NOP

(11)

UNITED STATES MARINE CORPS
MARINE CORPS AIR STATION
BOX 99100
YUMA, ARIZONA 85369-9100

IN REPLY REFER TO:
11000
3AQ/mesqpoc
25 Jan 99

Mr. Jurg Heuberger
Planning Director
Imperial County Planning Dept.
939 Main St.
El Centro, CA 92243-2856

Dear Mr. Heuberger:

We received your letter of December 14, 1998 requesting participation as a responsible/ cooperating agency in preparation of the EIS/EIR for the Mesquite Mine Expansion by Newmont Gold Company.

1. Mr. Ron Pearce from the Range Department at the Marine Corps Air Station will be the point of contact for this project. He may be reached at (520) 341-3401. A copy of this project has been sent to him for review.

Thank you for giving this Command the opportunity to comment. If you have any questions, please feel free to contact me at (520)341-2103/2272.

Sincerely,

T. A. MANFREDI
Community Planner
By direction of the
Commanding Officer

Copy to:
Mr. Ron Pearce, Range Dept
Environmental Dept

NOP

(A)

16 comments total

United States Department of the Interior
Fish and Wildlife Service
Ecological Services
Carlsbad Fish and Wildlife Office
2730 Loker Avenue, West
Carlsbad, CA 92008

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BUREAU OF LAND MANAGEMENT
EL CENTRO, CA.

FEB 04 1999

Mr. Jurg Heuberger
AICP, Planning Director
Planning/Building Department
939 Main Street
El Centro, California 92243

Re: Notice of Preparation of a Draft Environmental Impact Report/Statement for the Mesquite Mine Expansion by Newmont Gold Company, City of Brawley, Imperial County, California (1-6-99-I-24)

Dear Mr. Heuberger:

The U.S. Fish and Wildlife Service (Service) has reviewed the referenced Notice of Preparation (NOP), received December 16, 1998, concerning the proposed expansion of the existing Mesquite Mine. Currently, the 5,200 acre operation, located in Imperial County, California, maintains sufficient ore reserves to continue excavation until the year 2000 (East of Acolita, Ninemile Wash, and Clyde USGS 7.5' Quadrangles, T13S, R19E, Sections 2-11, 15-21, 28, and 33, and T14S, R19E, Sections 4, 28, and 33). With the planned development, however, the mine's lifetime could be extended until approximately 2006. Overall, the proposed action would involve enlarging the existing Big Chief and Rainbow pits, creating new overburden/interburden storage areas, and building additional heap leach/ancillary facilities. Associated surface disturbance to the surrounding Sonoran creosote bush scrub and desert dry wash woodland (or microphyllous woodland) areas, has been estimated at no greater than 472 acres.

The primary concern and mandate of the Service is the protection of public fish/wildlife resources and the species' associated habitats. Our mandates further require that we provide comments on any public notice issued for a Federal permit or license affecting the nation's waters (e.g., Clean Water Act, Section 404 and Rivers and Harbors Act of 1899, Section 10). The Service is also responsible for administering the Endangered Species Act of 1973, as amended (Act). Section 7 of the Act requires Federal agencies to consult with the Service should it be determined that a proposed action is likely to adversely affect listed species or critical habitat. Section 9 of the Act prohibits the "take" (i.e., harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of federally listed wildlife species. Harm (i.e., "take") is further defined to include significant habitat modification or degradation that actually kills or injures a listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take can only be permitted pursuant to the provisions in sections 4, 7, and 10(a) of the Act.

The Service offers the following information and recommendations to assist in planning for the conservation of sensitive wildlife species and habitat within the project area and furthering compliance with pertinent Federal statutes. To facilitate the evaluation of the proposed action for fish and wildlife conservation, the Service requests that the Draft Environmental Impact Report/Statement address these topics:

1. 1. A discussion of the need/purpose for the project, including each of the proposed alternatives.

2. 2. A complete description of the planned action, including all practicable alternatives that could reduce the overall impacts to locally sensitive wildlife, plants, and habitats (e.g., minimizing temporal/permanent loss of system function/structure through pit backfilling). Additionally, 3. provide an outline of the mine's consultation history with an accurate summary of previously approved activities (e.g., actual extent of exploratory drilling [385 holes]).

3. 4. A thorough narrative (accompanied with maps/tables and estimated acreages) on the different vegetation types (e.g., Sonoran creosote bush scrub, desert dry wash woodland [microphyllous woodland]) that could be potentially affected by the Mesquite Mine Expansion.

4. 5. A description of the biological resources associated with each habitat type. Discussions should include both qualitative and quantitative assessments of resources on the project site.

5. 6. An inventory of the federally listed/proposed/candidate species, state listed/candidate species, and locally sensitive species, including narrow endemics, occurring within and adjacent to the mine area. 7. Detailed discussions of the wildlife/plants, accompanied with information on local status/distribution, should be contained in the report.

6. 8. An assessment of the direct, indirect, and cumulative project impacts to wildlife/plant species and their associated habitat. All facets of the planned action (e.g., pit expansion, storage area creation, facilities construction, water diversion) should be included in the analysis. Furthermore, 9. provide a table itemizing all surface disturbance (i.e., acreages) associated with the mine expansion that has either received permit approval (with accompanying compensation) or will require future mitigation.

7. 10. Specific measures to fully offset mine-related impacts, including proposals to compensate for the cumulative effects of direct and indirect habitat loss, degradation, or modification. Adverse project effects can be mitigated through preservation or habitat restoration/revegetation. A restoration/revegetation program should direct efforts toward the reestablishment of a self-sustaining (i.e.,

pre-project) ecosystem. Former habitat structure/function can be promoted through the use of soil preparation techniques (e.g., recontouring, pitting), appropriate planting strategies (e.g., local native seed source use, outplantings, broadcasting, plant salvaging, fertilizer exclusion, minimizing/avoiding exotic seed collection, invasive plant removal, timing) and subsequent monitoring efforts (e.g., established/suitable success criteria, contingency plans). Overall, the preparation, inspection, and evaluation of components within the revegetation/restoration program should be conducted by a qualified plant biologist/ecologist with specific work experience in recovery of the affected system.

8. 11. An analysis of project activities on the hydrology of all ephemeral desert washes (e.g., microphyllous woodland) within the action's sphere of influence.

9. 12. Identification of methods to prevent soil erosion and siltation of habitats off-site or downstream of the project site; including erosion control techniques employed during/after construction, along with quantitative monitoring of direct and indirect effects.

10. 13. An Army Corps of Engineers' evaluation for Waters of the United States within the project area. Potential dredging/filling of jurisdictional waters may require issuance of a 404 permit prior to the onset of proposed surface disturbing activities.

11. 14. Identification of methods to prevent the discharge and disposal of toxic/caustic substances (including oil and gasoline) on the proposed site.

12. 15. A thorough assessment of potential noise and light impacts on wildlife and 16. measures to mitigate any adverse effects resulting from increased levels of noise and light.

The Service appreciates the opportunity to comment on the proposed Mesquite Mine Expansion. Any questions or concerns pertaining to this correspondence can be directed to Debbie MacAller of my staff at (760) 431-9440.

Sincerely,

Sheryl L. Barrett

Sheryl L. Barrett
Assistant Field Supervisor

cc: U.S. Bureau of Land Management, El Centro, CA (Attn: Kevin Marty)

STATE OF CALIFORNIA – THE RESOURCES AGENCY

PETE WILSON, Governor

DEPARTMENT OF CONSERVATION
901 K Street, MS 09-06
Sacramento, CA 95814
TEL: (916) 323-9198
FAX: (916) 322-4862
E-MAIL: omr@consrv.ca.gov

February 2, 1999

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IMPERIAL COUNTY
PLANNING, BUILDING

Richard Cabanilla
Imperial County Planning/Building Department
939 Main Street
El Centro, CA 92243

Dear Mr. Cabanilla:

Notice of Preparation and Reclamation Plan for the Mesquite Mine Expansion
Draft Envirnonmental Impact Report (EIR) SCH #98121054

The Department of Conservation's Office of Mine Reclamation (OMR) has reviewed the Notice of Preparation, Plan of Operations, and Reclamation Plan for the Mesquite Mine Expansion Draft Environmental Impact Report (EIR) SCH #98121054. The project is an exploration program on lands adjacent to the Mesquite Mine, located approximately 40 miles northeast of Brawley off State Highway 78. A site visit was conducted by OMR staff on December 9, 1997. The following comments prepared by Karen Wiese and Catherine Gaggini are offered to assist in your review of this project.

The Surface Mining and Reclamation Act of 1975 (SMARA) (Public Resources Code Section 2710 et seq.) and the State Mining and Geology Board regulations for surface mining and reclamation practice (California Code of Regulations (CCR) Title 14, Chapter 8, Article 1, Section 3500 et seq., Article 9 Section 3700 et seq.)(copies enclosed) require that specific items be addressed or included in reclamation plans. The following items were not adequately addressed in the document submitted; we recommend that the reclamation plan be supplemented to fully address these items.

End Land Use

(Refer to SMARA Section 2772(g),(h), CCR Sections 3704(a), 3706(a), 3707 (a),(c), 3708

1. I. SMARA Section 2772(c)(7) requires that the reclamation plan include a description of the proposed use or potential uses of the mined lands after reclamation. As discussed during the site visit, an end use, such as open space must be designated.

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2. 2. The reclamation plan should provide a discussion on what usable condition the open pits will serve upon termination of mining. If the pits are not backfilled, the reclamation plan should explain how the open pits will be reclaimed and readily adaptable for an alternate land use. Reclamation is defined in SMARA Section 2733 as the combined process of land treatment that minimizes water degradation, air pollution, damage to aquatic life or wildlife habitat, flooding, erosion, and other adverse effects from surface mining operations, including adverse effects incidental to underground mines, so that **mined lands are reclaimed to a usable condition which is readily adaptable for alternate land uses and create no danger to public health or safety.**

3. 3. SMARA Section 2772(c)(8) requires a description of the manner in which reclamation, adequate for the proposed use or potential uses will be accomplished. The reclamation plan does not provide sufficient information regarding the reclamation of each of the various vegetation types. For example, little information is provided regarding the wash habitat reclamation or proposed drainage ditch diversion. We recognize that it may be necessary to amend the revegetation mix or treatments after analysis of test plot data. Nevertheless, the revegetation plan should describe the range of treatments and species to be utilized for reclamation with the understanding that the treatments and species may change based on test plot results.

Environmental Setting and Protection of Fish and Wildlife Habitat

(Refer to CCR Sections 3502(b)(1), 3503(c), 3703 (a),(b),(c), 3704(g), 3705(a), 3706(a),(f),(g), 3710(a),(b),(c),(d), 3713(b)

4. 4. CCR Section 3502 (b)(1) requires that the reclamation plan include a description of the environmental setting of the mine site. As discussed during the site visit, a survey of the biotic resources on the proposed site are necessary for the following three reasons: 1) to document baseline conditions, 2) to aid in development and evaluation of an appropriate revegetation plan, and 3) to evaluate purported mining and reclamation impacts on sensitive species and wildlife habitat.

5. Prior to site disturbance, a quantitative description of the biotic setting of the site will be necessary to adequately establish baseline conditions of the site. This quantitative evaluation should include percent cover or density, and diversity measurements for **each** of the vegetation types that will be re-created on the reclaimed landform. Such quantitative data can also be used to guide the design of an appropriate revegetation plan.

6. 6. Also prior to any site disturbance, the lack of impacts to sensitive, rare, threatened, and endangered plants and animals should be verified. The

revegetation of the site should be designed to minimize impacts to those species. Without the knowledge of which species occur on the site, the revegetation design cannot target those species.

5. 7. CCR Section 3703(a) requires that all sensitive species be conserved or mitigated. The California Department of Fish (DFG) and Game Natural Diversity Data Base lists the following species as being detected in the proposed project vicinity. If surveys detect any of these species in the project area, then formal consultation and appropriate mitigation should be developed with the agency having jurisdiction over the species; the US Fish and Wildlife Service and/or the DFG.

Le Conte's Thrasher *Toxostoma lecontei*	CDFG : Species of Special Concern
Nelson's Bighorn Sheep *Ovis canadensis nelsoni*	
Flat-Tailed Horned Lizard *Phrynosoma mcalli*	CDFG: Species of Special Concern
Munz's Cholla *Opuntia munzii*	Federal: Species of Concern CNPS: 1B
Fairyduster *Calliandra eriophylla*	CNPS: 2

6. 4 If needed, we recommend that a copy of the Streambed Alteration Agreement be appended to the reclamation plan [CCR 3710(d)].

Geotechnical Requirements

(Refer to CCR Sections 3502(b)(3),(b)(4), 3704 (a),(b),(d),(f))

7. 9 The reclamation plan should be supplemented with a site-specific slope stability analyses that evaluates the long-term stability of the proposed final pit slopes and waste rock disposal sites. The final mine slopes are only specified for the east wall of the East Rainbow Open Pit. The slope angle specified has an inter-ramp slope angle of 43 degrees (approximately 1:1 horizontal to vertical) with a pit depth of 570 feet. The existing mine slopes have exceeded the critical gradient for the material currently being mined. Several failures, some massive, have occurred in the walls of the existing pits at the mine site. The failures have occurred in similar slopes described for the East Rainbow Open Pit. The reclamation does not provide final slope angles for the Big Chief Open Pit Mine – South Extension, North Extension, and Southeast Extension.

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If the pits are to remain open, a slope stability analysis must be performed to demonstrate long term stability of the proposed final pit slopes, as required by CCR Section 3502(b)(3). Final cut slopes are required to have a minimum factor of safety approved for the end use and conform with surrounding topography (CCR Section 3704(f).)

8. 10 The reclamation plan should be augmented to specify final slope angles of 2:1 (horizontal to vertical) or shallower for the Overburden/Interburden Storage Areas. If the fill slopes are not regraded to 2:1, the reclamation plan must provide a site-specific stability analysis of the proposed angle-of-repose fill slopes that substantiates their long-term stability. In addition, the reclamation plan is required to provide site-specific data that demonstrates the angle-of-repose slopes can be revegetated. For example, vegetation test plots could be installed on existing angle of repose slopes this spring. Topsoil should be applied to the slopes, and seeded. A time schedule should be provided for installation and monitoring of test plot areas beginning at the earliest feasible tiime. If, after a specified amount of time, test plots show that revegetation can not adequately occur on the angle-of-repose fill slopes, changes should be made to the slope design to ensure revegetation success of the fill slopes. Section 3704(d) requires that the final reclamation fill slopes not exceed 2:1, except when allowed by site-specific engineering analysis, and can be revegetated. Engineering reports for the proposed slopes should be submitted to OMR for review and comment prior to approval of the reclamation plan.

Hydrology and Water Quality

(Refer to SMARA Sections 2772(h)(1),(h)(2), 2773(a), CCR Sections 3503(a)(3),(b)(1), (d), 3706(c),(d),(e),(f),(g), 3710 (b),(c), 3711(e), 3712)

9. 11 The reclamation plan should be supplemented with site-specific sediment and erosion control criteria for monitoring compliance with the reclamation plan as required by SMARA Section 2773(a), and CCR Sections 3503 and 3706. The reclamation plan states that diversion channels will be constructed to engineering specifications to pass the design storm events. However, the reclamation plan is void of design specifications and monitoring criteria for the proposed diversion channels. Therefore, it is not possible to evaluate the adequacy of the proposed drainage control. The engineering design and monitoring criteria should be provided to OMR for review and comment prior to approval of the reclamation plan.

Resoiling and Revegetation

(Refer to SMARA Section 2773(a), CCR Sections 3503(a)(1),(f),(g), 3704(c), 3705(a),(b),(c),(d),(e),(f),(g),(h),(i),(j),(k),(l),(m), 3707(b),(d), 3711(a),(b),(c),(d),(e))

10. CCR Section 3711 establishes **mandatory** standards for topsoil salvage, maintenance, and redistribution. The seeds, microbial organisms, and organic

matter found in the upper six inches of growth media constitute a significant resource when used in reclamation. Successful revegetation of the site may not be possible without this resource. We recommend that the upper six inches of growth media be stockpiled and reapplied during reclamation. Phasing the operation would obviate the need for long-term soil storage. As discussed during the site visit, the reclamation plan does not discuss this requirement. We recommend that the reclamation plan be amended to address the five subsections set forth in this section [CCR 3711(a) – (e)].

11. 13 CCR Section 3705(g) requires that the revegetation efforts use native plant species. The reclamation plan states that "seeding will be of adapted native or naturalized plant species..." Table B-3 of the reclamation plan contains several species that are deleterious to the establishment of native plants. The following species are not native to the site and should not be seeded:

Bromus madritensis	Red brome
Shismus barbatus	Mediterranean grass
Brassica tournefortii	Mustard

14 In addition, the chart states that seeding rates are included. The seeding rates of these species have been **omitted** from Table B-3. These rates should be included for OMR review. The reclamation plan states that the "seed rate is sown by volume rather than by weight." Seed is sold and sown by **weight**, not volume. We suggest that the seed installation rate be expressed as pounds per acre.

15 The reclamation plan states that seeds from local plants will be collected from surface soils and plants. The OMR commends the collection of local seeds, but surface seed collection can be problematic. Seeds collected from the surface of the soil are likely to contain debris or invasive species, therefore, exact seeding rates cannot be ascertained. In addition, seeds that have been collected from the soil surface may contain insects that will eat the seeds if placed plastic bags. Proper seed storage is imperative for seed longevity. Please refer to the enclosed article on seed collecting.

12. 16 To mitigate potential visual impacts and blend the waste piles with the surrounding terrain, varnished rock hand-sized or larger could be removed from the soil surface and stockpiled. During reclamation, these rocks can be replaced on the waste piles with the varnished side visible. Replacement of rock will also create microsites favorable to natural revegetation.

13. 17. CCR Section 3705(b) requires test plots to be conducted simultaneously with mining to determine the most appropriate planting procedures. The information

gained from previously developed test plots should be contained in the reclamation plan. The reclamation plan discusses several revegetation techniques that may be employed. We recommend that specific test trials be designed to determine the most effective method(s) of site revegetation, based on microsite conditions. For example, the microsite conditions at the North Extension are different than those at the East Rainbow Extension. At a minimum, the tests should examine the effectiveness of seeding vs. container plantings, the effects of different types of mulches, the effects of fertilizer, if used, and the effects of irrigation. The most effective method(s) could then be incorporated into the reclamation plan, thereby, minimizing the possibility of poor revegetation. Test plots should be located in upland, angle of repose slopes, and wash habitats. We also recommend that revegetation treatments be delineated on a plan map.Any techniques that have not been tested, such as planting young ironwood and palo verde trees or seedlings should be tested prior to implementation.

14. 18 CCR Section 3705(j) states that if irrigation is used, it must be demonstrated that the vegetation has been self-sustaining without irrigation for a minimum of two years prior to release of the financial assurances. Success criteria must be developed for any containerized plants such as the ironwood or palo verde that will be irrigated to ensure that these species survive at least two years after irrigation has ceased.

15. 19 SMARA Section 2773(a) requires that a monitoring plan be developed that addresses topography, revegetation, and sediment and erosion control." Quantitative performance standards must be specified in the reclamation plan (see following comment). The monitoring plan should discuss frequency and duration of monitoring. For revegetation elements, monitoring should be conducted until performance standards are attained. The reclamation plan states that monitoring will continue for 5 years. Reclamation success in arid lands often exceeds the 5 year monitoring period. Monitoring should be conducted annually until performance standards are attained, with reports submitted to the lead agency and DOC.

16. 20 CCR Section 3705(m) requires that the reclamation plan include performance standards (success criteria) for each vegetation type that will be re-created that can be quantified by cover, density, species-richness, and a sample size that provides a minimum 80% confidence level. As discussed in the site visit, the success criteria provided in the reclamation plan do not adequately meet this requirement. We recommend that these criteria be redefined according to baseline data and submitted to OMR for review.

Administrative Requirements
(Refer to SMARA Sections 2774(b), 2776, 2777, PRC Section 21151.7)

When the revised reclamation plan has been completed, please forward the document to OMR at 801 K Street, M.S. 09-06, Sacramento, CA 95814-3529. As we discussed during the site visit, all technical studies relevant to reclamation of the mine site should be referenced in and appended to the reclamation plan submitted to OMR for review and comment.

If you have any questions on these comments or require any assistance with other mine reclamation issues, please contact me at (916) 323-8565.

Sincerely,

James Pompy, Manager
Reclamation Unit

Enclosures

NATIVE SEED COLLECTION

KAREN WIESE, Plant Ecologist
Office of Mine Reclamation
California Department of Conservation

For thousands of years, seed collecting has been an integral part of all cultures throughout the world. Seeds were gathered for food, trade items, and currency, and wars were fought over the right to collect them (Photo 1). Seed collecting continues to be a worthwhile business as the need to provide site specific native plant seed for revegetation grows by legislative mandate and a worldwide movement to preserve biodiversity.

In 1994, the Federal Native Plant Conservation Memorandum of Understanding (MOU) was established by seven federal agencies to identify priority conservation needs for native plants and their habitats. The MOU states that native plant species are of aesthetic, ecological, educational, historical, recreational, and scientific value to the United States and our native plant heritage should be maintained by ensuring native plant species and communities are conserved on public lands, and promoted on private lands. In fact, the Bureau of Land Management and the U.S. Forest Service have specific requirements for the conservation and maintenance of native plants on mined lands.

In California, the Surface Mining and Reclamation Act (SMARA) establishes legislation that requires mined lands to be reclaimed to a usable condition. Under AB 3551 and AB 3903, revisions to SMARA require statewide standards for the reclamation of mined land, including California Code of Regulations Section 3705(g), which requires native plant species to be used for revegetation except under special circumstances. This article provides guidelines for the collection of seeds of native plants to be used in reclamation projects such as mined-land revegetation. It is an excerpt from the California Department of Conservation's book *Rehabilitation of Disturbed Lands in California*, scheduled for release in early 1997.

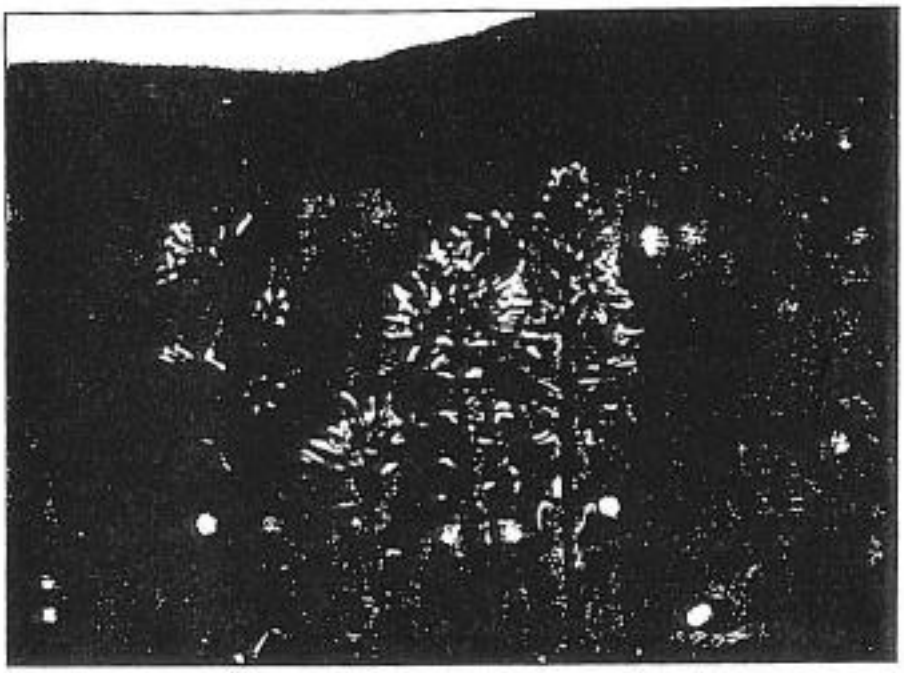


Photo 1. During the 1800s, Native Americans and pioneers fought over land that naturally produced native food staples. The bulbs of the camas lily, *Camassia quamash*, were particularly important to Native Americans but also enjoyed by the pioneers' livestock. *Photo by Karen Wiese.*

The goal of reclamation should be determined before any rehabilitation program begins. The end use of a site dictates what plant species should be chosen for revegetation. For example, if the end use of a site is a residential area, the goal of reclamation is erosion control until the site is developed. The plant species best suited for short-term erosion control may not be native plant species. An inexpensive erosion control mix may be sufficient. However, native plants should be used when the goal of revegetation is creation of open space or wildlife habitat, or reclamation of the site to the pre-disturbance vegetation type. Native plants are those species that existed prior to the European influx in the 1700s. With reclamation of wildlife habitat or open space in mind, species that existed on the site before disturbance and those that have naturally revegetated previously disturbed sites have the best chance to survive. It is these species that have evolved genetically to be adapted to the site-specific conditions of the soil, slope, aspect, and climate. Because of their outstanding adaptability, these plants provide a better chance for successful reclamation and therefore subsequent cost savings. Botanical surveys conducted before disturbance, or surveys of nearby reference areas can assist the reclamationist in developing a palette of revegetation species.

SEED COLLECTION

Once certain plant species have been chosen for the revegetation project, the seed can be collected from the

site by mine personnel or a contract seed collector, or purchased from commercial sources. If seed is purchased from a commercial seed company, it is important to know the origin of the seed and obtain seed from the same geographic location as the project site.

Genetic Considerations

Many plant species comprise local **ecotypes*** narrowly adapted to local climate and **edaphic** conditions (Plummer and others, 1955). The plants with the best odds of survival on a site are those ecotypes growing on (or near) the site (Millar and Libby, 1989). Use of nonlocal plants for revegetation can result in the application of a poorly adapted ecotype, as well as the potential for genetic contamination. Interbreeding of nonlocal and wild local native stock can be adverse and permanent.

Source of Plant Material

When working with sensitive species, geographically unique species, or disjunct populations for revegetation, only very local plant populations should be collected. General guidelines include collecting the seed within the same watershed as the project site, within 500 feet (150 m) elevation of the site, and on the same aspect and soil type.

There are restrictions for collecting plant materials, including seeds, on public land. Permits can be obtained at no cost from the state or federal agency that has jurisdiction over the area. The California Endangered Species and Native Plant Protection acts, administered by the California Department of Fish and Game, require a permit to collect seed of any state-listed species. The U.S. Fish and Wildlife Service can be contacted for federally listed plants.

*Terms in boldface type are defined on page 89.

Timing

The timing of seed collection is critical. Seed has to be collected when ripe and before it falls from the plant, rots, or is eaten. Seeds of native plants don't usually all ripen at once. Therefore, the collector has to visit the plants, take samples, decide when the greatest quantity of seed is mature, and then collect. This process usually takes more than one visit to the collection site. In addition, the seed quality may vary between stands and between years. Therefore, seed may need to be collected over more than 1 year. Care should be taken to obtain a diverse collection by gathering seed from more than one stand within the collection region, picking seed from multiple individuals within a stand, and not stripping a plant. At minimum, seed collections should be labeled with the species, geographic location including elevation, and date of collection. The collection guidelines on page 86 will help minimize inbreeding and diversify the resulting seed lot.

Seed ripening may take several weeks (Mirov and Kraebel, 1939). The characteristics of a ripe or mature seed vary with species, so look for indications in the fruiting structure that holds the seeds. Capsules, berries, and pods will expand and turn darker as seeds approach maturity. Usually seeds that are ripe will easily fall off the plant. One way to determine if a seed is ripe is to slice it in half lengthwise with a razor blade and look through a hand lens for an elongated embryo (Photos 2a, b, c). The embryo should be firm and nutlike, and not too moist.

Longevity

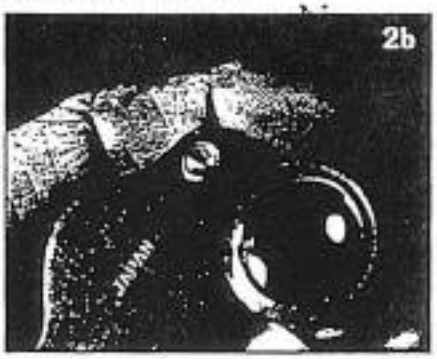
Longevity is the length of time seeds will remain **viable**, which depends on the species. Some plants, such as members of the pea family (Fabaceae) can live for 30 years. Seed longevity studies conducted at Michigan State University recorded seeds properly stored can remain viable for at least 160 years (Raven and others, 1981). California's native plant seeds remain viable for hours to years. Riparian plants, such as willow, cottonwood, and other members of the willow family (Salicaceae), produce seeds that live only a few hours. They die in the wild unless they are dispersed to a moist substrate like a stream bank. Seeds of ceanothus (wild lilacs) can remain viable for 9 to 24 years, depending on the species (Quick and Quick, 1961). Seeds of desert plants can remain viable for extended periods, until sufficient rain has fallen to leach inhibitory chemicals from the seed coat. The amount of water needed to remove the inhibitory seed coat is directly related to the amount of water the desert plant needs to become established. Growers should determine the longevity of their seeds and plan to use them while they are viable.

Periodicity

Some plants do not produce a large seed crop each year. Instead, they may produce more seed one year than another, or not produce any seed at all. Fir, juniper, pine, cedar, and oak are examples of trees that produce large crops of seed at 2- to 9-year intervals (U.S. Department of Agriculture, 1977). This periodicity may make it necessary for the seed collector to wait another year or more until more seed is produced.

COLLECTION METHODS

The most flexible method of harvesting fruit or seeds is by hand (Photo 3). Simple hand tools such as shears and rakes, as well as wire hooks to pull the



Photos 2a, b, c. A hand lens and razor blade can be important tools in determining when seed is ripe. The embryo should appear firm. *Photos courtesy of the California Department of Forestry and Fire Protection (CDFFP).*

limbs closer and cutters mounted on poles, can greatly increase the amount of seed collected.

Mechanical devices can be employed when larger quantities of seed are required. A vacuum harvester is often used to collect from plants that produce large amounts of seed, such as rabbitbush (*Chrysothamnus nauseousus*). The vacuum is mounted on either a backpack or vehicle, and seeds are vacuumed from the ground or plant. Tractor-drawn seed strippers and combines can be used with such shrub species as winterfat (*Krascheninnikovia lanata*) and fourwing saltbush (*Atriplex canescens*). Where large stands of grass occur, culms (grass stems) can be pulled through the mechanical fingers of a stripping device towed behind a truck (Young and Young, 1986). Mechanical tree shakers, first developed by the agricultural industry to harvest nuts from orchards, are often used to shake seeds from trees such as oaks (*Quercus* sp.).

Burlap bags, gunny sacks, and net bags that allow maximum air flow are optimum for transporting seed until it can be cleaned. Plastic bags are not recommended because they hold moisture and encourage the growth of mold.

Grasses

The seeds of grasses can be collected by stripping, either mechanically or by hand. The culms are dragged through the collector's fingers or the mechanical fingers on a truck-mounted or towed stripping device and the seeds fall into a container (Young and Young, 1986).

Herbaceous Plants

Many seeds of herbaceous plants can be collected by hand. These seeds can be harvested directly into a container or apron that is carried or worn by the picker. If the seeds readily fall from the plant, the branches can be shaken to loosen the seeds so they fall into the receptacle.

Some wildflower seeds are wind dispersed or borne in capsules that when mature, **dehisce**, or discharge their seeds. California poppy (*Eschscholzia* sp.) and Lupine (*Lupinus* sp.) are examples of seeds that are actively released from the plant. While this is a wonderful strategy for the dispersal of the species, this physiologic response presents a challenge for seed collectors. Collectors can use a ground tarp to collect seeds, put bags around the branches that are clipped closed to trap the seed, or collect seeds just before they are discharged.

Shrubs

Seed attached to the plant, such as that of Toyon (*Heteromeles arbutifolia*), can be picked or stripped by hand. A good pair of gloves is necessary equipment. Larger seeds, fruits, or pods can be collected by placing a tarp under the tree or shrub and shaking the branches or beating down the seeds

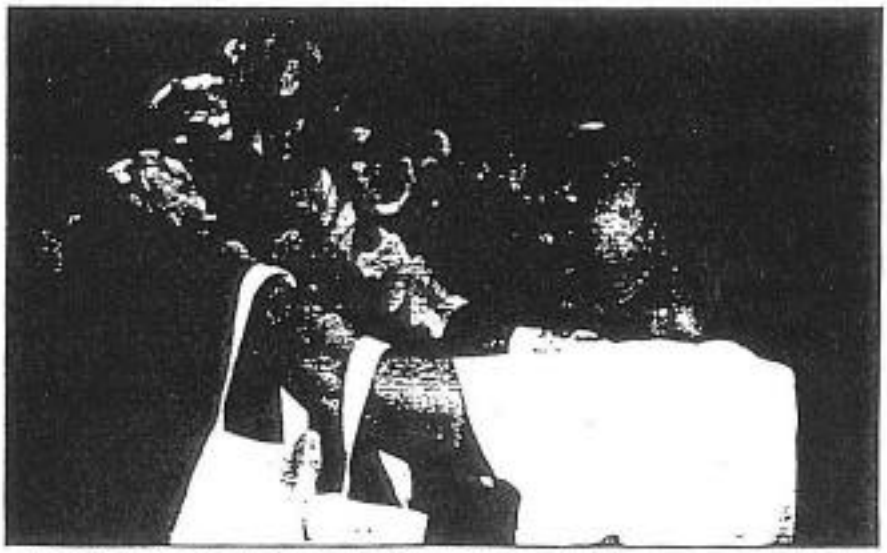


Photo 3. Seed pods of the western redbud, *Cercis occidentalis*, are ripe when red and easily separated from the plant. *Photo by Ken Davis.*

with a stick. California lilac (*Ceanothus* sp.) seeds are discharged at maturity and if not picked just before, can be lost to predation by birds, rodents, and insects that rely on seeds as a food source. The seeds of the desert shrub ocotillo (*Fouquieria splendens*) are also released quickly. The seeds of shrubs that ripen quickly can be collected by placing the seed head in a section of nylon stocking, cheesecloth, or netting (Lippitt and others, 1994).

Cactus

Seeds of spiny shrubs such as cactus can be collected by using the ridged lip of a lightweight 5- to 20-gallon (19- to 75-l) barrel to strip fruits. Salad tongs can augment this effort (Lippitt and others, 1994).

Trees

Harvesting the seeds of trees can present a physical challenge since many of the seeds are out of arm's reach, but many methods have been devised to accomplish the task. Hooking devices on light sectional poles can be extended as much as 50 feet (15 m) above ground (U.S. Department of Agriculture, 1977). Ladders and scaffolds mounted on vehicles can be used in an area where repeated collections will be made and it is economical to establish these temporary structures. Climbing into the tree is often the only method to gather seed, but some can be collected at ground level from

COLLECTION GUIDELINES

A genetically diverse collection of locally adapted plant material will increase the likelihood of success. This principle is behind the seed zones developed by the forest nursery profession for the collection of seed of commercial tree species. Decades of research on a very limited number of species were necessary to develop these seed zones. This type of data does not exist for the remaining thousands of California native plants. Therefore, some assumptions must be made prior to collection to result in a diverse, yet locally adapted, source of plant material. The following collection guidelines are condensed and modified from Guinon (1992), and can be used for most species. However, these guidelines are not appropriate for narrowly endemic species or rare and endangered species.

1) Collect at sites closely related ecologically to planting sites. Collection need not be restricted to project boundaries, but should be restricted by ecological boundaries (watershed, elevation, aspect, rainfall, etc.). Some indication of the genetic boundary of a species can be gained from the pollination strategy of the plant. The genes of a wind pollinated species will be more broadly distributed than those of insect pollinated species.

2) Collect propagules from 50 to 100 individuals spaced 325 feet (100 m) apart, rather than from a few close relatives, to limit inbreeding on the rehabilitation site and diversify the gene pool. Wind pollinated species such as pine can be collected within a 1-mile (1.6-km) radius.

3) Avoid growing donor plants in proximity to closely related exotic species (where genetic contamination may have occurred).

4) Document and label the genetic origin of the material until it is installed on the rehabilitation site.

5) Collect into net, cloth, or burlap bags, not plastic, to avoid moisture buildup and proliferation of detrimental fungi.

Though seed zones were developed for forestry crops, they can be adapted to all seed collecting. Zones refer to areas of regional similarity so collections should be made within the same seed zone as the project. *Modified from California Division of Forestry map, 1970.*

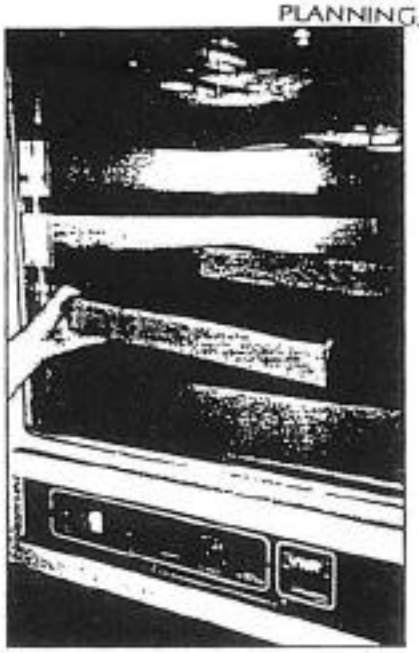


Photo 4. Cardboard box lids can hold seeds during the drying process. *Photo by Karen Wiese.*

Photo 5. Seeds can be sifted through a screen to remove unwanted material. *Photo courtesy of CDFFP.*

drooping branches or felled trees. Sometimes, seed from lower branches does not undergo pollination from wind or insects. These seeds do not fully develop and are not optimal to collect. Opening a cone or seed pod will reveal whether seeds have formed.

SEED PROCESSING

Drying

Drying seed reduces the chance of fungal infestation and aids in cleaning. Seed can be dried in open trays in a greenhouse, on an office desk, in an oven with a pilot light on, in the sun on a tarp (with provisions to protect from wind and precipitation), or in a dehydrator or drier (Photo 4). However, not all species' seeds can be successfully dried and stored. Acorns and the fleshy seeds of hollyleaf cherry (*Prunus ilicifolia*) cannot be dried without damage and must be collected fresh every year. Seed that can be dried takes a day to a week, depending on the humidity and species. Professional collectors dry the seed to approximately 7 to 14 percent seed moisture content. Viability will deteriorate through time, but with proper storage this effect can be minimized.

Photo 6. Using clean seed (on the right) will increase seeding accuracy and reduce storage volume. *Photo courtesy of CDFFP.*

Cleaning

Cleaning seed, often referred to as threshing, reduces storage volume and moisture, increases accuracy regarding the amount of seed to be placed on the site, diminishes the possibility of contamination with weed species, and minimizes the chances of fungal or insect infestation. Cleaning entails removing the seed from the stems and **chaff**, and seeds of another species. Depending on the species, the desirable end product may be pure seed, or seed encased in the capsule or protective shell.

Threshing methods such as hand sieving seeds through a screen, can be done in the field. This process consists of screening the seeds or fruits through a screen with large enough holes to allow the seeds or fruits to drop through but not the chaff (Photos 5 and 6). Seeds can also be cleaned simply by using a slant board. Using a gloved hand, the seeds are rubbed against the slant board or screen and gravity separates heavier material (seed, sand, and rocks) from the lighter chaff. Other seeds can be separated from the chaff by rubbing them against fine sand paper. Seeds that have a fleshy covering, such as those of coffeeberry (*Rhamnus californica*) and toyon (*Heteromeles arbutifolia*), can be removed from the pulp by hand or put through a meat grinder (Photo 7). The meat grinder will free most of the flesh from the seed, and the remaining pulp must be separated from the seed by washing, drying, and using an air separator to remove the dried skin.

The seeds of most conifer cones require drying to open them. Once dried, the cone can be cut or whacked with a hammer, and seeds can be shaken out and separated from the cone scales and debris.

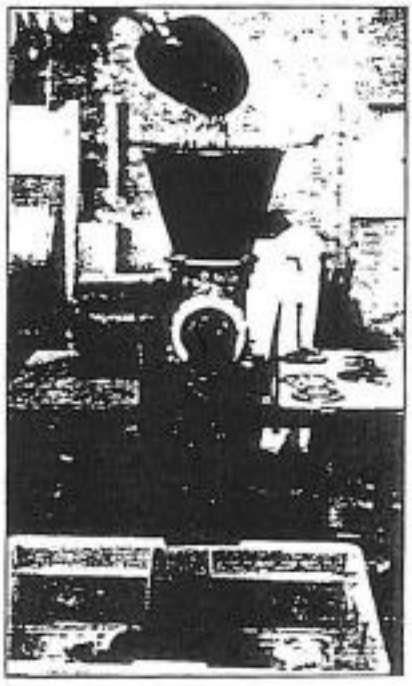


Photo 7. A meat grinder, fitted with the correct size plate, can remove most of the pulp from the seeds. *Photo courtesy of CDFFP.*

Seed Separators

Harvested seed often contains the seeds of other plants and empty or non-viable seed. To improve the purity, the seeds are put through an air separator which blows air to separate materials by weight (Photo 8). A hair dryer, on a low setting can also be used to blow light-weight material from the seeds.

Photo 8. When large quantities of seed need to be separated, an air separator should be used. *Photo by Karen Wiese.*

Disease and Insect Control

Cleaned stored seed can be ruined if insects and fungi attack. Most insects and fungi can be controlled by keeping the seed in dry, near-freezing or sub-freezing storage. With some plant species, these cold temperatures will kill the seed. An effective insecticidal treatment is emersion in a solution of one part Malathion in five parts water. This is followed by drying the seeds and dusting them with 5 percent Sevin (Lippitt and others, 1994). Sevin will remain in proximity to the seed during sowing and may inhibit beneficial **mycorrhizal** fungi.

Fungicides can be toxic to some seeds and may be avoided entirely by surface-sterilizing the seeds with a 90-second hot water soak followed by drying and storage. Substituting hot vegetable oil is also effective. The seeds do not easily absorb the oil so the embryo is not as likely to be affected (Lippitt and others, 1994).

SEED PREPARATION SERVICE

Often, seed collectors will rely on experts to clean, dry, and store seeds, or even plant and bring them to the seedling stage. Seed cleaning, storage, testing, and growing is done for a fee by COFFP, L.A. Moran Reforestation Center in Davis, California. Laurie Lippitt, Manager, can be reached at (916) 322-2299.

SEED STORAGE

The two most important factors for optimizing stored seed longevity are low temperature and moisture content. When storage conditions are not ideal, seed should be tested for viability prior to usage. The containers used to store the seeds should be rodent and bird proof. Seed should be checked regularly and those with signs of mold and mildew discarded.

COLD STORAGE

A Yukon mining engineer found seeds of the arctic tundra lupine (*Lupinus arcticus*) in a frozen lemming burrow that were carbon dated to be at least 10,000 years old. With their cold requirement met, the seeds germinated within 48 hours of planting (Raven and others, 1981).

SEED DORMANCY

Seeds do not grow at the same rate throughout the year. During unfavorable conditions, such as water scarcity or low temperature, plants limit their growth or cease to grow. Dormancy is a physiological condition of arrested growth. After periods of dormancy, growth resumes when limiting factors such as temperature, water, or light become available again. The delay in germination until conditions are right optimizes the survival of the species. If seeds were to germinate when they ripen during summer, the young plants would have difficulty with the hottest part of the year.

The seeds of some desert species germinate only when sufficient rain has fallen to leach inhibitory chemicals, an amount directly related to the seedling's needs. This is why, in some years following high rainfall, the desert puts on a spectacular show of flowers, with some plants blooming for the first time in 15 years.

Seed Storage Temperature

Once the seed is dried and cleaned, it needs to be stored in a cool, dry place. Seed will last the longest if stored at 0 degrees Fahrenheit (-18° C) at low humidity. Small amounts of dry, clean seed can be placed in an airtight jar and left in the back of a refrigerator until needed. Many commercial growers leave a 1-to-2-inch- (3-to-5-cm-) wide opening in plastic storage bags to allow for gas exchange. Larger amounts of seed may require commercial-size refrigerators.

If seed has the correct low-moisture content, freezing is best. If seed is not dry enough, storage below freezing subjects the embryo to ice crystal damage.

It is often thought that once seed has been collected it can be immediately planted, either direct seeded at the site or in the nursery in containers. The seeds of most annual plants will germinate with no difficulty within

several weeks. However, the seeds of most perennial plants have a natural mechanism that prevents them from immediately germinating when mature. To break dormancy, perennial plant seeds take 3 to 6 weeks and often longer and may require a combination of chemical, temperature, or light treatments.

Determining the correct seed pretreatment to overcome dormancy can be a challenge to anyone interested in growing native plants, but *Seed Propagation of Native California Plants* (Emery, 1988) is helpful in this regard. Treatments to break dormancy include scarification (scratching the seed coat—such as with sand paper or acid), stratification (placing the seeds between moist papers at low temperatures), soaking either in cold or hot water, chilling, exposure to elevated temperatures, exposure to a certain type of light (white versus red), exposure to a specific duration of light, fluctuating temperature, chemical treatments, and any combination of these.

FIRE INDUCED GERMINATION

Some species of plants have seeds that require fire for germination. In nature, the seeds of these plants have adapted to sprout after fire. Either intense heat from fire melts or cracks the seed coat, or a chemical stimulates germination after the wood is allowed to char (Keeley and Keeley, 1994). Chaparral species, such as California lilac (*Ceanothus* sp.) and some species of manzanita (*Arctostaphylos* sp.) are well known for this survival strategy. To get these species to germinate in the nursery, growers simulate a wildland fire by sowing the seeds in soil in a fireproof tray, covering them with a layer of pine needles 4 to 6 inches (10-15 cm) deep, and igniting the needles (Emery, 1988). After the seedbed has cooled, it is watered thoroughly and treated as any batch of seeds. This is often enough to break the dormancy of these fire adapted species.

REPRODUCING PLANTS WITHOUT SEED

Some species of plants do not produce adequate amounts of viable seed and need to be propagated vegetatively, from cuttings or underground roots. With a little practice and some experimentation, a grower can determine which species can or are best propagated vegetatively, since they usually resprout readily in the wild. The best candidates are those that produce underground stems (rhizomes) or above-ground, horizontal stems (stolons) from which new plants arise, such as is common with sedges and rushes, or plants that can be grown from bits of stem, such as willows and blackberries. Plants often propagated vegetatively include willow species (*Salix* sp.), cottonwood (*Populus* sp.), blackberry (*Rubus* sp.), dunegrass (*Leymus mollis* ssp. *mollis*), saltgrass (*Distichlis spicata*), pickleweed (*Salicornia* sp.), and red alder (*Alnus oregona*).

Some species, such as shad-scale (*Atriplex canescens*) and blackbush (*Coleogyne ramosissima*), can be very difficult to grow from seed and are best grown from cuttings or from seeds germinated in a greenhouse and planted in containers outdoors. Obviously, growers need some familiarity with the life cycle and ecology of the desired species to make these decisions. The availability (or nonavailability) of seeds or plant materials may determine the choice of propagule.

ACKNOWLEDGMENTS

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GLOSSARY

Chaff: The husks of grain after separation from the seed.

Dehisce: The opening of an anther, fruit, or other structure to permit the escape of the reproductive bodies, such as seeds.

Ecotype: A locally adapted variant of an organism, differing genetically from others.

Edaphic: Pertaining to soil conditions that influence plant growth.

Endemic: Pertaining to a highly localized distribution.

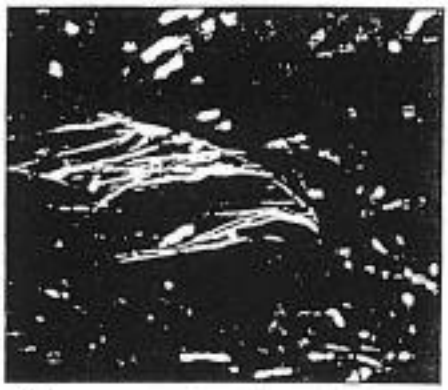
Exotic species: A species that originated in another geographic area. Yellow star thistle and dandelions, native to Europe, are examples of non-native or exotic plants.

Mycorrhizal: The favorable combination of the hyphae of certain fungi with the root of a plant, where the fungi aid in the absorbtion of water and nutrients.

Propagule: The part of a plant that is used to reproduce the plant vegetatively, for example by leaf, stem cuttings, or root.

Viable: Capable of germinating or growing under favorable conditions.

The perennial plant rabbitbrush (*Chrysothamnus* sp.) grows well in dry, disturbed sites. *Photo by Karen Wiese.*



Native grasses such as this needlegrass (*Nasella* sp.) are growing in popularity and availability. *Photo by Karen Wiese.*

Native legumes such as this lupine (*Lupinus* sp.) have the ability to convert atmospheric nitrogen to a form that can be used by the plant. *Photo by Karen Wiese.*

Cypress, mountain mahogany, larkspur, and needlegrass illustrations are by Mary Ann Showers. Ceanothus and black oak acorn drawings are from Mirov and Kraebel (1939). Buckeye seedling is from U.S. Department of Agriculture (1977).

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Nursery Sources for California Native Plants (Showers and Wiese, 1995) is a good reference for seed suppliers and people who will custom-collect seed for a project. It lists more than 1,400 taxa and the nurseries that supply each. The source of purchased native plant seed should be as close to the project site as possible. *Nursery Sources*, OFR 90-04, can be purchased for $10.00, prepaid, from:

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Division of Mines and Geology
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