Crest as scenic backdrops. The unlogged east section has a very high density of old-growth sequoias. Much of the western part of the grove was heavily logged before 1920 in a fascinating railroad logging episode. Old-growth stumps and vestiges of the early logging era give the grove unusual historical interest. Much of the logged section has recovered a scenic forest cover, including abundant young sequoias, mixed with scattered old-growth survivors.

D. McIntyre Grove: This is another large grove with a high density of surviving old-growth sequoias. It is part of the viewshed of Highway 190 east of Camp Nelson.

E. Packsaddle and Kennedy Groves: These are medium-sized, trailless, wilderness condition groves, which remarkably survive in old-growth condition adjacent to heavily logged non-grove timberland. These groves exemplify how even smaller groves can serve as impressive preserves of old-growth mixed-conifer forest, as well as sequoia preserves. Kennedy Grove has the ninth largest known sequoia (the Ishi Giant, discovered by the author in 1993, size ranking and volume computation by Wendell Flint) *(fig. 1)*. Packsaddle Grove has numerous exceptionally large specimens, including the Packsaddle Giant, a sequoia with a larger base than the General Sherman Tree (Flint 1987).

Even within National Parks, many major grove resources are relatively unknown. In particular, the relative remoteness of many Sequoia National Park groves has discouraged visitation and study. About 15 of the Park's groves are accessible only by rugged, sometimes even hazardous, cross-country routes. Park groves without trail access include Eden Creek Grove, one of the largest Park groves, and smaller Oriole and Suwanee Groves, which are known for having unusual concentrations of exceptionally large specimens.

It is important to emphasize that the USDA Forest Service has the largest single ownership of sequoia grove acreage (Author's calculations, confirming Meyer and others 1952) because some past academic authorities (e.g., Hartesveldt and others 1975) and outdated public agency interpretive materials (e.g., 1993 display at Sequoia-Kings Canyon National Parks' Grant Grove Visitor Center) have incorrectly maintained that most grove acreage was in National Parks. Such error fosters the mistaken impression that most grove acreage was protected by a legislative mandate that groves should be managed only for National Park purposes, which exclude commercial timber harvest. No such legislative protection exists for the National Forest groves, as illustrated by heavy logging of several Sequoia National Forest Groves for non-sequoia timber in the 1980's. In the absence of protective legislation, the only way to protect National Forest Groves is through the USDA Forest Service planning and land management process.

Non-Sequoia Resources within Groves

Sequoia groves have major resource values worthy of preservation aside from the old-growth sequoias. However obvious this perspective sounds, it has been lacking in much commentary on groves which focused preservation concerns solely on old-growth sequoias. A narrow view of grove resources has been expressed, for example, in disinterest or disdain for current resources of logged groves. In agency

Figure 1-Ishi Giant, Kennedy Grove. Though severely burned, this remote giant is 25.5 ft dbh counting buttresses, thicker than the General Sherman Tree. It was not definitively identified and measured until 1993, which suggests that other distinctive sequoia resources are yet to be discovered.

management, the narrow perspective resulted in heavy grove logging for non-sequoia conifers as recently as 1986.

Aside from their mature sequoias, many groves have some of the best remaining non-sequoia old-growth mixed-conifer forest in the Sierra Nevada and many of the largest individual pine, white fir, and incense cedar specimens. Old-growth groves also provide valuable wildlife habitat for southern spotted owl and other old-growth dependent species. This is particularly true in several grove areas (e.g., Long Meadow Grove) which are now small islands of old-growth surrounded by area in which logging has virtually eliminated old-growth habitat. Also, maturing young sequoia stands, most conspicuous in groves logged during the sequoia logging era, are a major resource not to be taken for granted. Some relatively "young" post-logging sequoia regeneration is now over a century old and larger than typical non-sequoia old-growth conifers.

The non-sequoia values within sequoia groves have been well publicized on occasion. For example, the need for protection of the exceptional old-growth sugar pines of the South Calaveras Grove area was stressed in the successful 1950's campaign for public acquisition of that grove. Non-sequoia values in groves are recognized in National Park and State Park protective management policies.

In contrast, 1980's grove management planning by Sequoia National Forest characteristically devalued non-sequoia grove resources, except as commercial timber. The apparent management assumption, permitted by applicable regulations, was that sequoia groves could be intensively logged, so long as old-growth sequoias were preserved. An example of the Forest's devaluation of non-sequoia resources was the heavy 1980's "whitewood" (non-sequoia conifers) logging in Black Mountain Grove. The logging fragmented a large block of old-growth forest wildlife habitat and cut some of the largest individual sugar pine specimens on the Forest, aside from scenic degradation and other drawbacks of clearcut logging. But the planning documents for that timber harvest did not even identify or discuss the issues of wildlife habitat fragmentation or elimination of rarely large conifer specimens (Sequoia National Forest 1983). Another example of past oversight of grove resources was Forest Service failure to discover that Starvation Creek Grove had an active California condor nest. Condors there were discovered only during 1984 logging operations.

The largest diameter southern Sierra Nevada sugar pine specimen that I am aware of (about 9 ft diameter at the cut) was harvested in the 1980's Black Mountain Grove logging. That may have been the largest sugar pine in Sequoia National Forest. Even if it was not, it was an extremely rare tree of scientific value. Nine-foot dbh (diameter at breast height, i.e. 4.5 ft above the high point of the ground) sugar pine in the southern Sierra, if any still exist, are almost certainly rarer than even 20 ft dbh sequoias. Such exceptional non-sequoia conifers in sequoia groves deserve to be inventoried and protected. They should not be categorized as nondescript commercial timber in Forest Service planning. Such trees may also be of commercial forestry value as a seed source if they are blister rust resistant.

To my knowledge, no Sierra Nevada national forest identified preservation of exceptionally large non-sequoia conifer specimens as a general issue or goal in their Forest Plans prior to January 1993, when interim guidelines were issued by the California Regional office of the Forest Service in order to protect conifers at least 30 inches dbh from logging in certain southern spotted owl habitat. Current interim protective policy should not erase memory that the 1993 management imperative for protection of old-growth spotted owl habitat and large individual conifers was not yet an official posture at the 1992 Giant Sequoia Symposium, and hardly considered in Sequoia National Forest grove management planning less than a decade earlier.

Many sequoia groves have lost much or all of their overall old-growth forest character because of past logging of non-sequoia conifers. "Whitewood" logging has been far more extensive in groves than logging of sequoias themselves. The amount of sequoia grove acreage which is generally old-growth forest habitat is considerably less than the acreage in which the old-growth sequoias themselves survive. Beyond the groves, huge old-growth ponderosa and sugar pine specimens have been logged almost to extinction in every accessible, unprotected area of the Sierra Nevada west slope. The remaining non-sequoia old-growth pine, fir, and incense cedar growing with the sequoias should be treasured, just as the old-growth sequoias themselves. The sequoia groves where such large old-growth specimens remain provide some of the best remaining opportunities to preserve areas of high quality mixed-conifer old-growth forest.

Sequoias as Rare Individual Plants

Sequoias are not generally thought of as rare plants, in the sense of being extremely limited in total population. This is an oversight with respect to the exceptional, largest size specimens (e.g., >15-16 ft dbh). In my view, the total population of a few thousand sequoias in the largest size classes is so limited that each such specimen should be valued as an individual rare plant, rather than just as a generic example of a mature sequoia type.

It is not surprising that sequoias, considered as an undifferentiated species, have not been perceived as rare. Sequoias are abundant within many of their natural groves, and young planted sequoias thrive in many sites outside of the natural groves. However, sequoias should not be considered merely as a relatively undifferentiated species. Unfortunately, that has been a common practice. Except for recognition of famous, near-record size specimens (range-wide or locally), land managers and writers on sequoia subjects have tended to casually lump sequoia subpopulations into two broad categories, old and young. More specifically, reference is made to "mature" or "old-growth" sequoias, the focus of awe and conservation concerns, on the

one hand, and "young" sequoias (also commonly referred to in the context of logged lands as "regeneration" or "second growth") on the other hand. There is typically not much discussion of the differences within each of these two broad categorizations, with regard to the natural groves.

In particular, the sequoia literature and grove management documentation do not contain much discussion of the differentiation among types (or subpopulations) within the various size classes of the category of "mature" or "old-growth" sequoias. For example, 1980's National Forest regulations classified sequoias as either "specimen" trees (those at least 8 ft diameter 6 ft above ground, which were protected from cutting) or as smaller trees which could be cut. (See Sequoia National Forest 1985 Environmental Impact Statement glossary and Forest Service Manual Sec. 2471 as of 1985.) National Park and Forest Service regulations do not differentiate among the largest sizes of "specimen" sequoias (except possibly for a few famous named trees), either in terms of resource values or management prescriptions. Yet, in the field, who does not recognize the striking difference between a relatively common 8 or 9 ft dbh "specimen" (which in highly favorable circumstances could be as young as 200-300 years old) and a singular, wonder-of-the-world, 20+ ft dbh (and 1,500+ years old) specimen? The obvious difference in kind should be reflected in evaluations of sequoia resources and in management prescriptions.

Mature sequoias are not a homogenous group. When the sequoia population is considered in terms of its subpopulations within various size classes, it is clear that the exceptionally large sequoia specimens (e.g., >15 ft dbh), which most engender awe of the species and represent it in the public eye, are actually very unrepresentative of the total large sequoia population. In particular, the erratically scattered population of the few thousand largest individual sequoias is so limited that it is reasonable to consider each of them to be a rare plant.

Despite the largely incomplete state of available sequoia inventory data, enough data exist to support my conclusion that there are now fewer than 5,000 individual sequoias which are at least 15 ft dbh. More narrowly defined subpopulations of larger diameter sequoias (>16 ft dbh, >17 ft dbh, etc.) decline dramatically in absolute numbers compared to smaller diameter class subpopulations of mature trees (e.g., see sequoia inventory data for Sequoia and Kings Canyon National Parks, Hammon, Jensen, and Wallen Associates 1964, 1970, 1975, 1976, Western Timber Service, Inc. 1970.). By my calculations, fewer than 800 sequoias in the entire Sierra Nevada are now at least 19 ft dbh. Sequoias 20 ft dbh or larger are extremely rare. Fewer than 75 sequoias are now 22 ft dbh or more, scattered among less than a quarter of the groves.[3]

To better appreciate the rarity of the largest size classes of sequoias, one should consider that, even in an unlogged grove, sequoias at least 10 ft dbh, though common, are almost always a relatively small minority of the sequoias >1 ft dbh in the grove. They are usually also a minority of the large (e.g., at least 5 ft dbh) sequoias in the grove. Such 10 ft dbh or larger sequoias, though common in unlogged groves, are not representative of the "average" or typical large sequoia.

Sequoias at least 10 ft dbh were found to be less than 20 percent of the sequoias at least 1 ft dbh in two very large old-growth groves in Sequoia-Kings Canyon National Parks (18.3 percent in the National Park section of Garfield-Dillonwood Grove and 16.9 percent in the National Park section of Redwood Mountain Grove). Sequoias at least 10 ft dbh are usually still less than 50 percent of the subpopulation of sequoias at least 5 ft dbh in unlogged old-growth groves (e.g., 48 percent in Giant Forest, 43.1 percent in the National Park section of Garfield-Dillonwood Grove, and 37.3 percent in Muir Grove). Sequoias at least 10 ft dbh were only about 19.1 percent of all sequoias at least 1 ft dbh, and only about 46.2 percent of those at least 5 ft dbh in the total sequoia inventory of the largest available sequoia inventory data base-that for all Sequoia and Kings Canyon National Parks' groves (inventoried 1964-76).[4]

By my calculations, the entire Sierra Nevada population of sequoias at least 10 ft dbh is certainly lower than 25,000 trees, and probably lower than 22,000. (The comprehensive Sequoia and Kings Canyon National Parks' sequoia inventory identified 10,184 sequoias as at least 10 ft dbh.) The total is almost certainly steadily increasing in recent times. At present, significantly more sequoias are growing to 10 ft dbh or larger than the number of sequoias that size that die, in the Parks and probably among almost all groves.

Sequoias at least 15 ft dbh are truly exceptionally large examples of the species. Relatively few mature sequoias that have attained literally "giant" proportions at least 10 ft dbh have grown to 15 ft dbh or larger. For example, the full Sequoia-Kings Canyon National Parks' sequoia inventory showed that only 2,463 specimens there were at least 15 ft dbh. This total was only about 24.1 percent of those at least 10 ft dbh, and only 11.2 percent of those at least 5 ft dbh.

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[3]Present lack of comprehensive sequoia inventory data for more than 35 percent of the grove area (by my calculation) prevents exacting estimates of all sequoia size class subpopulation ranges. (Most Sequoia National Forest groves lack comprehensive inventory data.) But enough unpublished data cumulatively exists (from numerous sources) to support reasonable estimates of subpopulations within approximate ranges for the exceptionally large size classes of sequoias in the entire range.

All sequoia inventory statistical analysis in this paper concerning Sequoia-Kings Canyon National Parks' groves is derived from the inventory data in Hammon, Jensen, and Wallen Associates (1964, 1970, 1975, 1976) and Western Timber Service, Inc. (1970), and from unpublished summary data concerning those inventories which was prepared by National Park Service staff, and which is on file at Ash Mountain offices, Sequoia National Park. In those inventories, sequoia diameters larger than 1 ft dbh were rounded to the nearest foot. This rounding-off is reflected in my discussion of that inventory. I also relied on the summary data computations, from the Park Service staff, of individual and overall grove acreages. These reflected the area of actual sequoia occurrence, rather than all area within a grove perimeter, which is often larger.

[4]Inclusion of the inventory data for the small amount of the Parks' grove area that was historically logged only slightly skewed the total sequoia inventory towards smaller size classes.

Groves like Giant Forest and Redwood Mountain Grove each have hundreds of sequoias at least 15 ft dbh. But this relative local commonality of exceptionally large specimens should not obscure their overall rarity. By my calculations, nearly 80 percent of all sequoias at least 15 ft dbh occur in only 8 large groves. Several groves have no sequoias that large (e.g., unlogged Cahoon Creek, Surprise, and Placer County groves, and logged Cherry Gap and Indian Basin groves), or less than 4 specimens that reach that size (e.g., unlogged Coffeepot Canyon, Dennison, Horse Creek, New Oriole, Pine Ridge, and Sequoia Creek groves in Sequoia-Kings Canyon National Parks). Even sequoias less than 15 ft dbh can also be considered as rare, in a local sense (e.g., the relatively few largest mature and old-growth sequoias which survive in heavily logged Converse Basin Grove). It reinforces the perception of rarity to remember that each sequoia at least 15 ft dbh is larger in dbh than almost all non-sequoia trees in the world, including almost all old-growth coast redwoods.

Recognition of the rarity of some sequoia specimens has management implications. Special efforts should be made to protect the rare sequoias. At a minimum, management should abate unnaturally extreme fire hazards in the immediate vicinity of rare sequoias, even if more widespread fuel management in the grove is not yet a management priority. Such specimens, which usually have fire scars vulnerable to re-ignition, should be carefully protected during management controlled burns, and given some recognition in wildfire suppression plans. Currently there is no National Forest policy to take special precautions against fire risks to what I regard as rare sequoias.

Management recognition of rarity can also promote public appreciation and enjoyment. In many groves, a visitor has little chance of finding the grove's largest specimens without trails or guidance. Several opportunities exist for providing visitor access to now-ignored clusters of rare sequoia specimens with new construction of a few short trails.

Undervaluation of Groves Where Sequoias Were Logged

Though no one asserts that logging has literally eliminated a grove, the misleading sense that logging has permanently eliminated all of a grove's sequoia values has often been communicated. This descriptive pattern has diverted attention from the high sequoia values that remain in groves which have suffered heavy old-growth sequoia logging. Regret about past logging should not lead to the wrong conclusions that logged groves no longer have significant sequoia resources, that they cannot regain an old-growth for-est character, or that they no longer need careful stewardship.

Many discussions of Converse Basin Grove, where the most extensive early sequoia logging occurred, exemplify the common tendency to unreasonably devalue the present resources of logged groves. Some prominent authors erroneously described the grove as if there was nothing left there by the early loggers. Walter Fry and John White, who served a total of more than 30 years as superintendents of Sequoia National Park, incorrectly asserted in printing after printing of their *Big Trees* book that every sequoia in Converse Basin Grove was logged except for the Boole Tree (e.g., Fry and White 1946). A prestigious National Park Service publication (Hartesveldt and others 1975) repeated that exaggeration. The error is puzzling, since surviving old-growth sequoias are readily apparent on the busiest grove road (to the Boole Tree trailhead) on the forest horizon only a few hundred yards west of the grove's famous "Stump Meadow" *(fig.2)*. A mundane example of the "past tense" type of thinking about logged groves is the 1993 Kings Canyon National Park interpretive sign at the Redwood Mountain Grove overlook on Highway 198, which states that Converse Basin was "once" the largest grove. Despite logging, Converse Basin Grove has not ceased to exist, nor significantly shrunk.

Some conservationists' priorities have also reinforced the attitude that logged groves are of far less concern than old-growth sequoia groves. In 1990, most conservationist appellants challenging the Sequoia National Forest management plan (Sequoia National Forest 1988) settled their appeals with an agreement (Sequoia National Forest 1990) which included provisions that barred commercial logging activities in all Forest groves during the current planning period, *except* in Converse Basin Grove. This signaled a uniquely lower level of concern with that grove.

The present and future sequoia values of logged grove areas should be recognized. First of all, most areas that suffered sequoia logging were not totally logged of old-growth. For example, heavily logged Nelder Grove retains 108 old-growth sequoias (Hawksworth 1979), including the Nelder Tree, the second largest known sequoia (in volume) in the eight groves north of the Kings River (See Flint 1987.). Nelder Grove probably has about 30 or more sequoias over 15 ft dbh (see Hawksworth 1979). Logged Nelder Grove has more surviving old-growth sequoias and more exceptionally large sequoia specimens than occur in several unlogged groves. Evans and Mountain Home Groves, and the University of California's Whitaker Forest section of Redwood Mountain Grove are other examples of groves with once heavily logged areas that retain many old-growth sequoias.

Second, sequoia stumps and logs which remain from early logging are highly interesting features. Many sequoia stumps provide the opportunity to review thousands of years of environmental history, reflected in tree rings. Available tree-ring studies indicate that in most areas where substantial old-growth sequoia logging occurred, there are commonly stumps of sequoias aged >1,000 years (Huntington and others, 1914).

In addition, many logged grove areas have sequoias that, while not old-growth, are significantly older than post-logging sequoia regeneration. These older types of relatively "young" sequoias, along with any residual old-growth,

Figure 2-Converse Basin Grove has scattered surviving mature sequoias. This old-growth cluster is west of Stump Meadow.

provide an older tree component of generally younger forest stands in logged areas. While most sequoias in logged grove areas regenerated after early logging, numerous surviving non-old-growth sequoias predate the early logging by decades, if not longer. While I am unaware of any systematic age studies of surviving large, but not old-growth, sequoias in logged grove areas, the size (in the range of 5 to 7 ft dbh) and/or rounded or rounding crown form of many present sequoias in such areas indicates that they are well over a century old. Many may be two centuries old or more.

This survival of pre-logging conifers in some logged grove areas like Converse Basin is not as surprising as it may sound. Historical photos and anecdotal reports show that much of the early grove logging was selective. Early loggers often ignored smaller trees (though many were destroyed in the process of harvesting the larger trees or in subsequent fires). My own limited, unsystematic tree ring studies of several pine and fir stumps cut in the 1980's in Converse Basin Grove (which were adjacent to old-growth sequoia stumps cut by the early loggers) showed that several were between 150 and 200 years of age when cut. This also indicates the early logging practice of sparing many small conifers.

Historical logging, however regrettable, has left vestiges aside from stumps which are interesting today. The human saga of the early logging era has an undeniable fascination. Resource destruction is an inescapable aspect of western Americana. The dirt roads to Cherry Gap Grove from the west and in Evans Grove largely follow pre-1920 logging railroad routes.

Finally, because of the good growing sites in groves, generally excellent sequoia regeneration in areas logged before 1920, and the common rapidity of young sequoia growth, much of the logged grove areas have recovered a scenic appearance dominated by impressive medium-sized sequoias. Many of these trees are now 3 to 6 ft dbh, and many may grow to the dimensions of what the Forest Service has called "specimen" size within the next century. Many grove sites logged a century or so ago can soon recover many old-growth forest characteristics.

Logged grove areas should still be regarded as prime grove areas which deserve protection. Those areas typically also have a road system, facilitating public recreation.

Globally Significant Converse Basin Grove

Converse Basin Grove should be recognized and studied as one of the world's most fascinating forest heritage sites for numerous reasons. The grove is probably the second largest in area, after Redwood Mountain Grove. Subjectively, it once might have been considered the most impressive of all groves in its primeval condition (c. 1890). The grove's size and high density of sequoia stumps makes it reasonable to conclude that it had one of the very largest, if not the largest, primeval population of mature sequoias, of any grove. (Cf