USFWS 1984

McDONALD'S ROCK-CRESS RECOVERY PLAN

(Arabis mcdonaldiana Eastwood)

Published by
U.S. Fish and Wildlife Service
Portland, Oregon

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Portland, Oregon

Approved: Richard J. Myshak

Regional Director, U.S. Fish and Wildlife Service

February 28, 1984

Date

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LITERATURE CITATION SHOULD READ AS FOLLOWS:

U.S. Fish and Wildlife Service. 1990. McDonald's Rock-cress, (Arabis mcdonaldiana Eastwood), Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 40 pp.

ADDITIONAL COPIES MAY BE OBTAINED FROM:

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Acknowledgements:

This plan was prepared under contract by John W. Willoughby, State Botanist, U.S. Bureau of Land Management, with assistance from the Arabis mcdonaldiana working team (listed below), and in cooperation with the Sacramento Endangered Species Office, U.S. Fish and Wildlife Service.

Arabis mcdonaldiana Working Team (inactive)

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L.E. Horton	U.S. Forest Service (to July 1983)
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Stephen P. Rae	California Department of Fish and Game (to mid-1982)

EXECUTIVE SUMMARY FOR THE MCDONALD'S ROCK CRESS RECOVERY PLAN

1. Point or condition when the species can be considered recovered.

   Threatened status could be considered when the single population at Red Mountain has been adequately protected from the threat of mining. Consideration for delisting would be appropriate when the species shows sufficient regeneration (i.e., significant seedling establishment and abundant flowering) for self-maintenance and expansion.

2. What must be done to reach recovery?

   Federal and State authorities must protect the rock-cress population from mining and other deliterious impacts. All areas of essential habitat must be adequately protected from these threats.

3. What specifically must be done to meet the needs of #2?

   Determine the extent of authority possessed by Federal (BLM) and State governments to protect the species from mining and other deliterious impacts; conduct research on life history requirements to determine criteria for delisting the species; identify and protect essential habitat; monitor population; develop and implement a conservation-education program.

4. What maintenance/management needs have been identified to keep the species recovered?

   Assurance of a longterm program to protect the species and its habitat including periodic reviews and monitoring; protective and enforced management plans; and public awareness program.

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D. Agencies asked to provide review comments.

* Printed here with permission of Dr. Jenny, Professor emeritus, University of California, Berkeley.

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MCDONALD'S ROCK-CRESS RECOVERY PLAN

I. INTRODUCTION

McDonald's rock-cress (Arabis mcdonaldiana) was listed as an endangered plant species by both the Federal (43 FR 44810, 28 September 1978) and State (California Fish and Game Commission, 25 May 1979) governments. This recovery plan summarizes current knowledge of the taxonomy, former and current distribution, and biology of the species, and presents recommendations for a program to restore it to threatened status. Because of the extremely limited range of the species and the very small number of individual plants [the Bureau of Land Management (Bureau) estimates between 1,000 and 5,000 plants] it is highly unlikely that A. mcdonaldiana could ever be delisted.

A. Description and Taxonomy

Arabis mcdonaldiana was first described by Alice Eastwood (1903). In her original description, Eastwood (1903) employed the spelling used in this recovery plan, naming the species in honor of Captain James M. McDonald. Critchfield (1977) altered the spelling to "macdonaldiana" following Recommendation 73C.4 of the International Code of Botanical Nomenclature (Latest edition: Stafleu 1978). Critchfield considered the Eastwood spelling to be an orthographic error. Since, however, the spelling change is based on a recommendation of the Code, not a rule, and because it is unclear whether this recommendation applies to previously published names, the original spelling "mcdonaldiana" is retained here.

Arabis mcdonaldiana Eastwood, (Brassicaceae), is a member of a large and widespread genus of western North American plants.

Within the genus Arabis exists a group of six perennial species of the Coast Ranges of northwestern California and southwestern Oregon. These six species are distinct from other American Arabis in having relatively large, conspicuous lavender to purplish flowers and a rosette, usually flattened, of obovate to broadly oblanceoate leaves from which the flowering stems arise (Rollins 1973). It is to this group that A. mcdonaldiana belongs. Other members of this purple-flowered group, as currently treated by Rollins (1941 and 1973), include A. serpentinicola Rollins, A. aculeolata Greene, A. oregana Rollins, A. modesta Rollins, and A. blepharophylla Hooker and Arnott.

Arabis mcdonaldiana is most closely related to A. aculeolata (Rollins 1941). Both have seeds which are winged at the distal end (in contrast to A. serpentinicola which has wingless seeds and A. blepharophylla which has seeds winged all around) and have trichomes (hairs) on the leaves which are simple (in contrast to A. oregana and A. modesta which have trichomes forked or dendritically branched, respectively). Arabis mcdonaldiana differs from A. aculeolata in being glabrous (without hairs) except for a few marginal trichomes on the basal leaves (A. aculeolata is densely covered with trichomes on the basal leaves and the lower part of the stems); in its smaller stature (A. mcdonaldiana is less than 1.5 dm. high while A. aculeolata is greater than 2.0 dm. in height); and in possessing narrower, usually truncate, petals. More technical descriptions of A. mcdonaldiana and the other five species can be found in the treatments by Rollins (1941 and 1973). The species was merged with A. blepharophylla by Jepson (1925) and treated as a variety of that species. Rollins (1941) again elevated the taxon to the rank of species.

B. Distribution

Both the original description (Eastwood 1903) and the treatment by Rollins (1941) were based on the type collection of Eastwood, May 26, 1902, from Red Mountain, northern Mendocino County, California. The species was not collected again for 40 years (Critchfield 1977). More recent surveys have delineated more accurately the species' distribution at the type locality where, according to Critchfield, the plant occurs over an area of 1-2 square miles at elevations of 3,500 to 4,000 feet on top of Red Mountain, approximately 4 miles northeast of Leggett. Goforth (1980) has described the distribution of Arabis mcdonaldiana on Red Mountain as follows:

> The Red Mountain population consists of approximately 10-20 colonies in a 5-square-mile area on the summit plateau. It is estimated that there are between 1,000 and 10,000 [individuals] in the Red Mountain population with the greatest concentration on the summit dome at an elevation of 4,000 feet.

Based on what is currently known regarding the range of A. mcdonaldiana on Red Mountain, it appears that the 5-square-mile figure suggested by Goforth should be adjusted to 2.5 to 3 square miles. The approximate distribution of A. mcdonaldiana on Red Mountain is indicated in Figure 1. Known localities and sizes of colonies are based on data from several sources, including surveys conducted by the Bureau's Ukiah District Office; a map prepared by R. Sutherland (pers. comm., 1981); and a map prepared by D. Goforth (pers. comm., 1981). Stippled areas represent lands managed by the Bureau. All other lands are privately owned.

Until 1979 it was believed that Arabis mcdonaldiana was restricted to Red Mountain, Mendocino County. A collection made by Alice Eastwood in 1907 in Del Norte County, California, and referred by

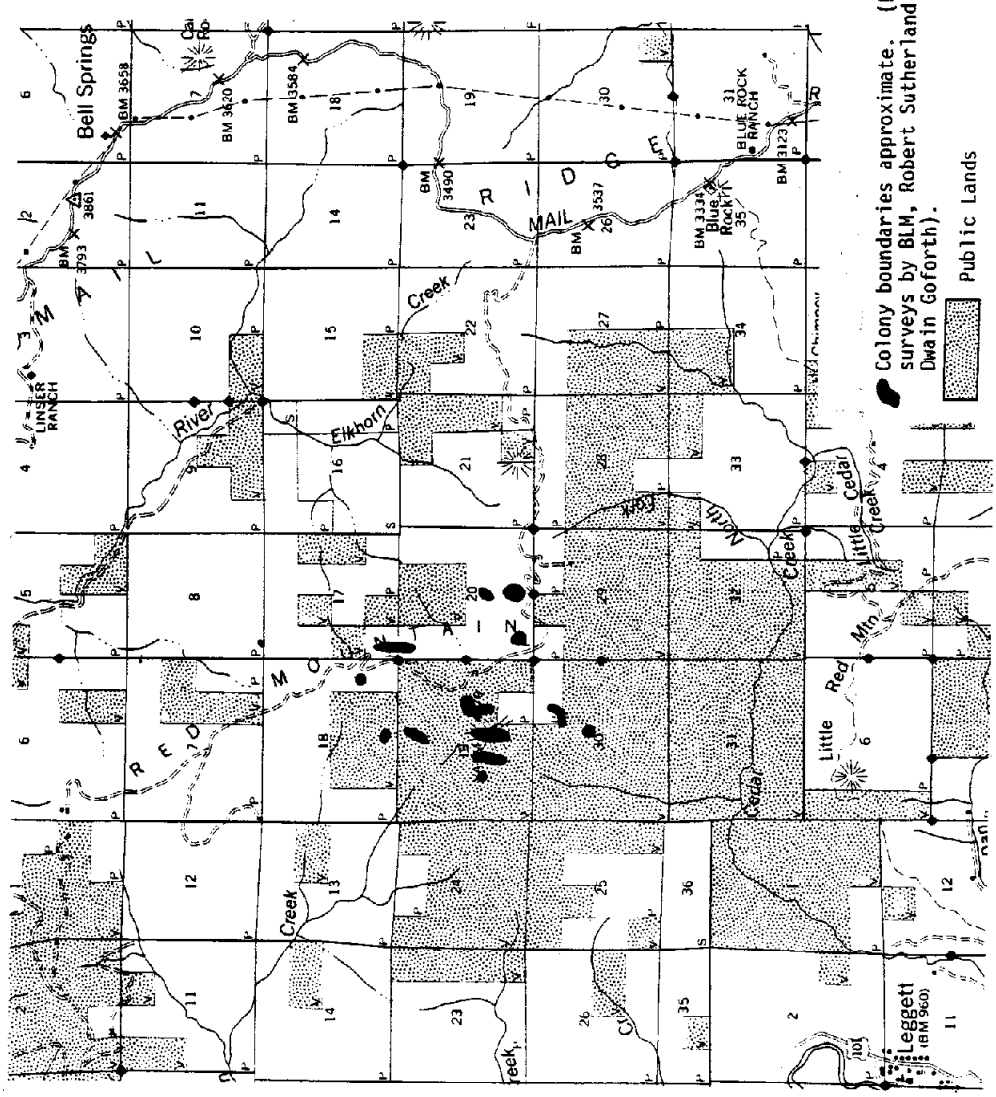

Figure 1. Localities of Arabis mcdonaldiana at Red Mountain, Mendocino County, California.

her to A. mcdonaldiana was tentatively placed in A. aculeolata by Rollins, who said of the Eastwood collection (Rollins 1973):

> The material is in flower only and is hard to deal with on that account. However, it clearly is not A. mcdonaldiana. The specimens are small for A. aculeolata and the trichomes are less acicular than in typical specimens, but otherwise they seem to fall within the range of variation of that species.

In 1979 and 1980 several collections of Arabis plants from Del Norte County, California and Curry County, Oregon, were made, all of which seemed to correspond to A. mcdonaldiana. These plants were declared by Goforth (1980) to be a "rediscovery" of A. mcdonaldiana in Del Norte County. The plants discovered in Del Norte County have a wider distribution and are significantly more abundant there than in Mendocino County. Goforth reported that approximately 200 colonies were located in Del Norte County and one very small colony (with fewer than 10 individuals) in adjacent Curry County, Oregon. He estimated the total number of individuals in the region to be between 20,000 and 50,000. However, the taxonomic status of the Del Norte Arabis had not been conclusively determined and questions regarding the taxonomic status of these new populations were raised (see discussion of Taxonomic Questions below).

Figure 2 indicates the known locations of the Del Norte County Arabis containing at least 100 individuals (Goforth 1980). Many additional smaller colonies occur along the North Fork of the Smith River and between Diamond Creek and the North Fork of the Smith River.

C. Taxonomic Questions

The discovery of plants in Del Norte County which seemed to correspond to Arabis mcdonaldiana raised questions regarding not only the true identity of the Del Norte County plants, but the taxonomic limits of the entire group of six species to which

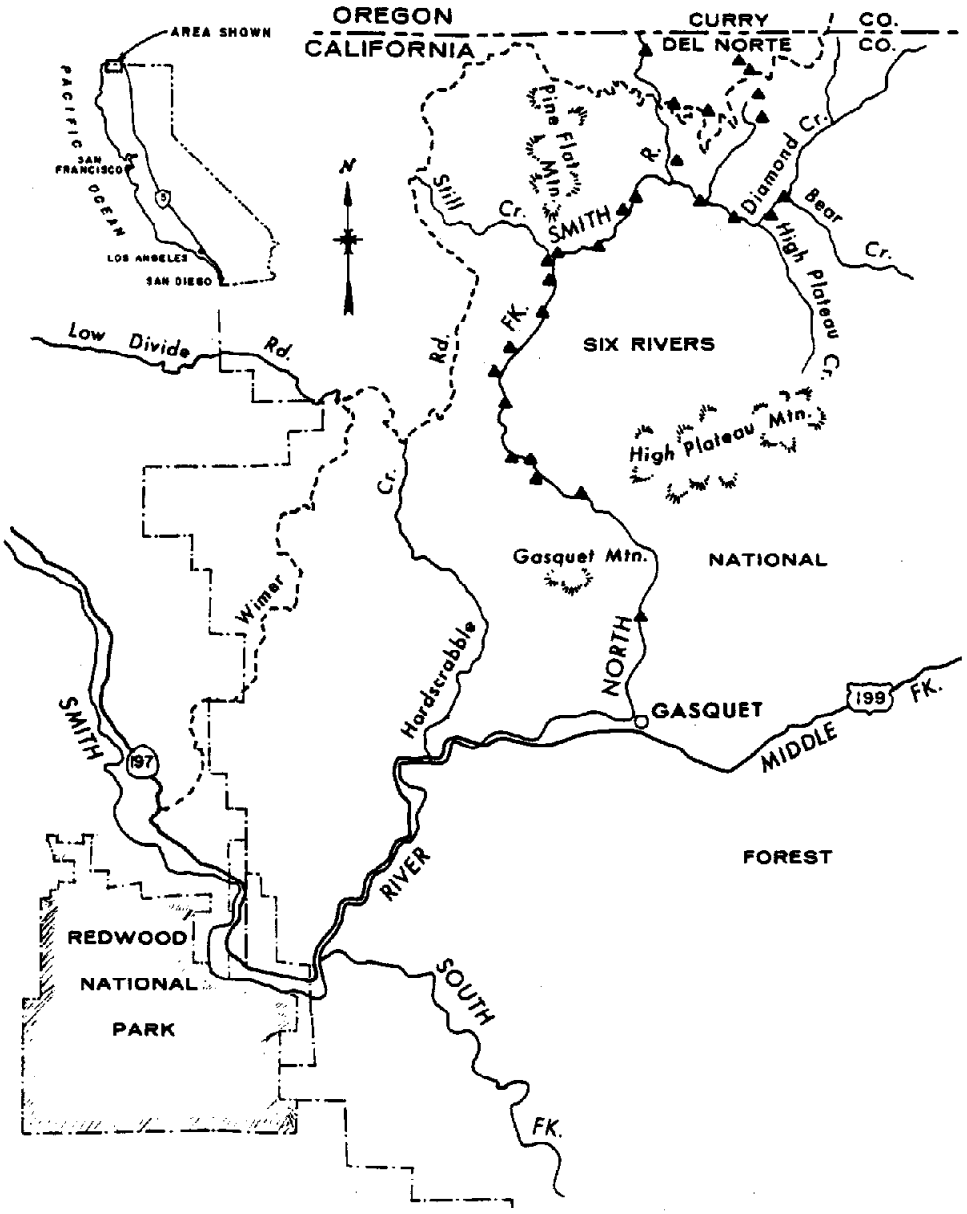

FIGURE 2. LOCATIONS OF ARABIS SP. IN DEL NORTE COUNTY, CALIFORNIA CONTAINING AT LEAST 100 PLANTS. ▲ INDICATES COLONY

A. mcdonaldiana belongs. Dr. Reed Rollins (pers. comm., 1980) inspected several of the recent Del Norte County collections; he believed them to be intermediate between Arabis mcdonaldiana and A. aculeolata. Rollins suggested that the taxonomy of the whole species group, especially the relationships of A. mcdonaldiana and A. aculeolata, be reexamined.

To clarify the relationships among the six members of the purple flowered Arabis group and thus make intelligent and prudent decisions concerning the management of these taxa, the U.S. Forest Service (Forest Service) in 1980, entered into a cooperative agreement with Humboldt State University (HSU) to study their taxonomy and ecology. The Bureau assisted the Forest Service in funding the 1981 portion of the study.

The study, conducted by HSU graduate student Dwain Goforth, involved data from 49 (of 120 known) Arabis sites (Goforth 1982). Cytological, morphological, floristic, and environmental data were used to evaluate the relationships of the various Arabis taxa. Although Goforth's taxonomic interpretations are questioned by other botanists (Joseph Dowhan, Jim Bartel, John Fay, USFWS, pers. comm., 1981) his results clearly show that the plants on Red Mountain are distinct. The latest taxonomic treatment (Rollins 1973) accords the Red Mountain material specific rank. It is possible that future treatments of Arabis may alter the nomenclature and taxonomic limits (and thus the recognized distribution) of Arabis mcdonaldiana. At that time, and after acceptance of such a treatment by experts in the family the Service may reassess the endangered status of the A. mcdonaldiana in light of a new distribution and/or range.

Because the original listing referred specifically to Arabis mcdonaldiana at Red Mountain, as recognized by Rollins (1973), the Del Norte County populations are here considered a different taxon. Therefore, this recovery plan views the Arabis plants at

Red Mountain as the federally listed taxon and will refer to the Arabis populations there as A. mcdonaldiana.

D. Land Status

The distribution of Arabis mcdonaldiana on Red Mountain is divided about equally between public lands managed by the Bureau and private lands (Figure 1). The majority of individuals occur on public lands, at least so far as is presently known. Most of the private lands (and the mineral rights thereon) are owned by Coastal Mining Company of California, a subsidiary of Hanna Mining Company. This same company has unpatented mining claims on that portion of the species' range occurring on public lands.

E. Habitat

Arabis mcdonaldiana is restricted to ultramafic rocks, chiefly peridotite, and soils derived from these. The parent ultramafic rocks are rich in magnesia, silica, and iron, and contain small amounts of nickel (Jenny 1977). As a result of weathering over a long period of time, red soils have been formed in certain areas such as the summit dome of Red Mountain (and other coastal areas of northern California). In these areas the iron has been oxidized and the silica and magnesia leached out. Residual metals such as iron, nickel, and chromium occur in high concentrations. A pronounced red color is evident in the soil because of the presence of iron. Nickel and chromium concentrations are much higher in these soils than in the parent material. Nickel concentrations, for example, may exceed 2 percent nickel oxide (NiO) (Jenny 1977).

The soils which have formed in the manner described above are similar to the lateritic soils found in many tropical and subtropical regions. The formation of lateritic soils requires a warm climate with abundant precipitation. As Jenny (1977)

reported, the prevailing opinion holds that the climate in the vicinity of Red Mountain was at one time tropical or subtropical in nature, although Jenny himself does not share in this belief (pers. comm., 1981).

Overlaying the distribution map for Arabis mcdonaldiana on Red Mountain onto the soil-vegetation map of the area (Cameron et al. 1951) shows that A. mcdonaldiana occurs on soils belonging to the Cornutt and Huse series. In the Smith River area of northern Del Norte County, Arabis plants growing there occur on soils whose profile resembles Huse but is less conspicuously red (Jenny 1980).

Arabis mcdonaldiana seems to occur infrequently in the deeper, well-developed lateritic soils on Red Mountain, but plants are most abundant in rock crevices (although small colonies are also found in deeper soils and in fine gravel in open areas and among shrubs). Goforth (1980) maintains that A. mcdonaldiana is not directly associated with lateritic soils. Further information regarding the soils and parent material of A. mcdonaldiana habitats on Red Mountain can be found in two papers by Hans Jenny (Appendices A and B).

The flora of Red Mountain, which has been briefly described by Walter and Irja Knight (1971), provides a partial species list of the area. Goforth (1980) also mentions some species which are associated with Arabis mcdonaldiana at Red Mountain.

The vegetation on the ultramafic rocks and soils of Red Mountain consists mainly of relatively open canopied forest with various mixes of Pinus ponderosa (ponderosa pine), P. jeffreyi (Jeffrey pine), P. lambertiana (sugar pine), and Calocedrus decurrens (incense cedar) comprising the overstory.

In some areas, however, the overstory is composed of rather dense stands of P. attenuata (knobcone pine). Although Arabis

mcdonaldiana has been found in direct association with P. attenuata at only one locality on Red Mountain, aspects of the pine's autecology may nonetheless bear upon the management and recovery of the rock-cress at least at this location. According to Goforth (1980) P. attenuata on Red Mountain is dominant on lateritic soils, whereas the other conifers dominate areas of "unaltered" ultramafics (the latter apparently referring to non-lateritic soils of ultramafic origin). Alan Goes, former Bureau Forester and student of the ecology of the Red Mountain area (pers. comm., 1980), believes there is no such relationship between the lateritic soils and stands of P. attenuata. Rather, he feels that these P. attenuata stands occupy areas in which fire has been more recent and/or more frequent than in those areas where the other conifers are dominant. The soil-vegetation map for the Red Mountain area (Cameron et al. 1951) appears to confirm Goes' assessment: Soils mapped as belonging to the Cornutt series are in some places dominated by P. attenuata and in others by various mixes of the other conifers. Additionally, Whittaker (1954) found that, in southern Oregon, recent severe burns on serpentine are indicated by stands of P. attenuata.

Evergreen shrubs are important components of the vegetation; these include Garrya buxifolia (dwarf silk-tassel), Quercus vaccinifolia (huckleberry oak), Arctostaphylos canescens (hoary manzanita), and Ceanothus pumilus (Siskiyou ceanothus). In addition to Arabis mcdonaldiana several other rare plant taxa are known to occur on the ultramafic substrate of Red Mountain. These are Eriogonum kelloggii (Kellogg's buckwheat), Sedum laxum ssp. eastwoodiae (Red Mountain stonecrop), Silene campanulata ssp. campanulata (Red Mountain campion), Lomatium engelmannii (Engelmann's lomatium), Lilium rubescens (redwood lily), and Cypripedium californicum (California lady's slipper; this species occurs in boggy areas). The first three taxa are known only from the vicinity of Red Mountain (E. kelloggii and S. campanulata ssp. campanulata also occur on Little Red Mountain). They are under review for listing

by the U.S. Fish and Wildlife Service (Service) (45 FR 82480-82569, 15 December 1980) and are considered endangered by the California Native Plant Society (Smith et al. 1980). The latter three species are not restricted to Red Mountain and are considered rare but not endangered by the California Native Plant Society.

Extensive areas in the vicinity of the Red Mountain summit dome have soils which are not derived from ultramafic rocks. Of these soils, the Hugo series is most prevalent. The vegetation associated with the Hugo series is Mixed Evergreen Forest, a vegetation type very widespread in northwestern California. It is dominated by Pseudotsuga menziesii (Douglas fir), Lithocarpus densiflorus (tanbark oak), and Arbutus menziesii (madrone). This vegetation type with its high degree of cover contrasts sharply with the more sparsely vegetated ultramafic soils. Neither Arabis mcdonaldiana nor the other rare plant taxa known from Red Mountain occur in Mixed Evergreen Forest; they are restricted to the plant associations occurring on ultramafic substrate.

F. Limiting and Threatening Factors

There is no evidence that the range of Arabis mcdonaldiana is any more restricted today than in the recent past. This is especially true given the scant information available regarding the species' range prior to the last few years. Strong circumstantial evidence indicates that the distribution of A. mcdonaldiana is currently limited by natural rather than anthropogenic factors. Human disturbance of the Red Mountain locality is minimal. Graded roads occur on the mountain and some pits have been excavated to assess mineral resources, but the proportion of the total habitat on Red Mountain impacted by these activities is small. Walter and Irja Knight (1971) state the following in regard to Red Mountain:

> It is worthy of mention that of all the places we have botanized in California, we can recall none so free of

introduced material as this one. Our assumption is that this is due to the area's poor accessibility. We also noticed that perhaps because of inappropriate soil conditions, grasses, too, were scarce. This is odd, for there was no evidence of grazing in the area.

The major factor limiting the distribution of A. mcdonaldiana is the restricted availability of suitable habitat, namely the presence of an ultramafic substrate.

In California, there are many species of vascular plants either wholly or partially restricted to serpentine (Raven and Axelrod 1978). The term "serpentine" is often used by biologists to describe most ultramafic rocks and the soils derived from them, although in its strictest sense "serpentine" refers to a small group of minerals which are products of hydrothermal alteration (Proctor and Woodell 1975). The term is used here in its broadest sense.

The subject of serpentine endemism, the factors accounting for this endemism, and plant responses to serpentine soils have been well treated elsewhere (e.g., Kruckeberg 1954, Walker 1954, Mason 1946, Whittaker 1954 and 1960, Proctor and Woodell 1975). The major factor responsible for the restriction of certain plant species to serpentine seems to be the lower degree of interspecific competition present on serpentine soils when compared to nonserpentine soils.

Serpentine endemics have evolved means of coping with the harsh growing conditions presented by serpentine (e.g., low amounts of essential nutrients, especially calcium, and high concentrations of potentially toxic minerals such as nickel, chromium, and magnesium), while most other plant species are either unable to grow or are less vigorous on serpentine. The net result is lower plant density and lower interspecific competition on serpentine.

Kruckeberg (1954) showed that herbaceous serpentine endemics actually grew better on nonserpentine soil in the absence of interspecific competition, but when sown on non-serpentine soil with typical nonserpentine plants, they were unable to survive. Kruckeberg concluded that serpentine endemics are restricted to serpentine not by a requirement for some factor present in serpentine soils, but because competition from other species is less rigorous on serpentine. Kruckeberg also demonstrated the genetic basis of serpentine tolerance. For species that occur both on and off serpentine, the serpentine populations are, in most cases, ecotypically distinct from the nonserpentine populations.

From what is presently known about its distribution, Arabis mcdonaldiana appears to be a rather poor competitor, even on serpentine. Not only is the species restricted to areas of serpentine substrate, but it occurs primarily (though not exclusively) in serpentine habitats with low interspecific competition (e.g., bare slopes, rock crevices). Interestingly, A. mcdonaldiana is absent from many areas on Red Mountain which would appear, at least upon cursory examination, to provide suitable habitat. Linda Ann Vorobik of the University of Oregon is studying the ecology of the genus Arabis, presumably including A. mcdonaldiana, as part of a doctoral research project. Results of her study may provide additional insights into the ecology and limiting factors of the species.

As previously discussed, there is no evidence to indicate that the range of Arabis mcdonaldiana has been reduced by anthropogenic factors. There has been no known decline in numbers or distribution. Thus, the purpose of this recovery plan is not to "recover" the species to a previously existing level but to address those factors which endanger the species and identify efforts to be undertaken to remove or ameliorate them.

The Arabis mcdonaldiana Working Team, for discussion purposes, identified twelve possible factors endangering the species. These are presented in Table 1.

Potential Threat of Mining

The final rulemaking on Arabis mcdonaldiana identified mining as the only threat, manmade or natural, to the species:

> Present or threatened destruction, modification, or curtailment of its habitat or range. Red Mountain, Mendocino County, Calif., is the only known locality for this species. Approximately half of the species' range is privately owned by the Coastal Mining Co., a subsidiary of Hanna Mining Co. This company has un-patented mining claims on the remainder of the species' range, public land managed by the Bureau of Land Management. Hanna plans to remove as much of the nickel-containing ore as is economically feasible. This operation could cover the entire top of Red Mountain and extirpate the species.

Such surface mining activities would entail substantial surface disturbance, including destruction of all vegetation present in the immediate area of the operation and acceleration of erosion from the increasing availability of easily erodable soil and small particles of rock. The construction of roads and support facilities would add to the amount of habitat disturbed. Although revegetation of these disturbed areas would probably occur under proper post-operation management, plant species composition and density might not be similar to that which existed prior to the onset of operations. For example, strip-mined areas of Colorado are characteristically recolonized by weedy, predominantly nonnative, plant species (R. Jackson pers. comm., 1981). Arabis mcdonaldiana might not be able to survive on the altered substrate.

Table 1. Activities or factors endangering McDonald's rock-cress.

Threat	Degree of Threat			Comments
	High	Medium	Low	
Human factors				
Off-road vehicles			X	
Road widening & maintenance		X		largely related to mining assessment
Cattle grazing			X	
Commercial collecting			X	
Fire supression activities			X	
Quarrying			X	
Herbicide drift			X	
Private development			X	
Mining activities	X			Potential to impact 100% of range
Special land use permits			X	
Natural factors				
Fire			X	
Disease			X	
Geologic instability			X	

Special Land Use Permits

Because the authority to issue special land use permits is completely discretionary on the part of the Bureau, any land uses covered by such permit should not threaten Arabis mcdonaldiana, so long as the authorized officers are fully apprised of the sensitive nature of the areas involved.

Herbicide Drift

The use of herbicides in the management of forest lands adjacent to areas supporting Arabis mcdonaldiana and subsequent drift into its habitat may pose a threat to the species. The threat is considered to be improbable since the Bureau of Land Management intends to preclude the aerial spraying of herbicides on public lands (U.S. Department of Interior 1981). Thus, drift of any herbicides which might be used in adjacent forest on public lands is greatly reduced. Aerial spraying of adjacent private forests near Red Mountain cannot be ruled out, however.

Development On Private Lands

Potential development of private lands supporting the species on Red Mountain would most likely be associated with mining activities. Other types of developments are not expected to occur on Red Mountain.

II. RECOVERY

A. Objectives

The primary objective of this recovery plan is to protect and maintain the existing population and habitat of Arabis mcdonaldiana on Red Mountain and reclassify the species to threatened status. No precise quantified recovery goal can be given at this time except to say that an area as much as 5 square miles may be necessary. A determination of the precise amount and distribution of habitat necessary for the recovery of this species is a specific task identified in the plan. It is assumed that by protecting and conserving all existing populations and habitats of the plant on Red Mountain, the species will survive and remain a viable component of the Red Mountain ecosystem. Nonetheless, the species will continue to occupy a range of less than 5 square miles. Consequently, the threat of stochastic extinction will remain high. It is, therefore, unlikely that the species will ever be delisted.

Potential threats to Arabis mcdonaldiana stem from mining activities. Although no significant mining activities within the range of the species have taken place to date, several unpatented mining claims have been issued for substantial portions of its habitat on Red Mountain is therefore vital to the recovery of the species. Once existing populations and habitat are precisely mapped and actions are taken to remove the threats from the habitat, it is anticipated that certain mining activities may take place outside of the habitat of A. mcdonaldiana with no resulting jeopardy to the species. Nonetheless, because of the potential for secondary effects such as acid rain, road construction, and mine waste deposition, future mining plans will require careful review. At this time it is not considered necessary to transplant or seed areas or otherwise supplement the reproductive process for A. mcdonaldiana. Programs providing for monitoring and increased public awareness are considered an important element of the recovery effort. These are presented in the Narrative.

B. Narrative

1. Enforce laws and regulations that may affect conservation of the species.

To accomplish the primary objective of this recovery plan it is necessary for the appropriate Federal and State agencies to rigorously enforce all laws and regulations which may affect conservation of Arabis mcdonaldiana. Foremost among these laws and regulations is the Endangered Species Act of 1973, as amended, and its associated regulations. Other relevant laws and regulations include the California Native Plant Protection Act, applicable to those areas within the range of A. mcdonaldiana that are privately owned; the Federal Land Policy and Management Act, under which the Bureau administers lands under its jurisdiction; the National Environmental Policy Act and California Environmental Quality Act; the Wilderness Act and Bureau regulations and policies applying to lands under wilderness review for those applicable portions of the species' range; the Bureau regulations governing the surface management of Federal lands under the U.S. Mining Laws; the State of California Surface Mining and Reclamation Act of 1975; the Clean Water Act of 1977 as it applies to the regulation of surface disturbing activities such as mining which pollute waterways; and the Clean Air Act as applicable to air pollution associated with the processing of minerals.

2. Protect essential habitat.

Sufficient habitat must be protected to insure the well-being of Arabis mcdonaldiana. This will require identification and precise mapping of the essential habitat as well as determining and selecting the appropriate means to do so. Much of the opportunity to protect A. mcdonaldiana will depend upon the authority of the State and Bureau to regulate surface mining.

21. Identify essential habitat.

At this time basic data on the distribution of Arabis mcdonaldiana and its requirements (i.e., pollinators, predation, soil requirements, etc.) are incompletely known. A number of studies and surveys will be necessary to identify the habitat essential to this species.

211. Determine the stability of the existing population.

Several biological studies are necessary to provide information about the status of the Arabis mcdonaldiana population (whether it is stable, declining, etc.), its life history, and habitat requirements. Such studies will clarify the geographic limits and biology of A.

mcdonaldiana and provide information necessary to ascertain the range of biological alternatives available in identifying essential habitat for the species.

2111. Examine seed production, seedling survival, and germination in the field.

To evaluate the status of the existing population, studies of recruitment will be necessary. Information on seed production, seedling survival, and germination can help determine if the population is stable, increasing, or declining.

2112. Examine Arabis pollinators and their habitat needs.

Information on pollination of Arabis mcdonaldiana is very limited. Nonetheless, knowledge of pollination, pollinating vectors and their habitat needs is necessary to manage and recover the species.

2113. Investigate plant-animal interactions.

Certain plant-animal interactions may be significant life history aspects for Arabis mcdonaldiana. For example, some herbivory has been noted. The impact on the population, however, is unknown. In addition, some herbivores may aid in seed dispersal, thus providing indirect assistance in maintaining the Arabis population. Studies of these interactions will provide additional insights into the requirements of the species.

212. Seek additional populations of Arabis mcdonaldiana in Mendocino County.

It is possible that additional colonies of Arabis mcdonaldiana exist in other areas of Mendocino County near Red Mountain. Areas of likely habitat should be identified (using geologic maps, aerial photos, etc.) and surveyed for the presence of A. mcdonaldiana.

22. Manage essential habitat.

Management of Arabis mcdonaldiana and its habitat will depend upon information gained from monitoring, threat analyses, and the evaluation of protection alternatives. The management program selected (#225) will require periodic review to insure that it is effective in protecting and recovering the species.

221. Identify and evaluate protection alternatives.

Because the major threat to Arabis mcdonaldiana is mining, withdrawal of lands for mineral mining is probably the most effective protection available. But several alternatives such as special area designation, wilderness designation, conservation easement, and land acquisition may have relevance for certain portions of the species' habitat. The various methods for protecting Arabis habitat should be identified and evaluated based on such information as threat potential, habitat significance, and cost-effectiveness. This could be accomplished by developing a Land Protection Plan.

222. Determine the extent of Bureau authority to regulate surface disturbance by mining in endangered species' habitat.

A legal analysis must be conducted by the Bureau through the Solicitor's Office of the Department of the Interior to determine the extent of the Bureau's authority in regulating surface disturbance by mining in endangered species habitat.

223. Determine extent of State authority to regulate mining in endangered species' habitat.

On private land certain State and local regulations may effect protection of habitat. The California Department of Fish and Game (DFG) should investigate and determine which State and local regulations are applicable and effective in protecting Arabis mcdonaldiana from mining activities on private lands.

224. Evaluate and monitor threats to Arabis mcdonaldiana and modify management program accordingly.

It is not clear at this time what portions of the species' range are currently under mining claim or what amount of habitat will be adversely affected by mining activities. Therefore, a program to monitor and analyze mining threats is necessary. Monitoring consists of making certain that all notices, plans of operations, permit applications for special use permits, etc. are rigorously screened by the appropriate land management agencies to ensure there will be no effect on the species.

It is possible that some portions of the habitat are not threatened by mining. Moreover, not all areas are subject to intensive threats. It is therefore necessary to determine which areas are likely to be affected by mining and the extent of these potential impacts.

2241. Determine portion of known range currently under mining claim.

Those areas under valid mining claims have the greatest potential for being affected. Therefore, by identifying which areas are claimed the distribution and extent of mining threats on Red Mountain can be determined.

2242. Determine extent of habitat likely to be affected should mining take place and the degree of impact expected.

After carefully mapping the distribution of Arabis mcdonaldiana on Red Mountain and comparing its distribution to areas under mining claim, the extent of anticipated mining impacts can be determined. The areas of greatest ore concentrations (determined by various geologic methods) should be mapped and overlain on distribution maps for A. mcdonaldiana. In this way the areas of greatest impact can be predicted for Bureau and non-Federal lands.

2243. Identify and monitor areas of Arabis habitat that are vulnerable to threats other than mining.

Although threats other than mining seem to be insignificant at this time, it is important that careful monitoring of populations be conducted to assure that these threats will not become significant. Such monitoring should include Bureau land as well as non-Federal lands.

225. Develop and implement a management plan.

Based on the evaluation of available protection alternatives (e.g., mineral withdrawal, land acquisition, special area designation etc.), the most cost-effective means of managing the essential habitat should be selected and implemented as soon as possible. A management plan will be developed and implemented as the major means of habitat protection and species maintenance.

3. Monitor agency compliance with the recovery plan.

To assure that all aspects of the recovery program are proceeding in an effective and timely manner, a compliance monitoring effort should be initiated.

4. Enhance public awareness of Arabis mcdonaldiana recovery effort through informational and educational programs.

Although an awareness program does not contribute direct benefits to the recovery effort, it can provide important long-term benefits. Audio-visual programs, a small brochure on the unique resources of Red Mountain, and a pamphlet on Arabis mcdonaldiana could help foster respect for the values addressed in this plan. In addition, scientific study of the soils, vegetation, and fauna of Red Mountain should be encouraged. Additional studies could provide as yet unknown benefits to future generations.

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B. IMPLEMENTATION SCHEDULE

The table that follows is a summary of scheduled actions and costs for this recovery program. It is a guide to meet the objectives of the McDonald's Rock-cress Recovery Plan, as elaborated upon in the Action Narrative Section. This table indicates the priority in scheduling tasks to meet the objectives, which agencies are responsible to perform these tasks, a time-table for accomplishing these tasks, and the estimated costs to perform them. Implementing Part III is the action of the recovery plan, that when accomplished, will satisfy the prime objective. Initiation of these actions is subject to the availability of funds.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

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

Priority 3 - All other actions necessary to provide for full recovery of the species.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

RECOVERY ACTION PRIORITIES

1 = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

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

3 = All other actions necessary to provide for full recovery of the species.

Implementation Schedule - Arabis mcdonaldiana

General Category	Plan Task	Task Number	Task Priority	Duration of Task (Yrs.)	Responsible Agency FWS Region	FWS Program	Other Agency	Fiscal Year ($1,000) FY 85	FY 86	FY 87	Comments/Notes
02	Enforce laws and regulations to protect Arabis mcdonaldiana	1	1	Continuous	1	LE	DFG BLM*	To Be Determined			
I1	Examine seed production, seedling survival, and germination in the field	2111	2	5	1	SE		1.5	1.5	-	
							BLM*	3.0	3.0	-	
							DFG	0.5	0.5	-	
I3	Examine Arabis pollinators and their habitat needs	2112	2	3	1	SE		2.0	2.0	2.0	
							BLM*	5.0	5.0	5.0	
							DFG	1.0	1.0	1.0	
I3	Investigate plant-animal interactions	2113	2	3	1	SE		1.0	1.0	1.0	
							BLM*	4.0	4.0	4.0	
							DFG	0.5	0.5	0.5	

Key to Responsible Agencies

BLM = Bureau of Land Management
CDFG = California Department of Fish and Game
FWS = U.S. Fish and Wildlife Service
SE = Endangered Species Program, Fish and Wildlife Service
LE = Law Enforcement, Fish and Wildlife Service

[1] Continuous = continuous once action has begun
*Indicates lead agency

General Category	Plan Task	Task Number	Task Priority	Duration of Task (Yrs.)	Responsible Agency: FWS Region	FWS Program	Other Agency	Fiscal Year ($1,000) FY 85	FY 86	FY 87	Comments/Notes
I1	Seek Additional populations of Arabis mcdonaldiana	212	3	2	1	SE*		2.0	2.0	-	
							BLM	2.0	2.0	-	
							DFG	1.0	1.0	-	
M7	Identify and evaluate protection alternatives	221	1	3	1	SE*		1.0	1.0	1.0	
							BLM	1.0	1.0	1.0	
							DFG	1.0	1.0	1.0	
03	Determine extent of BLM's authority to regulate surface mining in endangered species habitat	222	1	1	1	SE		0.5	-	-	
							BLM*	5.0	-	-	
03	Determine extent of State authority to regulate mining in endangered species habitat	223	1	1	1	SE		0.5	-	-	
							DFG*	5.0	-	-	
I2	Determine portion of known range currently under mining claim	2241	1	1	1	SE		0.5	-	-	
							BLM*	3.0	-	-	
I2	Determine extent of habitat likely likely to be affected should mining take place and the degree of impact expected	2242	1	2	1	SE		0.5	0.5	-	BLM has lead on BLM lands. DFG had lead on non-Federal lands.
							BLM*	2.0	2.0	-	
							DFG*	3.0	3.0	-	

General Category	Plan Task	Task Number	Task Priority	Duration of Task (Yrs.)	Responsible Agency: FWS Reion	FWS Program	Other Agency	Fiscal Year ($1,000) FY 85	FY 86	FY 87	Comments/Notes
I2	Identify and Monitor areas of Arabis habitat which are vulnerable to threats other than mining on BLM lands.	2243	2	Continuous	1	SE		0.5	-	-	BLM has lead on BLM lands. DFG has lead on non-Federal lands.
							BLM*	5.0	-	-	
							DFG*	7.0	-	-	
M3	Develop and implement a management plan	225	1	Continuous	1	SE	BLM*	-	-		BLM has lead on BLM lands. DFG has lead on non-Federal lands. Begin FY-88
							DFG*	-	-		
M7	Monitor agency compliance with the recovery plan	3	2	Continuous	1	SE*		3.0	3.0	3.0	
							DFG	2.0	2.0	2.0	
01	Enhance public awareness of the Arabis mcdonaldiana recovery effort through informational and educational programs	4	3	Continuous	1	SE		2.0	2.0	2.0	
							BLM*	2.0	2.0	2.0	

APPENDICES

Appendix A

Red Mountain at Leggett, a Valuable Scientific and Silvicultural Resource

Hans Jenny

A look at the soil-vegetation map of Mendocino County marks Red Mountain as a completely isolated blue-colored area with extraordinary features.

Origin

The mountain is the result of an intrusion of ultrabasic igneous rocks into pre-existing sandstones that took place many millions of years ago. The blackish rock has been identified as peridotite. In parts it has been pressured to greenish serpentine. The rocks are rich in magnesia, silica and iron, and they contain small amounts of nickel (less than 0.5 percent NiO). Long-time weathering has converted the rock to red soils by oxidizing iron and leaching out silica and magnesia and accumulating oxidized iron. Nickel (Ni) also has been enriched in the soil, to the extent of over 2 percent NiO. Nature's process of nickel concentration has now attracted Hanna Mining Company. Lumbering on the mountain has been limited because the forest is of low quality.

A question of values

The Bureau of Land Management is confronted by the question: What is the mountain good for? Why not strip-mine the red soil mantle or give off-road vehicles carte blanche to pulverize it? Other people's interests point to the ecosystem, the entirety of soils, plants and animals, as a valuable natural resource.

Flora

Over a hundred species of vascular plants have been identified and several of them are rare and endangered (e.g. Arabis sp., buckwheat sp.), as outlined in Professor Sawyer's proposal. The two species mentioned grow nowhere else and presumably represent responses to the geographic isolation and to the peculiar rocks and soils of Red Mountain. These endemic plants are valuable to systematists and geneticists for the study of evolutionary trends.

Vegetation and soil fertility

The growth habits of the common plant species are economically important. The pines, firs and cedars have gnarled trunks and branches and display a mangy cast. The few tall trees present have narrow rings meaning slow rates of growth. The fertility-demanding redwoods are absent. The site index is low, not because of unsuited climatic conditions--on adjacent

sandstones the trees on Hugo soils are magnificient--but because of the unusual, infertile soil.

It is one thing to recognize a low silvicultural site index and another to single out its cause. Is it shallow soil, or nickel or chromium toxicity, or lack of calcium, or phosphate fixation by iron, or absence of nitrification that induce biomass stagnation on Red Mountain? Forest science will want to know the answers. As old-growth forests are disappearing, silvicultural knowledge is becoming more and more crucial for forest design. It is the abnormal vegetation stands on unusual substrates that offer scientific challenges and hold the answers to understanding tree growth and to formulating the sophisticated management plans of the future.

On Red Mountain a spectrum of shallow to deep soils and their vegetation patterns should be preserved as benchmarks to enable coming forest researchers to examine plant response to soil, analyze soil and plant, initiate fertilization trials, and record nutrient cycling. A forest clearcut would rob silviculture of an irreplaceable, potential storehouse of knowledge. For educational purposes the Douglas fir forest on fertile Hugo soil of Section 18, T24N, R16W south of the red soil island of Cedar Springs and joining the main body of red earth deserves to be preserved for striking comparison.

The soil taxons. In the Red Mountain area the preliminary soil survey of 1950 recognizes several kinds of red soils: Huse and Cornutt on the mountain proper and Dubakella several miles farther southeast. The entire area is now being resurveyed by the Soil Conservation Service.

The Huse soils are distinctly red and stain hands and clothing. They are rocky and shallow even on nearly level terrain. They are slightly acid and unsuited to commercial timber production.

The Cornutt soils are more prevalent and are usually deeper, reaching 5 feet in the level areas between rises and ridges. The surface color is also strikingly red but is underlain by yellow, friable subsoil of clayey texture. The soils are water permeable, drain well, and carry a fair supply of humus; yet, in spite of these favorable attributes the trees grow poorly and shrubs are numerous. As said, the specific cause is still obscure.

In Mendocino County, Huse and Cornutt soils occur only on Red Mountain. Small areas of related types have been located in Siskiyou County, and nickel-rich relatives are being strip-mined in Oregon. In California these bodies are rare and qualify as endangered soil species.

Conceptual significance of the two soils

The Red Mountain soil series have long been a curiosity to geologists and pedologists (soil scientists), and both groups of

investigators have executed detailed chemical and minerological analyses. Whereas geologists search for economically promising minerals, the pedologists want to know why the soils have become what they are, how they originated, and where they are going. How does nature create a rich soil or a poor one? The answer is of scientific and practical interest.

The departure of silica and magnesia from soil and the simultaneous enrichment of red iron oxides as amorphous gels and goethite and hematite crystals of oxidic and ferritic mineralogy characterize the many lateritic red soils of tropical regions. The opinion prevails that at some time in the past Red Mountain must have experienced a tropical climate to acquire the red soil colors, which are seen as relicts or fossils. This view, questioned by the writer, elicts profound repercussions on ideas of biotic evolutionary trends, geological history and climatic change of California. Red Mountain is destined to become the proving ground of testing the pro's and con's of the hypotheses. Whatever the final answer, representative sites of the red soils deserve to be set aside and protected for the benefit of future scientific investigations. This effort rivals the significance of exploring the soils on the moon for which billions have been spent. According to soil profile features the soil domains on Red Mountain have existed a very long time. To evaluate their plant endemism more information on substrate habitats of the species is needed.

Are the plants restricted to stony soils, and are the stones exclusively ultrabasic? If no further sites are found, propagation of specimens on various soils in pots, alone and in competition with other species, might elucidate the role of substrate. Seeds might be planted on various rocks and soils at natural sites.

A reference: Wyllie, P.J. (Ed.), 1967. Ultramafic and related rocks. New York. Earth Sci. Libr. QE 461, W92.

Appendix B

Notes on Substrate of Arabis mcdonaldiana

Hans Jenny (July 1980)

On Red Mountain I was shown Arabis growing on Huse soil which has rocks and stones on the surface, and about 1 to 2 feet of reddish soil. Bedrock, a dark colored peridotite rich in olivine minerals, is set-apart sharply from the soil material. During soil formation silica and magnesia, the main cations, are leached out and in the remainder, which is the red soil material, iron oxide and accessory minerals (e.g. nickel) accumulate. I don't remember to what extent the root system of Arabis is anchored in the red soil.

In the Smith River territory of northern Del Norte County, Arabis was seen on two sites near Road 305, the first on a 40 percent grassy slope, the second in a saddle area. Again the country rock is a peridotite and the soil profile resembles Huse, though being less conspicuously red. At the first site Arabis grows in a thin sandy layer resting on a rock ledge surrounded by grass. At the second site, seemingly man-disturbed, the plant grows among gravels and stones.

A third site, at the base of a landslide across a canyon, was unfortunately not visited.

Distribution

So far, Red Mountain and Smith River territory are the only areas known to support Arabis mcdonaldiana. How are the occurrences, over 100 miles apart, to be explained? According to geologic maps numerous enclaves of ultrabasic rocks (peridotite, dunite) exist between the two locations, but to "jump" from one to the next, luxurient commercial forests (e.g. on Hugo soil) with underbrush and thick litter layer must be traversed.

According to soil profile features these soil domains have existed there a very long time. More information on Arabis substrate habits is needed. Is the little plant restricted to stony soils and are the stones exclusively ultrabasic? If no further sites are found, propagation of specimens on various soils in pots, alone and in competition with other species, might elucidate the role of substrate. Also seeds might be planted on various rocks and soils at natural sites.

A reference: Wyllie, P.J. (Ed.), 1967. Ultramafic and related rocks. New York. Earth Sci. Libr. QE 461, W92.

APPENDIX C
Bureau Mining Authorities

Under the United States Mining Laws (30 U.S.C. 22 et seq.), a person has a statutory right, consistent with regulations developed by the the Department of the Interior, to go upon the open (unappropriated and unreserved) Federal lands for the purpose of mineral prospecting, exploration, development, extraction and other uses reasonably incident thereto. This statutory right carries with it the responsibility to assure that operations include adequate and responsible measures to prevent, in the words of the Department of the Interior (43 CFR 3809.0-6), "unnecessary or undue degradation of the Federal lands and to provide for reasonable reclamation."

The Bureau has adopted regulations governing the surface use under the U.S. Mining Laws of Federal lands under its jurisdiction. The Bureau regulations became effective January 1, 1981, and are found in Title 43, Part 3800, Subpart 3809, Code of Federal Regulations (called "3809 Regulations" for brevity). Because most of the public lands at Red Mountain are part of a Wilderness Study Area, mining activities thereon are covered by regulations in Title 43, Part 3800, Subpart 3802, Code of Federal Regulations (or "3802 Regulations"), which apply to lands under wilderness review. The 3802 Regulations became effective April 2, 1980. The 3802 Regulations will apply to most of the public lands at Red Mountain until the U.S. Congress acts to either designate the area as wilderness or exclude it from the Wilderness System, at which time the 3809 Regulations will apply. (Part of the range of Arabis mcdonaldiana on Red Mountain appears to fall outside of the Wilderness Study Area and therefore falls under the purview of the 3809 Regulations.)

The Bureau's 3802 and 3809 Regulations require that the claimant submit a plan of operations prior to commencing mining operations on Federal lands when significant disturbance of surface resources is likely. These regulations set threshold levels of disturbance beyond which a plan of operations is required. It is safe to assume that the level of disturbance associated with the surface mining of nickel, chromium, cobalt and other minerals present in the lateritic soils of Red Mountain would require the submission of a plan of operations to Bureau. The critical issue in the present discussion, then, is the degree of control which may be exercised by the Bureau in regulating--through the process involved in the review and approval of a plan of operations--surface disturbance from mining in the habitat of a Federally listed endangered species.

Approval of a plan of operations is required prior to commencing the kinds of mining operations necessary for the surface mining of lateritic ores. At issue, however, is whether the Bureau is empowered to reject a plan of operations if a plan is judged to be in noncompliance with the Endangered Species Act of 1973, as amended. Both the 3802 and 3809 Regulations of the Bureau

specifically state that a plan of operations must be found to be in compliance with Section 7 of the Endangered Species Act prior to plan approval. The Supplementary Information section accompanying the Federal Register publication of the 3809 Regulations (45 FR 78905) states, "If there is an unavoidable conflict with an endangered species habitat, a plan [of operations] could be rejected based not on Section 302(b) of the Federal Land Policy and Management Act, but on Section 7 of the Endangered Species Act." Thus, insofar as Department of the Interior solicitors are concerned, the Endangered Species Act has in effect amended the United States Mining Laws to preclude mining operations in those cases in which a plan of operations cannot be modified to avoid jeopardy to an endangered species. It is important to note, however, that this is a legal interpretation which has not yet been tested in the courts.

APPENDIX D

Agencies Asked to Provide Review Comments

State Director, California State Office
Bureau of Land Management
2800 Cottage Way
Sacramento, California 95825

*State Director, Oregon State Office
Bureau of Land Management, USDI
825 NE Multnomah St.
P.O. Box 2965
Portland, Oregon 97208

Director
California Department of Fish and Game
1416 9th St.
Sacramento, California 95814

Friends of Del Norte County
125 Barker Street
Crescent City, California 95531

*Department of Biological Sciences
Humboldt State University
Arcata, California 95521

Regional Forester, Region 5
U.S. Forest Service
630 Sansome St.
San Francisco, California 94111

Regional Forester, Region 6
U.S. Forest Service
319 S.W. Pine Street
Box 3623
Portland, Oregon 97208

* Comments received.