ALTERNATIVES FOR RESTORATION OF HETCH HETCHY VALLEY FOLLOWING REMOVAL OF THE DAM AND RESERVOIR

Contents of this paper regarding the restoration of Hetch Hetchy Valley following removal of the dam and reservoir are drawn from general ecological principles and a knowledge of local ecosystem dynamics and topography. This proposal is based on the best information immediately at hand. and is designed to provide a reasonable evaluation of restoration alternatives and end results. Any more detailed consideration must be based on intensive literature search, professional contacts and detailed habitat evaluations. Due to the uniqueness of this undertaking. unanticipated problems and costs should be expected and planned for in the funding process, such as the possible need to propagate animal species unable to naturally recolonize the valley.

This paper makes and discusses the following assumptions as a necessary prelude to the development of alternatives:

ASSUMPTIONS

1) 0'Shaughnessy Dam would be removed down to the original level of the river bed. The original stream gradient and water table would be approximated in the restored valley.

2) Sediments are thin over most of the valley and would not need to be removed.

3) The river would reoccupy its original channel without human assistance.

4) The Park would not attempt to insure the restoration of all plant taxa that originally inhabited Hetch Hetchy Valley.

5) The Park would acquiesce to the invasion of many common non-native plant taxa into Hetch Hetchy Valley.

6) Extensive and intensive herbicide spraying would not be permitted.

7) Mechanical obliteration of scars left by dam construction activities would be carried out in preparation for revegetation.

8) All animal species endemic to the Hetch Hetchy Valley, except grizzly bears and wolves. currently exist in viable populations. in suitable habitat, immediately adjacent to the river canyon.

9) Some wildlife species may reoccupy recovering sites in such abundance to inhibit vegetative recovery or, if predators, recovery of other animal species.

10) Earthworms and other soil organisms, and airborne invertebrates will be naturally returned to the Hetch Hetchy Valley in a reasonable period of time without intervention.

11) Although wildlife restoration is not anticipated to be a major problem, animals with low mobility may need management assistance to accomplish recolonization.

12) Due to the nesting of endangered Peregrine Falcons in Hetch Hetchy Valley, all blasting and other activities that produce loud and sudden noises, during the critical nesting season. January 1 through August 1, will be individually approved by the Superintendent, Yosemite National Park.

13) The aquatic ecosystem of the Tuolumne River will return to near pristine conditions without management intervention

14) The "bathtub ring" on the cliffs surrounding the reservoir would disappear naturally, in time, without management intervention.

15) For alternatives 2 and 3, the dam would remain in place for the staged draining of the reservoir. Demolition of the dam would begin in year 6 of the restoration project.

DISCUSSION OF ASSUMPTIONS

1) The dam site was excavated 118 feet below the river bed to prepare a suitable footing for the dam (the river was diverted through a tunnel on the south side of the valley while this excavation was in progress). The removal of the lower 118 feet of the dam would vastly change the river gradient at the narrow lower end of the valley and would probably lead to rapid erosion of the meadows in the lower chamber of Hetch Hetchy. Some vestige of the dam would have to remain in order to allow restoration of the natural river gradient and water table in Hetch Hetchy. Restoration of natural plant communities in Hetch Hetchy would be impossible without restoration of the natural hydrology of the valley.

2) Extensive areas on the floor of Hetch Hetchy have been uncovered by several reservoir drawdowns in the past 54 years. Photographs and eyewitness accounts confirm that only a thin layer of sediments covered the exposed areas. The upper four miles of the reservoir bottom were exposed in the drought of 1977, and stumps, boulders and other features appeared to be covered with less than one inch of sediments in most places. Fine

sediments may have accumulated to greater depths directly behind the dam, but were probably removed by flow releases which originated at the bottom of the dam. In general the sediment load of the Tuolumne River appears to be quite low. This is inferred from qualitative observations and from the fact that the Tuolumne River descends from a watershed comprised largely of thin soils and great expanses of exposed and glaciated rock.

3) In 1977 the river was in its original channel through the upper four miles of the valley exposed during reservoir drawdown. Due to the low sediment load of the river, it is probable that the original river channel still exists through most if not all of the valley.

4) The identity of all plant taxa inhabiting Hetch Hetchy before inundation is unknown: therefore any attempt to insure the restoration of a specific list of taxa would be based on speculation. It is highly likely that all taxa originally inhabiting Hetch Hetchy still occur in close proximity to the valley and would reestablish themselves once habitat became available.

5) About 140 non-native plant species occur in Yosemite National Park. Many of these are Mediterranean annuals common throughout California below 6000 feet. About 40 widespread non-native grasses occur in Yosemite Valley and throughout the lower elevations in the park. It would be virtually impossible to prevent the rapid invasion of most of these taxa into Hetch Hetchy since many are characteristic pioneers of disturbed areas and already occur in close proximity to the reservoir. Massive herbicide spraying might hold these taxa in check initially, but such treatment would have to be continued indefinitely to be even partially effective long-term. Massive herbicide spraying would have a deleterious effect on most native taxa as well as non-natives.

6) Intensive and extensive herbicide spraying would possibly produce deleterious secondary environmental effects, and on balance these negative impacts would probably outweigh any short-term positive benefits.

7) A halt-mile long swath of material excavated from the dam site was laid across the lower meadow, and much of this rock and debris may remain on what was rich meadow alluvium along the river banks. A rock crusher plant was built on the north side of the valley to provide material for the concrete work on the dam. A railroad skirted the north side of the immense rock and debris pile to service a gravel pit near the base of Wapama Falls and a sand pit on the valley floor near the confluence of Rancheria Creek. The banks of the sand excavation pit appear in photographs to be about 15-30 feet high for a considerable distance along the Tuolumne River. Restoration of natural contours and soil types

would be required under any restoration alternative for aesthetic reasons and to allow natural plant communities the chance to become reestablished.

8) A wide diversity of vegetation communities surrounds the Hetch Hetchy Valley on broken cliffs. benches and permanent and intermittent streams. These plus upstream communities provide habitat for all species that probably occupied Hetch Hetchy Valley historically. Only the grizzly bear and possibly wolf (there is some question as to whether wolves occurred here once) were endemic to the park but are not now present.

9) It is very possible that granivorous birds and small mammals may recolonize the valley so rapidly and in such great numbers that 'seeds of herbaceous plants needed for vegetative recovery may be consumed at too high a rate to permit development of acceptable densities of important plants. In such a situation protective measures, such as avian exclosures or animal removal, may be necessary at selected sites and on a temporary basis.

Similarly, predators abound in the natural habitat around the Hetch Hetchy Valley and prey dispersing under high predator densities, into new and unfamiliar habitat, may have a difficult time building population numbers to exceed the threshold of predator limitation. In these situations steps could be taken to improve selected habitats, increase population size through capture and release efforts, or if necessary, temporary predator removal (killing or translocation) which would promote prey population response.

10) The narrowness of the canyon, broken cliffs and benches, periodic flood conditions, mud slides and regular water transport from upstream and from the canyon walls during heavy rains will all contribute to the recolonization of the Hetch Hetchy Valley by low mobility soil organisms.

Flying insects and other airborne invertebrates occur in abundance around the Hetch Hetchy Valley and turbulent and variable air currents will insure their rapid recolonization.

1l) The broken habitat of the cliff country around Hetch Hetchy Valley should provide ample pathways for dispersing individuals of most species. Extensive talus slopes may provide barriers for some small mammals, reptiles, or non avian invertebrates but will probably only retard recolonization, not stop it. A rare opportunity will be provided to observe animal dispersal and recolonization much as it occurred following the disappearance of the glaciers that made this park what it is.

12) Two nesting pairs of endangered Peregrine Falcons, in Yosemite National Park (one in Hetch Hetchy Valley and one in Yosemite Valley), constitute the fore breeding population for

Peregrine recovery in the Sierra Nevada Mountains. Accumulations of pesticides received from prey inhibit eggshell formation resulting in delicately thin eggs. Startling noises could frighten the incubating female resulting in broken eggs. Blasting activities during the restoration effort would have to be carefully coordinated and scheduled to preclude risks to peregrine reproductive success.

13) The biotic source for aquatic organisms in the Hetch Hetchy Valley historically, was the upper reaches of the Tuolumne River system. This system still remains intact, with only the introduction of two trout species and river otter. No vertebrates, invertebrates or plants are known to have been extirpated from the aquatic system. It is unlikely that species endemic only to the Hetch Hetchy Valley ever evolved because of the open nature of the aquatic system. Consequently, as the river resumes its natural course and historic habitats are reformed, aquatic organisms brought down with the river flows will recolonize and reestablish the natural aquatic ecosystem.

14) There is an unnatural, light-colored watermark ("bathtub ring") about two hundred feet in width which surrounds the reservoir and is highly visible to the visiting public. It is the result of impounded water killing the native rock lichen colonies which cover the granite walls. Natural restoration of such colonies would take between eighty and one hundred and twenty years. No practical way to hasten recovery is known.

ALTERNATIVES

The goal of restoration would be the re-creation of biotic communities representative of those that would have occurred in Hetch Hetchy Valley in the absence of all impacts of modern man. The text below describes three alternatives for the restoration of those communities and a monitoring plan to evaluate and insure the effectiveness of any selected alternative.

ALTERNATIVE 1: Recovery Without Management

Under this alternative, the reservoir would be drawn down in one year. No direct management intervention into the successional process would occur.

VEGETATION RESPONSE:

TWO YEARS: The invasion of herbaceous plants would be rapid. Within two years extensive areas on the floor of Hetch Hetchy valley would be covered with grasses, sedges, rushes, and other

sloping sides of the valley would occur even more rapidly because these slopes are drier and closer to seed sources. Thousands of stumps of trees felled before the valley was flooded would be highly visible. Most of the herbaceous taxa would be non-native broad-leaved plants such as thistles (Cirsium, Centaurea), dandelions (Taraxacum), and mullein (Verbascum) or non-native annual grasses such as brome (Hromus) and wild oats (Avena). Native taxa such as panic-grass (Panicum) and bent grass (Agrostis), cudweed (Gnaphalium), various rushes (Juncus) and sedges (Carex) would quickly invade low-lying moist areas and be able to compete well with non-natives.

Riparian vegetation would begin to reappear, but would not be well developed. Willows would begin to colonize the riverbanks.

Dense stands of conifer seedlings (mostly ponderosa pine and incense cedar) would appear in semi-moist areas along the edges of the valley and near rocky outcrops that provide some protection from wind and sun. In general, trees and shrubs would become reestablished more slowly than herbaceous plants due to slower seed dispersal from surrounding areas. The survival of conifer seedlings in the first two years would be strongly dependent on precipitation patterns. Canyon live oaks would become established along the base of the cliffs as acorns rolled downslope, but black oaks, lacking a major seed source adjacent to the valley, would not become established in significant numbers if at all.

TEN YEARS: Within ten years the general pattern of vegetative communities would become evident, with the exception of black oak woodlands. A few clumps of coniferous trees that became established in early succession would have grown rapidly, and those not subject to intense competition would be up to 20 feet high. Additional dense stands of conifer seedlings would become established during favorable years. and these would slowly expand deeper into the valley as seeds would be dispersed by birds, floods, and other means. Tree establishment would be sporadic so that uneven-aged stands of young trees would be separated by large openings. Tree stumps would still be highly visible.

A few black oaks would be present but the restoration of black oak woodland communities would still be severely deficient. Shrubs would still be largely absent from the valley.

Areas that had originally been meadows would again appear as meadows, with a fairly continuous cover of grasses, sedges and other herbaceous plants. Native plants would predominate in meadow areas, with sedges and rushes virtually excluding non-natives in the wettest areas.

The thin sediments would be eroded from the more elevated places in the valley, resulting in exposure of coarser soils and thus restoration of more natural habitats. The number of taxa inhabiting Hetch Hetchy would be perhaps ten times as large as the number after draining of the reservoir, but non-natives would still be dominant throughout most of Hetch Hetchy.

A few more willow thickets and alder clumps would be present in riparian areas, but these would be low-growing.

FIFTY YEARS: Vegetative cover would be complete except for exposed rocky areas. Forest communities would be well established, but still in the early stages of development. The forest cover would be more extensive than it was in Hetch Hetchy before inundation. Dense thickets of ponderosa pines and incense cedars would continue. to become established, with many of the older thickets being composed of slow-growing suppressed trees due to intense competition. Trees that were established 50 years earlier in openings on the floodplain would be up to 90 feet high.

Very few black oaks would have become established, and those that exist would be largely suppressed by dense thickets of ponderosa pines and incense cedars.

Stumps would be largely decayed and hidden by the dense forest cover.

At this time fire could be a significant force in shaping the development of plant communities in Hetch Hetchy. Under the Recovery Without Management alternative, however, the valley would be managed under a full suppression strategy. Prescribed burning and prescribed natural fire would be excluded.

Meadow plant composition would reach a state of equilibrium. with native plants well represented and dominant in the wetter areas. Non-native plants, especially grasses, would now have well defined habitats in which they would have largely excluded the native flora. Meadows would be beginning to be subject to more rapid invasion by conifers.

A few shrubs, largely of the genera Ceanothus and Arctostaphylus, would have become established, but would not be a significant element of the vegetative cover.

Almost all of the taxa that comprised the pristine flora of Hetch Hetchy would have become reestablished, but their distribution and abundance would be significantly different from pre-inundation conditions. Most plant communities would not *have* reached a state of equilibrium. Shade dependent taxa would become established as favorable habitat became available.

ONE HUNDRED YEARS: All plant communities would be well defined, but their distribution and composition would still be different from that of the pristine Hetch Hetchy. In general, the conifer forest would be more extensive and denser than in pristine times. Ponderosa pines and incense cedars would stand up to 125 feet high, and those growing in more favorable sites would be five feet in diameter. Forested areas would resemble those on the floor of Yosemite Valley in 1987 except for the virtual absence of black oak woodlands and the sparse representation of oaks in the mixed-conifer forest. The few oaks that would have become established would be largely suppressed by the dense conifer woodlands.

The number of plant taxa in Hetch Hetchy would have reached equilibrium with surrounding areas. Native species would have reoccupied favorable habitat, and all that were present under pristine conditions would be present again. Non-native plants would have decreased in abundance in 50 years, but would still be major components of some plant communities. About 50-75 non-native plant species would still occur in Hetch Hetchy.

Conifers would be invading the meadows, and in the absence of prescribed burning, meadows would be much smaller than in pristine times.

ONE HUNDRED AND FIFTY YEARS: The forests would be nearing maturity and cover even more of the floor of Hetch Hetchy than after one hundred years. Black oak woodlands would not have become reestablished, although some large oaks would occur in openings in the conifer forest. The reduction in meadow area would continue, and in the absence of prescribed fire, there would be significant danger of catastrophic wildfire producing major unnatural changes in plant communities.

WILDLIFE RESPONSE:

A rapid elimination of aquatic habitat would in the first year markedly reduce prey traditionally consumed by Peregrine Falcons. Sufficient alternate prey likely exists in surrounding valleys, however, to support the pair nesting in Hetch Hetchy Valley without-causing relocation of the nest site. There is a slight possibility that the alternate prey may support higher pesticide levels, thereby requiring nest augmentation to promote reproductive success sooner than would occur with the current prey. This possible decline in prey quality would be more than offset by the long term improvement of prey habitat as riparian and terrestrial vegetation reached aid and late seral stages, beginning approximately 30 years following drawdown.

Endangered Bald Eagles that winter at nearby Cherry Lake occasionally feed at the Hetch Hetchy reservoir. An immediate elimination of Bald Eagle food would occur if the reservoir were drained in one year. Bald Eagles would then quit using that portion of the park. Due to the marginal nature of the current habitat, a reduction in the Bald Eagle population would not be expected.

Seasonal deer use of the valley would begin the first year as herbaceous forage became available and the dry valley bottom began to provide acceptable travel routes to the other side of the canyon. Similarly, black bears would take advantage of .the green grass and herbaceous plants during the spring months. As hiding cover, thermal cover, and reproductive habitat became available, probably about 50 years following dewatering, use of the valley by both species would increase in other seasons. Heavy deer use of palatable forage plants such as ceanothus species and black oak would markedly inhibit recolonization by these plants.

Small mammals, amphibians and reptiles would naturally reoccupy the valley from surrounding habitats, probably within five years of food and cover becoming suitable. The time of recolonization following drawdown would vary with, species and habitat requirements. Most species would not be monitored so if physical barriers to restoration did exist. Such barriers would not be recognized and species recovery would occur slowly or possibly not at all. Also, any unnaturally heavy predation pressure due to high predator densities in immediately adjacent undisturbed habitats would inhibit species restoration or achievement of natural densities would not be mitigated.

Mammalian predators and all birds are mobile enough to reoccupy the valley on a regular basis as soon as foraging or breeding habitats become available. Exploratory forays by such species would begin as soon as the sites were water-free, and would continue as the plant succession took place

The long term result would be having most of the native animals represented in the valley. Abundances and distributions would vary with habitat and, without some management interference, may vary from the historic condition animal impacts on vegetation or predator limitation of prey populations may well occur and result in permanent alterations from the natural condition.

ALTERNATIVE 2: Recovery with Moderate Management

This alternative would provide five years for collection of native plant seeds and propagules before beginning to drain the reservoir. The Hetch Hetchy Reservoir would then be

progressively drained over a five-year period to permit a more controlled opportunity for revegetation. In each of the five years native vegetation would be restored to five to ten percent of all land exposed by this progressively draining of the reservoir.

Revegetation work would consist of planting and protectively fencing a mixture of 500 native trees and shrubs consisting of at least 300 black oaks and a combined subtotal of 200 white alder, black cottonwood, ceanothus. and manzanita each year. The various species of trees and shrubs would be planted in areas where those species originally occurred based on an analysis of historic photographs and stumps in Hetch Hetchy. Herbaceous plant seeds would be stored and selectively planted once favorable habitat had been created. No attempt would be made to suppress non-native plants or to water or otherwise maintain plantings.

Prescribed burning would be initiated after about twenty years to prevent rapid conifer encroachment on oak woodlands and meadows, and to produce a more natural species composition and distribution in coniferous forest areas.

If monitoring demonstrated the need for manipulative restoration of some animal species, individual animals would be captured and translocated from nearby, undisturbed habitats rather than brought in from expensive breeding facilities. Animal exclosures, habitat improvements, or animal removals may or may not occur depending on animal response to vegetative recovery and recolonization potential.

VEGETATION RESPONSE:

FIVE YEARS AFTER BEGINNING OF DRAINAGE: The entire valley would be exposed and partially planted with native vegetation. Vegetation at the upper end of Hetch Hetchy would be much Burr extensive and well developed than at the lower end. Conifers would be up to fifteen feet high and black oaks would be about six feet high in areas planted the first year. Many native herbaceous taxa would have become germinated and would have established in some areas. Non-native taxa would be common in the valley and would have achieved dominance over the natives in most areas.

The general pattern of vegetative establishment and succession would be similar to that of Alternative 1, except some native would have been afforded a competitive advantage and early seral-stage plant communities would more closely resemble those that would have occurred under natural conditions.

TEN YEARS: Plant communities and vegetative cover would closely resemble those in Alternative 1, except that there would be more shrubs and oaks in the valley and native herbaceous taxa would be even more abundant in most areas. Most of the oak woodlands planted in rocky areas or near the river would not yet have been invaded by conifers and would be well established, even though there would have been more considerable mortality of young trees.

FIFTY YEARS: Plant community boundaries would be stabilizing and resemble those that originally occurred in Hetch Hetchy, except that oak woodlands and shrub communities would not be as prominent. Prescribed burning used after about twenty years would have prevented rapid conifer encroachment on oak woodlands and meadows, thinned thickets of ponderosa pine and incense cedar. and produced a more natural species composition and distribution in coniferous forest areas.

ONE HUNDRED YEARS: Ponderosa pines and incense cedars would be 125 to 150 feet high. The conifer forest would resemble that growing on the floodplain of Yosemite Valley in 1987 except that it would generally be more open. Some dense clusters of conifers, missed by fire, would occur in localized areas. Oak woodlands would be starting to mature, but would not be as extensive as those originally found in Hetch Hetchy. The even-aged clusters of oak and conifers would stand in contrast to the more varied mixed-conifer forests outside Hetch Hetchy. Other conditions would be similar to Alternative 1.

ONE HUNDRED AND FIFTY YEARS: Forest and woodland communities would be nearing maturity, and the entire valley would appear much as it did before construction of the reservoir.

WILDLIFE RESPONSE

The slow elimination of aquatic habitat would gradually reduce prey traditionally consumed by Peregrine Falcons while alternate prey habitats were developing. Development of terrestrial and riparian vegetation in Hetch Hetchy Valley and downstream would proceed more rapidly than in Alternative 1, thus improving Peregrine Falcon habitat at a faster rate, likely producing good prey habitat within 20 to 25 years of dewatering.

Bald Eagle use of Hetch Hetchy would be extended through the five years of drawdown. Foraging opportunities would likely improve for Bald Eagles during that time due to increased availability of fish as the depth and surface area of the reservoir decreased. Long term impacts on Bald Eagles would be the same as Alternative 1.

Deer and black bear would use the Hetch Hetchy Valley much as described under Alternative 1, except that year-round use would increase at a faster rate because of the more rapid habitat development, probably with deer fawning in the valley 20 years following dewatering. Deer exclosures in some areas would increase the rate of vegetation recovery in selected areas and improve deer habitat in the long term.

Recolonization of the valley by small mammals, amphibians, reptiles, mammalian predators and birds would proceed much as described under Alternative 1. Monitoring of selected species would permit mitigation of over-utilization of important seeds. thus providing a more efficient revegetation process. Species that might have difficulty recolonizing due to potential physical barriers and, species that might experience artificial population suppression due to heavy predation rates would also be monitored to permit mitigation.

The long term result would be all but two native species recolonizing the Hetch Hetchy Valley. Animal numbers and distribution would reasonably mimic the historic scene. Animal recovery would occur at a faster rate than under Alternative 1.

ALTERNATIVE 3: Recovery with Intensive Management

This alternative would provide five years for collection of native plant seeds and propagules before beginning to drain the reservoir. The Hetch Hetchy reservoir would then be progressively drained over a five year period to permit a more controlled opportunity for revegetation. In each of these five years, native vegetation would be restored on ten to twenty-five percent of the land exposed by the progressively draining of the reservoir. A large-scale and detailed map of Hetch Hetchy plant communities existing before the reservoir was constructed would be developed and used as a basis for reconstructing those communities as closely as possible.

Revegetation work would consist of planting and fencing a mixture of native trees and shrubs consisting of at least 500 black oaks and a combined subtotal of 400 white alder, black cottonwood, Douglas fir, dogwood, willows, azaleas, manzanitas, and ceanothus each year. The various species of trees and shrubs would be planted in areas where those species originally occurred based on an analysis of historic photographs and stumps remaining in Hetch Hetchy. Herbaceous plant seeds would be stored and selectively planted when favorable habitat was created. Native bunch grasses and sedges collected and propagated prior to draining of the reservoir would be planted in meadows and oak woodland areas as these habitats became developed following drainage.

Greenhouse and nursery services to support continued seed collection and plant propagation for an indefinite number of years after the reservoir was completely drained would be developed in the park or accomplished by contract. Additional plantings would continue indefinitely to support restoration of certain plant communities. Horticultural techniques would be used to promote survival of plantings for their first two years. or longer if necessary.

Noxious non-native plants would be eliminated or suppressed throughout Hetch Hetchy continuously into the future. In the first five years after each section of the valley was drained the widespread Mediterranean annual grasses that would become established would be partially suppressed in certain areas to allow native grasses and sedges a better chance to become established.

Prescribed burning would be utilized as a management tool to produce and maintain vegetative communities closely resembling those that originally occurred in Hetch Hetchy. Fires would be used to prevent conifer encroachment in oak woodlands and meadows and to produce and maintain open conifer forests with a sore natural species distribution and composition.

Although the use of animal breeding and propagation facilities is not anticipated, this alternative would allow for that option if monitoring efforts indicated their use would significantly enhance the rate of recovery. Capture and translocation techniques would also be used to enhance rate of recolonization of species if unoccupied habitat occurred. More extensive monitoring than would occur under Alternative 2 would be used to document recovery rates and identify problems. Mitigation of identified recovery problems would occur for a greater number of species.

VEGETATION RESPONSE:

FIVE YEARS AFTER BEGINNING OF DRAINAGE: Vegetative cover and plant succession would resemble Alternative 2 except native plants would be more firmly established because non-natives would be suppressed. Watering and other techniques would insure greater survival and vigor of plantings. The reconstruction of natural plant communities would be more precise than in Alternative 2 due to more detailed analysis and mapping of pristine conditions. Vegetative cover of trees and shrubs would be more evident than in Alternative 2 due to the greater area initially planted.

TEN YEARS: Native plants would be much more prominent in the valley than under Alternatives 1 or 2. Most of the original plant communities would be represented. There would be a high survival

rate for plantings and most would be growing vigorously. Native grasses and sedges would be dominant in the meadows and would be reproducing and successfully competing with non-native plants.

FIFTY YEARS: Plant community boundaries would be stabilizing and would resemble those that originally occurred in Hetch Hetchy. Prescribed burning initiated after about twenty years would have prevented rapid conifer encroachment on oak woodlands and meadows, thinned thickets of ponderosa pine and incense cedar, and produced a more natural species composition and distribution in coniferous forest areas.

ONE HUNDRED YEARS: Ponderosa pines and incense cedars would be 125 to 150 feet high. The conifer forest would resemble that growing on the floodplain of Yosemite Valley in 1987 except that it would generally be sore open. Some dense clusters of conifers, missed by fire, would occur in localized areas. Oak woodlands would be extensive and starting to mature. The even-aged clusters of conifers and oaks would stand in contrast to the more varied mixed-conifer forests outside Hetch Hetchy. Other conditions would be similar to Alternatives 1 and 2.

ONE HUNDRED AND FIFTY YEARS: Forest and woodland communities would be nearing maturity. and the entire valley would appear much as it did before construction of the reservoir.

WILDLIFE RESPONSE:

The response of Peregrine Falcons would be the same as under Alternative 2 except that habitat improvements, and therefore increases in prey abundance, would occur at a faster rate, possibly within 15 to 20 years.

Bald Eagle response would be the same as under Alternative 2.

Deer and black bear would use the valley much as described under alternative 2 except that year-round use may occur as early as 15 years following dewatering.

Small mammals, amphibians, reptiles, mammalian predators and birds would respond as under Alternative 2. Since monitoring efforts, would include more species, there would be more opportunity to enhance vegetative recovery, encourage population growth of predator suppressed prey, and insure recolonization by most species.

The long tern result would be all but two native species resident in Hetch Hetchy Valley in abundances and distributions that would closely reflect pristine conditions. Ecosystem recovery time would be minimized.

MONITORING RESTORATION OF THE RETCH HETCHY VALLEY FOLLOWING REMOVAL OF THE RESERVOIR

Alternative 1: Recovery Without Management

VEGETATION MONITORING:

Incidental observations of the major native and non-native plant taxa present at various stages of succession would be recorded for historic files. The presence of unusual or unexpected taxa would also be noted. Several photo points would be established in and above Hetch Hetchy to document the appearance of the valley at various successional stages.

WILDLIFE MONITORING:

Wildlife monitoring under this alternative would document the presence or absence of selected endemic and exotic species to demonstrate the degree of ecosystem recovery.

The presence of readily visible species such as deer, bear, coyotes, most reptiles and many birds would be documented by incidental observations. The presence of selected secretive species would be determined by sampling with scent stations, live traps and calls at five year intervals, initially, then at ten year intervals for 100 years, followed by 20 year intervals until old growth forest communities exist.

Alternative 2: Recovery With Moderate Management

VEGETATION MONITORING:

Monitoring would be conducted to document the success of transplanting or seeding various taxa, the presence of major native and non-native taxa at various stages of succession, and the success of restoring natural plant communities.

The monitoring transplanting success would provide immediate feedback in selecting techniques and taxa for transplanting in each successive year of draining the reservoir.

Monitoring methods would include annually (for b years) recording the survival and vigor of transplants and qualitative assessment of seed germination rates and seedling survival by taxa. The composition of all major plant communities would be estimated

after 5, 10, 15. 20 years and thereafter every 10 years. Several photo points would be established in and above Hetch Hetchy to document the appearance of the valley at various successional stages. Photo points would be recorded annually.

WILDLIFE MONITORING

The goal of wildlife monitoring under this alternative would be to: 1) determine the presence or absence of most endemic and exotic species, and the population dynamics of selected species; 2) identify the over-utilization of selected vegetation by selected animal species; 3) identify the suppression of selected prey populations by predators; and 4) identify inhibition of establishment of selected endemic species due to competition with exotic species. The information would be used by management: 1) assess and document the degree of ecosystem recovery; 2) identify and restore endemic species not able to naturally recolonize; 3) mitigate over-utilization of vegetation by abundant animal populations until the desired vegetation becomes well established; 4) reduce predation mortality on selected prey species, as needed to release artificially suppressed prey populations; and 5) permit the removal of exotic species, as needed, to allow endemics an opportunity to become established.

Incidental observations would be used to document the presence of visible wildlife species not identified for intensive population monitoring. The presence of secretive species not identified for intensive monitoring would be determined by sampling with scent stations, live traps and calls at three to five year intervals, initially, then at five to ten year intervals until old growth forests exist.

Statistically valid sampling techniques would be used to monitor population dynamics of selected species to determine immigration rates, reproductive success, population trend, food habits, and habitat use. Species selected for monitoring would be those with low mobility potential which might limit their natural recolonization, those with the greatest potential for being limited by over-abundant predators or exotic species, those with the greatest potential of inhibiting the revegetation process, or other species of special interest. During the first three years, habitats surrounding Hetch Hetchy Valley would be sampled to provide baseline data to determine which species should be present and in what numbers. Intensive sampling in the valley would commence for a given species as the habitat becomes suitable. Sampling intervals would vary from one to three years depending on the species and would continue until stable plant and animal communities exist. Some intensive sampling would continue until old growth forests were established.

Alternative 3: Recovery With Intensive Management

VEGETATION MONITORING:

Monitoring would focus on the same subjects as in Alternative 2, but would be more rigorous. Based on analysis of historic photographs, soils, and stumps, areas expected to develop into each of the major plant communities would be initially identified. Monitoring plots would be randomly located in each prospective community, and succession would be monitored by annually recording species composition, density, tree diameter at breast height, tree height, and other parameters as appropriate.

Additional monitoring plots would be systematically located in areas subject to intense transplanting or seeding. Transplant survival and vigor and seed germination and seedling survival would be monitored annually for five years after each successive area of the valley become uncovered and treated.

Several photo points would be established at various points in and above, Hetch Hetchy to record the appearance of the valley at various successional stages. Photo points would be recorded annually.

WILDLIFE MONITORING:

This Alternative differs from Alternative 2 in the inclusion of more species for intensive monitoring, thus insuring a more natural balance of plants and animals in the recovery process.

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