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Attorneys for Plaintiffs

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF MONTANA, MISSOULA DIVISION

INLAND EMPIRE PUBLIC LANDS COUNCIL, a non-profit corporation; MONTANA WILDERNESS ASSOCIATION, a non-profit corporation; ECOLOGY CENTER, a non-profit corporation; AMERICAN WILDLANDS, a non-profit corporation; and CABINET RESOURCE GROUP, a non-profit corporation, Plaintiffs, v. U. S. FOREST SERVICE, an agency of the United States, Defendants.	Civil No. CV 94-108-M-CCL DECLARATION OF L. SCOTT MILLS IN SUPPORT OF PLAINTIFFS' MOTION FOR SUMMARY JUDGMENT AND PERMANENT INJUNCTION

I, L. SCOTT MILLS, declare as follows:

1. My name is L. Scott Mills. I am currently a Visiting Assistant Professor in the Department of Fisheries and Wildlife at the University of Idaho. I hold a B.S in Zoology from North Carolina State University, an M.S. in Wildlife Ecology from Utah State University and a Ph.D. in Biology from the University of California. A true and correct copy of my curriculum vitae is attached as Exhibit A hereto. I offer this declaration in support of plaintiffs' motion for summary judgment and permanent injunction. The matters set forth herein are stated upon my personal knowledge and if called upon to testify, I could and would testify competently as to them.

2. My specialty is population ecology, in particular the dynamics of forest fragmentation and its effects on the persistence of wildlife populations. I have taught graduate classes on the process of conducting Population Viability Analyses ("PVA"), and on principles related to the connectivity and persistence of populations distributed across a landscape. I also have published articles on population viability in leading peer-reviewed scientific journals, with my most recent article addressing extinctions in isolated populations that are subject to inbreeding depression and random variation. I have another article in press addressing edge effects and isolation in forest remnants.

3. I have reviewed the Biological Assessment prepared by the Forest Service in support of the Upper Sunday Timber Sales

Final Environmental Impact Statement ("FEIS"). I also have reviewed the declaration submitted by Dr. Sara Jane Johnson in connection with this case. In the following discussion, I do not address the specific predictions made by the FEIS regarding particular sensitive species. Rather, I explain why the approach used by the Forest Service is inadequate for determining the viability of any of the populations that the Biological Assessment considers. For the reasons explained in detail below, it is my opinion that the assessment of impacts in the FEIS cannot possibly lead to predictions of viability because it does not explicitly consider the sets of factors most important in determining population viability.

4. As a first principle, it is important to note that the viability of a population hinges not on the existence of the population in the present, but rather on the persistence of the population into the future. The Biological Assessment for the Upper Sunday FEIS addresses viability only on the basis of whether there presently is suitable habitat for the species in the project area. Although the term "viable" is used several times in that document, those references relate specifically to <u>habitat characteristics</u>, not <u>population dynamics</u>. <u>See</u> <u>e.g.</u>, Biological Assessment at 27 ("The proposed action will retain sufficient amount and distribution of [boreal owl] nesting habitat to maintain viable territories"). The mere availability of suitable habitat within the artificial boundaries of the project area does not provide a scientifically sound basis for

determining population viability, which must measured against the yardstick of persistence over time.

5. Ecological theory, supported by laboratory experiments and field observations, has established several factors as critical to the consideration of long-term population persistence. Leading among these factors are three: the growth rate of the population, the size of the population, and the connectivity of the population with surrounding populations of the same species. I will consider each of these three factors in turn.

6. Population growth rate. Impacts that influence long-term population growth are perhaps the most important factor affecting persistence. A population can be negatively impacted by habitat loss, introduced predators, or overharvest and will not persist if these damaging effects continue unabated. In addition to direct effects, lowering demographic vital rates (survival and fecundity), there are indirect effects. For example, as a population declines, there may exist a threshold size below which population decline is accelerated. These "Allee effects" can result from both social and behavioral phenomena, such as the inability of a female to find a mate or a breakdown in social structure when population size is reduced. Also, genetic damage can occur. Because the deleterious "deterministic" effects caused by habitat disruption have a known outcome of population decline and may adversely affect long-term persistence, we can say with a high degree of certainty that some

estimate of population growth rate, or at least discussion of factors that may negatively alter population growth, should be an integral part of a viability analysis.

7. Population size. Population size is the second critical consideration in a viability analysis because, quite simply, larger populations will take longer to decline to dangerously small numbers. Importantly, assessment of population size is critical for another reason: Even those populations whose demography and life history indicate a positive growth rate are not immune to extinction, due to the operation of stochastic (random) factors whose effects are often population size-dependent. Three types of stochastic or "randomly-acting" factors are generally recognized:

a. The first stochastic factor, demographic stochasticity, is simple sampling error. For example, all individuals in a small population may, by chance, die in a certain year. Another example is that in a given year all offspring might be males, thereby eliminating reproduction. Demographic stochasticity can cause populations with a positive intrinsic growth rate to fluctuate to extinction, although that possibility is usually not a concern after a population exceeds about 100 individuals. The other two stochastic factors, however, can cause extinctions of larger populations, even those with a positive intrinsic growth rate.

b. Genetic stochasticity arises from random sampling of the genome (set of chromosomes) that occurs in the mating of animals. It is otherwise known as genetic drift, or inbreeding depression in a finite population. Because inbreeding can lead to increased expression of deleterious recessive genes, and therefore a reduction in fitness, populations with a higher inbreeding coefficient may have decreased demographic vital rates leading to a higher chance of decline to extinction. Although different populations will vary in their susceptibility to inbreeding depression according to their historical breeding structure and natural selection, a vast literature indicates that inbreeding depression will be a problem in many isolated populations. Inbreeding depression may be minimized or eliminated by large population size or gene flow from other populations.

c. The last type of stochastic variation is environmental stochasticity. It arises from random variation in all of the processes that affect populations, including changes in the weather, predation, etc. Particularly hot summers and winters of high snowfall are but two examples. Because environmental stochasticity has the potential to affect the whole population, even quite large population sizes may not be sufficient to escape the random "push" to extinction. This is particularly true for extreme environmental events, often termed "catastrophes," that can eliminate all individuals of even a quite large population. Indeed, it is widely accepted that in the real world, the only way to truly minimize extinction due to environmental variation is to maintain multiple populations linked by movement or gene flow.

8. Linkages to other populations. Both genetic and environmental stochasticity lead population biologists to an examination of the third vital factor that was ignored in the Upper Sunday viability analysis: potential linkages with other populations outside of the harvest area. Immigrants into a population have three critical roles. First, they can boost a flagging local population, moving it away from the absorbing boundary of extinction (the so-called "rescue effect"). Second, they can provide new genetic material that minimizes the accumulation of an inbreeding coefficient in the local population. Third, they can provide the raw material for recolonization if stochastic factors do cause local extinction.

9. In conducting a viability assessment, it is not sufficient to merely state, as the Upper Sunday FEIS and Biological Assessment do, that there are available corridors between populations which might be used by certain species. Rather, viability analysis for a local population should take into account the dynamics of other populations; that is, whether they are growing or declining and whether they are likely to contribute individuals to the local population. If neighboring populations are suffering due to habitat fragmentation or other factors, they cannot be counted on to provide any benefit to the local population. This fact serves to remind us that political boundaries or lines on a map are of little consequence to

wildlife, and that population viability can only be considered in that light. Thus, at the heart of viability analysis for any local population is consideration of cumulative effects on, and the status of, nearby populations.

10. It should be noted, moveover, that the extinction factors described above do not operate independently. The term "extinction vortex" has been coined to describe the fact that populations become increasingly prone to extinction at smaller sizes due to the interplay between all factors. For example, a population that is buffeted by a negative environmental event then becomes more susceptible to inbreeding depression, which reduces vital rates and makes Allee effects more probable. These effects can quickly bring a population into a range where demographic stochasticity can cause the blinking out of the population.

11. In sum, populations with negative growth rates present the most obvious cases of concern. However, the ubiquitous action of stochastic factors causes all populations, even positively growing ones, to have a non-zero probability of "bouncing" to extinction. The key to viability is maintenance of a large enough population size, in combination with sufficient interconnectedness with other populations, so that the chance of random bounce to extinction is minimized.

12. These considerations suggest that population viability can best be assessed through use of a comprehensive PVA computer model that incorporates population-specific demography and life

history information. Unfortunately, the data required to properly parameterize such a model are not always available. For those situations, there are a number of alternative approaches and rules of thumb that can be used with whatever data are available. At an absolute minimum, factors that could negatively impact a population should be identified and examined in light of the critical factors that affect extinction, including, most significantly, population growth, size, and connectivity to other populations. Merely noting or tallying the availability of habitat and/or potential migration corridors does not present a credible case either for or against the viability of a population.

I declare under penalty of perjury that the foregoing is true and correct. Executed this 31 day of October, 1994 in Moscow, Idaho.

L. Scott Mills

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EDUCATION

- **PhD.**, Biology July 1993
  University of California, Santa Cruz.
  Dissertation Title: Extinctions in habitat remnants: Proximate mechanisms and biogeographic consequences.
- **M.S.**, Wildlife Ecology July 1987
  Utah State University, Logan
  Thesis Title: The effect of prey abundance on coyote movement patterns.
- **B. S.**, Zoology May 1983
  North Carolina State University, Raleigh

PRESENT POSITION Aug. 1993-Present

Fisheries & Wildlife Department, University of Idaho.
VISITING ASSISTANT PROFESSOR/Post-Doc Fellow (Sabattical replacement for 9 months; currently continuing on research contracts). Fall semester I taught a Senior level Population Ecology course; spring semester I taught graduate courses in "Metapopulation Theory" and "Viability Analysis"; also advised graduate and undergraduate students. Currently I am working through contracts for the U.S. Forest Service and Idaho Fish & Game; projects involve using ɔpulation Viability models to assess reintroduction efforts in ɘneral, and the particular case of endangered caribou populations.

PREVIOUS RESEARCH EXPERIENCE

University of California, Berkeley Oct. 1992-June 1993
PROJECT LEADER
Research involved mark-recapture work (including supervision of 3 field assistants) and modelling to develop a long-term viability plan for the endangered Fresno kangaroo rat, including habitat restoration and maintenance recommendations to the land-use agency administering the remaining habitat.

University of California, Santa Cruz Oct. 1989-July 1993
GRADUATE RESEARCH ASSISTANT
My dissertation research involved field experiments to examine ecological and genetic effects of forest fragmentation on wildlife species in the Pacific Northwest.

Olympic National Park, WA May-Sept. 1989 and Feb.-Aug.1988
LEAD BIOLOGICAL TECHNICIAN AND SUPERVISOR
Established the research plan for a major project assessing habitat preferences of northern spotted owls in the backcountry of the Park. Six field assistants were supervised over two years in work ranging from vegetation sampling to owl calling surveys.

National Wildlife Federation, Washington, D.C. July-Dec. 1988
CONSERVATION INTERN, Fisheries and Wildlife Division
Responsibilities ranged from investigation of effects of acid rain on waterfowl to researching the basis for an NWF position on Federally Listing the northern spotted owl.

Utah State University Sept. 1984-June 1987
GRADUATE RESEARCH ASSISTANT, Dept. of Fisheries and Wildlife
Field work included radio-telemetry of coyotes and jackrabbits, small mammal trapping, and coyote abundance measures (see publications). Six field assistants supervised over 2 years.

Utah State University Summer 1984
FIELD ASSISTANT, Predator Ecology and Behavior Unit
Participated in a black-tailed jackrabbit study which emphasized radio-tracking and nighttime capture of jackrabbits.

University of Idaho Summer 1983
FIELD ASSISTANT, Dept. of Zoology
Pronghorn antelope play behavior was studied using focal animal sampling.

Olympic National Park Summer 1982
WILDLIFE TECHNICIAN, Natural Science Studies Division
Mountain goat research and management through the Student Conservation Program; duties included backcountry sampling and marking of mountain goats.

TEACHING EXPERIENCE

Taught as Visiting Assistant Professor, Univ. of Idaho (1993/94):
- -- Undergraduate: **Population Ecology for Wildlife and Fisheries** (55 students; 3 lectures and 2 Labs per week).
- -- Graduate Seminar: **Readings in Metapopulation Theory**
- -- Graduate Seminar: **Population Viability Analysis and the Real World.**
- -- Directed Study: **Monitoring Biotic Responses to Habitat Perturbations.**

Teaching Assistantships:
- Winter Quarter 1991, Winter Quarter 1992 - **Vertebrate Biology Laboratory** (UCSC).
- Fall Quarter 1990 - **Global Ecosystems** (UCSC).
- Fall Semester 1988 - **Conservation Biology** (U. Mich.).
- Fall Semester 1985 and Fall Semester 1985 - **Introduction to Natural Resources** (Utah State University).

Invited Guest Lectures in Classes (Class name given in bold):
- October 1993 - **Wildlife Habitat Assessment** (UI).
- March 1993 - **Biology for Non-Majors** (UCSC).
- December 1992 - **Population Biology** (UCSC).
- November 1992 - **History of Ecology** (UCSC).
- Feb. 1991 - **Mammalogy** (UCSC).
- March 1991 - **Biology and Ecology of Vertebrates** (UCSC).
- March 1990 - **Wildlife Conservation** (UCSC).
- April 1990 - **Issues in National Parks Management** (UCSC).
- November 1989 - **Conservation Biology** (Univ. of Michigan).

PUBLICATIONS

Journal Articles:

Mills, L.S. and F.F. Knowlton. 1989. Observer performance in known and blind radio-telemetry accuracy tests. Journal of Wildlife Management. 52:340-342.

Mills, L.S. and F.F. Knowlton. 1991. Coyote space use in relation to prey abundance. Canadian Journal of Zoology 69:1516-1521.

Mills, L.S., M.S. Soulé, and D.F. Doak. 1993. The keystone species concept in ecology and conservation. Bioscience 43:219-224.

Mills, L.S., R.J. Fredrickson, B.B. Moorhead. 1993. Characteristics of old-growth forests associated with northern spotted owls in Olympic National Park. Journal of Wildlife Management 57:315-321.

Doak, D. and L. S. Mills. 1994. A useful role for theory in conservation. Ecology 75:615-626.

Tallmon, D. A., and L. S. Mills. 1994. Log use and home ranges of California red-backed voles on a forest remnant. Journal of Mammalogy 75:97-101.

Mills, L. S. and P. E. Smouse. 1994. Demographic consequences of inbreeding in remnant populations. American Naturalist 144:412-431.

Mills, L. S. IN PRESS. Edge effects and isolation: Red-backed voles on forest remnants. Conservation Biology.

Scott, J.M., T. Tear, and L. S. Mills. IN PRESS. Socioeconomics and the recovery of endangered species: Biological assessments in a political world. Conservation Biology.

Clarkson, D. A., and L. S. Mills. IN PRESS. Ecological factors associated with hypogeous sporocarps in fragmented forests. Northwest Science.

Book Articles:

Mills, L. S. IN PRESS. Keystone Species. **INVITED ARTICLE FOR:** Nierenberg, W. A., editor. Encyclopedia of Environmental Biology. Academic Press.

Mills, L. S. IN PRESS. Keystone Species. **INVITED ARTICLE FOR:** Paehlke, R., editor. Encyclopedia of Conservation and Environmentalism. Garland Publishing Co., New York.

Soulé, M.E., and L.S. Mills. 1992. Conservation genetics and conservation biology: a troubled marriage. Pages 55-69 in Sandlund, O.T., K. Hindar, and A.D.H. Brown (eds), Conservation of Biodiversity for Sustainable Development.

Other Publications:

Mills, L.S., R.J. Fredrickson, B.B. Moorhead, and D.U. Sharp. 1988. Spotted owl distribution along elevation and vegetation gradients in Olympic National Park. 1988 Progress Report. Olympic National Park, Port Angeles, WA.

Fredrickson, R.J., L.S. Mills, and B.B. Moorhead. 1989. Spotted owl surveys in Olympic National Park -- 1988 and 1989. Olympic National Park, Port Angeles, WA.

Mills, L. S. and M. Morrison. 1993. Final Report: Ecology of the Fresno Kangaroo Rat and associated small mammals at NAS Lemoore. Prepared for Lemoore Naval Air Station.

Mills, L. S. 1994. Effects of forest fragmentation on small mammals in Southwest Oregon. COPE Report [(Coastal Oregon Productivity Enhancement Program), an educational non-technical publication for forest managers.] 7:6-8.

Cassidy, K., E. O. Garton, W. B. Krohn, L. S. Mills, J. M. Scott, and K. Williams. 1994. National guidelines for assessment of reliability of GAP vertebrate distributions. National Biological Survey.

Publications Submitted/In Preparation:

Mills, L. S. Sex ratios in wildlife translocations.

Mills, L. S., Hayes, S., and 5 others. A comparison of several population viability models: Grizzly bears as a case study.

Mills, L. S. Isolation of fragmented natural communities: a case study of small mammals in forest remnants.

Mills, L. S. Book Review: Principles of Conservation Biology.

PROFESSIONAL PRESENTATIONS

Mills, L. S. 1993. Inbreeding in habitat remnants: Does it matter? Society for Conservation Biology Meetings, Tempe, AZ. *** received 2nd place for best graduate student paper ***

Mills, L. S. 1992. Small mammal communities on forest remnants: nested subsets and the prediction of extinctions. Society for Conservation Biology Meetings, Blacksburg, VA.

Mills, L. S. 1992. Edge effects on small mammals of forest remnants of SW Oregon. Northwest Scientific Association Meetings, Bellingham, WA.

Tallmon, D. A. and L. S. Mills. 1992. Log use by California red-backed voles. Northwest Scientific Association Meetings, Bellingham, WA.

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PRESENTATIONS (continued)

Clarkson, D. A., L. S. Mills, M. P. Amaranthus, and J. Ramstetter. 1992. Hypogeous sporocarps in managed and unmanaged forests of southwestern Oregon: coarse woody debris-fungal-small mammal interrelationships. Northwest Scientific Association Meetings, Bellingham, WA.

Mills, L.S. 1990. Islands amidst clearcuts: does isolation weaken the survivors of old-growth fragmentation? 17th Annual Natural Areas Conference, Concord, CA.

Mills, L.S. 1989. Demography and costs of inbreeding: A theoretical model of relationships. Midwest Ecology and Evolution Conference, Madison, WI.

Mill... L.S., and P. Mohai. 1988. Dominant use, multiple use, and the BLM: Characterizing management orientations in the Bureau of Land Management. Second Symposium on Social Science in Resource Management, Urbana, Illinois.

Mills, L.S. 1987. Coyote territoriality and home range use relative to prey abundance. Animal Behavior Society, Williamstown, MA.

INVITED SEMINARS:
- December 4, 1992 - California State University, Chico.
- November 23, 1993 - University of Montana, Missoula.
- January 24, 1994 - Washington State University, Pullman.
- June 1, 1994 - Australia National University, Canberra.

PROFESSIONAL ASSOCIATIONS
- American Institute of Biological Sciences.
- Ecological Society of America
- The Wildlife Society.
- Society for Conservation Biology.
- Northwest Scientific Association.

PROFESSIONAL INVOLVEMENT
- Reviewed manuscripts for:
  * Biological Conservation (1993)
  * Northwest Science (1993)
  * NSF grant (1994)
  * Journal of Mammalogy (1994)
- Invited participant in U.S. Fish and Wildlife Service Workshop to evaluate validation procedure for vertebrate GAP Analysis Projects.
- Invited participant in workshop for the development of an Expert System on Response of Wildlife to Development (San Luis Obispo, CA, June 4, 1992).
- Member of Task Force on Conservation Biology, School of Natural Resources, Univ. Mich., 1988-89.

GRANTS RECEIVED:

- November 1989 — $40,000
  Dissertation Research funding from Pacific Northwest Research Station, U.S. Forest Service.

- January 1990 — $6,000
  Graduate Student Research Award from National Audubon Society.

- April 1991 — $10,000
  Renewal of Pacific Northwest Research Station Grant.

- July 1991 — $6,000
  Renewal/Re-granting of National Audubon Society Grant.

- January 1992 — $3,000
  Research Fellowship, Biology Dept., Univ. of CA, Santa Cruz.

- June 1994 — $18,000
  U.S. Forest Service grant to use Population Viability Models to gain insight into re-introduction programs.

REFERENCES FOR L. SCOTT MILLS

PRIMARY REFERENCES:

Dr. Jim Estes, Research Associate Professor
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Santa Cruz, CA 95064 (408) 459-2820; FAX: (408) 459-4882

Dr. Edward "Oz" Garton, Professor
Fish and Wildlife Resources
University of Idaho
Moscow, ID 83844 (208) 885-6434; FAX: (208) 885-9080

Dr. Michael Soulé, Professor and Chair
Environmental Studies Department
University of California
Santa Cruz, CA 95064 (408) 459-4837; FAX: (408) 429-5427

ALTERNATE/ADDITIONAL REFERENCES:

Dr. Douglas Houston, Research Biologist
Olympic National Park
Port Angeles, WA 98362 (206) 452-4501; FAX: (206) 452-0335

Dr. Fred Knowlton, Leader
Predator Ecology and Behavior Project
Utah State University
Logan, UT 84322 (801) 750-2445