless we do some intervention; it's not totally hands-off. But no veterinary care and no feeding unless they're corralled — and they're not fenced in any way; they're allowed to roam wherever they please.

They are grazers and this is a concern to us. There is an island that lies west of Assateague Island, out in the bay. It had a very large colony on it about three years ago. A state biologist came in and said the

colony seems to be declining and the horses may be the root of the problem; we should fence the horses off the island. We installed barbed wire fence around much of the island where the colony had been. After just one season there was a tremendous difference between where horses had been and had not been. We are also concerned with trampling problems. Salt marsh tends to be very sensitive and we feel that some of the erosion that's occurring on the fringe of our salt marsh may be related to grazing activity and then trampling activity that's occurring along the shores edge. We haven't done anything quantitative, it's more anicdotical evidence, but we feel that there's also some grazing pressure that's occurring out on our dunes. American Beach grass is a favored species that's grazed by the horses and here out on the primary dunes. Particularly up on the north end of the island, we've got places that have been essentially denuded to vegetation. That's a major concern for us because feral islands are hydrologically and meteorologically drift and sediment. Movement is extremely important and this beach grass plays a key role in trapping some of that sediment and allowing the island essentially to stay quasi stationary (feral islands are never stationary, maybe a bizarre concept, those of you are working inlet areas, but my resource on a daily basis is moving around. I go out to the beach and see detectable changes almost on a daily basis with the resources moved around somehow or other). Well, if we allow the horse to graze all of this off, we have a fair sand.

We also have problems in our developed portion of the park. We have campgrounds and parking lots that provide horses access onto our protected beach. In order to protect those, we have a primary dune line that we actually manage. We manage that dune to hopefully provide a minimum of protection to significant investments made into facilities. In other areas of the park we don't do it, just in the developed area. We want to try to protect that from storm activity, so we're not constantly losing parking lots, constantly losing our campgrounds. So we go out and we plant beach grass on this dune to help stabilize it. The horses get into the fenced area that we planted and of course they're more interested in grazing on this than what they are finding growing on the island because it's much more succulent because it comes out of a nursery.

Essentially we have been engaging in research for almost twenty years. Early research was started in 1974, 1975 by Dr. Ron Kiper, at State University. He was looking at behavior and organization; just getting a handle on how many are out there and actually has continued with his biological studies since that time off and on. More recent years it hasn't been as intense as early years. Kiper also looked at carrying capacity and established a carrying capacity for the national seashore between 120 and 150 animals.

There have been a number of studies to attempt to document the impacts of the grazing and it's just been within the past year or two that we are starting to get some of the results back. We seem to see evidence of destruction of nutrient cyclings in salt marsh vegetation. We have major exclosures that have been put out both on the primary dune and on the salt marsh with preliminary data collected on them. No repetition yet, but anadotally you can go out to our exclosures now on the primary dune and visibly see a tremendous difference between the grazed and the ungrazed. So we've done grazing research.

We've been looking at fertility control through contraception. Dr. Research is starting to look at long term effects of this procedure and the Park Service isin the process of working with some other individuals to work out population modeling so that we have a good firm model in hand before we go out and start doing mass darting of our horses. We want to make sure that we don't crash the population. We are being very cautious about what we do. At this point we are in the modeling mode.

The carrying capacity that Kiper developed was a carrying capacity in the classic sense. How many horses can the vegetation on the island support. Well, our thinking now is that we are just starting to go through talking process about that is that really isn't what we are interested in at the National Seashore at all. Our objective is to maintain the population, and to somewhat satisfy social and political interest and to maintain the population so we don't crash it as well as to minimize other ecological effects.

We are not producing horses, so that's not what we're interested in. We just want to keep the horses around and try to maintain all other ecological processes. That might be really off the wall for those of you that are working with the research utilization field. But that's where our thinking is right now regarding some of our management goals and objectives with the horses.

Regarding philosophy with the horses, we essentially tell the researchers when they come in that we do not care for research that is highly manipulative. Our mission is to protect and preserve the resources of the park. That means sometimes protecting and preserving resources from researchers. If there is something that can be better done in the laboratory or can be better done in a managed situation where you've have corrals and stalls and what- not, that's where you go to do the work. The work that we're interested in having done has got to be work that is the least manipulative and least constraining on the vegetation and wildlife that exists in the park. Although that's not really written in our management policy, it's alluded to. That puts tremendous constraints on our investigators.

Corralling would be much easier in terms of making sure you're getting the injection to occur but we're not interested in corralling the animals. We want them to essentially have some rights and we want them to be unconstrained as much as possible.

That philosophy sort of shows where we are coming from and results in the techniques that we permit researchers to use and they're also the techniques we want them to develop for us. I think in this case we've been very successful in doing that.

Another situation that quite frankly that drives this policy or philosophy is one of finances and practicality. It's very difficult to locate horse in Assateague Island. You get into that bay berry thicket, you can't find horses; you don't even know where you are. It's very difficult to round them up. That is why, on the refuge, they've got compartments already established. Those compartments make it much easier for the fire department volunteers to round up their animals. We don't have that situation, so you can be chasing those animals from one end of the island constantly trying to get them rounded up. In order to really do that, it's going to take a tremendous amount of money, money that we don't have. We are interested in finding techniques that are really practical within the financial frame work that we have to operate with.

We don't and haven't gotten rid of surplus animals. The only animals we have moved have been animals that are problematic to us. Our population has kept growing and it's only been within the last couple of years that we have hovered around the point at which we are exceeding that carrying capacity that Kiper set for us. Right now we have about 160 animals, which is ten more than the upper limit of what he said. But from our perspective our thinking is that carrying capacity is bogus from the perspective of meeting our management objectives. It may very well be valid from a range land management point of view, but we're not interested in managing range for the production of horses. We're not in a position to identify excess animals per se.

Robert P. McQuivey, Habitat Division Chief
Nevada Department of Wildlife

Opportunity for Making Wild Horses, Burros, and Wildlife Uses Compatible

Making horses, burros and wildlife uses compatible. As you can tell by the title I'm one of those guys that would stop and take a look at the deer and the antelope on the side of the road. I also enjoy looking at the horses. I'd like to change the title just a little bit because I think when we talk about making wild

horses, burros and wildlife compatible, we are also talking about livestock because the three are really interrelated.

We certainly can't develop a wildlife program or a livestock program or a wild horse program without addressing the other two. In order to get to that, I'd like to go through a brief history of the use by those three class animals. I think it's a history of Nevada, parallel to the history throughout the western United Sates. If we look back a long time ago, 10,000 to 12,000 years, wildlife is a lot different than it is now. Obviously, they were more domesticated animal. Archeological records show that there were three club horses; the species has been extinct for a long time. Wildlife species consisted of camels, ground slops, other types of things we are really not familiar with now.

Moving forward to about 1800 to 1850, again there was no domestic livestock and the sheep and cattle had not moved into the western United States yet. Few if any domestic horses, there may have been one or two here and there, but certainly no numbers showed up for domestic or wild horses as we know them today. In our primary species of animals who used the range land at that time were antelope and big horn sheep and we had very few yield there. And full of elk. But basically Nevada, as much of the west, was grass line, it's not the grouse type plank communities that we have today.

The changes really started in about 1850, between 1850 and 1900, and several things happened. Number one is the mining exploration activity with the Comstock and other activities throughout the state. What we saw was a tremendous amount of use camping on springs, and probably the biggest thing that happened was the harvest of timber. Timber not only for the mines but timber for houses and also for the many chuckle gangs throughout the state. The woodlands we are seeing today weren't like that between 1850 and 1900. Most of those woodlands were taken out. In fact most of the Sierras and above it were completely logged.

In addition to the mining activities and effects on trees between 1850 and 1900, we saw the movement west for ranchers and the start of domestic livestock herda. Qhile the mining people were taking the trees, we had an influx of cattle and sheep which were taking grass. What that did throughout the western United States, particularly in Nevada, is that it created a different set-back. It created a grouse type community, that invaded sagebrush, fairbrush, mahogany and a lot of other plants that we have now.

What that did in terms of wildlife, it made some changes in the species that regularly utilizes those kinds of communities. Between 1850 and 1900, I would guess that was the greatest impact that we've ever seen in terms of wildlife species; not only from consumption use but also from a standpoint of changes in the range in terms of vegetation.

Between about 1900 and 1950, that was really kind of a continuation of livestock grazing; mining had gone to a wall. The livestock grazing continued as a dominant use of western range lands. A lot of the miners left their burro loose and some of them escaped. That's where we see the real establishment of those populations. Same thing happened, I think, with the wild horses. In fact, in most of Nevada, prior to 1971, the wild horses were controlled by a County Commissioner as opposed to state government or federal government. There was an opportunity for a lot of livestock people to run horses on the range and they had roundups and so on. They more or less managed them in terms of what they thought they needed.

Also in the period from 1900 to 1950, there were some tremendous changes in all kinds of uses on the public land as well as the private land. We can look at a few things that happened around here. We look at the development of a lot of Nevada. Some of our most important winter ranges were along the foothills, west of Reno, between Verdi and the State Line. We move forward to the period of about 1950 to 1990 and again we see some different types of changes. Changes that I think were the most significant during that time

period were more social, political, and economic as opposed to changes in the active range plan. We see an interest in the public being involved in wildlife issues and wild horse issues, in the NEPA process, the 1971 Wild Horse and Burro Act. All these things have really made a big change in the way we do business, not only from a wildlife perspective but the livestock regulators. The public is just really deeply involved in the land uses planning processes.

I'd like to briefly focus on the Bureau of Land Management plan process because they do manage most of the land in Nevada, As far as the federal agency goes. If we look back in the early to mid- 1970's, what the bureau tried to do was to go with four allocations: wild horses, wildlife, and livestock. Let's take a look at in terms of geographical area, figure out how many animals that area can support and then we'll figure out who's going to get what. In other words let's cut up the pie. We went with that process for a couple of years in some of the early plans but then it kind of shifted gears about 1976 in Nevada and moved away from that into a monitoring program.

I think that what we have been able to do is the wildlife people, the livestock people, and the wild horse people have become very good at what I call playing games, manipulating the system to try to use that system to benefit our particular interest. Let me give you some examples.

We're using the numbers game when it suits us. We are using the monitoring process and it's created a considerable amount of confusion. A more important problem than that, I think, is what it's doing is putting us back into the mode of looking at court decisions or management as opposed to making decisions based on resources. I really think that a court decision that is based on the legal interpretation of the law often has nothing to do with what is needed from a resource perspective. I would hope that we could get back into the mode of working together on livestock issues, as agency people; wildlife interest and wild horse interests working together to make a decision ourselves instead of having judges make those decisions for us.

I think for us to continue jumping back and forth between how we are going to make decisions on the type of data we are going to use, we will continue to cause confusion. I know in working with some of the wild horse interest groups in the past, they were very willing to look at numbers back in the mid-70s, early '80s; look at numbers with some conditions on the other side: conditions of the wildlife perspective, land management agency perspective, and livestock criteria. I think we've gotten away from that. I think we've gotten away from looking at what will this particular geographical area hold.

Let's establish some criteria either in numbers or monitoring, or a combination of both. Establish those rules and then play by those same rules for a given period of time until we can determine whether or not those objectives are being met. I wanted to make just one point about the fighting geological balance. Since that seems to be the new buzz word in terms of management. Ecological is a branch of science concerned with the inner relationship of organisms and their environment. The definition of balance, however, that's by a different part. One, a judging or deciding; two means a stability produced by an even distribution; three, it means a body between a poll on two sides; four, aesthetically pleasing integration of elements; and five, to bring into harmony or proportion. To define the threat of ecological balance depends upon who you are, what your interest is, in terms of what the definition is going to be. If we are going to use ecological balance in terms of future land management, I think the first thing we need is an agreed-upon good definition that everybody can abide by. Otherwise, describing ecological balance is not going to mean anything.

Finally, I would like to point out the most important thing is that we all only be workig for the preservation of soil, water and vegetation; whether we're in the livestock business or the wildlife business or interested in wild horses, I think that's something we should all have in common.

Demar Dahl, 1st Vice President
Nevada Cattlemen's Association

I was the only speaker who wasn't given a topic, so I guess I can say anything that I want. (There was a note, that came with the request for me to participate, that asked me to be positive and to say something positive about the wild horse issue. You see, I always call it the wild horse problem, so I'm already being positive. But I'll probably mention a set of problems.

It's difficult for me to be optomistic when I view the wild horse situation, especially the way it relates to us in agriculture and as the law relates to the resources out there. If, ten years ago, someone would have told me that in 1991 we were not going to have made any more progress on this issue than we have, I would never have believed it.

I have been deeply emersed in the wild horse issue since it's beginning. I have had wild horses before Wildlife Anne got her bill through — and I was supportive of that. When they said we couldn't run them at all and you can't get them at all, I was concerned about that. I can be positive about the horses themselves. I have an appreciation for horses and I have a little appreciation for the wild horse. I believe they have a place on the range, but let me tell you where I've spent the last few days.

I spent the last few days on winter range with cattle and horses. On the first of April we made considerable efforts to get all of the livestock off the winter range. BLM is very insistent that all livestock be off the white sage area by the first of April and I fully agree. Every responsible person in the livestock industry should also agree with that. We need to protect that winter range resource at all costs.

I spent yesterday and the day before going back over that winter range trying to get a good idea of what the utilization has been over the winter. What I saw on that range were hundreds of wild horses and, as soon as the white sage was coming up, as soon as the grass was starting, here are the horses just standing waiting. This happened a lot in my past. I had to sell a ranch one time for that very reason. I had a good winter range and I moved the cattle off that winter range in the spring and go back to it in the fall and there wasn't anything there because the horses had camped here the whole time. Now on this same range (where I have been the last few days), are the Peacrop Mountains. There are very few springs on that range; the only water there is in what we call dirt ponds, where we make a little pond to catch this water as the snow melts and runs off. As the grass starts to grow on the Peacrop, the horses follow the grass and they're moving up the Peacrop. For at least the last five years there hasn't been any livestock use on that mountain at all because the horses follow the grass and they get there first and they camp on those ponds. By the end of June, when the water dries up, the horses head back down off the range where it is lower and not as far to go to water and there's no livestock use.

I can tell you there are a lot less deer scattered there than there used to be.

So the question always comes up about how many horses are there. I always raise this same question. In 1980, there were 30,000 horses in BLM (the best guess, I think, is 31,000+ in 1980), and we're still saying there are 30,000 horses in Nevada today. If there were 30,000 horses in Nevada in 1980 and we use Washington's best guess on what the rate of increase is, which is 18% to 20% (which they get from Univesity of Minnesota study), multiply that out and subtract 45,000 horses (which were gathered between 1980 and 1990), that would still be over 70,000 head of horses.

Nobody seems to want to address that issue. We have a lot more horses in Nevada than we think. These horses are doing some serious damage to the resources. I know a lot of times we like to pretend that it isn't happening but on the winter range that I had along the county line between Churchill and Lander County, there was one live water spot and the rest of it was all pumped. The live water was right on the west edge of hole-in-the-wall winter range. If you travel from that spring and go east, during that time of year you start out at the spring with deep, deep, trails and no vegetation and as you travel, you can see it get better, and better, and better. When you get far enough away from the spring that the horses hadn't been able to get there, it's a lush, beautiful piece of range.

These are some of the facts that I think we need to confront. I am a little bit optimistic and positive in I think I see a shift in people's perception and people's view of what is really happening out there. I think that there is a realization that we do have a problem and that we do need to address it. When I hear the discussions about tubal ligation, about manipulation of the herds and gathering the horses and at least taking off what can be adopted and putting the rest back out and fixing them so that they are not going to reproduce, I am encouraged; but the politics of the horse tells me that this is not likely to be the solution, although I would like to see it happen.

I saw a BLM memorandum yesterday that said the horses were going to be moved out to sanctuaries. I think it referred to 20% that were going to be able to be adopted out of there and that the rest of them were going to be brought back and put onto the range. I made several phone calls this morning to try to verify that and have. These horses are going to be brought back and put out on the range. Maybe there are some things we can do, if we can get some guarantees.

There's one aspect of that which upsets me and upsets a lot of people in the livestock industry and that is that apparently was a unilateral decision in that we were not consulted on it. I don't know if a lot of people have an interest in this issue but I think we should have all been brought together and had an opportunity to calmly discuss this issue. I hope that in the future that we will be consulted and that all of us will have an opportunity to participate in this kind of decision — at least to be able to make our wishes known.

The number one responsibility that we all have is for the resource. Whether you're interested in the livestock, or horses or wild life, the home for all of those animals is the range. A thriving range is just a good range one that anybody can go out there and look at and say this is in good shape and this is good range conditions. I think we have to decide how much room there is and for how many horses. We need to know how much forage is available and how we can all live together out there and get along. I think we can if some people with common sense had an opportunity to sit down and work that out. We could figure out how many horses should be able to be out there.

The other thing we have to decide is, when we reach that limit we're going to have to gather those excess horses. Then I support using the adoption bill; then we could say we can take the ones that are adoptable out and adopt them. Then, inevitably, if we were to use common sense, we would have to say those that we can't adopt we will sell. We will take the money from the sale of those horses, put it back into the program and let the program be self-sustaining as much as possible so the program won't have to be supported by taxpayers.

I think that would make sense and I know that a lot of people think it's not even possible that we are going to ever see sale authorities granted. I think it's the only solution and someday I hope we get back to the point where we can say this is what we have to do.

I hope somebody will bite the bullet and have some common sense to check into this issue.

John Boyles, Chief, Division of Wild Horses and Burros
Bureau of Land Management, Washington, D.C.

Looking at New Horizons

This year marked the 20th anniversary of the passage of the Wild Horse and Burro Act. It's a milestone that obviously has not gone unnoticed by the people who have presented papers here, who attended the various events that have surrounded the forum. I think that's needed to be. It was time that we had a session like this.

Meanwhile the Horse and Burro Act is as much about people as it is about animals. It's about people who cared enough to take time to protect these animals. It's about children who cared enough to write their congressional delegations to get in the act. It's people who are involved in perpetuating their existence. You and me; people who adopt the wild horse and burro; people who ike the idea that America has room for wild horses and burros. There's 20 years in the Act. There have always been an abundance of issues on the horizon.

After listening to presentations for the last 2½ days, I think it's safe to say that the landscape, that once again has been altered. I would like to share with you the next few minutes what I think is changing the horizon. I'm going to go back to what I mentioned before, the energy level. Last fall the Secretary of Interior and Agriculture appointed the Wild Horses Revised Report. Several members of the board are in this forum and have been for the last few days. I certainly hope you have taken the time to get acquainted with them and share your perspective about the program. I think it's vital. The representation on the board is very broad. It includes livestock, wildlife, research, brain science, the general public, that make up the main organization in wild horse and burro management. The credentials of the people on the board are impeccable. They are well qualified to give the Secretary their best advice. But they need to know what's happening in the program; they need to know what each perspective is from each of the users.

The board has met twice since its appointment. It'll meet again next week in Pueblo, Colorado. At it's first meeting, the Director met with the board. I think he laid out some directions for the board to think about and come back to the Secretary in terms of direction. I think he made it very clear that this Bureau is not going to go to Congress and ask to save those horses. He also asked that the board take a look at the balance of the program and pointed out that we need to spend more time on management. We are using a lot of hours, a lot of manpower, and a lot of resources on the tail end of the program. Decisions have been made in hopes that things will change and we'll have a new horizon. Certainly the board has located a lot of things already and the board gets it done and it has until December of this year to provide a report to the Secretary. It can provide interim recommendations as it so desires and probably will.

We have seen new things on the horizon, here, in terms of fertility control, modeling, and the use of aircraft. Various things have been presented here, that I think are important for them and for presentation to the Secretary. Before the establishment of the advisory board, the BLM put together a steering committee. The steering committee was composed of five state representatives, the Assistant Director for Land Removable Resources in the Washington office and the Special Assistant to the Director. Last year we expanded that series of eight to include a representative from the National Forest Service, which I think was a good move.

I perceived a lot of things going on. The federal office was awfully booked with things going on at the state house and perhaps it's time to take a stand in that steering committee at least by one more: perhaps

including preservation specifically for wild horses and burro. I noticed there are several things that maybe didn't get said or there were not presentations on that I would have liked to see. One of them, or at least the one comes to mind anyway, is I know Wyoming and Montana have done extensive work with microchips. It seems to me that microchips, implantable microchips, are something that we can use in this program, in terms of gathering data and recording it. I think it has some advantages in terms of reducing error, transcribing numbers, etc. I think we need to inquire about doing that. For both the animals that come off the range and for tracking animals that are on the range that we want to gather data on.

Marv mentioned wild horses sanctury. I think I'd like to take a stand on that. In 1988 the BLM entered into a memorandum of understanding with the State of South Dakota for American mustangs, to open a wild horse sanctuary. Operative sanctuary were to undertake the campaign and make the sanctuary financially self-sufficient within three years. For the first three years the federal government was to underwrite the cost of operating the sanctuary at a cost of almost $900,000 a year. Although the snactuary had provided an excellent home for the horses, it appears the sanctuary will not be financially self-sufficient by the end of that three year period, which is August 11, 1991. Based on reports from the sanctuary and a meeting we had with the operators back in February, we finally came to the conclusion that it was not going to be financially self-sufficient.

Recently the operators were notified that even if the sanctuary was self-sufficient, the federal government will not continue the agreement beyond the August 11, 1991 date. We would, however, consider continuation of a portion of the sanctuary if it could be made financially self-sufficient. I'm not sure if you are aware that there are two units to South Dakota sanctuary. One is in the Black Hills, which houses about 300 head; the other is a larger unit, Central Park, and has about 1,500 of them.

At the present time we are in the process of developing plans to remove the horses in the sanctuary. Certainly our first effort will be to try and find homes for those horses that we get. It will probably be a major undertaking. I think we are a little bit optimistic but certainly there's going to be some that we are going to find that are not going to be adopted. It'll be a no net gain policy. We will exchange animals on the sanctuary for a younger age class animal. I think a poor outlook of reaching finanacial self-sufficiency on South Dakota sanctuary and the likelihood that the sanctuary in Oklahoma would not reach financial self-sufficiently, makes it unlikely we'll go through this one more time.

I think the Director felt we could put our funds more wisely into the management programs or act on what we thought of in term of modeling, fertility control, rather continue to spend $900,000 a year into the unseeable future.

Let me mention for a minute the thriving ecological balance that seems to be a popular subject referred to maybe four or five times in the last 2½ days. I think it's something we need to think about. First we need to define objectives. We need to define our objectives in terms of what the vegetation can be or should be or what we want them to be. One is conviction to know that we can decide what the desired plant community on the range can be. We can specify what that is. We can write our objectives to say we want this type of utilization or this type of composition or however you want to define that. And once we reach that, the cows got to go, the horses got to go, we can have reduction of the wild horse.

To think that everybody is going to agree to those objectives, certainly everybody could agree that when time comes to remove animals what needs to be done for the benefit of the animals, but more importantly needs to be done for the benefit of the range on which those animals depend.

Move on to the adoption program for a minute. The adoption of wild horse and burros from the range has been and probably continues to be the bright spot on the horizon. Certainly if we move into a program that

raises fertility control, we aren't necessarily holding off on adoption program. It's a program that has drawn a great deal of attention in the last year. It attracted a corporate sponsor on the east coast that helped fund a venture. It was a cooperative venture between a horse park and the BLM. Everyone seems to think that was a huge success and it was so much of a success that Briar Animal Creations has decided to participate in four other events this year.

The goal is to increase the number of options for the public in the older age class of horses. At the present time BLM has agreements with the states of California, Colorado, New Mexico, and Wyoming. Most of these facilities train wild horses for barter although I feel it will go beyond that. Recently, a training technique used by a professional trainer, Richard Schrepe, was taped by BLM's New Mexico office. Many of the policies and procedures used in the correctional facility are under development by BLM. They are included in the craft handbook that's been out for review. Because we gained experience in the training program, we should be able to raise the eight class that to which animals bring. Currently this has been raised once. It started out originally from 4 thorugh 7 and now it's at 9, 5 through 9. I think we're hopeful of raising that to 12. Reports from the Department of Corrections in all states shows the program has benefits not only for the wild horse but the inmates. And these reports are substantiated somewhat by a more recent request to move into a similar program, recognizing that the popular establishment the earliest programs were very high and that some states are now willing to share the burden in order to receive the benefits.

BLM recently decided not to continue to program in one facility in New Mexico, but we will continue to consider the program in those states who are willing to share the burden of training these horses. I think the BLM is perfectly willing to provide the feed, veterinary care and the animal, but I think we should ask the state to probably share or at least shoulder the burden of the facility house. We continue to believe that the future of the program is excellent. But the program we see today will be somewhat different from the program of tomorrow.

Over the last four years the language that accompanied that required that the Bureau not use any appropriated funds for destruction of excess wild horses and burros that are protected by the Act. When we look at decisions made that we are not going to have sanctuaries unless they are self-sufficient and I think our direction is pretty well set. We are probably going to get into a program that probably involves selective removal of animals. Some areas probably will also involve some type of fertility control. These things will be continued to look at by the advisory board.

Dawn Lappin, Director
Nevada Commission for the Preservation of Wild Horses

Closing Remarks

I want to thank everyone for attending. This kind of forum started In the early '70s with the University of Nevada; such a small organization could not continue to come by itself so it died a slow death with the last meeting in Utah. The Utah meeting was a very popular meeting, attended by more than 200 people from all walks of life; people like yourseves, your representatives, a diverse field of people.

It has always been my dream to reinstitute that because I feel that forum if the communication among this diverse group of people is to continue because none of us make decisions in a closet or in isolation. And we must make decisions in the best interest of our public range lands. What we have on the ground supports vast numbers of animals and people and we need to take that into consideration.

Cathy did a tremendous job of putting this forum together. The glitches that we feared would happen by and large haven't happened and I hope the commission will take my recommendation further so that we can experiment over the years by working together in a partnership of protecting the public western range land and all of our resources.

DISCUSSION OF SCS RANGE SITES AND CONDITION RATING

Prepared by: Floyd W. Rathbun
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A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Each range site is the product of all the environmental factors responsible for its development. It is capable of supporting a native plant community typified by an association of species that differs from that of other range sites in the kind or proportion of species or in total production. Each range site is repeated at different geographic locations where the combination of soil and climate characteristics are the same.

The natural plant community of a range site in the absence of abnormal disturbances and physical site deterioration is the climax plant community for that site (original and natural potential are synonyms for climax). It is the total plant community that is best adapted to the unique combination of environmental factors.

Plant communitites are dynamic. They are ever responding to changes in their environment, to their use, and to stresses to which they are subjected. Species change in proportion and amount in the plant community. Climatic cycles, fire, insects, grazing, and physical disturbances are some of the many causes of changes in plant communities. Some changes, such as those resulting from seasonal drought or short-term heavy grazing, are temporary. Other changes, such as those resulting in soil erosion, are long lasting. Range condition is an indication of the amount of change which has occurred in a plant community.

Range condition is the present state of vegetation of a range site in relation to the climax (natural potential) plant community for that site. It is an expression of the relative degree to which the kinds, proportions, and amounts of plants in a plant community resemble that of the climax plant community for the site. Range condition ratings are basically ecological ratings of the plant community.

Description of the present plant community involves measurement of the percent of the total composition contributed by each species. Air-dry weight of the annual production of each species (of the above ground parts of the plants) is the unit of measure used to determine species composition. Comparison of the species composition and production of the present plant community with the climax plant community provides the range condition class. A numerical rating between 0 and 100 (percent) is used to determine the range condition class of a plant community.

There are four possible range condition classes, as follows:

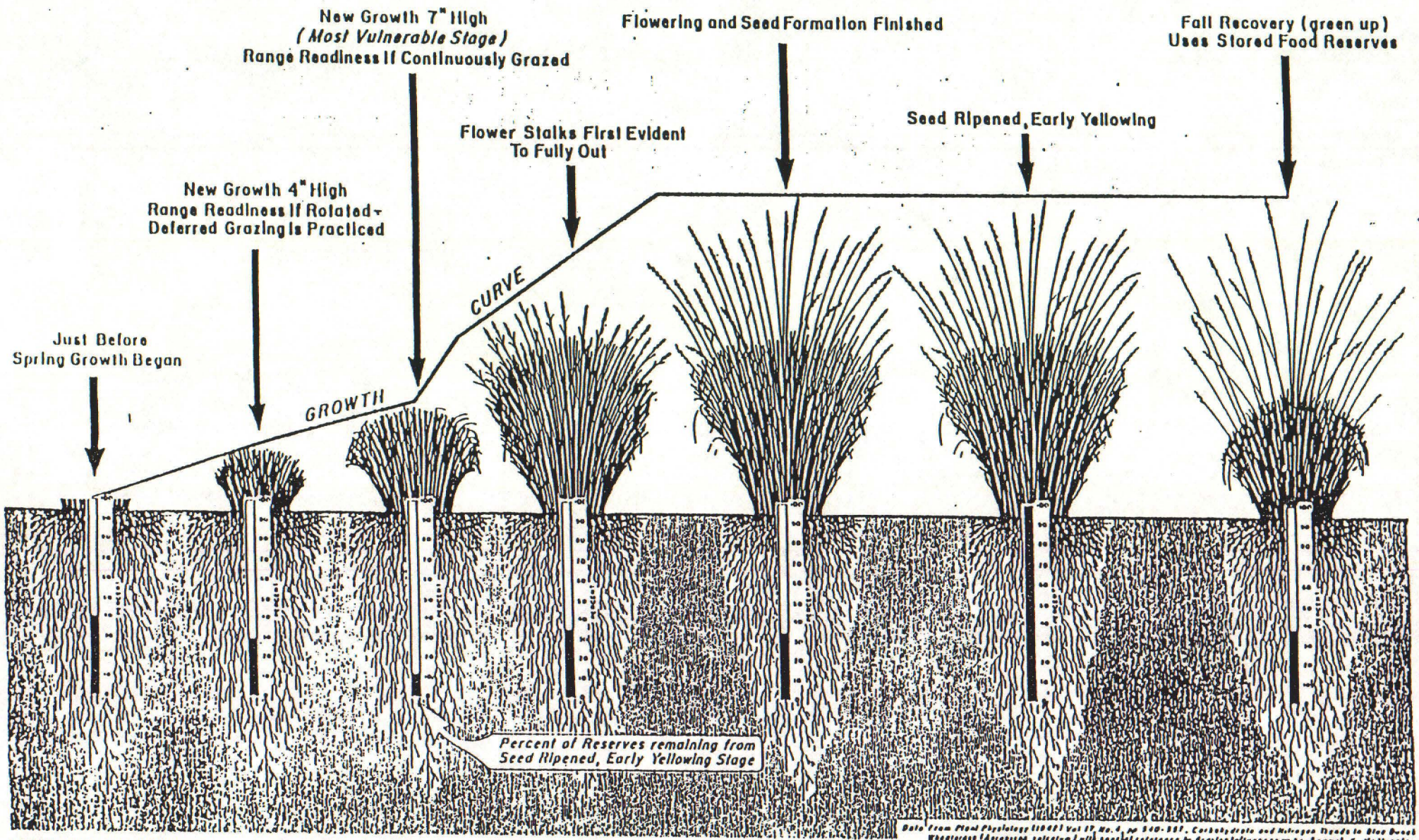
Range Condition Class	Percentage of present plant community that is climax for the range site
Excellent	76 - 100
Good	51 - 75
Fair	26 - 50
Poor	0 - 25

Range site and condition criteria are based on an objective ecological approach. To maintain this approach, the following points are recognized:

(a) Each species of a climax plant community has its ecological niche and inherent functions in that community.
(b) Range sites are differentiated on the basis of significant differences in kind, proportion, or amount of plant species in the plant community, regardless of their value for any specific purpose.
(c) Range condition is determined by comparing existing plant communities with the presumed climax plant community for a specific range site, regardless of the value of individual plants or the plant community for specific uses.
(d) Departures from climax, which can result from many causes, can enhance or depreciate the value of the resultant plant community for various uses.
(e) An abnormal amount of any species, compared with the climax, represents a change in range condition, regardless of the value of the species for any specific use.

FOOD RESERVES STORED *in* ROOTS *and* LOWER SEED STALKS *of* BLUE BUNCH WHEATGRASS

IN RELATION TO GROWTH STAGES AS SHOWN BY RESERVE POLYSACCARIDES (Simple Sugars)



Data from Plant Physiology (1942) Vol 17, No. 4, pp 540-557. Carbohydrate and Nitrogen Trends in Blue Bunch Wheatgrass (Agropyron spicatum) with special reference to Grazing Intensities — by Samuel A. McReynolds.

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RANGE NOTE NO. 4 - ARIZONA

"FOOD RESERVES STORED IN ROOTS AND LOWER SEEDSTALKS OF BLUEBUNCH WHEATGRASS"

by

Waldo R. Frandsen, Range Conservationist (West)

"How Grass Makes Food For Growth", explains and illustrates how plant foods are stored in grass roots from which regrowth is made after each removal of part or all of the leaves and stems. The chart does not illustrate how stored food reserves are used to make new growth at the beginning of the next growing season.

The visual aid, "Food Reserves Stored in the Roots and Lower Seedstalks of Bluebunch Wheatgrass", was therefore, designed to show range users when, and up to what growth stage, a grass uses its food reserves for initial growth, and at what growth stage it replenishes them.

Bar graphs are inserted in the roots of each growth stage to show the percentage of reserve polysaccarides remaining in relation to the stage of maximum storage which for Bluebunch Wheatgrass is at the seed ripened, early yellowing stage. The black bar is, therefore, shown at 100% at this stage, and all the black bars inserted in the other growth stages are shown as a percentage of the season's maximum (seed ripened, early yellowing stage).

Fall regrowth during wet years is made from stored food reserves, which is shown by the drastic lowering of the black bar. Just before spring growth began in late March, the food reserves were down to 40% of the season's maximum.

The simple sugars were only 12% of the season's maximum at the seven inch height growth. This was considered to be the most vulnerable stage.

Simple sugars were replenished to some extent during rapid spring growth, but held to about 35% of the season's maximum until flowering and seed formation had finished. The stage of growth during which Bluebunch Wheatgrass rapidly replenishes its food reserves, apparently lies between its seed formation completion and its early yellowing stage.

The chart is used to explain the injurious effects of heavy grazing that starts before range readiness, or even after range readiness, and continues throughout the green or growing season.

It also has proved quite effective in explaining why young plants frequently do not survive even under moderate grazing that extends throughout the growing season; the reason being, that the young plants were not protected by carry-over old growth, are succulent to their crowns, and closely grazed whenever discovered by grazing animals.

It also serves as a guide to setting up needed rotated-deferred systems of grazing that are based on plant-growth requirements, rather than by arbitrary dates.

The major lesson taught by the chart is the need for avoiding full growing season grazing on our ranges.

Attachment: "Food Reserves Stored in Roots and Seed Stalks of Bluebunch Wheatgrass." (Visual Aid M-1081 7-0-13000-102-L)

Note: The above visual aid chart is available from the Portland Cartographic Office, and also in the form of a 35 mm. black and white slide for projector showing. This is an excellent tool to be used in "Grass Management" talks in group meetings.

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CRITERIA FOR FERTILITY CONTROL

AND WILD HORSE MANAGEMENT

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I am pleased to be a part of this panel to discuss fertility control of wild horses and burros. I believe that an understanding of the topic that I will be discussing today -- criteria for fertility control and wild horse management -- is fundamental to the consideration of any fertility control or management program for wild horses.

The wild horse and burro issue is one characterized by highly-charged controversy. It seems that each entity interested in wild horses has their own ideology about the issue, and approaches wild horse problems uniquely. Perhaps this is simply human nature, or perhaps the pioneer spirit of the Old West is to blame. Nevertheless, for as many people as are interested in wild horses, there are opinions on how best to manage them. Fertility control of wild horses is no exception.

We have heard several different ideologies and approaches to this vexing problem. They all have some good points. They all have downfalls. How is one to judge which is best? The answer to this question requires stepping back several steps and considering four fundamental questions: 1) Is management of wild horse herds on public rangelands necessary? 2) If so, is fertility control an appropriate tool for management? 3) If so, what constitutes an acceptable fertility control agent; and finally, 4) What elements are necessary to develop an acceptable fertility control program? Without carefully determining the answers to these basic questions, the BLM cannot develop a realistic and adequate program. Thus, management of wild horses, including fertility control, would continue to be haphazard, at best, guided by changing politics, personalities, and management philosophies.

I would like to address each question separately. First, is "management" of wild horses necessary? The BLM's program has traditionally centered around removals of large numbers of wild horses from federal rangelands -- a costly and intensive endeavor. In fact, since 1985, nearly 65,000 animals have been

• Paper presented at the National Wild Horse and Burro Forum, Reno, Nevada, May 5-7, 1991.

removed at a cost of over $100 million. The HSUS and other animal and horse protection organizations have repeatedly questioned these large-scale removals because the BLM's decision-making regarding the number of wild horses to be removed from federal rangelands has not been based on evidence that existing numbers of horses exceed the capacity of the land. In fact, because round-ups are conducted despite the lack of consistent data to support such action, we have concluded that the BLM has been basing removal decisions on totally inappropriate factors, such as allegedly returning wild horse populations to historic levels, or serving the perceived interests of livestock ranchers. Further, although improvement of range conditions has been the alleged focus of wild horse removals, neither reductions in livestock grazing levels nor range improvement plans accompanied wild horse removals. Consequently, range conditions have not been significantly improved, and a number of other problems have resulted, including saturation of the Adopt-a-Horse program. In answer to the overload, the BLM developed fee-waiver, sanctuary, and prison-training programs; however, these programs have been wrought with problems, including abusive and exploitative treatment of the wild horses and increased financial burden for the government. Moreover, two of these programs are incapable of absorbing anything but the most token number of excess wild horses. The GAO report, Rangeland Management: Improvements Needed in Federal Wild Horse Program (August 1990), clearly reaches the same conclusions regarding BLM's program. Therefore, The HSUS continues to urge the BLM to address the serious deficiencies currently plaguing the wild horse program.

In our view, solutions to these problems must be approached in the most basic context -- changing management of the public lands to reflect equitable resource allocations to wildlife, wild horses and burros, and livestock. The BLM must utilize existing data, such as the GAO report, to implement concurrent programs to improve range conditions and provide equitable resources to all public land interests. Only when such actions have been taken and relevant information gathered can fertility control be considered as an option to maintain supportable populations in specific wild horse areas.

However, I only mention these things to provide the necessary context to our agreement that under certain current conditions in specific situations active management, including reductions in numbers or reproductive potential of horses, is necessary.

This brings us to the second question -- is fertility control an appropriate tool for wild horse management? First and in general, I would assert that ecologically sound and humane fertility control is an acceptable technique for such population control, particularly as compared to more invasive and destructive forms of control.

At this juncture, BLM must determine the most desirable fertility control agent. Yet BLM has no criteria by which to select the most appropriate fertility control agent. While the following list of criteria is not exhaustive or all inclusive, it can provide the beginning for establishing such criteria. A suitable agent must meet the following criteria:

1. Be as safe and humane as possible;
2. Be as non-invasive as possible;
3. Leave horses behaviorally unaltered;
4. Not pass through the food chain;
5. Be reversible;
6. Require a maximum of one treatment per year; preferably one treatment per two or three years;
7. Require minimum handling;
8. Have no impact on pregnant animals; and
9. Be easy to handle in the field.

Finally, whether fertility control is found to be appropriate or not for every herd where reduction or stabilization of herd size is found to be necessary, a complete management and herd control program must be developed for each herd. In developing such a program two levels of information need to be considered.

General Information:

- cost
- size of problem
- public support
- ethics/cultural values and
- practical consideration of implementing of fertility or other control programs.

Specific Information for the Area:

- size of herd
- mortality/reproductive parameters
- accessibility
- predators/disease
- sex ratio
- age at first breeding
- average annual reproduction per female
- primary and secondary sex ratios
- proportion breeding at each age
- genetic characteristics.

In general, such a program must be developed very carefully because of the all too real potential for the misuse or poorly considered use of contraception or other manipulative management. As you have heard in this conference, various methods of contraception have been used to control reproduction in wild horses. However, whether we use fertility control or another form of herd control, we now have an incredible and awesome

responsibility which many people have thought was reserved for God. Now, we can control which animals breed; we can control the genetic makeup of a population; we can control the evolution of characteristics within a population. In short, whether through fertility or other herd control, we are opening Pandora's box.

Therefore, the BLM must acknowledge this responsibility and deal contemporaneously with:

i) establishing criteria for a suitable contraceptive;
ii) final phases of the development of workable contraceptives, and
iii) development and use of criteria that will restrict use of fertility controls and other management controls in wild horse populations.

Basically, fertility and other herd control programs must be based on conservative strategies that include a margin of error sufficient to protect the viability of the animal population in question. Further, provisions for the maintenance of the full range of genetic diversity and characteristics of the animal population must also be part of the program. Additionally, full public disclosure and discussion must accompany each proposed use of contraceptives. Finally, there must be requirements that contraceptive strategies be used only to attain or maintain natural population levels or cycles in seriously altered habitats.

In conclusion, it has become obvious, as we have listened to the presentations today, that the issue of fertility control in wild horses is both scientifically complex and administratively challenging. It is complicated by lack of protective management criteria for conducting fertility control or other management programs. Many historical and political factors cloud this issue, and make rational decision-making elusive. It is the responsibility of the BLM to set standardized criteria against which fertility control agents and management programs can be quantitatively measured. If such criteria are not developed and consistently utilized, the controversy surrounding this issue will continue to delay good faith efforts to determine and implement effective, safe and humane methods of fertility control and population management.

I complement the Committee for the Preservation of Wild Horses for holding this symposium. I ask that you, by letter and with a copy of the proceedings of this symposium, urge the BLM to establish blue ribbon committees to develop criteria that define the characteristics of a suitable contraceptive and to develop protective criteria to guide wild horse control and management programs.

MODELLING WILD HORSE POPULATIONS: EXTENDING PROJECTIONS OF POPULATION BIOLOGY TO MANAGEMENT DECISION ANALYSIS

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Considerable effort has been devoted to gaining understanding of the population biology of the feral horse. Raw data have been obtained from management programs of capture and census. Field and laboratory research has provided experimental explanations for observed patterns of horse demography. Some of the best biologists in the world have examined patterns of behaviour, physiology, endocrinology, genetics, and demography. Modelling studies have included extensive analysis of the raw data and of the underlying theoretical foundations of pattern and process in horse populations. The population biology of the horse is sufficiently well understood to demonstrate a background of patterns that can guide the expectations of managers charged with daily decisions that affect the status of the feral horse. We now need to move from academic discussions of patterns to management decision analysis — a new effort of collation and development must begin. Certainly demographic patterns of the horse are well enough understood to allow rational simulation within the larger context of management decision analysis. The next generation of models for horse populations will be dynamic not static. They will avoid mathematical assumptions that cannot be met, and they will be active, dynamic representations of existing populations. They will provide control of relevant management information, including economics as well as biology. They will be hands-on tools for sophisticated, trained managers who must consider alternative decision paths and the potential consequences of pursuing such alternatives. The next generation of models will allow consideration of demographic particulars for chosen herds, economic realities, and "what-if" gaming involving alternatives and potential outcomes of rational management scenarios. They will guide collection of missing but essential data, and will incorporate existing data. Such a decision analysis environment will properly include an open data base of relevant information, and analysis and modelling tools to manipulate that information. Accomplished properly, the open presentation of the realities of horse biology will allow separation of issues relating to biological fact from economic and political considerations. In this manner, each may be considered in turn and on the merits of the case. In this manner, all interested parties will be in a position to isolate and consider points of agreement and disagreement. In open workshops that will deal with such alternatives analysis, consensus and understanding can be sought. In this discussion, I provide a brief history of such efforts, the status of our current capabilities, the potential for future development and use, and some milestones to watch for that will indicate successes and failures that require project revisions.

population level) and sterilization of males and/or females (influencing breeding vectors). While discussion of specific methods for implementing management alternatives is currently beyond the scope of this proposal, I am well aware that some methods are more acceptable than others, and that some methods are unlikely to work at all, once full consideration of the demographic effects are understood. Even so, there are pragmatic and philosophical limits to some alternative strategies; my assumptions concerning these limits will be elaborated as necessary in what follows.

This proposal describes a multi-staged (and of necessity, ultimately long-term) effort that culminates in a fully developed management decision analysis environment that guides the collection, archiving, analysis, and modelling of data on horse populations. Just the tools, however, are not an adequate solution, the users of the tools must be concomitantly trained to expert status. Finally, just some tools and some expert tool-users, are not a final solution — the entire system of decision pathways *must* be as open and clearly scientifically based as it is possible to make it — only in this manner can we finally separate what are the ecological facts from what are the economic and political realities. Once the biological facts are agreed to, extensions of the modelling environment can easily be made to include cost-benefit analyses.

The inevitability that final decisions in any specific instance will include political considerations is clearly recognized — this last consideration is beyond the scope of this proposal[2]. *What is intended, however, is that this proposed project can serve to influence final decisions with the very best analysis and projection of real data and realistic scenarios that it is possible to have.* Recognizing that it is an imperfect world, "very best" will still have failings. Full illumination of both the strengths and weaknesses in the methods and the data can play a significant role in wise management decisions. Thus, this proposal describes an open and cooperative approach to analysis and modelling that can serve to clarify the basic facts involved in any decision for all parties concerned.

2.2 The Current State of Modelling Horse Populations

Current work in modelling populations such as horses does not mimic the characteristics of real populations. Much of the recent work on parameter estimation is simply not applicable to horse populations, and without good estimates of the demographic variates, there can be no believable projections. In part this body of work stems from that of the Chapman-Robson (*e.g.* 1960) techniques that explicitly require stability to equilibrium points that allow inference of attainment of stable age distributions. In some cases, these methods require stationary age distribution (instantaneous rates of increase = zero), and in other cases, this constraint has been relaxed to allow growing or declining populations, but still require stable age composition.

These methods include those of Eberhardt (1985, 1987, 1988); Dapson (1980); Eberhardt and Siniff (1988); Eberhardt, Majorowicz, and Wilcox (1982); along with a host of similar papers in the literature on parameter estimation in wildlife populations. The use of these methods in the various parameter estimation papers and modelling

[2]Note that there is no suggestion here that such influence is necessarily bad. Imposing economic and political influence on such decisions is the way that our society works. The issue here is not whether such considerations are to be made, but rather *when*. I submit that the system works best when the biological facts can be separated from the economic and political facts — each set of information being applied in turn to approach a wise decision.

projections by Garrott and Taylor (1990: J. Wildl. Mgt.); Garrott (1991: Wildl. Soc. Bull.); Garrott, Eberhardt, and Siniff (1991: J. Wildl. Mgt.); Garrott, Siniff, Tester, and Plotka (1991: Proc. Wildl. 2001); and Garrott, Siniff, Tester, Eagle, and Plotka (Submitted, Wildl. Soc. Bull.) provides results that are demonstrably not meeting the explicit mathematical assumptions upon which these methods are based. Although not fully within the scope of this proposal, the correct estimation of demographic parameters also depends to a large extent on the constancy of detection probabilities in sampling schemes for horses. Based on the census work of the Minnesota researchers in the late 1970's (Siniff, et al., Final Report to BLM, and draft version of Census and Population Analysis Manual dated 16 Sep 1983, U.S. BLM), it is clear that we cannot even meet this assumption in horse populations. Depending on terrain, habitat, and season, as well as time of day, cloud cover, and ground cover, the probabilities of sighting individuals and bands of horses vary significantly across locations and through time. Thus, pooling of data across management units, districts, or at state and regional levels is proscribed.

All of these critical assumptions have been repeatedly laid out in the literature. Caughley (1977) described the assumptions and clearly defined some of the mis-estimation problems that arise. Conley (1978) demonstrated the assumptions in a theoretical paper dealing with the mathematics of population projection models. Sauer, Barker, and Geissler (In Press) provide a thoroughly documented examination of parameter estimations involving finite rates of increase (λ), and conclude that in most realistic cases, it is not possible to properly estimate this much mis-used parameter from the kind of data typically being used. Seber (1973) described additional problems in estimating survival and natality from age structure data. The work of Anderson (1975 and papers cited therein); Pollock, Nichols, Brownie, and Hines (1990); and Sauer and Droege (1990) clearly lay out the problems, and provide some solutions. In many cases, the "solutions" reduce to advice that such calculations simply should not be attempted. In addition, the monograph by White, Anderson, Burnham, and Otis (1980 and citations therein) describe models and algorithms by which such estimates can be accomplished properly, given the proper data in the first place.

The blunt fact is that we are probably going to have to abandon age-specific parameter estimation in vertebrate populations, unless the data are drawn from marked cohorts and followed for periods of time that approximate generation times of the species involved[3]. We cannot continue to ignore the mathematical constraints in demographic models if we want to have some *right* answers, rather than simply some sophisticated-looking answers.

This rather bald contention requires documentation — Conley (1991 ms) provides the demonstration (see also the series of papers cited above). In this paper, Conley demonstrates that these modelling techniques are generally inadequate and too shallow to provide computational images of real horse populations. This research included extensive projections of realistic demographic mechanics in horse populations. The projections were followed by sampling from the simulated populations. The results demonstrate that the sampling and estimation techniques criticized above do not return reasonable estimates of the actual parameters by which the projections are generated. The assumption that horse

[3]In horses, generation times are variable, and the results also depend upon which technique is used. Conley (1978) presents a discussion of these contrasts. For most purposes, generation times in horses are on the order of 10–13 years depending on which method is used, and on the shape of both the survival and reproductive schedules.

populations are existing in any state approaching equilibrium cannot be demonstrated as fact — quite the opposite — real horse populations are demonstrably variable in their density, age structures and breeding proportion vectors. Even if the further assumption that horse populations are "closed" *i.e.* no immigration or emigration is true (a debatable question for most horse populations) the equilibrium assumptions in the mathematical approaches being employed in the above cited papers cannot be demonstrated as having been met. Finally, even if the assumptions of stable age can be met, and even if the population is indeed closed, the problem of sampling and estimation schemes that fail to incorporate varying detection probabilities would still render the results essentially useless.

Things are not nearly as bad as they might seem. These issues can be circumvented — to do so, we need a two-track approach to solving some of the problems.

- We require some immediate capability to analyze and project data on specific horse populations. This means that people are going to have to learn some new tricks and gain access to some new tools. It also means that we are going to have to get our field act together, and design a proper sampling program for horse populations.
- Second, we require some additional theoretical development to resolve current inadequacies in analysis and modelling approaches. From this effort, we can expect to gain new tools, and a thorough knowledge of what we can and cannot achieve in modelling horse populations (assuming the existence of cost constraints).

We *can* have both of these at the same time. Because they are inextricably linked, proper development of either track requires progress on the other. Thus, this proposal seeks to proceed on both tracks, maintaining the focus of each through consideration of the other. A pragmatic approach suggests that we require a small number of test populations (2–4 at most to allow a focus of resources), that these test populations be manipulated in reasonable ways, and that both the history and the trends of these populations be tracked. Test populations must be carefully chosen, and the design and implementation of these "management-experiments" (*sensu* Macnab 1983) must be carefully done. What this means in practice is that we ought to get on with some reasonable management programs, and use these manipulations as test cases to develop and evaluate our capabilities to collect and analyze the data. Given such test cases, the modelling environment can reasonably proceed in parallel[4].

In contrast to most current approaches, the next generation of analysis tools and projection models for horse populations must be dynamic not static. They must not make *a priori* assumptions of unattainable states of equilibrium. They must be structured in a manner so as to allow relaxation of untenable mathematical assumptions involving stable age distributions. And, critically, the sampling schemes by which such models are fed data must be designed properly. Thus, we are going to require more relevant data (instead of *more* data), and we are going to require development of a different approach to modelling projections of horse populations.

The next generation of demographic models must allow consideration of site-specific information concerning demographic particulars, and must encourage a style of "what-if"

[4] Again, the specific design of such test cases is beyond the scope of this discussion, and must be elaborated elsewhere. It can be noted, however, that the design requirements are well within our capabilities if we limit the data collections to that which is really needed.

gaming that fully involves consideration of alternatives and potential outcomes of rational management scenarios. Such a decision analysis environment will properly include an open data base of relevant information, as well as analysis and modelling tools to manipulate that information. Accomplished properly, the open presentation of the realities of horse biology will allow separation of issues relating to biological fact from economic and political considerations.

3 Problem Statement

3.1 Problems and Proposed Solutions

Each of these objectives are detailed in the sections that follow.
Primary goals for this project are as follows.

An Open, Dynamic Data Base of information is required. Such a data support facility will accomplish several objectives:

- it will indicate what kinds of data are required for collection;
- it will serve to demonstrate openly just what information is available for analysis;
- it will serve as a common pool of information for comparing techniques.

An Analysis Package of tools that address various analysis requirements is required. This analysis toolkit will serve to generate common analyses across management units. The analysis toolkit is to be flexible, open, and expandable, as development of the theoretical issues proceed to application status.

The Demographic Model proposed is an extension of a model that currently exists. Thus, we start from mid-way, not at the foundation. Ultimately, the coded representation of this model will need to be rewritten, so as to accommodate the extensions proposed, and the integration required for the next step in the project.

An Integrated Decision-Analysis Environment draws the above components into a whole environment. At this point, we will also be able to incorporate considerations of economic analyses that include cost/benefit ratios. Properly trained specialists will be able to move in and out of the sub-environments that include the data archives, the analysis toolkit, and the modelling environment in a reasonable and competent manner. This integrated environment will thus support the development of alternate decision pathways, and the evaluation of each by competent specialists.

A Project Manual that describes the components of the emerging environment (*i.e.* serves as what professional programmers refer to as a "project design document") will be evolve in parallel with all phases of the project. This manual will be developed out of the demographic manual and the Computational Ecology book already written by W. Conley. Essentially, the project manual will serve as a user's guide to the theory, the analyses, and the computational environment proposed.

Theoretical Advances — one ought not burn down the house without having some suggestions for a better abode. In this case, Conley (1991 ms) argues that much of the age-based technical literature in vertebrate ecology pertaining to analysis and modelling of population dynamics is ill-advised, and produces the wrong answers. In fact, there is a better approach which is documented fully in the above paper, and in the background review provided above. In part what is needed here is a careful delineation of just what is possible given the kind of data that is obtainable under a management (as opposed to a research) scenario. Other parts of this puzzle are to be drawn from various schools of work that have not been commonly applied to the "horse problem."

A Training Program is essential — the entire project will fail unless there is a program to train the specialists that must ultimately be assigned the duties of such analyses and modelling efforts. In part this becomes a BLM commitment to establish a contingent of competent vertebrate ecologists ("wildlife biologists") who have the necessary background for understanding the technical details, and in part a commitment to provide for continuing training and workshop sessions where experiences can be gained and shared. This proposal includes some preliminary funding to begin this task. It is hoped that the critical importance of such a program will ultimately result in an institutionalized program that serves to raise the level of sophistication of participating personnel.

Importantly, I propose to also use this training program as an opportunity to formally obtain comments and critique from participants concerning the current state of the project, as measured against project goals and milestones. In this manner, we provide the opportunity for mid-course corrections and increase the likelyhood that products of the project will actually be useful to someone other than the developers.

3.2 Achieving the Objectives

In this section, I discuss each of the above objectives in turn, documenting where we currently stand, and detailing what needs to be done next. Keep in mind that these various components are intended to ultimately fit together in an integrated package.

3.2.1 An Open, Dynamic Data Base

Being able to argue that "...my data show..." without everyone having the access to that data does not solve problems. We require a fully documented and open data base of demographic information on the Nevada horses. The much-referenced data base of "over 60,000 records" of horses mentioned in the Minnesota Final Report to the BLM, may solve part of this problem. However, the actual contents and manipulations of this data base are only sparsely described, and I do not know the level of documentation that accompanies the actual numbers. Because of the uncertainties of the status or quality of this data base, it may be best to develop the base for this project from the foundation up. Given the general lack of quality of much of the existing data on horse populations, it is probably best not to spend too much time digging in the past. Rather, our efforts are better devoted to properly designed sampling and analysis schemes in field populations.

It should be noted, that for the levels of funding requested, this proposed project will not be able to actually gather field data from Nevada populations. In this respect, we depend upon agency and Commission cooperation. This project *will* be able to function in the role of providing help with field sampling design, and *will* properly archive and test incoming field data.

A background discussion might prove of help to clarify the data base goal of this project. For the past 10 or so years, W. Conley has been working on a project that has come to be known as the NMSU "Science WorkBench" (SW^b). This project involves research and development of a cooperative computing environment that facilitates the goals of small research teams seeking answers from data. Reports on this project include the original published discussion (Conley, Slator, Anderson, and Sitze 1984) and results of research on user interfaces and philosophy (Slator, Anderson, and Conley 1986). The entire SW^b environment and philosophy is described in detail in a 22 chapter book (Conley, W., "Computational Ecology: Management and Synthesis of Ecological Data", Ver. 4.03, Aug 1990), and a series of papers on theoretical ecology and data analysis (Conley 1991, In Press b, c, d, and Conley and Brunt, In Press). The data base environment is fully developed and functional[5], and needs no further development. This relational data base has been fully integrated into the SW^b environments over the years, has been recently ported out to the MS-DOS platform, and simply awaits our need to use it, and at moderate costs as well. This data base system fully supports the SW^b philosophy of data management, and facilitates a new model of "Computational Workshops" described by Conley (In Press d).

The Computational Workshops operate as open data analysis, interpretation, and synthesis sessions, where competing ideas and methods can be fully put to the test using available data and relevant theory. This proposal seeks funding to apply this approach to the horse issue, and part of what I propose involves a routine series of open workshops where analyses are conducted *on the spot* and with full participation of those present. This approach makes use of the techniques being applied in modern decision analysis in large industry. There is simply no better way to illuminate both the strengths and failings of the background information or the approaches involved in interpreting that information.

The data base itself (as opposed to the applications program that performs manipulations on the data base) is to be developed from BLM records, available research records, and other sources. Given that the BLM has paid for several million dollars worth of research over the past 15 years, it is in a position to request the *raw data* that resulted in the many project reports for funded research. This is a BLM policy decision that I strongly suggest be taken up immediately — the BLM should be getting copies of well documented raw data to accompany all final reports of work accomplished under research contracts.

Review of the various reports, and the resultant published papers reveals that there is simply insufficient detail presented to serve future needs of such information [6].

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[5]Much of this software has been tested in the SW^b laboratories (among many others), and is now commercially available for various computing machines, including IBM PC's and proper compatibles.

[6]What happens here is commonly encountered — analyses for final reports and published papers make use of data analyzed for the specific purposes of that particular paper. Thus, data are presented in summarized forms that serve the purposes of the paper at hand, and are too often insufficient for addressing related questions that require additional detail. If the data are not properly documented and archived, any future use of this expensive information is precluded.

Additionally, data collected under management monitoring programs from BLM District records, and those of the collection corrals (i.e. Palomino), are relevant.

Such information forms the foundation, following which newly collected information is simply appended. In the process, decisions concerning the development of the data base necessarily involve what data should be collected, and that leads to some minimal lists of information that might be expected from the test areas chosen. (Note also, that such listing of expected information will also generate discussion on techniques that can lead to some minimal standardization of approach.)

3.2.2 The Analysis Package

The analysis package begins with the set of existing tools as described in Conley ("A Manual for Demographic Analysis of Wild Populations," Ver. 3.1, June 1990). Various versions of this package have been used in 5 short courses taught by W. Conley for the BLM over the past 13 years. This proposal seeks to extend this package, to make it more sophisticated, to make it easier to use, and to integrate the parts into the proposed decision analysis environment. Extensions include the incorporation of additional methods of parameter estimation from demographic data, including some that I consider unworthy, but appear to be necessary to include for contrast and testing purposes, and to provide a means to deal with such issues among potential critics. New tools to be added include a broad suite of techniques now emerging from the series of papers cited above, and referenced as the "Patuxent–NC State" axis (among others).

This package, as with all of the development proposed, will make extensive use of available code, some of which has been developed by W. Conley, and some of which simply need be assembled and integrated for our purposes. Some new code will have to be developed to fully accomplish these goals, but the total time devoted to actual programming of these tools is not large compared to overall project effort.

3.2.3 The Demographic Model

3.2.3.1 Background: The most recent version of this ever-changing research model was described by Conley ("A Manual for Demographic Analysis of Wild Populations," Version 3.1, June 1990). The basic mathematical structure and theory that underlies this continuing modelling effort was described by Conley (1978). As in all such research models, the coded version is not particularly forgiving of inexperienced users, and it does not have particular focus on any given species. Nontheless, various versions of this model (and some of the analytical tools) have been used in 5 short-courses taught to BLM and Forest Service specialists over the past 13 years, several of which have been also attended by representatives of the horse protection groups. Various papers that describe the evolution of the NMSU approach to modelling vertebrate populations have been produced on a diverse range of species. A review of such models was provided by Conley and Nichols (1978). Among various species and topics that have been considered are reproductive strategies in desert rodents (Conley, Nichols, and Tipton 1977), which led to further discussions concerning temporally dynamic reproductive strategies (Nichols, Conley, Batt, and Tipton 1976). Management and theoretical issues were considered in restocking quotas in alligators (Nichols, Chabreck, and Conley 1976), and in desert bighorn sheep, where stochastic versions of this model were used to investigate

reintroduction strategies and reproductive potentials (Lenarz and Conley 1980, 1982). Demographic mechanics and reproductive potentials in feral goats, as well as extinction probabilities in remnant populations of desert bighorn sheep were investigated by Watts and Conley (1984, 1981). Demographic compensation in coyotes was demonstrated by Sterling, W. Conley, and M. Conley (1983). Potential rates of increase in horse populations were described in (Conley 1979, 1984). Various possibilities for extensions of such models that employed machine intelligence have been described by Conley (1983) and Conley and Sengupta (1988, 1989). The latter 3 papers are important in another context, since they demonstrate the lack of depth of realistic theory that can be used in modelling population dynamics. Kurt Nelson (1978) used an earlier version of this model to investigate the potential for male sterilization as a mechanism of population control in horses. In addition to the above published works on this philosophy of modelling, about 60 technical papers concerned with various aspects of this work have been presented by W. Conley and co-workers over the past 20 years.

3.2.3.2 Work to Be Done: Generalized models typically make compromises, and this model is no exception. The model needs to be modified to specifically incorporate the gestation times and breeding window found in the horse. This means that the time steps in the model need to be reduced to 3 months from the current 6 month intervals. We also require more complete control of breeding vectors in the males (thus explicitly incorporating contributing males as other than critical breeding sex ratio). Various other modifications to the model will make it even more specifically applicable to horse populations. Automatic control of repeated runs for monte carlo simulations of parameter sensitivity needs to be available, as well as capability for automatic development of internal data structures that can be passed on to a statistics environment for extensive exploratory analysis.

The primary work to be accomplished, however, involves integrating this model within the larger environment proposed, and providing a considerably enhanced interface for user-computer communication. The model must readily and flexible communicate with the data base and the toolkit. At the present time, the model produces only extensive tables of numbers — the new version will provide plots of trends and current conditions. The current version of the model allows batch processing of long simulations (i.e. re-reading of previous simulations), but this implementation is not wholly satisfactory from the user's viewpoint, and will be redone. Current versions of the model contain extensive places in the code where "hooks" are embedded that allow retrieval of specific information. Such hooks also allow establishing many of the demographic parameters as functions of potential driving attributes in the environment. Early versions of this model were coded to run on mainframe computers. Over the past 10 years or so, much of the development has been accomplished on mini-computers and UNIX workstations. Recently, hardware technology has caught up, and in 1990, the model was ported from the big computers into the IBM MS-DOS platform. (This version was used in 1990 for a successful BLM short-course held at the state offices in Reno.)

The current version of this model, last coded from scratch in the early 1980's, has been extensively expanded, and now requires recoding from the bottom up if it is to serve the purposes of the next few years and the goals of this project. This work will be accomplished as part of the effort on this proposed project. It is perhaps worth noting

that W. Conley served as Associate Director of the NMSU Computing Research Laboratory for 5 years (1982-86), is considered a professional programmer and researcher on the interface between Computer Science and Biology, and is wholly competent to continue the biological side of this project while at the same time accomplishing the computational development required.

This proposal package contains, as appendices, the demographic manual mentioned above, and the book describing the goals and contents of the Science Workbench project.

3.2.4 An Integrated Decision-Analysis Environment

The bulk of the work to be accomplished here involves putting the various pieces together on a suitable computer, and integrating the parts into a blended whole. Such work has already been accomplished in the technical environments of the SW^b . Much of the SW^b capabilities have recently become available and are being tested in MS-DOS, on IBM-PC computers. Thus, the task of bringing things together is perhaps 80% resolved, and requires only some minor amounts of integrating code. The new work to be completed involves trapping desired information from the analysis and modelling modules, and processing it for further use in some other component of the decision analysis environment.

Some of this further use predictably involves such operations as making hardcopy graphs from the various results, writing results back into the data base with proper documentation, and capturing arbitrary segments of the results and analyses for additional statistical or modelling operations that cannot be predicted ahead of time. In this manner, the proposed environment remains "open" and will accept any level of future development and new ideas. This approach lies in stark contrast to a closed environment, where the developers presume to know everything about what might be desired in future use of the system — this project makes no such assumption. This programming development philosophy has worked well in the SW^b environments, and will work well with the proposed project.

The final analysis and projection environment will run on virtually any computer for which we can obtain a C compiler. Screen graphics restrict such choices considerably, since graphics programming requires specification of the hardware target. The proposed programs can be expected to run on standard IBM PC's and compatibles, as well as larger workstation platforms, and mainframe machines.

3.2.5 Theoretical Advances and Outside Help

Conley (1991 ms) presumes to argue that much of the current theory and analysis being conducted on vertebrate populations is misguided. The series of papers cited above demonstrate what I submit is a better way. However, much of this work fails to convey the sense of urgency that we need to move beyond the current strictures of modelling theory. The proposed travel budget contains adequate funding for project workers (primarily W. Conley) to maintain close contact with the sponsors and the participants (Nevada BLM and Commission representatives). This aspect of the project is described below.

In addition, I propose to allocate some of these travel funds to support travel and subsistence for a continuing series of periodic Computational Workshops to be convened and hosted at the NMSU SW^b laboratories. These workshops would involve a moderate-size group of experts in various aspects of the modelling and analysis world. It

is notable that the primary literature being cited by one long series of reports and papers on horse demography and modelling is extremely narrow in its' coverage of the relevant literature. Among these possibilities are the series of modelling papers by Conley cited above, only one of which is being acknowledged. Further, and probably more importantly, an entire realm of literature on parameter estimation in vertebrate populations is totally ignored. Even though much of this work involves parameter estimation in waterfowl populations, the theoretical basis for the conclusions are generally applicable to all population estimation procedures.

This includes the works (as cited above) of Jolly, Seber, Pollock, Nichols, Burnham, Anderson, Brownie, White, Sauer, Barker, Otis, and others that represent (with the exception of Seber and Jolly) what might be called the "Patuxent-North Carolina State" group (although they are spread further than that now). This body of literature is arguably the best we have when it comes to parameter estimation of demographic variates in vertebrate populations, particularly for survival schedules, and, particularly with respect to realistic treatment of mathematical assumptions. This body of work stands in stark contrast to the work of Eberhardt (see especially 1985, 1988) which almost exclusively dominates much of the recent work on horse dynamics. The explicit assumption of stable age distributions that overrides this work virtually negates its' use in estimating parameters from populations of many species — horses are simply one representative.

I leave as an open question for the moment, the possibility that we may discover some means by which age-based estimates from wild populations can be calibrated against more reliable estimates. We will be exploring the simulation results (statistically), and some such patterns may emerge. At the present time, however, I am not particularly hopeful that this can be accomplished. The proposed workshops will endeavor to work through any approach that appears to have promise for cost effective success, and we will explicitly not *a priori* exclude any point of view without testing and evaluation.

The proposed workshops will consider questions and problems that have been demonstrated on horses by Conley (1991 ms) to be critical to getting the right answers, as opposed to just getting some answers. The proposed workshops would be held on an approximately annual basis and would deal with important issues of the basic mathematical structures being employed.

Critically, this group (and others as needed) will form the basis of a proposed cooperating team that will be helping with reviews and directions for the proposed horse analysis and modelling efforts. What we gain here is the attention and advice of a group of what can easily be demonstrated as some the world's best population ecologists. W. Conley has a long association with many of these people, who have agreed that this proposed project is interesting and worth some of their limited time and attention. Essentially, what I propose to do here is bring in some new people with demonstrated credentials and expertise to help with some of the esoteric mathematical problems that have been raised.

The issues to be delt with here are, while admittedly narrow, are in fact critically important to the success of this project. The standard operating procedure for analysis and modelling of horse populations as most recently demonstrated by the Minnesota team are simply not meeting mathematical expectations. An infusion of new ideas, a fresh approach, and a more critical view of the possibilities for mis-representing the state of horse populations is required. With this component of the project, we intend to seek a better way.

Abstract

Vegetation dynamics of the sagebrush steppe

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The sagebrush steppe of western North America has its origins dating back to the Miocene era (5-20 M yrs BP). As the Cascade-Sierra cordillera began to uplift, thereby blocking Pacific storms, the climate of the lowland trough between the Cascade-Sierra and the Rocky Mountain cordilleras became progressively more xeric. The temperate forests of this inland region were gradually replaced by shrublands and the forest-dwelling fauna replaced by new forms of browsers and grazers adapted to the arid steppes. This coevolution of flora and fauna continued until the Pleistocene when the Ice Age brought about massive extinction of much of the mega-fauna.

Wanning of the Ice Age and the continuing xeric climatic trends produced a shrub steppe vegetation over most of the intermountain trough with a somewhat more depauperate flora and fauna. Coevolutionary processes continued the development of this natural herbivory.

The aridity and preponderance of cold season precipitation favored a shrub-dominated, herbaceous-dependent flora of cool season species (C-3) with short growing seasons and long dormant periods. Evolution of this flora was likely impacted and influences by herbivores and fire. Faunal adaptations to this intermountain environment included small body size and a tendency

these western ranges with adapted exotic grazers increased the foraging intensity (especially of herbaceous vegetation), shifted the foraging pattern from seasonal to season-long and fire-proofed the sagebrush steppe. The inevitable consequences was an increasing shrub or woodland aspect to the vegetation at the expense of herbaceous species; a process which continues to the present.

Additionally the inadvertent introduction of preadapted exotic plants, especially cheatgrass, predetermined a major irreversible floristic change in the drier portion of the sagebrush steppe. In those areas with mild, wet winters and early hot, dry summers (essentially the Wyoming big sagebrush sites) cheatgrass is better adapted than the native perennials which evolved there, In this environment, irregardless of livestock grazing, cheatgrass and other Mediterranean annuals have largely replaced the herbaceous understory.

Due to the continuous carpet of fine-stemmed annual grass, flammabiltiy is now higher and fire frequency in recent years has increased. With more frequent fires the shrub overstory has been eliminated and prevented from reestablishing, thereby creating an annual grassland. This change from sagebrush-bunchgrass to sagebrush-annual grass to annual grassland has occurred widely in the more xeric, lower elevation portion of the sagebrush steppe. Conservative livestock grazing or no grazing does not prevent or reverse this change.

In the more mesic, higher elevation portions of the sagebrush steppe (i.e. mountain big sagebrush sites), cheatgrass

is poorly adapted and has not flourished. The native perennial grass understory remains largely intact and fire, if allowed to burn, functions in much the same manner as it did throughout the evolutionary history of the sagebrush steppe.

Genetic Conservation and Management of Feral Horses

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inbreeding. Loss of genetic variability can lead to lowered overall health or vigor of the population and, for the long term, loss of adaptability. Genetic drift is the loss of variation due to sampling errors in the union of gametes at fertilizations. The rate of loss of genetic variation due to genetic drift is 1/4Ne where Ne is the effective population size (essentially the number of individuals that contribute to the next generation). The loss of genetic variation by inbreeding is due to the increased likelihood of an offspring inheriting the same gene from each parent because their genomes share a common ancestor.

In random mating populations, such as ones found in most mammalian species, inbreeding considerations alone require that MVP numbers should not be less than fifty individuals (Franklin, 1980). In the long term, without intensive management, genetic variability can only be maintained if population sizes are an order of magnitude greater.

These estimates are based upon rare or endangered species where there is little or no possibility of the indroduction of new individuals. The situation for wild horses on public lands is somewhat different, although there are additional considerations. For example, it may be desirable to maintain the particular phenotype that is common to the area.

The major difficulty confronting managers of feral horse populations is balancing population size with herd health and viability. Horses are exotic species to this continent and the environments that feral horses occur in are often fragile ones. According to Coblentz (1990), exotic organisms are frequently the most pervasive influence affecting biodiversity in many ecosystems and may cause many extinctions or serious alterations to the physical environment. Genetic marker analysis can be used as a management tool for maintenance of small populations.

In terms of genetic management of a small population, effective popula-

tion size (Ne) is the most important consideration. As mentioned earlier, Ne is operationally the number of individuals that contribute to the next generation. One way Ne can be estimated is by the formula

$$\frac{4NmNf}{Nm+Nf}$$

where Nm = the number of Nm+Nf breeding males and Nf = the number of breeding females. The social structure of horses is such that Nf greatly exceeds Nm. If we assume that there are 3 reproducing females to every breeding stallion, a total of 68 successfully reproducing individuals would be required to maintain an effective population size of approximately 50. Considering immature individuals, bachelor stallions and mares that fail to produce a surviving foal, the census population number required for an effective population size of 50 would easily exceed 100 individuals.

The above estimate is based upon the assumption that the dominant stallion of a harem group is the sire of all or nearly all offspring produced by that harem group. Recent evidence reported by Bowling and Touchberry (1990) for feral horses indicate that up to one third of the offspring of a harem band are not sired by the dominant harem stallion. For such herds, the ratio of reproducing females to males is reduced and Ne will be higher. However, different herds may vary in the number of males that reproduce. Only by genetic marker typing can the necessary parentage verification analyses be performed to determine how many individuals are actually part of the successfully reproducing population. Thus, genetic typing can provide the information for the most accurate estimates of effective population size.

Sex ratio is not the only factor that influences Ne. Variance in reproductive performance will have a major impact upon Ne. If sex ratios are even and all reproducing individuals contribute equally to the next generation then Ne can actually be twice the number of breeding individuals. However,

large differences in the number of offspring produced among individuals reduces the Ne relative to the census number. There are other factors that complicate the calculation of Ne which I will not go into here. For horses, because there are overlapping generations, unequal sex ratios and variance in reproductive success among males due to the breeding structure of equine populations, Ne is difficult to evaluate. Genetic analyses of herds will help to make the estimation of Ne simpler.

Genetic marker analysis also is useful for determining the current genetic status of a herd. At the Univ. of Kentucky we currently test for 18 polymorphic genetic marker systems. These data can be used to calculate a number of measures of gentic variability including level of polymorphism, individual heterozygosity and effective number of alleles. Additionally, genetic marker data can be used to estimate inbreeding levels.

The goal of genetic management is to maintain genic variability. Based upon data from most breeds and some feral herds, horses naturally have high levels of genetic variation, both in terms of the number of identified allelic variants and individual heterozygosity. The natural social system of horses (population subdivision into harem bands) is conducive to maintaining high levels of genetic variation. However, small population size will have a greater influence on levels of genetic variation than will population structure. Low levels of heterozygosity in a feral population would be an indication of inbreeding and/or genetic drift.

One of the best ways to preserve genetic variability in small populations is to artificially subdivide the populations into smaller breeding units (Chesser et. al., 1980). Loss of genic variation will occur in the subpopulations through genetic drift and inbreeding; however, because the loss is random, different variants will be lost in the different subpopulations. Individuals must be exchanged among subpopulations before fitness declines due

to inbreeding depression.

The above scheme was formulated for rare and endangered species and for most feral horse populations may be unnecessary. Only if there are unique populations that should remain pure would such a plan be necessary. With the exception of unique herds, the feral horse populations are already subdivided among the various tracts of public land. Exchange of horses of the various herds also is a viable strategy for maintaining genetic variation within feral populations. However, this raises the question of what is the resource being managed. The effort should be directed at maintaining those herds with unique characteristics such as old Spanish origins rather than those of mixed and recent origin. Genetic marker typing could be used in concert with external morphological characteristics in making these decisions.

Another problem involved in the management of the wild horse herds is the question of what exactly is the resource protected. The legend of the wild horses of the American West is that they are descendents of horses lost by the early Spanish explorers and settlers around 400 years ago. On the other extreme, many believe that the wild horses are simply derived from horses that were turned loose or escaped from ranches within the last century. The truth is probably somewhere in between these extremes. Genetic marker analysis can help to determine the origins of the wild populations.

Because genetic markers are inherited characteristics, markers that are shared by two populations or taxons are indicators of common ancestry. Genetic markers have been used to access genetic relationships among organisms since the mid - 1960's and a wide variety of statistical methods for analyzing genetic relationships have been developed. To test for possible ancestral relationships of the feral populations, data from the feral herds can be compared to data from as many breeds as possible.

There are several potential difficulties that must be considered in an

analysis of the possible genetic origins of feral horse populations. First, all horses are related, at least in terms of sharing a common ancestor. Thus, most genetic variants found in horses are likely to be present in any breed. In addition, most modern horse breeds are a mixture of horses from a variety of origins and few breeds have bloodlines that are "pure", at least in terms of the last 200 years. Next, most wild populations probably are derived from a small number of founders or have experienced a period of small population size. The loss of alleles through genetic drift is greatest with small populations. Thus, allele frequencies in current feral populations may be quite different from those of the ancestral breed. As well, most genetic variants that are unique markers of a breed or a place of origin tend to be rare. Rare alleles are the most likely to be lost through genetic drift or inbreeding (Berg, 1986). Finally, it must be kept in mind that measures of genetic similarity are simply measures of resemblance and do not necessarily indicate genetic relatedness; although, often relatedness can be inferred. Despite these potential problems, preliminary results (see below) indicate that genetic analyses can provide valuable information about the ancestry of feral horses.

PRELIMINARY STUDY

The wild horse or mustang has an important place in the heritage of the American West. In recognition of the mustang as a "symbol of the historic and pioneer spirit of the West" the U.S. government in 1971 enacted the Wild and Free-roaming Horse and Burro Act. This act, in part, states that the wild horse herds shall be managed "in a manner that is designed to achieve and maintain a thriving natural ecological balance on the public lands". When areas are found to be overpopulated, the Act provides for wild horses to be captured and removed for private maintenance. As pointed out earlier, a sig-

nificant part of effective management of isolated herds is an understanding of the genetic makeup of the herds, with the additional question of interest being what is the origin of these wild horses? There is no question that the original wild horses of North America were descended from horses brought by the early Spanish explorers and settlers. How much of this Spanish ancestry is retained in current mustang populations is unresolved. I here report the results of genetic analysis of six samples of horses of feral origin.

The first sample will be referred to as Mustangs (or pooled mustangs). All horses in this sample (n=156) were in private ownership and were either wild caught or descended from wild caught horses. These horses were from a variety of different bloodlines and geographic origins. In future analyses, when sufficient samples are obtained, this group will be divided into distinct bloodlines or groups with similar geographic origins. Sample two (n=110), the Kiger herd, is from west-central Oregon. All horses in this sample were wild caught in October 1989. Sample three consists of two samples of horses, wild caught in the Cerbat mountains of northern Arizona, captured 20 years apart (n=14 and n=8 for the 1970 and 1990 samples, respectively). The horses of the Cerbats are believed to have been isolated for over 100 years in an extremely arid habitat at an elevation of about 2100m. The feral population size in 1970 was in excess of 70 individuals. By 1990 the population size in the same area was estimated to be 21. Sample four (n=76) was from the Cruce ranch on the Mexico-Arizona border. The herd was feral when sampled. It was said to have come from Mexican stock with no introductions of new stock since the 1880s. However, there also was some information that suggested that there may have been introduction of Quarter Horses into the herd. Sample five (n=14) was wild caught in the Pryor mountains of southern Montana. These horses are from the first nationally designated wild horse preserve. There are conflicting reports on the history of this herd. Horses may have been there two cen-

turies ago but have certainly been there for all of the 20th century. There is little detailed information available for the herd prior to 1968 when the BLM began management of the herd. Sample six represents horses classified as American Spanish Barbs (n=64). These horses are similar to sample one in that they are of diverse feral origin. They are considered to represent, conformationally, the Barb type; however, little is actually known of their ancestry. All were in private ownership.

Genetic analyses were based upon 17 polymorphic genetic loci (7 red cell antigen systems and 10 biochemical polymorphisms). The systems examined were the A, C, D, K, P, Q, and U blood groups and the Al, Es, Gc, Hb, PGD, PGM, GPI, Pi, Tf, and A1B systems. Standard equine blood typing methodologies were employed and a total of 125 variants were recognized.

Levels of genetic variability within the feral horse populations were comparable to those of domestic horse breeds with the exception of the Cerbat sample (Table 1). Variability was measured as the effective number of alleles (i.e., the average number of alleles per locus that contribute to heterozygosity) and effective heterozygosity (expected heterozygosity based upon Hardy-Weinberg principles). The Mustang, Kiger, and Pryor samples had levels of variation above the median for domestic breeds. For the Mustang sample this was not surprising due to the diverse origins of the horses. For the Kiger and Pryor samples, the high variability was largely due to evenness in frequency of the variants rather than to the actual diversity of variants observed.

The level of variation in the Cerbat samples was greatly reduced compared to most breeds. Only 36 different variants were observed for the 17 loci in the 1970 sample and this was reduced to 25 by 1990. Individuals of the 1990 sample were virtually identical genetically, especially at the blood group loci. One interesting observation: all individuals of the 1990 Cerbat sample

were heterozygous at the Tf locus and 5 of the total 25 variants were Tf alleles. This may be an indication of selection acting upon the Tf locus or the chromosome region where the Tf locus is located.

Genetic similarity (Rogers' 1972 coefficient $\underline{S}$) of the feral samples to domestic breeds is shown in Table 2. The $\underline{S}$ values in Table 2 are the means of breeds grouped as draft, pony, hotblood, and Spanish groups. Highest average $\underline{S}$ for all feral samples except the Cruce and Cerbat samples was with the Spanish breeds. The Cruce and Cerbat herds were most similar to the hotblood group. Highest individual $\underline{S}$ values for the feral samples were with either hotblood or Spanish breeds. It should be noted that several of the hotblood breeds have a significant contribution from Spanish breeds in their ancestry, and that these breeds tended to have the highest similarity, among the hotblood group, to the feral horses. What is most clear from the genetic similarity analyses is that determining the ancestry of feral horses is not a simple matter. A better understanding of the ancestry will require a more complete understanding of which genetic markers are most diagnostic of particular breed lineages.

Preliminary work does indicate that at least some of the horses of feral origin have Spanish ancestry. The results also suggest that other non-Spanish breeds could have played a part in the makeup of these populations. More work is needed to understand the associations among the markers and the breeds. It also is necessary to sample additional breeds, especially New World breeds of Spanish descent, and more feral horses to better understand the genetic origins of the wild horses of North America. The data also show that some feral herds have levels of genic variation within the range expected for genetically healthy horse populations, while other herds are depauperate in genetic variation and may face imminent inbreeding problems. More study of the currently wild herds is clearly needed. If the current wild horse herds are maintained

as fragmented populations, which may be the most desirable situation in order to preserve local cultural resource aspects of herds as well as maximum genetic diversity, genetic management will be necessary for the long term preservation of the wild horses in America.

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Talble 1. GENETIC VARIABILITY IN FERAL HORSES

	EFFECTIVE NUMBER OF ALLELES	EXPECTED HETEROZYGOSITY
MUSTANGS	1.802	.445
SPANISH BARB	1.791	.442
KIGER HERD	1.878	.467
CRUCE HERD	1.679	.405
PRYOR MTNS	1.864	.463
CERBAT 1970	1.510	.338
CERBAT 1990	1.147	.129
DOMESTIC HORSE MEAN (32 BREEDS)	1.730	.422

Table 2. GENETIC SIMILARITY OF FERAL HORSES TO DOMESTIC BREEDS

	MUSTANGS	SPANISH BARB	KIGER HERD	CRUCE HERD	PRYOR MTN	CERBAT 1970	CERBAT 1990
DRAFT	.796	.753	.779	.750	.766	.700	.634
PONY	.830	.792	.795	.771	.802	.714	.622
HOT BLOOD	.862	.787	.846	.827	.811	.756	.669
SPANISH	.871	.807	.859	.814	.818	.737	.640

FERTILITY CONTROL IN WILD HORSE POPULATIONS

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Introduction

In June 1985, the Bureau of Land Management issued solicitation AA852-RP5-27 which described three separate studies. We answered Part Three of this solicitation entitled "Fertility Control in Wild Horse Populations". This solicitation was very detailed in study design. It specified that contraceptive experiments should focus on both males and females. Contraception methods for mares would be tested in pen studies prior to being implemented on free-ranging individuals. Male sterilization would be tested using vasectomy of dominant band stallions and would be carried out on free-ranging individuals in two different study areas. The solicitation called for selecting four comparable areas in each of two states, thus, making a total of six study areas; two vasectomy areas, two mare experimental areas, and two mare control areas.

We attempted, in our answer to this solicitation, to fulfill

the major study objectives and we provided detail as to how this would be accomplished. This report summarizes the results of studies initiated by the solicitation. In fulfilling the objectives, certain changes in study design were implemented as the study progressed. These changes were discussed with BLM and the National Academy Committee on Wild Horses and Burros, which initially developed the solicitation.

The final report was composed of five papers. Other papers were published as the study progressed and others are currently in press. The papers of the final report covered the results of the mare contraception work, the stallion vasectomy field studies, and results derived from modeling studies using data obtained from the Bureau of Land Management on horses gathered during herd reduction.

The study required that we handle a large number of animals to meet the sample size requirements outlined in the solicitation. The gatherings were handled through a contract with a professional roundup contractor recommended by BLM personnel in Nevada. Radio transmitters housed on collars with numbers and numbered marker collars were attached to a large number of horses since it was required that individuals be relocated after treatment to check on reproductive performance. In the case of males, their status in the herd, and the overall reproductive performance of their band was required. A number of events occurred during the field work that tended to make the study controversial, and the controversy seemed to increase as the study progressed. Throughout the controversial periods, we tried to concentrate on the objectives of

the work and attempted to fulfill the obligations we had to BLM and the National Academy of Science Committee under the contract. In general, we were successful in fulfilling these obligations as the results in the final report and papers rising from the study suggested. As controversies arose, they were generally investigated by either the National Academy Committee or BLM representatives; reports and/or communications were written as part of a record. These reports and communications are generally available and were summarized in a final report of the National Academy of Sciences Committee, which was released in 1991.

Mare Studies

The mare contraceptive studies began with four objectives that were outlined in our original answer to the solicitation. These were: (1) to select and test an economical contraceptive method that can be administered in a single treatment to selected individual animals with a 90% efficiency over at least two full breeding seasons. (2) To develop or select a delivery system for the contraceptive treatment. (3) To assess possible adverse consequences of the contraceptive treatment and (4) to investigate the effectiveness of one or two promising treatments and/or delivery systems in field trials using mares in free-ranging bands. With these objectives before us, we began pen studies in the holding facility in Lovelock, Nevada.

Implanted silastic rubber rods impregnated with hormones were developed. Similar methods had been used successfully on humans and various species in zoos to prevent unwanted pregnancies, and it

was felt that the method could be successful for horses. We began by considering various estrogen compounds in combination with progesterone. Initially, silastic rubber implants were placed in the neck of sample groups of mares held at Lovelock. Blood was collected from 5 mares, from each group, approximately every two weeks to assay hormone levels and check the implants. These initial implants proved successful with respect to suppressing estrus, but were judged unacceptable because many of the implants eventually fell out. Thus, we consider another implant site and, in consultation with veterinarians, placed several implants in the peritoneal cavity. Intraperitoneal implants were quick to administer, recovery from the implantation surgery was nearly instantaneous, and we had no difficulty with infection. Because of the time pressure to complete the study on schedule, we used the neck implants on the mares in the first mare control area, (Wassuk herd management area) before we were aware of the implant losses mentioned above. Once it was established that the intraperitoneal implants produced levels of hormone which prevented pregnancy, we continued in the field with intraperitoneal implants.

As mentioned above, in the original request for proposal it was suggested that two treatment and two control areas be used for the mare contraception work. We initiated this design by choosing Wassuk and Stone Cabin as the first mare control and experimental areas, respectively. However, after these areas were established it became obvious that there could be a significant area affect which influenced the overall reproductive rate of females. That is, if the habitat conditions were poor, reproductive rates were

generally low, and in such instances, the effect of contraception could not be separated from the effect of the environment. After the Wassuk and Stone Cabin phases were completed, it was decided that for the second treatment area, treatments and controls should be contained on the same area. Thus, for the mare contraception studies, three areas were finally established. These were: the Wassuk area, which has served as a control beginning in the spring of 1986, the Stone Cabin area where treatment was carried out in the late fall of 1986, the Clan Alpine herd, completed in late 1987, where both control and experimental animals existed together. As mentioned above, in the Wassuks, implants were placed in the neck. The Stone Cabin and Clan Alpine implants were intraperitoneal.

The results of the mare studies demonstrated that hormone implants were effective in suppressing reproduction for at least 2 years and provided data, from the Stone Cabin area, which demonstrated effectiveness for 3 years. Furthermore, calculations based on serum concentrations of penned animals, suggested that the contraceptive could be effective for as long as 5 years. We were able to collect data on the effectiveness of the contraception in the Stone Cabin area for three seasons, and data in the Clan Alpine area for only one season. Data were collected only in the Stone Cabin area in the final year of our research (spring 1990), because public and BLM pressure would no longer allow us to use helicopters to monitor reproduction. In the spring of 1990 we concentrated on obtaining foaling rates for treated mares, from the ground, in the Stone Cabin study area. The Stone Cabin area was deemed the most

important because this was the third year that the contraceptives would be effective for these mares.

The results of the mare studies are currently being published in the open literature, and reprints are available from the authors at the University of Minnesota.

Stallion Vasectomy Studies

The vasectomy studies were conducted on the Flanigan Study area just north of Reno, Nevada and the Beatty Butte study area in eastern Oregon. In each area, 20 dominant stallions were gathered with their bands and the dominant stallion was vasectomized and returned to the free-ranging population. Radio transmitters were attached to the dominant vasectomized stallions. We attempted to follow the bands through the reproductive seasons in order to assess the effectiveness of the vasectomies. This study became difficult, because when the stallions fought, they often used the collars as the focus of their battles. Collars were frequently torn off when these encounters occurred. Therefore, we lost track of several of the vasectomized stallions, but obtained some data from ground observations, relying on physical characteristics for identification. As a result, our sample sizes for the vasectomy studies were small. In the Flanigan area, an investigator spent a good deal of time walking through the area observing band structures with and without vasectomized stallions. We obtained some data in this way, but complications occurred because animals were lost and there were switches in band membership and structure. Regardless, the data we obtained, we feel, depicted the likely result of using male sterilization to control population growth

rates. The results suggested some depression in foaling rates, but this required band stability which varied much with environmental and population characteristics.

We carried out a population modeling exercise to explore the effects of the presence of vasectomized stallions on annual reproductive patterns. Since horses are polyestrous, they cycle several times during the summer if the postpartum mating is not successful. The presence of a vasectomized dominant stallion would likely cause the female to cycle many times through the summer until successful breeding from a fertile male occurs, or the reproductive season ends in the fall. The modelling effort predicted a shift in the foaling season would occur if the probability of not breeding post partum became very large. Such a result would need to be considered if male sterilization in seasonally breeding animals is to be used to control population growth rates.

Some Management Consequences of the Application of Mare Contraception

Finally, we used population data obtained from the horses gathered for herd reductions by the Bureau of Land Management over the past 15 years to produce a model to explore the consequences of the management options. Over 60,000 records on age structure and reproductive condition of individual animals were obtained from various Bureau of Land Management offices. In addition, detailed data from the Pryor Mountain wild horse range were also valuable in this effort. Further, annual census data obtained by BLM were also

available on many herd areas. These data were used to obtain estimates of population growth rates of various horse herds. The results of the analyses of all these data provided the foundation for a population model that was used to predict the consequences of various management options, including the use of mare contraception. Data on the cost of various management procedures which had been previously used by BLM were contrasted to the costs of the contraceptive techniques used in our studies. Because of the quality of the data used in the simulations, it seems likely that the predictions found in this work would be very close to the actual results that one could expect if the contraception program were to be applied to wild horse herds. This work showed that contraception is not a panacea that solves all of the problems, but would contribute to slowing the growth rates and lessening the problem of the number of horses that need to be removed to achieve herd management goals.

Conclusion

When this work was initiated, the National Academy Committee and others obviously envisioned that these procedures would contribute greatly to controlling growth rates of wild horse herds in the West, and would be widely accepted by concerned conservation groups. Although our studies were controversial because of various incidences and procedures, there were important general conclusions which could have significant influence on future management decisions.

The mare studies demonstrated that we can significantly slow the growth rate of the herds by implanting slow release hormones in

a significant fraction of the prime age mares. In applying mare contraception techniques our data and simulations showed that a large proportion (at least 80%) of the prime age mares (ages 4 through 12) may need to be treated approximately every three years for the herd growth rates to be significantly depressed. We have shown this procedure to be cost effective as compared to the other management procedures which are available for wild horse herds. Mare contraception, as developed within our research, could be used to develop long-term management plans, where the number of animals on a given herd range could be managed closely, and would be relatively predictable over the long term. Management plans could be written so that procedures could be outlined on a yearly basis and could be projected into the future. In this way, public scrutiny of future plans would be possible for several years in advance of the actual management manipulations.

Mare contraception significantly reduces the overall number of animals that need to be taken into captivity to maintain herd management goals. The combination of gathering younger animals, which are adoptable, and using mare contraception greatly limits the number of individuals that need to be taken from the wild to maintain a herd management area at a given population level.

The male sterilization studies we feel depict rather precisely what future implementation of this approach would produce in terms of contraception. Sterilization of dominant stallions had some influence on foaling, particularly in bands where the sterilized stallion remains dominant. However, the degree of suppression of the overall growth rate of the herd was complicated and

unpredictable because it depended upon the stability of the bands which make up the population. The more potential for turnover that exists, the more unsuccessful this approach is likely to be. We have found, through models, that male sterilization would have a significant influence on changing the overall seasonal pattern of foaling. Since mares have a gestation period of slightly less than one year, and since they will continue to go through estrus cycles if not bred following parturition, there will be a tendency for individual mares to foal later and later in the summer. This tendency, of course, would be detrimental, since foals born late in the summer would be at greater risk for surviving the winter. This tendency for increased foal winter mortality would be more pronounced at high altitudes and in the more northern herd areas.

FERTILITY CONTROL FOR WILD HORSES: IMMUNOCONTRACEPTION

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PRESENTED AT THE WILD HORSE FORUM, RENO, NV; MAY, 1991.

I am pleased to see this Wild Horse Forum occurring. The recent history of the feral horse, especially in the western United States, has been a time of great difficulty. The greatest difficulty has of course been for the horses, which have been caught in the dusty storms of powerful politics and management decisions with little or no data base. The hard times for the horses have been intensified by the availability of only one management tool - roundups, followed by sale and/or slaughter.

However, I have optimism that we can leave much of that behind as we turn to what is happening now and how it may brighten the feral horse future. The subject which I will address is fertility control, with a focus on immunological or vaccine-based contraception. Since our research team has been studying feral horse reproduction for many years, I would like to explain how we have come to immunocontraception.

It was 1973 when my colleague Jay Kirkpatrick, at Eastern Montana College, and I, at the Medical College of Ohio, first became aware that feral horse populations were rising. We thought of contraception early on, but had to first explore the literature and further develop a database on feral horse reproduction and behavior. By 1978 we were ready to test several contraceptive agents in captive ponies at the University of Pennsylvania Veterinary School. Our initial focus was on stallion contraception, since our own field studies and most reports in the literature at the time indicated that harem studs generally maintained good harem integrity and did not permit breeding by subordinate or outside males. We also focused on sex steroids, which seemed most promising at the time. At the University of Pennsylvania we performed a study with domestic ponies which demonstrated that a timed-release version of the male sex hormone, testosterone, effectively inhibited sperm production while maintaining harem-related behavior. Between 1980 and 1984 we did field testing and follow-up on this agent, called microencapsulated testosterone propionate (MTP) in the Challis horse range in

unacceptable. While potent synthetic estrogens might be effective in smaller volume, they exhibited poor biodegradability and could be passed through the food chain, a consideration of special concern regarding wildlife which might eat the carcass (including protected species such as the golden eagle). We also considered that the USDA, which has banned the use of estrogenic steroids in cattle, would disallow the use of these steroids in any species which may be consumed by humans, including horses and deer. Both these species are candidates for management by fertility control and are also established food sources in various countries. Many of the horses already removed from western U.S. ranges are purported to have become human food. At this time in our research, an alternative, non-steroidal contraceptive seemed highly desirable.

Interestingly, as a result of information exchange at a 1986 conference in Bishop, California on feral horses, we became aware of a non-steroidal, immunological contraceptive. This vaccine, prepared by Irwin Liu, at the University of California, Davis, was highly potent and effective in small volumes, making it a good candidate for remote delivery. Because the vaccine seemed very promising for our intended applications, we embarked on a collaborative study to field test it on feral horses inhabiting Assateague Island National Seashore. For those who wish to read the scientific details of our feral horse contraception studies, I have attached a copy of 2 of our recent *Wildlife Society Bulletin* publications (References # 1 and 2). I will however, outline the important aspects of this work below.

The most widely studied contraceptive vaccine, and the one we used, is called PZP. This is the abbreviation for porcine zona pellucida, which is the coating around the eggs from pig ovaries. This coating plays an important role in fertilization of the egg by the sperm. If some of this PZP is injected into females of another species, that species will make antibodies against its own ZP which will bind to the ZP and thereby prevent sperm from fertilizing the eggs. This type of vaccine has been used successfully in a number of species, including baboon, monkey, rabbit, rat, dog and horse. In a study using domestic mares, our colleague, Dr. Liu, demonstrated that the PZP vaccine effectively inhibited fertility in 13 of 14 treated mares and that the effect lasted approximately one year. When the mares were bred a year later, pregnancy rates were again normal, and healthy foals were born. With this encouraging database we began the Assateague field study.

The Assateague feral horse population has been on the island for several hundred years, and since the late 1970's population and lineage records have been

recently developed adjuvant that will not cause abscesses. The second disadvantage is that complete immunization has required 2 injections, about 3 weeks apart. This is clearly unacceptable for management purposes, and we have been developing a timed-release vaccine which will provide complete immunization in a single injection. The single injection will contain the initial inoculation plus a second dose sequestered in a bioedegradeable polymer matrix (much like timed-release cold capsules) which will breakdown in the body over a 3-week period, releasing the second dose of vaccine.

We have tested this timed-release pattern of vaccination in a preliminary study in 3 mares and have produced levels of PZP antibody identical to antibody levels in successfully contracepted mares given the usual 2-injection protocol. The final bioengineering of this timed-release vaccine is underway. We are also pursuing the engineering of a 2-year vaccine, similar to the above timed-release vaccine, but also containing a timed-release booster dose which will release after 1 year. The biotechnology for this capability already exists, but the formulation for our specific vaccine still must be developed.

Since many participants in this wild horses form are involved in management, I would like to share a breakthrough in the monitoring of population reproductive function which has come from our contraceptive work. As I have stated, we strongly believe that future management of feral horses must be done with a minimum of handling. We have therefore developed methods for monitoring reproductive status, including pregnancy testing and estrus cycles, via measurement of sex steroid metabolites in urine and feces collected from the ground. This technology has proved of great value in answering questions such as contraceptive effectiveness and reversibility without having to wait for foaling each year. The levels of sex hormone metabolites in urine and feces increase sufficiently to be detectable by 1-3 months of pregnancy. For those who are interested in the details of these studies I have included information from 3 representative journal papers (References # 3,4,5) which we have published on this subject.

As a final comment I would like to direct your attention to a more philosophical aspect of the wild horse contraception issue. Dr. Jay Kirkpatrick and I have been pushing for fertility control for feral horses since 1975. Now that it is finally on the horizon we must begin to address some important concerns regarding its use. We strongly believe that any fertility control method requiring capture with immobilization or restraint is unacceptable. We have seen it and have participated in it. As a consequence we have dedicated

ourselves to finding alternatives.

Part of the intellectual evolution of humans has involved the development of beliefs about how people should act. These beliefs are often expressed by the words "civilized" and "humane." We have talked of supporting the rights of animals for a long time, and we now stand at the threshold of putting words into action regarding the wild horse. I believe that there is only one thing that may stand in the way of achieving our positive human potential in this issue - our narrow perspective. Remember, the whole issue of non-lethal control centers around humane treatment. If the method of control is not humane, then what has been accomplished?

NOTE: The complete journal articles for the topics addressed in this paper are on the pages which follow.

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REMOTELY-DELIVERED IMMUNOCONTRACEPTION IN FERAL HORSES

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Reducing fertility among free-roaming feral horses (*Equus caballus*) has been the goal of numerous studies over the past 16 years (Kirkpatrick et al. 1982, Goodloe et al. 1988, Plotka et al. 1989). Initial experiments by Kirkpatrick et al. (1982) and Turner and Kirkpatrick (1982) resulted in an 83% decrease in foaling among feral mares bred by stallions which were first immobilized and then treated with injectable microencapsulated testosterone propionate (mTP). Although the treatment decreased sperm count and motility, the high costs and the stress caused by immobilization or capture made it clear that the contraceptive agent needed to be delivered remotely. In a second study Kirkpatrick and Turner (unpublished data) demonstrated the pharmacological effectiveness of mTP in stallions, but difficulty was encountered in remotely delivering a sufficient mass of the steroid.

Recently, attention has turned to contraception in the feral mare. Experiments with ethinylestradiol-progesterone Silastic® implants (Vevea et al. 1987, Plotka et al. 1988, Plotka et al. 1989) showed pharmacological promise, but the technique required capture, restraint, and field surgery to place the implants intraperitoneally. An alternative to steroid-induced fertility control is immunocontraception. A conjugated form of luteinizing hormone releasing hormone (LHRH) has been used successfully to raise antibodies in captive feral mares (Goodloe et al. 1988), and solubilized porcine zonae pellucidae (PZP) injections inhibited fertility in 13 of 14 domestic and captive feral mares (Liu et al. 1989).

The success of the PZP vaccine in suppressing fertility is based on its ability to inhibit fertilization or possibly implantation (Sacco et al. 1984). The porcine zona pellucida consists of 3 glycoproteins. One of those, ZP3, is the receptor molecule for sperm surface molecules (Florman and Wassarman 1985). Equine antibodies raised against PZP are thought to block the sperm receptor sites on the equine ovum, thereby preventing fertilization (Liu et al. 1989). To date, PZP has been used to successfully inhibit fertility in a number of mammals, including 5 species of nonhuman primates and in vitro fertilization in humans (Sacco 1987).

The objectives of this study were to (a) determine the effectiveness of remote delivery, (b) test the contraceptive effectiveness of a PZP vaccine in free-roaming feral mares, (c) determine the contraceptive effectiveness of the vaccine in pregnant and nonpregnant mares, and (d) evaluate the safety of the vaccine for use in pregnant mares.

MATERIALS AND METHODS

Forty-six sexually mature mares were selected for the study from among the approximately 100 feral mares inhabiting Assateague Island National Seashore, Maryland. The ages and fertility records, some dating back as far as 1974, were known for almost all animals on the island (Keiper and Houpt 1984). Ages ranged from 3 to 18 (mean = 9.12, SD = 4.45 years). The mares chosen for treatment were not randomly selected. Instead, they were selected because of their high fertility rates, which averaged about 10% higher (51.7%) than the overall herd rate (approximately 40%) annually for the preceding 3 years. The PZP vaccine was prepared from porcine ovaries (Liu et al. 1989) and stored frozen at −5 C until used in the field.

The inoculation was prepared as an emulsion, of 0.5 cc of vaccine (equivalent to approximately 5,000 zonae or 64.3 μg of protein) in phosphate buffer and 0.5 cc of Freund's Complete Adjuvant. The second and third inoculations were the same as the first except for the addition of 0.5 cc of phosphate buffer solution and substitution of 0.5 cc of Freund's Incomplete Adjuvant for the complete adjuvant. The 2 vaccine components were mixed in the field, using 2 10-cc glass syringes joined with a plastic connector. After 100 strokes the emulsion was loaded into a 3.0-cc self-injecting plastic dart which was tipped with a 3.81-cm barbless needle. The needles were rinsed with 70% EtOH prior to being loaded into the rifle.

National Park Service regulations prohibited the capture or handling of any horses during the course of the study. Twenty-one mares were darted from the ground, at distances from 25 to 30 meters, in the hip region, using a Pax-Arms® 0.527-caliber capture gun. Between 29 February and 10 March 1988, 26 mares received an initial inoculation of vaccine. Eight of the mares were acclimated to humans, and the initial vaccine delivery was accomplished with a 3-cc syringe and a jab-stick and thereafter by dart. Between 12 and 21 March, 26 of the 29 mares received a second inoculation by dart, as described above. Three of the mares became extremely wary, could not be approached for the second inoculation, and were dropped from the experiment. Between 16 and 25 April, 18 of the 26 mares which received the second inoculation received a third inoculation, which was identical to the second. The 6 control mares, which were selected from the original 46 mares, received only phosphate buffer and adjuvant in 2 inoculations, between 3 March and 29 March. Identifying markings were recorded for each horse, and the animals were observed throughout April for abscesses at the sites of injection.

A minimum of 2 inoculations is required in horses in order to raise sufficiently high antibody titers for a minimum of 6 months (Liu et al. 1989). The schedule of inoculations used in this study was based on the spacing of inoculations in the 1 previous study with horses (Liu et al. 1989) and the breeding and foaling activity patterns of the Assateague horses, which peak in May and June (Keiper and Houpt 1984). The first inoculation causes antigen recognition and temporary increases in antibody titers. The second inoculation causes increased titers which last several months, and each subsequent inoculation increases the duration of high titers.

During October 1988, 5 months after the last inoculation and 2 months after the breeding season, the mares were located and identified, and the number of foals was recorded. Urine samples were collected from each of the 26 treated and 6 control mares, without capture, by extracting the urine from the soil or aspirating it directly from the ground immediately after urination. The urine samples were assayed for estrone conjugates (E_1C) and indexed to creatinine (Cr) concentrations (Kirkpatrick et al. 1988) and for nonspecific progesterone (Po) metabolites (iPdG) (Kirkpatrick et al. 1990). Pregnancy determinations were made on the basis of the urinary E_1C and iPdG concentrations.

In August 1989, the mares were again located, identified, and observed for the presence of foals. The 1989 foal production for the treated mares was compared to foal production (1) for the same group of mares for 1987 and 1988, (2) for the 6 control mares for 1989 and (3) with 11 untreated mares for 1989. The validity of these comparisons is based on long-term records of reproductive success among the Assateague horses (Keiper and Houpt 1984) which demonstrate that foaling patterns are consistent from year to year and that the probability of a mare having a foal is independent of her foaling success the previous year. Finally, in August 1989, a random sample of 7 uncaptured treated mares was tested for pregnancy by means of urinary steroid metabolites (Kirkpatrick et al. 1988, Kirkpatrick et al. 1990) in order to test reversibility of the vaccine's antifertility effect. Differences in foaling rates among treated, control, and untreated groups were tested for significance by means of binomial probability distribution (Freedman et al. 1978:231, 236).

RESULTS

Three abscesses were observed among the 26 horses treated. The abscesses appeared at the site of injection approximately 48 hours following the third treatment, were about 10–25 mm in diameter, and drained from 6 to 9 days after treatment. Complete healing had occurred within 14 days following treatment.

Of the 26 treated mares, 14 were pregnant at the time of inoculation (57.6%) and all 14 produced foals in the spring of 1988, approximately 1–3 months after the last inoculation of PZP vaccine. The 6 control mares produced 2 foals in 1988. By October 1988, a foal belonging to 1 of the treated mares had disappeared and was presumed dead. Another foal belonging to a treated mare died during the fall of 1988 as a result of a leg injury. All other foals born to treated or control mares were in good health in August 1989 as yearlings. During the 18 months following inoculation, only 3 mares moved to different bands.

Urinary E_1C and nonspecific Po metabolite concentrations in mid-October 1988 indicated there was 1 pregnancy among the 26 treated mares. None of the 18 mares receiving 3 inoculations were pregnant, and 1 of 8 receiving

Table 1. Foaling rates for treated and untreated mares for pretreatment and post-treatment years, Assateague National Seashore, 1987 through 1989.

Group	Inoculations/ horse	No. horses	% of mares producing foals (no. foals)		
			Pretreatment		Post-treatment
			1987	1988	1989
Treated	3	18	50.0 (9)	51.1 (11)	0.0 (0)
Treated	2	8	62.4 (5)	37.4 (3)	12.4 (1)
Control	0	6	33.3 (2)	33.3 (2)	50.0 (3)
Untreated	0	11			45.4 (5)

2 inoculations was pregnant. Three of 6 control mares were pregnant. Mean urinary E_1C and iPdG concentrations of nonpregnant treated and control mares (0.12 ± 0.35 SE μg/mg creatinine [Cr] and 3.42 ± 0.486 ng/mg Cr, respectively; $n = 28$) were lower than those of pregnant mares (3.41 ± 0.723 μg/mg Cr and 227.82 ± 89.7 ng/mg Cr, respectively; $n = 4$) ($t = -12.59$, 30 df E_1C; $t = -9.47$, 30 df, iPdG, $P < 0.001$).

By August 1989, 1 and 3 live foals were present among the 26 treated and 6 control mares, respectively, as precisely predicted by the urinary hormone metabolite measurements (Table 1). Post-treatment foaling rate for the treated mares (3.8%, $n = 26$) was less ($P < 0.002$) than that for the 2 pretreatment years (53.8%), for control mares in 1989 (50.0%), and for untreated sexually mature mares in the study area in 1989 (45.4%). Three of 7 randomly selected treated mares were determined to be pregnant in August 1989, based on urinary estrone conjugates and iPdG.

DISCUSSION

The choice of Freund's Complete Adjuvant for the first inoculation and Freund's Incomplete Adjuvant for the second and third was based on the work of Liu et al. (1989). While only 3 abscesses were noted in this study, the evaluation of other adjuvants which are less likely to cause abscesses is an important direction for future research.

No previous studies have been conducted in which pregnant animals of any species were vaccinated with PZP. In this study the immunosuppression which accompanies pregnancy did not interfere with the effectiveness of the antifertility effects of PZP vaccine, the pregnancies were successful, and the foals healthy. These are important considerations because the use of this vaccine for management will likely include pregnant mares among the treated animals.

A major advantage of the PZP vaccine is the small volume required and the aqueous base, both of which facilitate administration by dart. Remote delivery eliminates the need to capture horses, the attendant costs, and the likelihood of injury to horses, although our experience did not include long-distance darting of extremely wary feral mares. An advantage of PZP is the reversibility of the vaccine's contraceptive effects. Liu et al. (1989) demonstrated that captive treated horses that failed to conceive after PZP treatment could breed successfully the following year, as did at least 3 of 7 free-ranging mares in this study. The issue of reversibility is politically as well as biologically important because it is unlikely that public opinion will favor irreversible sterilization among feral horses.

A final advantage of the PZP vaccine is the protein nature of the contraceptive antigen. This characteristic precludes the possibility of passage of the antifertility agent through the food chain. In most circumstances some treated animals will die from natural causes and a variety of predators and scavengers will feed

upon the carcass. Protein, unlike steroids, and particularly synthetic steroids, cannot be accumulated intact in the predators' and scavengers' tissues. In addition, protein vaccination avoids urinary and fecal contamination by poorly metabolized steroids, and especially those synthetic estrogenic steroids which have high potency and high resistance to biodegradation.

Despite the return of normal fertility among PZP-treated horses reported by others and in this study, the long-term effects of continuous PZP immunocontraception have not been described. In the domestic rabbit (*Oryctolagus cuniculus*) (Wood et al. 1981), the domestic dog (*Canis familiaris*) (Mahi-Brown et al. 1985), and the baboon (species not given; Dunbar et al. 1989) there are data that suggest the antibody response of the treated animal attacks not only the mature ovum, but oocytes and other ovarian tissues, with resulting changes in estradiol and progesterone secretion. These effects have not been demonstrated in any of the 4 other species of nonhuman primates studied or in horses. Histological studies of ovaries among captive PZP-treated horses revealed no changes 3 years after treatment, and plasma progesterone values during treatment were consistent with normal cyclicity (Liu et al. 1989).

Behavioral integrity of treated animals is important, particularly in the case of social animals such as the horse. Bands with treated horses remained intact during the 18-month duration of this study, and the exchange of 3 mares between bands was within accepted limits for the Assateague herd during the previous 3 pretreatment years.

These results suggest that PZP immunocontraception is a possible alternative for controlling fertility in feral horse populations. However, the requirement for at least 2 inoculations for successful fertility inhibition is a weakness, and the current limitations of remote delivery are impediments for the use of PZP in management. The 3 mares which received only 1 inoculation were extremely wary and not approachable for a successful second inoculation. If this form of immunocontraception is to become an effective management tool for controlling feral horse populations, it must first be developed as a single-dose vaccine. Technology to convert the PZP antigen into a single-dose vaccine currently exists in the form of microencapsulation. This process, which provides a sustained release of drug, has been used successfully with contraceptive steroids (Kirkpatrick et al. 1982) and antigenic protein (Eldridge et al. 1989). Recently, the specific porcine zona antigenic proteins have been produced with monoclonal tissue cultures, eliminating the need for time-consuming preparation from fresh ovarian tissue and providing a potentially inexpensive source of the vaccine (Takagi et al. 1988). The effectiveness and safety of this form of immunocontraception can also be improved through the use of monoclonal proteins, because the pure receptor protein, ZP3, can be produced instead of the entire spectrum of zonae proteins which were used in this study. Experiments are under way to assess the effectiveness of a single annual booster inoculation, once antigen recognition has occurred. If a booster is effective, as it appears to be on the basis of urinary steroid metabolites, it is probably possible to incorporate the booster in an initial inoculation which delivers an initial bolus of antigen, a second pulse of microencapsulated antigen a month later, and the microencapsulated booster a year later.

CONCLUSIONS

This study provides the first description of successful fertility inhibition among uncaptured free-roaming mammals by means of remotely delivered immunocontraception. Remote inoculation of feral mares with PZP was an effective means of fertility inhibition and did not affect intact pregnancies. The process was reversible, it did not affect social integrity

of horse bands, and the vaccine cannot be passed through the food chain. The impact of PZP contraception is on fertilization, and no hormones are involved which might impinge upon the brain and change behavior directly. Coupled with remote pregnancy testing by means of urinary and fecal steroid metabolites, the remote delivery of PZP offers a potential noncapture technology for feral horse contraception. This in turn makes public acceptance of contraceptive control of mammalian wildlife more likely than with approaches that require capture and handling.

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"IN MY EXPERIENCE . . ."

NEW DEVELOPMENTS IN FERAL HORSE CONTRACEPTION AND THEIR POTENTIAL APPLICATION TO WILDLIFE

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The concept of sex steroids as contraceptives is not new and was originally directed toward fertility control in humans (Pincus et al. 1958). In the 1960's the development of extended-action steroids as contraceptives was explored (reviewed, Beck et al. 1980), and application of this technology to captive exotic animals was pioneered in the 1970's (Seal et al. 1976). In the light of rapidly increasing problems of wildlife overpopulation, and continued advances in contraceptive technologies, new approaches to fertility control in wild, free-roaming animal populations are now being examined (Kirkpatrick and Turner 1985, 1991). Because of local overpopulations of free-roaming feral horses (*Equus caballus*) in some areas of North America and the highly publicized nature of management efforts to control these populations, the feral horse has been the focus of a number of contraception studies in free-roaming populations (Kirkpatrick et al. 1982, Turner and Kirkpatrick 1982, Plotka and Vevea 1990).

This article examines approaches to fertility control in feral horses, including currently available and experimental antifertility agents and delivery systems, and their potential for adaptation to various free-roaming species, particularly ungulates. As a first step, it is useful to list the characteristics of the ideal wildlife fertility control agent. First, it has to provide a high degree of effectiveness across a given breeding season. Second, it has to be free of harmful side effects to the animals receiving it, including pregnant animals. Third, the ideal contraceptive should be reversible. The genetic pool in each population exists in the dynamic state, with each reproductively active animal having the potential to influence the pool. Impact on the process of natural selection will be minimized when a fertility control program is reversible. There are also important social and political reasons demanding reversibility of wildlife contraception (Kirkpatrick and Turner 1985). Fourth, the ideal agent will be relatively inexpensive. However, no fertility control program can compete on a cost-effectiveness basis with a management method such as hunting, where the public not only provides the manpower but also provides revenue. Fifth, the ideal agent should have a flexible duration of action, so that a single treatment can act for a predetermined period or number of breeding seasons. Sixth, the agent should have minimal to no effect on social organization or behavior. Finally, the ideal agent should be capable of being delivered remotely. The capture or immobilization of large numbers of animals, regardless of the skill of the management team, may lead to injuries, mortality, and monetary expense that will ultimately be unacceptable (Turner and Kirkpatrick 1986).

FERAL HORSE CONTRACEPTION

Contraception in feral horses has focused on steroids and vaccines, with delivery methods including surgical implants or intramuscular (i.m.) injection in immobilized animals and i.m. injection by remote-delivery projectile. However, the subject is not a simple one. A number of variations on these basic approaches have been explored, and an awareness of attendant advantages and disadvantages has emerged during the course of several feral horse studies.

One of the first issues faced in the feral horse studies was which sex should be targeted for fertility inhibition. Although ovulation inhibition in domestic mares by pharmacological doses of progestins had been demonstrated by Loy and Swan (1966), and confirmed by subsequent studies (Ginther 1979), the social structure of feral horse herds made males seem a preferable target (Turner and Kirkpatrick 1986). In data from 14 of 16 herds surveyed, dominant stallions controlled and bred harems of several (range 2–24, average 5) females, preventing males from outside the harem and subordinate males from breeding (Kirkpatrick and Turner 1986). Because sexual behavior and harem maintenance behavior were regulated by testosterone (Turner and Kirkpatrick 1982), we reasoned that any agent that could satisfy the basic characteristics of the ideal contraceptive while permitting maintenance of normal testosterone levels would be a promising candidate.

In a screening study 4 potential antifertility agents were evaluated in 24 pony stallions (Turner and Kirkpatrick 1982). The agents were α-chlorohydrin (nonsteroidal), 2 long-acting formulations of testosterone (testosterone cypionate [TC] and microencapsulated testosterone propionate [MTP]) and the potent, long-acting synthetic estrogen Quinestrol (17α-ethinylestradiol 3-cyclopentyl ether). The α-chlorohydrin was unacceptable because of neurotoxic side effects. The Quinestrol and both androgens were effective. We chose to use androgens, which had less potential for contamination of the environment.

Within 6–8 weeks after treatment initiation with i.m. injection of MTP (2.6 g/100 kg) or TC (1.7 g/100 kg, monthly 6×), significant decreases from control values occurred in sperm number and sperm motility, while libido scores (based on vulval sniffing, flehmen, erection, and mounting) did not change. These effects persisted for approximately 6 months (treatment phase). In the recovery phase, the affected parameters had returned to control values. No side effects were observed. In this preliminary study, the treatment decreased sperm production but did not compromise the normal sexual behavior of the male. Presumably a harem stallion given this treatment in the field would maintain his harem while being infertile.

MTP was chosen for a field trial on the basis of its more extended action in a single injection. The MTP, prepared by Southern Research Institute (Birmingham, Ala.), consisted of microdroplets of testosterone propionate coated with a nontoxic biodegradable polymer of varying thickness. The basic principle is that a thick coating biodegrades more slowly than a thin coating. By varying the thickness of the coating, it is possible to achieve delay times for MTP release ranging from several days to more than 6 months. By including a range of coating thicknesses in a single injection, hormone presence in the blood can be continuous throughout the release period. Both release rate and duration depend on the chemical characteristics of the agent which is microencapsulated. The current technology has been refined to potentially provide steroid preparations with up to an 18-month release period capability (T. Tice, Southern Research Institute, Birmingham, Ala., pers. commun.).

In an initial field study, 10 harem stallions in the Challis Horse Range in Central Idaho were immobilized from a helicopter and injected directly with MTP several months prior to the 1980 breeding season (Kirkpatrick et al. 1982). Pretreatment foaling, in 1980, was sim-

ilar in control and treated bands. In the summer of 1981, 83% fewer foals were produced among mares in the harems of treated stallions. In 1982 the foal counts in the treated bands had returned to pretreatment (1980) levels. Sexual behavior was evaluated from 1980 to 1982 using standard male parameters of mounting, intromission, and ejaculation. A sociosexual scent marking behavior, exhibited by males (Turner et al. 1981), was used as an index of harem maintenance behavior. There were no differences in stallion behavioral parameters between treated and control animals in the years monitored (1980–1982), with the exception that mating behavior continued further into the summer in treated bands. This probably reflected continued estrus cycling in the mares due to infertile matings (C. Asa, St. Louis Zoo, St. Louis, Mo., pers. commun.).

On the basis of these data, we concluded that a single injection of MTP given several months prior to the breeding season significantly decreased the fertility relative to untreated controls for a single breeding season, did not interfere with stallion behavior, and permitted a return to normal fertility in the breeding season of the following year.

Despite the encouraging outcome of this study, we found the method for delivery of the drug to be unacceptable. Factors such as the cost (approximately $50.00 per dose of etorphine and reversal agent for an equid), the immobilization-treatment-recovery time, and the danger to the animals made immobilization undesirable. We therefore focused on a method for remote delivery of the drug without the intermediate immobilization step (Harder and Peterle 1974), by loading the antifertility agent into a dart to permit administering the MTP directly.

In a trial to establish the feasibility of this approach, 15 feral horse bands in a 64-km^2 area of the Challis Horse Range were located from helicopter. After harem stallions were identified by observing characteristic movement patterns in the band response to the helicopter, remote delivery capability was demonstrated by firing a paint ball from a paint gun (Nelson Paint Company, Iron Mountain, Mich.). Thirteen of the 15 stallions were hit on target in the first pass, and the remaining 2 stallions were marked on a second pass with an average elapsed time of 5.25 minutes from locating a band to hitting the target. Most of this time was used in approach, descent, and maneuvering the horses into a safe path of movement. Usually less than 15 seconds elapsed from the beginning of close pursuit to firing.

A second issue which emerged from the field test was whether to treat males or females. The vast majority of feral horse herds have a single dominant male breeding the harem (Keiper and Houpt 1984), and treating males would be more cost and time efficient. However, it appeared that treatment could be delivered to several horses with relative ease and speed after a band of horses was within firing range. This potentially lessened the time advantage of treating males. Because helicopter time would be the major cost in treatment, the cost advantage may also be minimal. Pursuing remote delivery for female fertility control also offered the potential to increase population management flexibility and permit the possible application of this technology to nonharem species.

Between February 1986 and August 1987 on Assateague Island National Seashore (Maryland), we attempted to determine the antifertility effectiveness of MTP delivered remotely to stallions and of microencapsulated norethisterone (MNET) delivered remotely to mares. MNET is a potent synthetic progestin which has been shown to be a safe and effective extended-action antifertility agent in primates (Beck et al. 1980), acting primarily by blocking ovulation. The microencapsulated form of MNET, prepared by Southern Research Institute (Birmingham, Ala.), was designed to release over a 6-month period from the time of administration (March 1986) through the entire breeding season.

In the male study 4 harem stallions, each with a harem of proven fertility, were treated by remote delivery in February–March 1986. The 14 mares of proven fertility which were associated with the 4 treated stallions exhibited a fertility rate of 28.9% during the foaling season of 1987 (Kirkpatrick and Turner 1987). The foaling rate for a control population of 15 fertile mares for the 1987 season was 45.4%, and the foaling rate for the experimental mares for the previous 5 years ranged from 42% to 50%.

In the MNET study the drug was administered in February–March 1986 by remote delivery to 6 mares of proven fertility. No inhibition of fertility was observed (Kirkpatrick and Turner 1987). The study data did not permit determination of whether the failure was due to the agent, the dose, or the mode of delivery. It appears that the method of delivery was not the cause of failure, because the remote delivery method did work for males. Although progestin-mediated contraception has proven effective in some other species (reviewed, Kirkpatrick and Turner 1985), it may be that protestins are simply ineffective as contraceptive agents in feral mares. Plotka et al. (1988) were unsuccessful in suppressing estrus for longer than 5 weeks in captive feral males with Silastic® implants containing large amounts (24 g) of progesterone.

Valuable information in these Assateague Island studies was derived from technical problems associated with the remote administration of microencapsulated steroid. First, treatment administration occurred during several very cold days (−10 C), such that the increased viscosity of the carboxymethyl cellulose used to suspend the microcapsules sometimes interfered with rapid injection. It was thus necessary to keep the carrier warm prior to delivery. Second, the suspension of microcapsules tended to settle out and clump in the dart if not delivered within 10 minutes of initial mixing. Third, delivery of nonimmobilizing drugs (i.e., no handling of animal) necessitated barbless or micro-barbed darts which would ultimately fall out. Thus, velocity and trajectory had to be regulated carefully to ensure injection without rebound. Fourth, while it was possible to remotely deliver the effective amount of microencapsulated steroid with multiple injections in these studies, this would be unacceptable for routine use. The volume : dose ratio must be reduced sufficiently to permit administration of the complete dosage in a single dart.

If the problem of drug volume can be overcome, there is another remote delivery method which may be promising. R. Goodloe, R. J. Warren, and D. C. Sharp ("Sterilization of feral horses by immunization against LHRH," presentation, Wildl. Dis. Assoc. Conf., Univ. Ga., 7–11 Aug 1988) have successfully delivered antifertility agents to feral horses in a biodegradable bullet fired from a CO_2-powered rifle (Ballistivet, Inc., Minneapolis, Minn.). The hollow 0.25 caliber bullet is made of a compressed food-grade material. Once the bullet is lodged, biodegradation occurs over 24 hours, and the agent is freed for action. Maximum deliverable volume is 0.3 cc.

While the remote delivery dart or bullet methods cannot presently be easily used to administer steroids due to excessive volumes required for available steroids, they may be useful with water-soluble agents which can be delivered at high concentration, lyophilized, or in low volume. Most of the water-soluble reversible contraceptive agents currently being studied are vaccines.

Immunoantifertility

Immunoantifertility currently appears to be 1 of the most promising areas of contraceptive technology. The general principle is that antibodies are raised in the individual against some structural or functional protein or peptide involved in the reproductive process. The presence of the antibodies hinders or prevents some aspect of the reproductive process. Suc-

cessful immunocontraception has been achieved by raising antibodies against (1) gonadotropin releasing hormone (GnRH) in both sexes, (2) spermatozoa, and (3) ovarian zona pellucida. The latter has received the most extensive investigation.

GnRH is a hypothalamic peptide which regulates pituitary gonadotropin release. The gonadotropins, follicle stimulating hormone, and luteinizing hormone (LH), in turn regulate aspects of gonadal function, including gamete production. Thus, reproduction may be inhibited by immunizing an individual against self GnRH, which makes the GnRH unavailable for biological actions. Anti-GnRH has been used successfully to reduce fertility in several species, including pigs (*Sus scrofa*) (Esbenshade and Britt 1985), rats (*Rattus norvegicus*) (Ladd et al. 1988, Ladd et al. 1989), and rabbits (*Oryctolagus cuniculus*) (Ladd et al. 1988). In a study of domestic ewes (*Ovis aries*), Roberts and Reeves (1988) reported that immunization against either LH or a combination of estradiol-ovalbumin and testosterone-ovalbumin resulted in marked reduction of lambing relative to albumin-immunized controls.

Two contraceptive studies using anti-GnRH in the horse have been reported. In 1 study a conjugated form of GnRH was used successfully to raise antibodies in captive feral mares, but contraceptive results were poor (R. Goodloe, R. J. Warren, and D. C. Sharp, 1988, unpubl. presentation). Using a similar approach, Dowsett et al. (1990) suppressed GnRH in colts and reduced testosterone concentrations for up to 20 weeks post-immunization, suggesting contraceptive potential in males.

One major drawback of using antibodies against GnRH, LH, or sex steroids as a means of inducing infertility is that gonadal steroid production or steroid bioavailability will be decreased by these manipulations. Thus, steroid replacement will be required to ensure integrity of both reproductive and social behavior of the population involved.

Immunization of individuals against gametes or gamete proteins has the distinct advantage of avoiding steroid/behavioral effects, and this approach currently appears to be promising for immunocontraception. Antibodies to spermatozoa have been causatively implicated in human infertility (Menge 1980, Bronson et al. 1984). Spermatozoal or testicular extracts used to immunize individuals of several species have been shown to decrease fertility via both pre- and post-fertilization effects (Carron et al. 1988, Edwards 1964, Menge and Naz 1988). Antibodies raised against a recently isolated sperm-specific glycoprotein antigen found in the sperm cell plasma membrane (Naz et al. 1986) have been shown *in vivo* and *in vitro* to inhibit aspects of fertilization in several species (Naz 1988, Menge and Naz 1988, Herr et al. 1990).

In the female, active immunization of several species with porcine zona pellucida (PZP) has been associated with reduced fertility (reviewed, Henderson et al. 1987, Shivers and Liu 1982), and antizona antibodies have blocked *in vitro* fertilization in humans (Sacco et al. 1981). To date, reported side effects of PZP immunization have included some alteration in ovarian follicular growth and function in rabbits (Skinner et al. 1984), monkeys (*Saimiri* sp.) (Sacco et al. 1983), dogs (*Canis familiaris*) (Mahi-Brown et al. 1985), and baboons (*Papio* sp.) (Dunbar et al. 1989), with potential irreversibility reported for dogs. It may be possible to avoid the potential side effect problems of PZP antibodies by using cumulus oophorus matrix antibodies, which are unlikely to react with younger follicles. Rabbit oophorus matrix has been shown to effectively inhibit human fertilization *in vitro* (Tesarik 1989).

It should be noted that many of the initial PZP studies utilized high antigen concentrations for immunization. At lower concentrations side effects may be minimal to nonexistent. This appears to have been the case for PZP immunocontraception in the mare. In a recent study with captive feral and domestic mares, Liu et al. (1989) successfully produced

reversible immunoinfertility by immunization of mares with PZP. Pregnancy was prevented for approximately 8 months in 14 of 15 mares. When antibody titers had decreased to lower levels in 4 monitored mares, they conceived normally.

In a subsequent study of free-roaming feral mares on Assateague Island, Kirkpatrick et al. (1990) determined the effectiveness of remote delivery PZP immunocontraception. Between February and April of 1988, 26 Assateague mares of proven fertility received 2 or 3 inoculations (1 ml each) with PZP vaccine in adjuvant. The treatments were administered remotely via dart rifle as described for the other Assateague studies. Only 1 foal was born to the 26 treated mares, and among untreated control mares there was a 50% pregnancy/foaling rate. Regarding reversibility, 14 of the nonpregnant, PZP-treated mares were given a remotely delivered PZP booster inoculation in February or March 1989. Pregnancy determinations based on urinary steroids (Kirkpatrick et al. 1988) were made in samples collected in the fall of 1989. Results revealed only a 7.2% pregnancy rate in these mares, as compared to a 41.6% pregnancy rate among the 12 PZP-immunized mares which did not receive a booster inoculation (Kirkpatrick et al. 1991). Of 16 mares of similar age never treated with PZP, 43.7% were pregnant in the fall of 1989. These findings demonstrate the reversibility of treatment and the effectiveness of an immunization booster.

POTENTIAL FOR WILDLIFE CONTRACEPTION

From the standpoint of both antifertility agents and delivery techniques, a fair armamentarium for feral horse contraception already exists. The potential for broadened application of contraceptive technology to other wildlife populations has not yet been explored, although contraceptive efficacy has been reported for a number of domestic and captive exotic species (Kirkpatrick and Turner 1985). By carefully assessing the reproductive patterns, behavior, habits, and environment of a given free-roaming species, it may be possible to adapt existing contraceptive technology to assist in the management of some species. In this regard a brief discussion of advantages and disadvantages of currently available technology (Table 1) may be useful.

Major contraceptive agents and procedures have already been presented. However, to summarize, the agents are primarily natural and synthetic sex steroids and immunotropic protein and peptide antigens. The steroids are able to act over extended time periods via structural modifications to the molecule, microencapsulation, or gradual release from Silastic® polymer rods. Although steroids have the advantages of being well researched, biologically active in most vertebrates, and often active orally, they also have several serious disadvantages. Among captive feral mares, placement of Silastic® rod implants containing estradiol and progesterone (Vevea et al. 1987, Plotka et al. 1988) met with limited success in controlling fertility. Although Plotka and Vevea (1990) reported successful inhibition of fertility in captive feral mares given Silastic® rod implants containing ethinylestradiol, the use of such synthetic steroids, which often exhibit poor biodegradability, raises the issue of possible consumption by nontarget species, including humans. This circumstance makes acceptance for registration with regulatory agencies such as the FDA, USDA, and the EPA unlikely.

The use of natural steroids, which are rapidly metabolized, may minimize the biodegradability issue. However, the dosages of these steroids must be relatively large in order to inhibit fertility. This may limit the administration of the agents to surgical implants, which necessitates the undesirable circumstances of capturing and handling the target animals. Thus the potential seems low for the use of steroids for contraception use in free-roaming

Table 1. Current wildlife contraceptive delivery systems, route of administration, agents, and characteristics of potential target species of their use.

Delivery system	Route (I.M. vs. oral)	Agent		Target animal		
		Type[a]	Format[b]	Size (large or small)	Style (secretive or exposed)	Habitat (cover or open)
Capture and chute	IM	S, N, I	SI, E, ILA, V	L	E	C, O
Live trap and restraint	IM	S, N, I	SI, E, ILA, V	L, S	SE	C, O
Immobilizer	IM	S, N, I	SI, E, ILA, V	L	E	O
Remote delivery	IM	S, N, I	SI, E, ILA, V	L	E	O
Bait or food	O	S, N	E, ILA[c]	L, S	SE, E	C, O

[a] Agent type: Steroid (S), Non-steroid chemical (N), Immunological (I).
[b] Agent format: Subdermal implants (SI), Encapsulation (E), Intrinsic long-action (ILA), Vaccination (V).
[c] Steroids only.

wildlife. One exception to this may lie in the use of long-term, nonsurgical subcutaneous (sc) implants of steroids in certain smaller mammals which can easily be live trapped. In a recent study Bickle et al. (1991) successfully inhibited fertility (no litters in 23 treated females) in free-roaming ($n = 4$) and captive ($n = 19$) female skunks (*Mephitis mephitis*) given subcutaneous implants of levonorgestrel (Norplant®), a progestational steroid. The implant was a 2.5 × 30 mm flexible rod inserted sc into the neck via trocar. While the possibility of consumption by nontarget species remains, this issue may be minimized, for example, when treatment is applied to an urban population of skunks, in which predation and scavenging are minimal.

The immunological approach to wildlife contraception appears promising on the basis of the feral equid data demonstrating a high degree of effectiveness and reversibility. Immunocontraceptives have the advantage of high potency for low volume delivery. In addition, they do not have potential for contaminating the environment and do not have behavioral effects. Potential disadvantages also must be considered. For example, immunocontraceptives are not active orally without modification, may require more than 1 inoculation for the initial immunization, and may be variably effective across species. However, with the use of biodegradable polymer coatings it may be possible to provide oral delivery of active vaccine (Saffran et al. 1990). Furthermore, microencapsulation, which permits timed-release of the agent, can potentially eliminate the need for multiple inoculation. The potential side effects of long-term use are unknown, with the extreme possibilities including permanent infertility or escape from the antifertility effect over a period of years.

Assuming the availability of a viable wildlife contraceptive agent, a method of delivery must be chosen. The 2 pathways routinely used for getting chemicals into an animal are oral and intramuscular. In some respects the delivery aspect of wildlife contraception is the most variable and difficult to accomplish because of the wide variety of species and habitats. Put simply, however, the possibilities are "hands-on" or "hands-off." The "hands-on" methods include round-up and capture, live trapping, or chemical immobilizer. Once captured or trapped the animal can be darted, hand-injected, or implanted with the antifertility agent. The viability of the "hands-on" approach will depend on the size, accessibility, and numbers of the targeted species. For example, skunks can readily and safely be live-trapped, and it may be feasible to treat sufficient numbers to eventually limit their population in a given urban area. Access to species such as large ungulates can often be accomplished with chemical immobilizer, and treatment can be made in the field at the immobilization location. However, the already discussed disadvantages

of immobilizer in terms of cost and danger to the animal may well outweigh the on-site "hands-on" advantage, particularly when dealing with large numbers of animals.

In contrast, the "hands-off" methods provide an on-site remote delivery methodology without capture, live trapping, or immobilization. Remote delivery methods include the use of baits and the use of a gun which fires a dart or plastic bullet containing the antifertility agent. The earliest wildlife contraception efforts used baits (Marsh and Howard 1969), and this approach remains potentially viable for many species, especially for small mammals and birds (Kirkpatrick and Turner 1985). Two common disadvantages of baits are the lack of target specificity and poor bait acceptance (Harder and Peterle 1974).

These disadvantages are not shared by remote delivery methods using a projectile fired from a gun. Despite its limited usage to date for contraception, this form of remote delivery has several distinct advantages over "hands-on" methods. Perhaps most importantly it reduces the incidence of harassment, injury, and death in the target animals. In our experience with feral horses remote delivery darting has proven to be a far more cost-efficient and time-efficient method than capture and handling, requiring fewer personnel and equipment by eliminating the capture-immobilization step.

However, there will undoubtedly be circumstances where the delivery method used is dictated by situation, animal characteristics, and habitat. For example, darting of animals from a blind at waterholes may be useful in arid areas, and firing darts from a helicopter may be effective for some large ungulates in open or semi-open terrain. Live trapping and injection or baits may be preferable for some smaller species inhabiting burrows or dense underbrush.

SUMMARY

During the past decade the problem of overpopulation of many wildlife species on preserves of limited area and in urban parks has reached crisis proportions despite existing management efforts. The development of contraceptive technology for free-roaming wildlife may become essential. Using research studies of contraception in free-roaming feral horses as a contextual framework for critical analysis, an evaluation of the potential for wildlife contraception is presented. Topics include species-specific requirements regarding choice of sex, type of agent, and method of delivery. Agent types include steroidal, nonsteroidal, and immunocontraceptives. Considerations of delivery include release characteristics of the agents and capture versus remote delivery. In the continuing development of contraceptive technology for wildlife it is important to address, in addition to efficacy, issues of environmental and animal safety, reversibility, and cost effectiveness.

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Pregnancy determination in uncaptured feral horses based on steroid metabolites in urine-soaked snow and free steroids in feces

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Urine-soaked snow from 13 uncaptured feral mares was collected and measured without extraction for estrone conjugates (E_1C) and nonspecific immunoreactive pregnanediol-3-glucuronide (iPdG) by enzyme immunoassays. The hormone values were indexed to creatinine (Cr). Mares that produced foals had urinary E_1C values of 7.30 ± 1.39 (SE) μg/mg Cr versus 0.096 ± 0.084 μg/mg Cr for mares that did not produce foals. The difference was significant ($P < 0.001$). Nonspecific iPdG concentrations for mares producing foals was 167 ± 80.33 ng/mg Cr versus 7.04 ± 1.69 ng/mg Cr for mares that did not produce foals. The difference was significant ($P < 0.0025$). Urine samples collected directly from the ground from 34 uncaptured feral mares were measured for E_1C and nonspecific progesterone metabolites and compared with fecal total estrogen concentrations in matched fecal samples, measured by means of radioimmunoassay. Both E_1C and iPdG concentrations differed significantly ($P < 0.001$) between mares producing foals and those that did not. Mean fecal total estrogen concentrations for mares producing foals was 3.18 ± 0.70 ng/g feces versus 0.552 ± 0.08 ng/g feces for those that did not produce foals. The difference was significant ($P < 0.001$). The correlation coefficient between urinary E_1C and fecal total estrogens was 0.928. The results indicate that both urine-soaked snow and fecal samples can be used to reliably assess pregnancy in uncaptured free-roaming feral horses.

KIRKPATRICK, J. F., SHIDELER, S. E., et TURNER, J. W., JR. 1990. Pregnancy determination in uncaptured feral horses based on steroid metabolites in urine-soaked snow and free steroids in feces. Can. J. Zool. **68** : 2576–2579.

De la neige imbibée d'urine de 13 juments sauvages en liberté a été recueillie et les concentrations de composés d'estrone (E_1C) et de prégnanediol-3-glucuronide immunoréactif non spécifique (iPdG) y ont été mesurées, sans extraction, par des tests immunologiques enzymatiques. Les concentrations hormonales ont été déterminées relativement à la créatinine (Cr). Les juments qui avaient un poulain avaient des concentrations urinaires d'E_1C de 7,30 ± 1,39 (SE) μg/mg Cr, comparativement à 0,096 ± 0,084 μg/mg chez les juments sans poulain. La différence était significative ($P < 0,001$). La concentration d'iPdG non spécifique était de 167 ± 80,33 ng/mg Cr chez les juments avec petit et de 7,04 ± 1,69 ng/mg Cr chez les juments sans petit. La différence était significative ($P < 0,0025$). Des échantillons d'urine de 34 juments sauvages en liberté ont été recueillis directement du sol et soumis à des analyses afin de mesurer les concentrations d'E_1C et des métabolites non spécifiques de la progestérone (Po); ces concentrations ont été comparées aux concentrations totales d'oestrogènes dans des échantillons correspondants de matières fécales soumis à des tests radioimmunologiques. Les concentrations d'E_1C et d'iPdG différaient toutes deux significativement ($P < 0,001$) chez les juments avec petit et chez les juments sans petit. Les concentrations totales moyennes d'oestrogène dans les matières fécales des juments avec petit, 3,18 ± 0,70 ng/g fèces, différaient significativement ($P < 0,001$) des concentrations observées chez les juments sans petit, 0,552 ± 0,08 ng/g fèces. Le coefficient de corrélation entre la concentration urinaire d'E_1C et la concentration totale d'oestrogène fécal a été évalué à 0,928. Les résultats indiquent que la neige imbibée d'urine et les échantillons de matières fécales peuvent servir à déceler efficacement la grossesse chez des juments sauvages en liberté.

Introduction

The ability to determine pregnancy in uncaptured wild animals is a useful tool for the wildlife biologist. Kirkpatrick et al. (1988) demonstrated that pregnancy could be determined in uncaptured feral mares by recovering urine from soil and measuring estrone sulfate (E_1S), a conjugated metabolite of plasma estrone in horses. The method is accurate, but procedures for extracting urine from the soil are often time-consuming and certain types of soils have the potential to interfere with hormone or creatinine assays. Two strategies for simplifying noncapture pregnancy testing in free-roaming animals are to measure reproductive hormones in either urine-soaked snow or fecal samples. DelGiudice et al. (1988, 1989) and Mech et al. (1987) were able to measure winter condition in white-tailed deer and wolves, respectively, by measuring certain electrolytes, urine nitrogen, and creatinine in urine-soaked snow; however, the sensitivity of these tests is significantly less than that required for steroid hormone analysis. This study was carried out to determine if pregnancy could be diagnosed in feral horses by measuring steroids or their metabolites in feces and urine-soaked snow. Two experiments were carried out. Estrone conjugate (E_1C) and nonspecific immunoreactive pregnanediol-3-glucuronide (iPdG) concentrations were measured in urine-soaked snow, indexed to creatinine (Cr), and compared between mares that produced foals and those that did not. In a second experiment, fecal total estrogens were measured and compared with urinary E_1C and iPdG concentrations in pregnant and nonpregnant mares.

Methods

Urine-soaked snow samples were collected from 13 sexually mature feral mares on the Pryor Mountain National Wild Horse Range,

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Montana, in December. Each horse was identified by means of specific markings and observed at 100–200 m until urination occurred. Urine-soaked snow was scraped from the site with a plastic spoon, taking care to recover only stained snow, and placed in a 20-mL glass vial, allowed to thaw, and stored frozen at −5°C until assay. Urine samples, collected directly from the ground, and matched fecal samples were collected from 34 sexually mature mares on Assateague Island National Seashore, Maryland, in October. The urine samples were collected and stored as described by Kirkpatrick et al. (1988); the fecal samples were placed in plastic bags, sealed, and stored at −5°C until assayed.

The urine samples collected from snow were assayed by enzyme immunoassay (EIA) for the estrone conjugates (E_1C) estrone-3-glucuronate and estrone-3-sulfate as described by Munro et al. (1989). Each sample was diluted 1:100 in distilled H_2O and 20 μL was taken to assay. The antibody (R522) has equal cross-reactivity for both the glucuronate and sulfate conjugates of estrone. The inter- and intra-assay coefficients of variation were 13% ($n = 10$) and 10% ($n = 15$), respectively. The assay for urinary iPdG was described by Shideler et al. (1990) and Kirkpatrick et al. (1990). Samples were diluted 1:1 and 20 μL was taken to assay. The inter- and intra-assay coefficients of variation were 11:45% ($n = 10$) and 10.04% ($n = 15$), respectively. To account for differences in urine concentration and dilution caused by mixing with snow, each sample was analyzed for creatinine by the microcolorimetric method of Taussky (1954). E_1C values are given as micrograms per milligram of creatinine and iPdG values as nanograms per milligram of creatinine. The 13 mares were located and identified during the following summer and observed for the presence of foals. The specificity of the assays was previously validated by high-performance liquid chromatography (Kirkpatrick et al. 1990). In addition, dilutions of 1:2, 1:4, 1:8, and 1:16 were assayed and compared for parallelism with the standard curve.

The urine samples from the 34 Assateague Island mares, collected from the ground, were assayed for E_1C and nonspecific iPdG immunoreactivity as described earlier. Matched fecal samples were assayed for total free estrogens. Each 0.5-g sample was placed in a glass scintillation vial and approximately 1000 cpm (16.7 Bg) of ^{3}H-17β estradiol (17β-E_2) (New England Nuclear) in 20 μL of water was added to assess procedural losses. Each sample was extracted with 11 mL of chromatography-grade ethyl acetate – hexane (3:2, v/v) on a reciprocal shaker for 5–12 h. Eight millilitres of the organic phase was transferred to 13 × 100 mm glass tubes and dried at 37°C under N_2. The residue was suspended in 1.0 mL of assay buffer, vortexed briefly, and incubated for 12 h to place into solution as much of the extracted estrogens as possible. To assess procedural losses, 0.5 mL of assay buffer was transferred to scintillation vials and counted in 10 mL of cocktail (Aquasol, New England Nuclear). The remaining 0.5 mL was assayed for total estrogens by I^{125} RIA, using an anti total estrogen antibody (ICN Biomedical, Carson, California) and ^{3}H-estradiol (^{3}H-E_2) as the standard. Cross-reactivity of the antibody with estrogens was 100% for 17β-estradiol (17∂-E_2) and estrone, 9.0% for estriol, and 7.0% for 17∂-E_2. All other steroids, including androgens, progestins, and corticosteroids, cross-reacted at <0.01%. The coefficient of variation for intra-assay precision was 5.7% and recovery was 62.18 ± 6.45 (SE) %. Results are presented in nanograms of total estrogens per gram of feces. Confirmation of pregnancy was accomplished by foal counts. Mean values for hormone concentrations were compared for statistical significance with Student's *t*-test.

Results

Five of the 13 Pryor Mountain mares (38%) produced foals in 1989. These five mares had E_1C concentrations ranging from 2.71 to 10.57 μg/mg Cr, with a mean of 7.3 ± 1.39 (SE). The eight mares that did not foal had E_1C concentrations ranging from nondetectable to 0.68 μg/mg Cr, with a mean of 0.096 ± 0.084. The difference between mean E_1C concentrations for mares that produced foals and those without was significant at the $P < 0.001$ level of confidence. Mares with foals had iPdG concentrations ranging from 47.27 to 469.23 ng/mg Cr, with a mean of 167 ± 80.33. Those without foals had concentrations ranging from 1.23 to 16.81 ng/mg Cr, with a mean of 7.04 ± 1.69. The difference between mean nonspecific concentrations for mares that produced foals and those that did not was significant at the $P < 0.025$ level of confidence. Creatinine values for the 13 horses ranged from 0.11 to 0.814 mg/mL, with a mean of 0.321 ± 0.063. All urine-soaked snow samples were collected 180–200 days postconception.

Twenty-eight of the 34 Assateague mares did not deliver foals and had a mean urinary E_1C concentration of 0.11 ± 0.034 μg/mg Cr, compared with 3.47 ± 0.735 μg/mg Cr for the 6 mares that did produce foals. The difference was significant at the $P < 0.001$ level of confidence. The 28 mares that did not produce foals had a mean iPdG concentration of 3.6 ± 0.499 ng/mg Cr, which differed significantly ($P < 0.001$) from mean concentrations for the 6 mares that did produce foals (215.8 ± 83.4 ng/mg Cr). The mean fecal total estrogens for the 28 nonpregnant mares was 0.552 ± 0.08 ng/g feces and differed significantly ($P < 0.001$) from a mean value of 3.18 ± 0.70 ng/g feces for the 6 pregnant mares. The coefficient correlation (r) between urinary E_1C and fecal total estrogens was 0.928. All urine and fecal samples from Assateague Island were collected approximately 120–180 days postconception.

Discussion

These data indicate that pregnant mares can be distinguished from nonpregnant animals by measuring either E_1C or iPdG in urine-soaked snow, or by measuring fecal total estrogens. The Cr levels in samples collected from urine-soaked snow were similar to those reported for urine collected directly from domestic horses with catheters (Evans et al. 1984) or in samples of soil soaked with urine from feral horses (Kirkpatrick et al. 1988), and indicate that dilution by snow is not great, nor does it interfere with the hormone assays. The water content of snow may vary from sample to sample, but indexing hormone values to Cr concentrations will account for these differences, as well as for differences in urine concentration. E_1C values, measured by enzyme immunoassay (EIA), were also similar to E_1S values for pregnant and nonpregnant horses reported previously but measured by RIA (Kirkpatrick et al. 1988; Evans et al. 1984), and dilutions demonstrated parallelism with the standard curve.

Among the Assateague horses, urinary E_1C, iPdG, and fecal total estrogens were all reliable indicators of pregnancy in this study, and the strong correlation between urinary E_1C and fecal total estrogens supports the use of fecal samples for pregnancy diagnosis. In mammals, estrogens and other steroids are metabolized in the liver, conjugated with sulfates and glucuronates, and secreted into the gastrointestinal tract via bile. Some steroid hormones reach the gastrointestinal tract without change in structure or solubility. In a species-dependent manner some steroids are excreted directly with the feces, while a portion of their conjugates is resorbed into the blood and excreted in the urine or returned to the bile. It is the urinary pathway of steroid excretion that formed the rationale for the urinary estrogen and progestin conjugate analyses that have been used successfully in zoo biology (Loskutoff et al. 1983). The fecal steroids, however, add an important new dimension to the study of reproduction and problems of wildlife biology, where urine collection can be difficult.

It is important to note that all fecal samples in this study were collected 120–180 days postconception. Mostl et al. (1984) and Bamberg et al. (1984) have demonstrated a time-dependent

increase in fecal estrogens in pregnant domestic cows and mares, with discriminating values occurring at about 90 days. Thus, one limitation of the fecal approach is inability to determine pregnancy early in gestation. Urinary E_1C, however, can be used with a high degree of accuracy after day 40 of pregnancy in mares (Evans et al. 1984).

The difference between fecal estrogen values reported in this paper (ranging from 0.30 to 5.82 ng/g) and those in the study by Bamberg et al. (1984), which were in the 100–300 ng/g range, cannot be easily explained, but two factors probably contributed. First, significantly different antibodies were utilized in the two studies. Mostl et al. (1983) demonstrated that in pregnant cows, the concentration of 17∂-E_2 is 10× that of other estrogens, but this is not true for horses. The antibody used by Mostl et al. had a 30% cross-reactivity with this biologically weak estrogen, and therefore obviously binds with a number of other steroids. This lack of specificity is not important, however, because the cow excretes primarily 17∂-E_2. In contrast, the horse, which secretes very little 17∂-E_2, produces estrogens that are either more immunoreactive or in significantly larger quantities that those found in the cow. The precise nature of the immunoreactive fecal estrogens remains to be demonstrated. Secondly, the differences in values between the two studies might be attributed to the extraction methods used. Initial attempts to extract estrogens using the methods of Mostl et al. (1984) met with little success, and seldom recovered more than 15–20% of ^{3}H-E_2. Consequently, the ethyl acetate – hexane extraction method, which is widely used for extracting estrogens and which recovered in excess of 60%, was used. Why the extraction methods and recovery success of Mostl et al. (1984) could not be reproduced and why the difference in extraction methods reported in this study should lead to such significant differences in free steroid values remain unexplained. Thus, care must be taken to avoid generalizations regarding quantitative evaluations with nonquantitative, nonspecific assays, despite success in differentiating pregnant from nonpregnant animals.

The differences in iPdG values between the pregnant and nonpregnant horses were significant; however, using this metabolite alone appears to be less reliable than using E_1C. The highest value in a nonpregnant animal was 16.81 ng/mg Cr, compared with the lowest value in pregnancy of 47.27 ng/mg Cr. This relatively small difference probably reflects either the relativity low plasma progesterone concentrations in the horse, particularly in the second half of pregnancy, or the ability of this assay to detect the metabolites of the 5-α reduced progestins which are found during the second half of gestation in the horse. Progesterone concentrations reach a peak of about 15 ng/mL plasma between days 60 and 120 postconception (Holtan et al. 1975), then decline to low concentrations. In contrast, extremely high plasma estrone concentrations occur during the same period of pregnancy in the horse, persist, and reach levels as high as 160 ng/mL (Cox 1975).

The use of iPdG alone could be confounded by the presence of a persistent corpus luteum, which can produce plasma progesterone values as high as those found during pregnancy (Stabenfeldt et al. 1974). Thus, iPdG should be measured only along with E_1C for pregnancy determination. Nevertheless, iPdG can be measured in urine-soaked snow or in soil and values will reflect plasma progesterone concentrations and ovarian activity.

There are advantages and disadvantages to the use of either feces or urine for pregnancy diagnosis in feral mares, and the method selected must be matched to the field conditions and the resources of the investigator. Urinary estrogen conjugate analysis provides a method that requires no extraction and can be applied as early as 40 days postconception. The enzyme immunoassays are inexpensive (about $0.05/assay) and accurate but the antibodies and conjugates are not commercially available. Also, collection of urine samples requires a significant investment of time. Collection of fecal samples is easy, requires about one-fourth of the time taken to collect urine samples, and the assays are commercially available. Extraction is necessary, however, and assays cost in excess of $1.00/sample.

Although this study was confined to feral horses, applications to the study of many free-roaming species can be pursued with this methodology. These applications include the determination of fetal loss rates, and of foaling, calving, and fawning rates where neonatal mortality might obscure true rates. An important consideration in designing experiments of this nature is that each species has its own particular metabolic end-products and pathways of excretion for reproductive steroids. Assays must be selected with care and validated for each species. Nevertheless, extension of this strategy to field studies is a logical and potentially valuable next step.

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Reference # 4

Pregnancy Determination in Uncaptured Feral Horses

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Journal of Wildlife Management 52(2):305-308, 1988

Abstract

The urinary excretion of estrone sulfate (E_1S) by 25 free-roaming feral horses (*Equus caballus*) was measured by radioimmunoassay applied to extracts of urine-soaked soil. Twelve of 15 mares have E_1S concentrations > 1.0 μg/mg creatinine ($\bar{x}$ = 2.64 ± 1.02 [SD]) produced foals. All 10 mares with E_1S concentrations < 1.0 μg/mg creatinine ($\bar{x}$ = 0.44 ± 0.26) did not foal. Extracting urine from soil and measuring E_1S and creatinine can be used to determine pregnancy in free-roaming feral horses without the stress of capture or immobilization.

Reference # 5

Pregnancy Determination in Uncaptured Feral Horses by Means of Fecal Steroid Conjugates

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Abstract

This study was carried out to develop an accurate, rapid and inexpensive method for diagnosing pregnancy in uncaptured feral horses by analysis of fecal steroid metabolites and to compare the accuracy of this method with diagnosis by urinary estrone conjugates (E_1C). Paired urine and fecal samples were collected from 40 sexually mature feral mares during August and October. Urine samples were extracted directly from the soil and analyzed by enzymeimmunoassay (EIA) for E_1C. Water extracts of fecal samples were assayed by EIA for E_1C. Water extracts of fecal samples were assayed by EIA for E_1C and nonspecific progesterone metabolites (iPdG). Urinary E_1C, fecal E_1C and fecal iPdG concentrations for seven mares which produced foals were 3.9 ± 1.3 (SEM) 5 μg/mg creatinine, 4.2 ± 0.8 ng/g feces and 1.411 ± 569.6 ng/g feces, respectively. Urinary E_1C and fecal E_1C and iPdG concentrations for the 33 mares which did not produce foals were 0.1 ± 0.0 μg/mg creatinine and 0.5 ± 0.1 and 32.8 ± 4.5 ng/g feces, respectively. These differed ($P < 0.01$) from values in mares which produced foals.

EXCERPT FROM A LETTER SENT BY JAY KIRKPATRICK, WHILE HE WAS WORKING ON ASSATEAGUE ISLAND, TO HIS PARTNER IN RESEARCH, JOHN TURNER. — MARCH 1991

I WAS UP ON THE NORTH END YESTERDAY, ONLY A COUPLE OF HUNDRED FEET FROM THE BASE OF THE JETTY AND I FOUND THE CARCASS OF AN OLD FRIEND OF OURS. IT WAS M4. SHE WAS TWENTY AND JACK TOLD ME SHE DIED IN DECEMBER. SHE WAS STILL PRETTY MUCH INTACT AND I COULD MAKE OUT HER WHITE SOCKS AND THE STAR ON HER FOREHEAD. THERE WERE TWO SMALL DEPRESSIONS IN THE SAND WHERE SHE HAD PAWED VAINLY AFTER GOING DOWN, BUT THE DEPRESSIONS WERE SHALLOW AND I DON'T THINK [redacted] SHE SUFFERED LONG. SHE WAS ONE OF OUR ORIGINAL TREATED MARES, JOHN, AND I KNOW SHE WAS AS SPECIAL TO YOU AS TO ME. I BRIEFLY LAID MY HANDS ON HER NECK - TOUCHED HER - SOMETHING NO MAN HAD DONE DURING HER TWENTY YEARS. SHE DIED LESS THAN A MILE FROM WHERE SHE HAD BEEN BORN. SHE HAD NEVER BEEN CAPTURED, ROUNDED UP, IMMOBILIZED, OR OTHERWISE HARASSED, OUR DARTS NOTWITHSTANDING. M4 WAS BORN WILD, LIVED FREE AND PERMITTED THE DIGNITY TO DIE WHERE SHE HAD LIVED. WE ARE SCIENTISTS BUT MY EMOTIONAL HALF MOURNED HER LOSS. FOR A FEW MOMENTS I LOST SIGHT OF THE FACT THAT I SHOULD HAVE BEEN CELEBRATING HER LIFE AND NOT MOURNING HER DEATH. I ALMOST LOST SIGHT OF THE TRIBUTE THAT HER LIFE - AND DEATH - REPRESENTED TO THE PARK SERVICE OFFICIALS WHO ELECTED TO FIND A HUMANE SOLUTION. I ALMOST MISSED THE WHOLE PICTURE.