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NATURAL SOUNDSCAPE

ISSUES

Major issues and concerns regarding natural soundscapes from public and internal scoping include:

- Motorized versus non-motorized trips.
- Address noise impacts (helicopters, motorboats, electronics, loud visitors).
- Provide a primitive experience and wilderness character.
- Provide access to a variety of trip types and trip lengths.
- Incorporate best available pollution control (i.e., quiet) technology.
- Appropriateness of helicopter exchanges.

Human noise sources from activities associated with river recreation in the section of river from Lees Ferry to Lake Mead include motorized rafts, river human activities (camp noise, generators, stoves, transfer and gathering areas, loud voices, electronic sounds, etc.), backcountry users sharing river access, and helicopter shuttles in the Whitmore area. There would also be cumulative impacts from sources not associated with river recreation including commercial air tours, high altitude commercial jet aircraft, and military, general aviation, and park administrative flights.

The section of river from Diamond Creek to Lake Mead includes all of the above river-related human noise sources, except that helicopter shuttles occur in the Quartermaster area instead of Whitmore, and different motorized boat types occur in the Lower Gorge, including pontoon boats and high-powered jetboats.

Noise related to river recreation activities would include aircraft noise only to the extent that helicopter shuttles transport passengers who are also river passengers. This would be limited to alternatives that include helicopter shuttles for river passengers in the Whitmore area (for Lees Ferry Alternatives), and in the Quartermaster area (for Lower Gorge Alternatives). All other aircraft activity and associated noise would be a cumulative effect independent of the management alternatives, but considered in the sections on cumulative effects. Such aircraft activity would include commercial air tours between helicopter pads on Hualapai tribal lands in the Quartermaster area and Grand Canyon West Airport (i.e., those that do not involve river passengers), aircraft using Special Flight Rules Area 50-2 for commercial air tour and support flights, high altitude commercial jet traffic, and military, general aviation, and park administrative flights.

GUIDING REGULATIONS AND POLICIES

Grand Canyon National Park Enlargement Act, 1975 (Public Law 93-620) — This law established the current boundary of Grand Canyon National Park. Section 8, titled "Aircraft Regulation" states:

> Whenever the Secretary (Interior) has reason to believe that any aircraft or helicopter activity or operation may be occurring or about to occur within the Grand Canyon National Park, … which is likely to cause an injury to the health, welfare, or safety of visitors to the park or to cause a significant adverse effect on the natural quiet and experience of the park, the Secretary shall submit … such complaints, information, or recommendations for rules and regulations or other actions as he believes appropriate to protect the public health, welfare, and safety or the natural environment within the park. After reviewing the submission of the Secretary, the responsible agency shall consider the matter, and after consultation with the Secretary, shall take appropriate action to protect the park and visitors.

National Parks Overflights Act of 1987 (Public Law 100-91) — Section 3 of this act identified noise associated with aircraft overflights at Grand Canyon National Park as causing "a significant adverse effect on the natural quiet* and experience of the park," and that current aircraft operations at the park "have raised serious concerns regarding public safety, including concerns regarding the safety of park users." The act required the Secretary of the Interior, working through the National Park Service, to submit recommendations to the Federal Aviation Administration regarding "the actions necessary for the protection of resources in the Grand Canyon from adverse impacts associated with aircraft overflights." The recommendations were to "provide for substantial restoration of the natural quiet and experience of the park and protection of public health and safety from adverse effects associated with aircraft overflight," and the Federal Aviation Administration was to implement the recommendations of unless they would adversely affect aviation safety. Subsection (3)(c) of the act specifies that "helicopter flights shall not be prohibited (1) which fly a direct route between a point on the north rim outside of Grand Canyon National Park and locations on the Hualapai Indian Reservation (as designated by the tribe); and (2) whose sole purpose is transporting individuals to or from boat trips on the Colorado River and any guide of such trip."

Executive Memorandum April 22, 1996, Regarding the Impact of Transportation in National Parks — Specifically, the President directed the Secretary of Transportation to issue regulations for Grand Canyon National Park that would place appropriate limits on sightseeing aircraft to reduce noise immediately, and to make further substantial progress towards restoration of natural quiet, as defined by the Secretary of Interior, while maintaining aviation safety in accordance with Public Law 100-91. With regard to Grand Canyon National Park it stated "should any final rule making determine that issuance of a further management plan is necessary to substantially restore natural quiet in the Grand Canyon NP, [the Secretary of Transportation, in consultation with Heads of relevant departments and agencies] will complete within five (5) years a plan that addresses how the Federal Aviation Administration and the National Park Service . . . will achieve the statutory goal not more than 12 years from the date of the directive [i.e.,2008]."

National Park Service Report to Congress, *Report on Effects of Aircraft Overflights on the National Park System,* July 1995 — The report defines "substantial restoration of natural quiet,"

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* Current NPS policy refers to natural soundscapes, in part because a natural setting is not necessarily quiet, and it may contain numerous "natural sounds." It may also be noted that what is generally intended with the earlier usage was not "quiet," but rather the absence of human-caused sounds. Outside of the formal legal use of the older term, natural quiet is replaced, following NPS Policy, by the term "natural soundscape(s)."

as it relates to aircraft overflights in Public Law 100-91, as "a substantial restoration requires that 50% or more of the park achieve 'natural quiet' (i.e., no aircraft audible) for 75-100 percent of the day." The report also lists the following goals and objectives developed to further assist in evaluating the effectiveness of measures to meet the requirements of Public Law 100-91:

(1) Substantially restore natural quiet as a resource;

(2) Provide recreation opportunities and experiences for park visitors, consistent with park policies, where the opportunity for natural quiet is an important component;

(3) Mitigate any aircraft-related impacts on other natural and cultural resources; and

(4) Address issues of health, safety and welfare of on-ground visitors and employees.

The management objectives (and the management zones they apply to) were:

a. Restore and maintain natural quiet by protecting the wilderness character of remote areas. (Backcountry Use Zone, River Corridor Use Zone)

b. Provide primitive recreation opportunities without aircraft intrusions in most backcountry areas, most locations on the river and at destination points accessed by both. (Backcountry Use Zone, River Corridor Use Zone, Corridor Trail System Use Zone)

c. Provide developed recreation opportunities with limited aircraft intrusions for visitors at rim developed areas and major front-country destination points accessible by road. (Frontcountry (Paved Access) Use Zone)

d. Provide for the protection of sensitive wildlife habitat areas or cultural resources. (Backcountry Use Zone, River Corridor Use Zone, Corridor Trail System Use Zone, Frontcountry (Paved Access) Use Zone)

e. Provide for welfare and safety of below-rim, backcountry, and rim visitors. (Backcountry Use Zone, River Corridor Use Zone, Corridor Trail System Use Zone, Frontcountry (Paved Access) Use Zone)

f. Provide a quality aerial viewing experience while protecting park resources (including natural quiet) and minimizing conflicts with other park visitors. (Air Tour Use Zone, Backcountry Use Zone, River Corridor Use Zone, Corridor Trail System Use Zone, Frontcountry (Paved Access) Use Zone)

NPS Management Policies 2001, Section 4.9 — Requires the managing agency to preserve, to the greatest extent possible, the natural soundscapes of the park. Natural soundscapes exist in the absence of human-caused sound, and are made up of an aggregate of all natural sounds that occur in the park, together with the physical capacity for transmitting natural sounds. This policy directs Superintendents to identify what levels of human caused sound can be accepted within the management purposes of the park.

Directors Order (DO) #47: Soundscape Preservation and Noise Management — DO #47 provides direction in the management of soundscapes and offers guidance on soundscape planning, measurement of sound characteristics, and technical guidance on the inventory and monitoring of soundscapes, as well as noise prevention and mitigation. The overall goal of the National Park Service is the protection, maintenance or restoration of the natural soundscape resource. DO #47 recognizes that some sound producing activities, including resource

management activities, may be appropriate if they are included in the park's purpose, as defined by its enabling legislation, or in proclamations or public planning processes.

MANAGEMENT OBJECTIVES FOR NATURAL SOUNDSCAPE RESOURCE

As stated in Chapter 1, the objective for natural soundscapes as it relates to management of recreational river use in the Grand Canyon is to manage river recreation use in a manner that is consistent with management zoning while minimizing the adverse effects of human caused noise impacts to the natural soundscape or natural quiet.

METHODOLOGY FOR ANALYZING SOUNDSCAPE IMPACTS

The general process for assessing impacts to the environment is discussed in the "Introduction" to Chapter 4. Effects specific to the natural soundscape are characterized for each alternative based on the impact thresholds presented below. The methodology used to assess noise impacts in this document is consistent with the methodology being developed for "NPS Reference Manual #47, Soundscape Preservation and Noise Management," in accordance with NPS Director's Order #47 and NPS *Management Policies 2001.*

Context, timing (especially frequency of occurrence), duration, and intensity all interact in a complex manner that determines the level of noise impact from an activity. In some cases the analysis of all the factors can indicate a certain impact level where analysis of only a single factor may indicate a much different impact level. To help the reader understand how these varying factors combine to arrive at an impact level, the text below explains the criteria or factors considered in the impact thresholds.

Natural ambient sound levels used in the analysis were established by earlier field acoustic measurements at Grand Canyon National Park (NPS 2000b; Harris Miller Miller & Hansen [HMMH] 2003, 1993). Typical water influenced natural ambient levels along the Colorado River in the park varied between 24 dBA and 51 dBA, depending upon proximity to rapids, with the area around Separation Canyon at full lake level as low as 11 dBA. This shows how natural sounds, in this case moving water, can influence and help to mask human noise sources.

In a brief look at potential motorized raft noise along the river corridor (HMMH 2003), a 35-foot S-rig four-stroke motor-powered raft was measured traveling down the river at ¾ and full speed settings, similar to what one would expect on a river trip. The four-stroke powered raft could be heard (audible) at a distance of up to 542 feet from the recording site, when operating ¾-speed coming down the river. At full speed, the raft could be heard as far away as 592 feet, or just over one-tenth of a mile. The time the raft was audible was calculated at 30 to 88 seconds, or up to 1.5 minutes. The time audible is expected to increase as the effects of water, or other natural sounds, diminish. This same raft would have been audible for 6.5 to 9 minutes if the existing ambient was away from the influence of the rapid, such as a location where the Desert Scrub natural ambient is more typical (20-34 dBA). For purposes of this analysis, 3 minutes audibility is estimated for non-motorized rafts, which would include sounds audible 100 feet or more from the source as rafts float by under quiet natural ambient conditions, such as loud voices (not quiet conversation), waterfights, oars on oarlocks, etc.

Human noise on the river, in general, tends to be random and audible for short spans of time. The "percent time audible," the amount of time human noise is audible over a typical day, and the "noise-free interval," the time between human noise events when only the natural soundscape is audible, are measures used to quantify noise impacts to the natural soundscape. The percent time audible and noise-free interval are related in that as the amount of time noise occurs increases during the 12-hour day, the amount of potential time for large noise-free intervals decreases. With less opportunity for large noise-free intervals, the natural soundscape is impacted to a greater extent.

Calculations of "percent time audible" and related predictions of noise-free interval are used to assess motorized rafts/vessels and air traffic noise impacts to the natural soundscape. The associated noise indicators are calculated for a 12-hour day (7 A.M. to 7 P.M.) and seasonality of occurrence. Because there is insufficient data to consistently characterize any day other than peak days throughout all the alternatives, and because soundscape goals for the park are defined in terms of "any given day" (meaning that there would be no day with more impacts than the goal portrays), the analyses below are based upon peak days.

Additional data on motorized watercraft and aircraft noise intrusions, natural soundscape and noise-free interval along the river is being collected in summer/fall 2004 too late for inclusion in this *Draft Environmental Impact Statement*. Initial results are expected in time to include them in the final environmental impact statement.

Impact Thresholds

For the purposes of this analysis, impacts are evaluated for the noise produced at various locations along the river corridor (percent time audible), and contrasted to the amount of unaffected natural sounds (noise-free interval) to be expected or desired in the particular zone. Percent time audible and noise-free intervals are assessed in terms of a 12-hour day (7 A.M. to 7 P.M.) to provide an assessment of what would be expected during the time when most river-related noise would be expected. The following impact thresholds for the river soundscape incorporate intensity, context, timing and duration, as described above. The noise impact varies for each alternative, based primarily on the numbers of launches per day, numbers of motorized versus non-motorized rafts per trip, and helicopter shuttles in the alternatives.

> **Intensity —** The "pitch" or sound frequency spectrum, and the "loudness" (energy or sound pressure level) of both the human noise source and the natural soundscape all interact to define the intensity of the impact from the noise event, including the distance and time a given noise event would be audible. Natural soundscapes that are "loud" (i.e., contain considerable energy) in portions of the sound frequency spectrum in which the noise source also produces sound can "mask" some or all of the noise, whereas a noise source, such as a boat motor or helicopter, can be readily audible even in the presence of a "loud" overall soundscape (such as a rapid or waterfall) when the frequency spectra are different. This, plus timing, is basically the same effect that allows, for example, a piccolo to be audible above the rest of the band during a loud passage of music (e.g., in Souza's "Stars and Stripes Forever").

The intensity of noise levels varies greatly by time and location along the river corridor. The distance that noise is audible from the noise source is important in assessing the intensity of the impact. Distance also can vary due to the "pitch" and "loudness" (amplitude), etc., of the noise source. In general, noise from boat/raft motors and human activities generate the majority of noise associated with recreational use and enjoyment of the river corridor. These levels of noise are expected (and measured) to be audible at a distance of up to 1-1.5 miles (HMMH 2003). However, helicopter supported river activities at passenger exchange points or landing pads and river locations under defined aircraft routes will have greater levels of noise, which can be audible for five or more air miles from the source. The boats, though, travel the entire river corridor (regional impact), whereas management alternatives with river-related aircraft use are confined to two areas, Whitmore and Quartermaster (localized impacts).

Context — Management zones are defined in Chapter 2, and they have different sensitivities for sound impacts as described in the impact thresholds below.

Duration — Noise levels caused by river recreational activities within the river corridor are usually temporary, in that discontinuance of the source would allow the opportunity for the natural soundscape to return to the condition that existed prior to the particular recreational activity (however effects from the sound may have caused changes, such as displacement of birds, which result in a changed natural soundscape). The amount of time during each day that noise is present due to river running activities is percent time audible, which is factored into the intensity threshold. The duration threshold is defined in terms of the length of time the effect occurs, not the time the noise is present. It is the length of time the soundscape requires to return to a natural state after a noise impact (i.e., short-term to long-term effects).

Timing — Natural sounds and human-caused sounds vary daily, seasonally, and even minute-to-minute. During seasons with lower levels of use, noise levels are also generally lower than seasons with higher use. During daylight-hours noise levels are typically higher than night-time, due to increased human activity and available recreational opportunities. Noise often increases during evening camp activities and decreases as the night progresses. Motorized boat use on the river can be looked at as a "pulse" of noise that is introduced at various times of the day, along various sections of the river corridor, and for varying durations. The periods of time when only natural sounds are present is called the noise-free interval. Timing also considers periods of higher or lower sensitivity to noise impacts, and whether the noise occurs frequently or infrequently, occurs randomly or regularly, and whether it occurs for long or brief periods of time.

Intensity

Negligible — Human caused noise would be detectable or barely audible for 5% (36 minutes) or less of the day (7 A.M.–7 P.M.). There would be enough time when the natural soundscape was unaffected by humans that noise-free intervals of more than 3.5 hours could be common during each day.

Minor — Human caused noise would be audible for 10% (72 minutes) or less of the day. There would be enough time when the natural soundscape was unaffected by humans that noise-free intervals of 1.5 to 3.5 hours could be common during the day.

Moderate — Human caused noise would be audible for more than 10% but less than 25% of the day. There would be enough time when the natural soundscape was unaffected by humans that noise-free intervals of 1 to 1.5 hours could be common during the day..

Major — Human caused noise would be audible for 25% or more of the day (for Zones 3 and 4, 33% or more). The total time when the natural soundscape was unaffected by humans would commonly allow for noise-free intervals of no more than 1 hour during the day.

Context

Localized — Impacts would occur to a small area such as a campsite or attraction site, or a segment of river no more than a mile in distance.

Intermediate — Impacts would occur over an intermediate area, such as a tributary or 1 to 20 miles of the river. The 20-mile distance is used because a non-motorized trip generally travels up to 20 miles in a day.

Regional — Impacts would occur over a large area, such as more than 20 miles of the river.

Sensitivity — Sensitivity enters into the analysis in that the intensity levels apply differently to different zones. Areas in Zone 1 are the most sensitive to sound impacts, followed in order by Zones 2, 3 and 4. The same noise meeting the criteria of a given intensity level (e.g., minor) in Zones 3 and 4 would be rated the next higher level of intensity (e.g., moderate) in Zones 1 and 2.

Duration

Short term — The natural soundscape would return to pre-disturbance conditions in a day or less.

Intermediate term — The natural soundscape would return to pre-disturbance conditions in more than a day but less than a month.

Long term — The natural soundscape would not return to pre-disturbance conditions for more than a month.

Timing

Timing tends to indicate less of an impact when a noise occurs in a random or infrequent pattern, for brief periods of time, and/or outside sensitive periods. Timing tends to indicate more of an impact when a noise occurs in a regular or frequent pattern, for long periods of time, and/or during sensitive time periods.

Mitigation of Effects

Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to natural soundscapes, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Additional mitigation measures not already incorporated into Alternative A that are judged likely to reduce impacts to natural soundscapes include:

- Set use limits, curfews, or restrictions on the noise source such as time of day use is allowed, the volume and duration of use of the source, and/or how often the source can be used for various zones and sensitive areas of the park (e.g., endangered species nesting sites or critical habitat, traditional cultural properties, etc.).
- Limit the allowable sound emissions of equipment or motors utilized in an activity, project, or function (use of mufflers, hand operated (non-mechanized) equipment, and designated "quiet technology," etc.).
- Prepare a soundscape management plan for the park.
- Propose curfews on certain camping activities to reduce evening noise levels and duration.
- Require the use of best available technology (BAT) for all motors used for river operations in Grand Canyon National Park. The intent would be to ensure that commercially available motors used in the park are the cleanest and quietest under current and future technology (i.e., continuous improvements in motor technology would result in use requirements being updated).
- Recommend that quiet technology aircraft consistent with the best available technology concept be used by the air tour industry.
- Continue to monitor and model aircraft and motorized watercraft use in the park and conduct sound/noise monitoring to ensure accuracy of the model predictions, and to better characterize the natural soundscape and noise impacts to the soundscape.

Cumulative Impacts

Cumulative impacts on the natural soundscape were determined by combining the incremental impacts of each alternative with other past, present, and reasonably foreseeable future actions (see the "Introduction" to Chapter 4 for a list of such actions).

The primary activities with the potential to cumulatively affect the natural soundscape and related values are the impacts from aircraft overflights not associated with river recreation. Such flights are numerous over parts of the park, but they occur completely independent of the alternatives in this document. They include commercial air tours and their support operations, helicopter operations controlled by the Hualapai Tribe (i.e., Whitmore and many of the flights in the Quartermaster area), high altitude commercial jet traffic, military aircraft, general aviation, and most administrative aircraft activities.

Hualapai Tribe helicopter operations that utilize Grand Canyon West airport and/or aircraft landing sites within the canyon on tribal lands outside of the park, and which carry passengers who are not also river passengers are part of the cumulative effects analysis, and not part of the impacts of the alternatives. Helicopters used for passenger exchanges at Whitmore and Quartermaster are controlled by the Hualapai Tribe, not the National Park Service, because they land and takeoff solely on Hualapai tribal lands. In the case of Quartermaster, the Hualapai Tribe has indicated that approximately the same number of helicopter flights will occur in that area independent of the alternatives and independent of whether any of the helicopter passengers are also river passengers.

However, use of helicopters for river passenger shuttles and transfers at Whitmore and Quartermaster will be considered as part of the impacts of the alternatives as the use of helicopters in these cases are directly tied to the number of river passengers needing transfer.

Tools Used to Analyze Effects to the Natural Soundscape

The River Trip Simulator model was used to assess the distance and timing between trips under current conditions as analyzed in Alternative A (No Action). The noise-free intervals used in the impact thresholds above are based on this analysis.

Assumptions

General assumptions used for analysis of effects from each alternative are discussed in the "Introduction" to Chapter 4. Assumptions that specifically relate to the alternatives and their effect on the natural soundscape are presented below:

- The block of time available for noise-free intervals was arrived at by estimating the total time that periods of random and unscheduled noise events are audible over a 12-hour day, and then subtracting that total from 12 hours. Because the human activity that introduces noise in the river corridor is often variable in amplitude, sporadic in nature, and can occur at various times of the day, it can be difficult to accurately determine the noise-free interval at any one location on the river; therefore, estimations of the noise-free interval are used in the following analysis to represent field conditions and seasonal use patterns.
- Average speed of the rafts is tied to Glen Canyon Dam release flows, but 3 to 5 mph is selected for non-motorized watercraft, and up to 10–12 mph for motorized rafts. An average sized non-motorized commercial raft will carry five people and gear, a non-motorized noncommercial raft, four people and gear, and a motorized raft, 20–22 people and gear.
- Motorized rafts travel over an average 40 miles per day, and run their motors for about 3.5 hours each to travel that distance, so that although the noise from motorboats is produced in a localized area, it also creates a regional impact because it occurs over the entire river corridor during the course of a trip.
- Trips with multiple boats will sometimes bunch and sometimes spread out as they travel down the river, so noise overlap will sometimes occur, reducing the total amount of time raft activity noise is audible. Even when traveling in a group, boats can often be 15–20 minutes apart in traveling past a point on the river. Therefore, it is reasonable for a peak-period analysis to assess each boat separately.
- The aircraft and raft noise values presented for the following scenarios are based on actual field measurements conducted at Grand Canyon National Park. The calculation of "percent time audible," as used in the following analysis, is based on the maximum number of passengers and trips that could be launched under each alternative (a "worst case" scenario). It is understood that the number of raft trips and helicopter shuttles will fluctuate daily and seasonally, thus affecting the numbers of daily passengers, trips and noise generated. However, there was insufficient data to quantify the fluctuations. The

maximums were used to assess the relative differences between alternatives in a consistent manner using the same basis for the inputs. Therefore, the noise estimates are maximums, and they represent expected conditions during peak days in the peak season. It is recognized that days or time periods when the inputs are less than the maximums, the noise estimates would be less. Rafters do not make noise all the time; expected noise events would generally be infrequent and random. However, if the "worst case" scenario does not cause major adverse impacts, then any other combination of trips, passenger numbers, and river activities less than the peak should also not lead to major adverse impacts.

- For purposes of this analysis, it is assumed that all helicopter shuttles carry 5 passengers on every flight (or are empty if there are passengers only on one end of the shuttle). As an example, if there are 20 passengers flying in to Whitmore or Quartermaster and 20 passengers flying out, eight flights are assumed (i.e., four flights in plus four flights out, each filled with five passengers each way). However, if there were 20 people to fly out, but only 10 to fly in, then eight flights would still be assumed (i.e., two flights carrying the 10 people in to the river and two flights returning with 10 of the people flying out, plus two flights for the remaining 10 people flying out, but an additional two flights coming in to the river empty to pick up those 10 people).
- For all commercial air tour and helicopter shuttle use the following applies:
  - The park has long recognized the experience provided by air tours as a park visitor experience and their passengers as park visitors. As with many visitor experiences, though, they provide benefits to those visitors who participate in them, but may create impacts for park resources and other visitors.
  - The number of daily commercial air tours and shuttle flights flown has not been provided to the NPS in time for consideration in the draft EIS. Therefore, flight numbers are estimates based upon the maximum number of passengers needing to be exchanged or transferred.
  - There are days when air tour and shuttle operations are reduced, or not conducted at all, especially during the winter and shoulder seasons.
  - Summer numbers of flights make up the greater percentage of aircraft noise intrusions at Whitmore and Quartermaster under existing conditions. Observations indicate that winter use of helicopters for passenger exchanges is limited, and winter use may not add significantly to the total amount of time helicopters are audible.
  - It is understood that some trip members use other forms of watercraft than rafts for their recreational adventure (e.g., dory, kayak), but using rafts is a simplifying assumption considered reasonable for the nature of the analyses. It is recognized that noise produced by motorized trips is different from noise produced by non-motorized trips, and off-river noise and helicopter noise are also different. Therefore, the noise is presented separately for all the different scenarios present in an alternative. However, because this is a peak-period analysis, and because there may be additional effects from the combination of noise produced by all sources, the analysis also considers the combined noise effects that may be present.

  - Helicopter use in support of commercial river operations will vary each day and depend on the number of passengers needing transfer. Helicopter engines run continuously at exchange points. There may be times during the transfer process that overlap of helicopter noise will stream together and become one long continuous noise event.
- Bottlenecks, gathering points, launch/retrieval sites, and camping areas will be noisier than lesser used natural areas, and moving water (rapids and fast flowing whitewater areas) and wind will help to reduce noise impacts by masking the noise source.
- Where river rapids raise the natural ambient levels, rafting noise is expected to be less impacting on the natural soundscape due to the masking effect of the sound from moving water, and by other natural sounds (wind, storm activity, insect activity, etc.).
- Human voices in reasonably quiet conversation are not considered noise impacts in this context, but human voices and activities that are clearly audible more than 100 feet away from the source in a quiet natural ambient environment are included in noise impact considerations. Off-river noise considers such sources as electronic devices (e.g., boom boxes), camp stoves, and activities such as loading/unloading rafts and games. The noise is usually not continuous, and groups vary in their "loudness" and when and where such noise occurs during a trip. There are no data allowing such noise to be quantified or predicted, but its presence is considered in that larger groups tend to have more opportunity to create such noise.
- Sounds from wildlife are part of the natural soundscape, and can be masked or otherwise adversely impacted by human noise. (This is discussed under "Terrestrial Wildlife.")
- The impact analyses focus on the relative differences between alternatives within groups (i.e., Lees Ferry and Lower Gorge groups), not on the absolute amounts of noise estimated. Because the assumptions and approaches are similar, the relative differences among the Lees Ferry alternatives, and the relative differences among between the Lower Gorge alternatives, are considered to be accurate to acceptable levels within those groups of alternatives.

IMPACT ANALYSIS — LEES FERRY ALTERNATIVES

The potential for impacts for Lees Ferry alternatives are based on a comparison among Lees Ferry alternatives and the existing conditions.

Alternative A (Current Conditions)

Analysis. Under Alternative A, management of recreational use would continue to allow large group sizes, lengthy trips, and spikes in trips at one time, people at one time, and daily launches (see Table 4-1). User-days would remain capped at current levels, which would result in approximately the same number of total yearly passengers. Similarly, user discretionary time would remain similar to current levels.

Alternative A has a range of 3 to 9 launches per day during the summer season, up to 3 launches per day during shoulder seasons, and very little use during winter. Maximum trip lengths are 18

days for all trips during the summer, and 30 in the winter. Shoulder season limits are 18 days for commercial motorized trips, to 21 days for either non-motorized commercial or noncommercial (private).

Motorized Trips — For purposes of characterizing this, a typical peak day for a commercial motorized trip in the summer season would consist of the following:

- A motorized raft would run its motor approximately 3.5 hours per day at typical river levels and trip lengths.
- There would be two rafts per motorized trip.
- Trips average 40 miles traveled per day and have similar trip lengths.
- Four motorized trips would launch per day, or eight motorized rafts total per day.

This would result in motorboat noise passing by a single point on the river 8 times a day, at about 9 minutes audibility per boat, for a total of 72 minutes, or about 10% of the time audible, which over the 12-hour day is considered a moderate adverse impact. In addition, a person on the boat (or the natural soundscape alongside the boat) would experience noise from the boat's motor operating approximately 3.5 hours (210 minutes) per day. The total time the motor creates noise in the park's natural soundscape would be a regional impact over the average 40 miles of river that motorized rafts travel per day. However, the motor use would not be constant (i.e. there would be periods of no-motor use).

The noise-free interval on the motorized raft itself is expected to be low, with only 30 to 60 minutes between noise events when the motor is used. For the single spot on the river, which represents the natural soundscape in this scenario, the noise intrusions are expected to be random in nature and infrequent (Jalbert, pers. comm. 2004).

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 39 people per group, so 8 rafts per trip;
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft and 16 people per group, so 4 rafts per trip;
- Five non-motorized trips launch on the busiest days, with up to two noncommercial and three commercial, so up to 32 non-motorized rafts launch per day (24 + 8) in this scenario;

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or in the range of 12 to 24 minutes per trip (4 rafts × 3 minutes for noncommercial trip, 8 rafts × 3 minutes for commercial trips). With up to five trips per day, and a water flow of 3 to 5 miles per hour (mph), human noise at any one point is expected to be about 96 minutes of total human raft activity noise per day, or about 13% of the day audible. Non-motorized raft sounds would be mostly human voices and intermittent. The noise-free interval on the non-motorized raft itself is expected to be high, with voices and oars being the primary human sounds. For the single spot on the river, which represents the natural soundscape in this scenario, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — Adding the noise expected at a single point on the river from both motorized (72 minutes) and non-motorized trips (96 minutes) under this scenario gives a total from floating rafts of 168 minutes, which is a bit over 2.5 hours of the 12-hour day, or about 23% of the time audible, a moderate intensity level.

The human activity noise contribution off the river (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops, etc.) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives in terms of numbers of launches, group sizes, and user discretionary time (i.e., alternatives with greater numbers of launches, larger group sizes, and/or higher user discretionary time would tend to have greater impacts). This noise would be spread out over 15 to 40 miles of river. It would not occur at the same time or place, but it could overlap (e.g., nine different trips at nine different locations). The noise-free intervals in this scenario are expected to be in the range of 1.5 to 3.5 hours.

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenarios. Average noise-free intervals of 1.5 to 3.5 hours would be commonly expected when considering only the boat-related activities in Alternative A, including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. Helicopter shuttle impacts in the Whitmore area would also reduce noise-free intervals in that area (see below).The noise intrusions from all trips are expected to be short term, of minor to moderate (at high-use gathering areas and campsites) intensity, random to periodic in nature (i.e., at common gathering areas like trailheads and takeouts), and infrequent, based on typical river use launch rates and practices.

Whitmore Helicopters — Using existing flight and passenger data from FAA and the Hualapai Tribe, approximately 10,300 passenger exchanges occur at Whitmore each year, with 3500 flying into Whitmore and 6800 flying out. Assuming that there are five passengers per flight, and that operators carry the maximum number of people on every flight, a total of 2,720 flights occur from this transfer location over the course of a year (i.e., 700 flights for passengers in, plus 700 flights for passengers out, plus 660 flights empty in to pick up passengers, plus 660 flights for passengers out). River data show that approximately 66% of all yearly flights occur during summer (i.e., 1795 flights during summer, or an average of 14-15 flights per day). The remaining flight transfers take place during the shoulder season, (i.e., 925 flights during shoulder seasons, or an average of 7-8 flights per day).

The average time helicopters are audible at any given site is 3.5 minutes, based on 16 logged events measured in the field at Hermits Rest Trail Head on May 28 and June 1, 2004 (Field work conducted by Ken McMullen) checked with data from HMMH 1993 that measured helicopter time audible at 2 to 4 minutes duration.

Using the average number of flights per day and 3.5 minutes audibility per flight, summer days would average 49-52.5 minutes of audibility from helicopters, and shoulder days would average about 24.5-28 minutes. However, observations indicate that the average rarely occurs. Many

summer mornings at Whitmore tend to be noise saturated for most of the time between 7 A.M. to 11 A.M., which is approximately one-third of the total 12-hour day. Other days have few or no flights, corresponding to the uneven launch patterns and motor trips traveling at similar speeds. Helicopters exchanging river trip passengers at Whitmore have been measured at up to 83 dBA at a distance of 200 feet from the source. This is almost 50 dBA above existing natural ambient levels (34 dBA). Whitmore shuttle helicopters have also been observed on occasion to fly very low over the river rather than directly to their destination at Bar 10 Ranch. On the many days of heavy helicopter use, adverse, major impacts would occur to the natural soundscape in a 10–20 mile diameter area at Whitmore, with helicopter shuttles audible more than 25% of the day, and close to 100% of the morning hours. These flights are authorized by Public Law 100-91. There are days even during even the summer season of low or no helicopter use.

Non-Peak Periods — Almost all of the river use in Alternative A occurs from March through October, so there are few river-related impacts to the natural soundscape during other months. Within the March–October period, use and corresponding soundscape impacts peak dramatically from May through August.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above, but given the history of the current situation, it is unlikely that mitigations would be implemented at a level sufficient to reduce the impacts of Alternative A to the natural soundscape to a minor intensity or less.

Generator use is currently allowed and causes minor to major localized impacts to the natural soundscape, depending upon the amount of time generators are used. However, generator use is being restricted under all alternatives, including no-action, so is not further evaluated here. This restriction is an important mitigation for the natural soundscape.

Cumulative Effects. Cumulative human noise impacts that adversely impact the park's natural soundscape come from the use of aircraft for commercial air tours, park administrative flights, high altitude commercial jet traffic, and to a lesser extent military and general aviation aircraft use over and adjacent to the park. As discussed above, several laws require the Federal Aviation Administration and the National Park Service to address the aircraft noise issue and to work together to "substantially restore natural quiet" to Grand Canyon National Park. There is a continuing effort to determine whether "substantial restoration of natural quiet" has been achieved. However, cumulative aircraft use are causing a "significant adverse effect" and an adverse, long-term, major impact on the natural soundscape. Alternative A adds a negligible increment to this adverse, major cumulative effect.

Commercial air tour numbers were at their highest in 1997 and 1998 when over 120,000 air tours took place annually over the park. Current numbers of air tours and support flights are about 83,000 annually (FAA 2003 reported data). However, noise intrusions by high altitude commercial jet traffic over the park have increased significantly. Military use has been largely routed away from the park, and military compliance with NPS policies is good. General aviation aircraft and park administrative use of aircraft has remained fairly constant.

Commercial air tours have shown a slight increase over the park since 2002, with most of the increase occurring in the west end of the park, in support of Hualapai Tribe river recreation activities and commercial air tours.

Commercial air tour operations at Grand Canyon National Park occur in the Special Flight Rules Area 50-2, which includes all of the river corridor (Zones 1 through 3). Air tour routes are directly over the river in the Dragon and Zuni corridors (see Figure 4-1), and in the Lower Gorge (i.e., flights originating from Las Vegas going to the airport in Tusayan or Grand Canyon West).

To address the Grand Canyon National Park aircraft overflight noise issue, of the more than 300 hours of active logging data collected on September 10, 12, and 13, 1999, fixed-wing propeller aircraft and helicopters accounted for over 99.5 hours, and high altitude commercial jet aircraft were logged for just over 69 hours, for a total of about 168.5 hours of aircraft audibility data. This equates to approximately 56% of the day being impacted by aircraft noise**,** for all days monitored (HMMH 2004). Since the data was collected in September, which is not the peak month of commercial air tours over Grand Canyon National Park, these values may under-represent the true number of commercial air tours typically conducted during the peak season. However, the data indicates that aircraft were audible for over half the day, thus reducing the percentage of time natural sounds were unaffected by humans to less than half the time in one-third to one-half of the park. The study showed that high altitude commercial jet aircraft are audible across all sites monitored, with time audible ranging from 14.8% to 68.2 % of the day, on a daily basis.

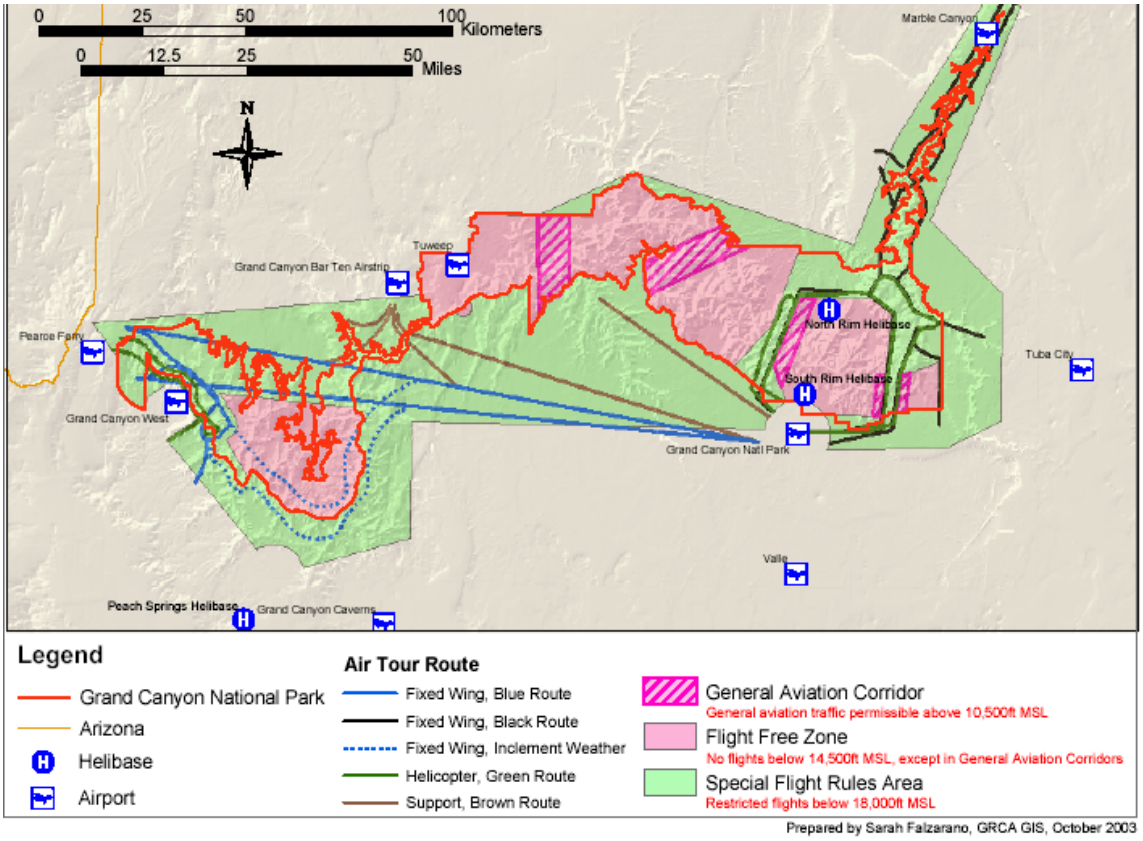
It is expected that further analysis would indicate that high altitude jet aircraft are audible for over 50% of the time in some of the most remote and quiet portions of Zone 1, in and around the river corridor. Adding flight information from Whitmore estimates, and estimating park administrative flights and general aviation aircraft flight additions, another 10% to 33% of the day can be added to the total time aircraft are audible in portions of Zone 1, on any summer day. Aircraft overflights thus represent major adverse cumulative impacts on the park natural soundscape for about 245 days per year in most of the park, and they are frequent and periodic, depending upon location. Adding motorboat and non-motor boat noise from river recreation further increases the cumulative impact.

Additional data on aircraft noise and watercraft noise intrusions and noise-free intervals are proposed for collection in 2004. Park areas targeted for this effort include the mid-park Flight Free Zones, shown in the Figure 4-1 below, and the western portion of the park, between Whitmore and Lake Mead National Recreation Area. Initial results are expected by completion of the release of the final environmental impact statement later this calendar year (2004).

Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. Under Alternative A, motorized rafts passing by a single point on the river are estimated to be audible approximately 10% of the 12-hour day, and non-motorized rafts an additional 12%. Additional off-river noise would be created by recreationists, especially at gathering areas such as attraction sites, lunch stops and campsites, but this cannot be quantified.

FIGURE 4-1: SPECIAL FLIGHT RULES AREA GRAND CANYON NATIONAL PARK



Average noise-free intervals of 1.5 to 3.5 hours (minor intensity level) would be expected if raft-related noise was the only consideration, but the cumulative effects of aircraft overflights make it likely that noise-free intervals would be reduced to infrequent, small blocks of time in much of the river corridor. The raft-related impacts result in an overall minor to moderate adverse impact, with generally short-term impacts from each event, but they occur most days over enough of the year that some long-term effects are probable. Motorboats travel over an average 40 miles per day and run their motors for about 3.5 hours each to travel that distance, so that although the noise from motorboats is produced in a localized area, it also creates a regional impact over the entire river corridor during the course of a trip.

Helicopter shuttles in the Whitmore area create major adverse impacts in an area up to 10–20 miles in diameter around the Whitmore landing site (i.e., localized). The helicopter river passenger shuttles average about 50 minutes audibility during the busy summer months, but on busy days can be audible during most of the time between 7am and 11am (almost one-third of the day). The noise is repeatable and periodic in nature, and easily audible (i.e., the noise intrusion is 50 dBA or more greater than ambient). The noise-free interval is significantly reduced by the continuous nature of the morning passenger transfers, dropping to less than 10 minutes between flights for almost one-third of the day on busy days. Once the flight transfers are completed, the natural soundscape is expected to return to noise-free interval's similar to the up-river stretch. Because the flights are authorized in Public Law 100-91, it is unlikely that

mitigation can be implemented to reduce impacts in the Whitmore area to minor levels or less. Alternative A would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative A are major adverse long-term regional impacts primarily due to extensive aircraft overflights of the park independent of the *Colorado River Management Plan*. The cumulative impacts are not likely to be able to be mitigated to minor intensity or less. There are "significant adverse effects" and "substantial restoration of natural quiet" has not been achieved as required by Public Law 100-91 and other mandates. Noise-free intervals due to aircraft overflights would be reduced to infrequent, small blocks of time in many parts of the park. Noise from river recreational activities contributes additional noise to the natural soundscape; however, even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be an adverse, major impact.

Alternative B

Analysis. Under Alternative B, recreational motor trips are prohibited and group sizes, trips at one time, people at one time, daily launches, user-days, and probable total yearly passengers would be at their lowest levels (see Table 4-1).

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 25 people per group, so five rafts per trip;
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft and 16 people per standard group (so four rafts per trip) and 8 people per small group (so two rafts per trip);
- Four non-motorized trips launch on the busiest days, with up to two commercial and one each noncommercial standard and small groups; so up to 16 non-motorized rafts launch per day (10 + 4 + 2) in this scenario;

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately three minutes per raft, or in the range of 6 to 15 minutes per trip (2 rafts × 3 minutes for noncommercial small trips, 4 rafts × 3 minutes for noncommercial standard trips, 5 rafts × 3 minutes for commercial trips). With up to 4 trips per day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be about 48 minutes of total human raft activity noise per day, or about 7% of the day audible (a minor impact intensity level). Because there would be more than 11 hours without motorboat noise for a single location on the river under this scenario, noise-free intervals are expected to be high, in the range of 60 minutes to several hours (3.5 hours +) between boat noise intrusions. The noise-free interval on the non-motorized raft itself is expected to be high. For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — The human activity noise contribution off the river (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting

locations and other stops) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative B would have fewer launches per day and smaller group sizes than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 20 miles of river. It would not occur at the same time or place, but it could overlap (e.g., four different trips at four different locations).

Since human noise activity on the raft and in the off-river locations would not be constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenario. The average noise-free interval for Alternative B is expected to often exceed 3.5 hours (an adverse, negligible impact) when considering only boat-related activities, including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. The noise intrusions from all trips are expected to be adverse, short term, negligible to minor, random to periodic in nature (i.e., at common gathering areas like trailheads and takeouts), and infrequent.

Non-Peak Periods — Most river use in Alternative B would occur from May through August, with half the summer level in the fall shoulder, and lower use the rest of the year. Because there would be no-motor or helicopter use year-round, coupled with small group sizes and low launch levels, Alternative B would have lower non-peak season soundscape impacts than Alternative A and any of the action alternatives.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. Impacts are already expected to be at negligible to minor levels, but a noise monitoring program and quick action to address impacts would be necessary to ensure that impacts stayed at those levels.

Cumulative Effects. Cumulative impacts would be similar to those discussed under Alternative A. Alternative B would reduce overall noise compared to Alternative A, and would have a beneficial, negligible impact on cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park natural soundscape. Even if all river-related noise was removed from the park, the park would still experience major adverse effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. The natural soundscape would benefit the most from adoption of Alternative B due to removal of motorized uses from the river, as well as the fewest overall daily launches, the lowest group sizes, and no helicopter exchanges at Whitmore. Removal of motors on the river would remove about 3.5 hours of motors running on each motorboat each day, and removal of Whitmore helicopter transfers would remove up to 4 hours of aircraft noise from that area. Noise from non-motorized trips would be audible about 48 minutes or 7% of the 12-hour day at a single point along the river. There would be additional off-river noise, but it is not quantifiable.

That would leave almost 90% of the day noise-free from river-related activity, with expected noise-free intervals of 3.5 hours or more. Therefore, noise intrusions to the natural soundscape under this alternative would be adverse but localized, short term, and negligible to minor (at high-use areas and gathering points). This would be a beneficial reduction in noise compared to Alternative A (no action) by providing ample opportunities for long periods of unaffected natural sounds (thus long noise-free intervals), consistent with desired experience in Zone 1. Alternative B would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative B would continue to be regional, adverse, long-term, major impacts primarily due to extensive aircraft overflights and could probably not be mitigated to a minor intensity or less. Alternative B would have a beneficial, negligible impact on cumulative effects as it would reduce noise compared to Alternative A, but it illustrates the point that even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be an adverse, major impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic, and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative C

Analysis. Under Alternative C recreational motorized trips would be prohibited; group sizes, trips at one time, people at one time, daily launches, user-days, and probable total yearly passengers would be mid way between Alternatives A and B (see Table 4-1).

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 30 people per group, so six rafts per trip.
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft and 16 people per standard group (so four rafts per trip).
- Four non-motorized trips launch on the busiest days, with up to two commercial and two noncommercial standard groups; so up to 20 non-motorized rafts launch per day (12 + 8) in this scenario.

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or in the range of 12 to 18 minutes per trip (4 rafts × 3 minutes for noncommercial standard trips, 6 rafts × 3 minutes for commercial trips). With up to four trips per day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be about 60 minutes of total human raft activity noise per day, or about 8% of the day audible (a minor impact intensity level). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — The human activity noise contribution off the river, (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops, etc.) cannot be quantified as discussed in the assumptions above, but

relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative C has fewer launches per day and smaller group sizes than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 20 miles of river. It would not occur at the same time or place, but it could overlap (e.g., 4 different trips at 4 different locations).

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenario. The average noise-free interval for Alternative C is expected to often exceed 3.5 hours (negligible intensity impact) when considering only boat-related activities, including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. The noise intrusions from all trips are expected to be adverse, short term, minor, random to periodic in nature (i.e., at common gathering areas like trailheads and takeouts), and infrequent. At any one location on the river, time audible noise events would be less than that for current conditions (Alternative A), but more launches and larger group sizes would increase impacts compared to Alternative B.

Non-Peak Periods — Alternative C would have relatively high-use levels all year. Thus, even though there would be no motorized use and no helicopter exchanges, soundscape impacts would tend to be higher from October through March than under Alternative A and many of the action alternatives.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. Impacts are already expected to be at minor levels, but a noise monitoring program and quick action to address impacts would be needed to ensure they would stay at those levels.

Cumulative Effects. Cumulative impacts would be similar to those discussed under Alternative A. Alternative C would reduce overall noise compared to Alternative A, but not as much as Alternative B, and would have a negligible beneficial impact on cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. Even if all river-related noise was removed from the park, the park would still experience adverse, major effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. The natural soundscape would benefit from adoption of this alternative compared to Alternative A because removal of motors on the river removes about 3.5 hours of motors running on each motorboat each day, and removal of Whitmore helicopter transfers removes up to 4 hours of aircraft noise from that area. Noise from non-motorized trips would be audible about 60 minutes or 8% of the 12-hour day at a single point along the river (a minor impact intensity level). There would be additional off-river noise, but it is not quantifiable. That would leave over 90% of the day free from noise generated by river-related activity, with expected noise-free

intervals of 3.5 hours or more. Therefore, overall noise intrusions to the natural soundscape under this alternative would be localized (at high-use areas and gathering points), adverse, short term, and minor. If mitigation was instituted at a reasonable level, impacts would likely remain at minor levels or less. Alternative C would not result in the impairment of the natural soundscape at Grand Canyon National Park.

The cumulative effects of Alternative C would continue to be regional, adverse, long-term, major impacts primarily due to extensive aircraft overflights of the park, and they could probably not be mitigated to minor intensity or less. Alternative C would have a beneficial, negligible impact on cumulative effects as it would reduce noise compared to Alternative A, but even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be adverse and major. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative D

Analysis. Under Alternative D recreational motor trips would be limited to eight months each year, with a four-month no-motor season. There would also be reductions in group sizes and trip lengths, increases in launches and user-days from March through October, and no helicopter operations at Whitmore under this alternative (see Table 4-1).

Motorized Trips — For purposes of characterizing Alternative D, a typical peak day for a commercial motorized trip in the summer season would consist of the following:

- A motorized raft would run its motor approximately 3.5 hours per day at typical river levels and trip lengths.
- There would be up to two rafts per motorized trip (i.e., with an assumption of 20 people per motorized raft and group sizes of 25, two rafts would be required).
- Trips average 40 miles traveled per day and have similar trip lengths.
- Up to three motorized trips would launch per day, or up to six motorized rafts total per day.

This would result in motorboat noise passing by a single point on the river 6 times a day, at about 9 minutes audibility per boat, for a total of 54 minutes, or about 8% of the time audible, which over the 12-hour day would be considered an adverse, minor impact. In addition, a person on the boat (or the natural soundscape alongside the boat) would experience noise from the boat's motor operating approximately 3.5 hours (210 minutes) per day. The total time the motor creates noise in the park's natural soundscape would be a regional impact over the average 40 miles of river that motorized rafts travel per day. However, the motor use would not be constant (i.e., there would be periods of no-motor use).

The noise-free interval on the motorized raft itself is expected to be low, with only 30 to 60 minutes between noise events when the motor is used. For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 25 people per group, so 5 rafts per trip;
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft, 16 people per standard noncommercial group, so 4 rafts per trip;
- Two non-motorized trips launch on the busiest days, with one commercial group, and one noncommercial standard group, so up to 9 non-motorized rafts launch per day (5 + 4) in this scenario;

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or in the range of 12 to 15 minutes per trip (4 rafts × 3 minutes for noncommercial standard trips, 5 rafts × 3 minutes for commercial trips). With up to 2 trips per day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be about 27 minutes of total human raft activity noise per day, or about 4% of the day audible (a negligible impact intensity level). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — Adding the noise expected at a single point on the river from both motorized (54 minutes) and non-motorized trips (27 minutes) under this scenario gives a total from floating rafts of 81 minutes, which is a bit a bit less than 1.5 hours of the 12-hour day, or about 12% of the time audible, an adverse, minor to moderate impact.

The human activity noise contribution off the river, (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops, etc.) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative D has fewer launches per day and smaller group sizes than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 40 miles of river. It would not occur at the same time or place, but it could overlap (e.g., five different trips at five different locations).

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenario. Average noise-free intervals of 1.5 to 3.5 hours would be commonly expected when considering only the boat-related activities in Alternative D, including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. The noise intrusions from all trips are expected to be adverse, short term, minor to moderate, and infrequent.

Non-Peak Periods — Most river use in Alternative D occurs from May through August, with less than half the summer level in the fall shoulder season, slightly lower still in the spring shoulder season, and some of lowest launch levels in winter. Because there would be no helicopter use, coupled with no motorized launches in the spring and fall shoulder seasons, Alternative D would

have lower shoulder season soundscape impacts than Alternative A, but greater impacts in winter due to motorized winter launches and greater numbers of launches than Alternative A.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. To reduce impacts to minor levels or less, a noise monitoring program and quick action to address impacts would be necessary, especially for the increases in launches and user-days from March through October.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative D would have reduced impacts compared to Alternative A, in large part because no helicopter use would be allowed at Whitmore, and would contribute a beneficial, negligible increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. Even if all river-related noise was removed from the park, the park would still experience adverse, major effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. The natural soundscape would benefit from adoption of this alternative compared to Alternative A, because removal of Whitmore helicopter transfers removes up to 4 hours of aircraft noise from that area, and daily launches would be evened out along with smaller group sizes and fewer boats per day. Noise from commercial motorized trips would be audible about 54 minutes or 8% of the 12-hour day, and non-motorized trips would be audible about 27 minutes or about 4% of the day at a single point along the river, for a combined total from all rafts of 81 minutes and 12% time audible (a minor to moderate intensity level). There would be additional off-river noise, but it is not quantifiable. Also, each motorized raft would run its motor about 3.5 hours to travel an average 40 miles, with noise impacts spreading out over that entire stretch of river during the course of each day. That would leave over 80% of the day free of noise from river-related activity, with expected noise-free intervals of 1.5 to 3.5 hours (an adverse, short-term, minor impact). Therefore, noise intrusions to the natural soundscape under this alternative would result in localized, adverse, short-term, and minor to moderate impacts (at high-use areas and gathering points). If mitigation is instituted at a reasonable level, it is likely that impacts can be maintained at minor levels or less. Alternative D would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative D would continue to be major adverse, long-term regional impacts primarily due to extensive aircraft overflights of the park, and are not likely to be able to be mitigated to minor intensity or less. Although Alternative D would have a beneficial, negligible impact on cumulative effects, even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be an adverse, major impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative E

Analysis. Under Alternative E, recreational motor trips would be limited to six months, with a six-month no-motor season. Compared to Alternative A, there would be increases in launches and user-days from March through October (see Table 4-1).

Motorized Trips — For purposes of characterizing Alternative E, a typical peak day for a commercial motorized trip in the summer season would consist of the following:

- The motorized raft would run its motor approximately 3.5 hours per day at typical river levels and trip lengths.
- The maximum group size would be 30, so there would be two rafts per motorized trip.
- Trips average 40 miles traveled per day and have similar trip lengths.
- Up to three motorized trips would launch per day, or up to six motorized rafts total per day.

This would result in motorboat noise passing by a single point on the river six times a day, at about 9 minutes audibility per boat, for a total of 54 minutes, or about 8% of the time audible, which over the 12-hour day is considered a minor adverse impact. In addition, a person on the boat (or the natural soundscape alongside the boat) would experience noise from the boat's motor operating approximately 3.5 hours (210 minutes) per day. The total time the motor creates noise in the park's natural soundscape would be a regional impact over the average 40 miles of river that motorized rafts travel per day. However, the motor use would not be constant (i.e. there would be periods of no-motor use). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 25 people per group, so five rafts per trip;
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft, 16 people per standard noncommercial group (so 4 rafts per trip), and 8 people per small noncommercial group (so 2 rafts per trip);
- Up to three non-motorized trips launch on the busiest days, with one commercial group, one noncommercial standard group, and one noncommercial small group, so up to 11 non-motorized rafts launch per day (5 + 4 + 2) in this scenario;

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or in the range of 6 to 15 minutes per trip (2 rafts × 3 minutes for noncommercial small trips, 4 rafts × 3 minutes for noncommercial standard trips, 5 rafts × 3 minutes for commercial trips). With up to 3 trips per day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be about 33 minutes of total human raft activity noise per day, or about 4% of the day audible. The noise-free interval on the non-motorized raft itself is expected to be high. For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — Adding the noise expected at a single point on the river from both motorized (54 minutes) and non-motorized trips (33 minutes) under this scenario would give a total from floating rafts of 87 minutes, slightly less than 1.5 hours of the 12-hour day, or about 12% of the time audible, an adverse, short-term, moderate impact.

The human activity noise contribution off the river, (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops.) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative E would have fewer launches per day and smaller group sizes than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 40 miles of river. It would not occur at the same time or place, but it could overlap (e.g., six different trips at six different locations).

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenario. Average noise-free intervals of 1.5 to 3.5 hours would be commonly expected when considering only the boat-related activities in Alternative E, including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. The noise intrusions from all trips would be expected to be adverse, short-term, minor to moderate, random to periodic in nature (i.e., at common gathering areas like trailheads and takeouts), and infrequent.

Whitmore Helicopters — For Alternative E, 5,000 passenger exchanges would occur by helicopter at Whitmore each year, with 2,500 flying into Whitmore and 2,500 flying out. Assuming that there would be five passengers per flight, and that operators would carry the maximum number of people on every flight they could, a total of 1,000 flights would occur from this transfer location over the course of a year (i.e., 500 flights for passengers in, plus 500 flights for passengers out).

Because Alternative E evens out the launch patterns, as many as three groups of 30 passengers could need helicopter shuttles during most summer days. This would correspond to 36 flights per day (18 in and 18 out for the 90 passengers), and at 3.5 minutes audibility per flight would result in up to 126 minutes (about 2 hours) of helicopter audibility on many days. When helicopter shuttles occur, noise-free intervals would be less than 10 minutes. Helicopters exchanging river trip passengers at Whitmore have been measured at up to 83 dBA at a distance of 200 feet from the source. This is almost 50 dBA above existing natural ambient levels (34 dBA or less). On the many days of heavy helicopter use, moderate to major adverse impacts would occur to the natural soundscape in a 10–20 mile diameter in the Whitmore area, with helicopter shuttles audible about 17% of the day, and about 50% of the morning hours. It should be noted that such flights are authorized by Public Law 100-91, and that there would be days during even the summer season of low or no helicopter use.

Non-Peak Periods — Alternative E would have peak use from May through August and relatively high mixed use in April and September. It would also have higher use levels than Alternative A during the rest of the year, with correspondingly greater soundscape impacts. This

would be partially offset because use from October through March would be non-motorized, and Alternative E would have smaller group sizes.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. Implementing these mitigation actions would require increased funding and staff, and a monitoring program with quick response to reduce impact as needed. But it is reasonable to expect that sufficient implementation could be achieved to reduce impacts to minor levels or less.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative E would have adverse, minor to moderate impacts, the same overall level as Alternative A, and it would contribute a negligible adverse increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. Even if all river-related noise was removed from the park, the park would still experience major adverse effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusions. The natural soundscape would benefit from adoption of this alternative compared to Alternative A (no action). Noise from commercial motorized trips would be audible about 54 minutes or 8% of the 12-hour day, and non-motorized trips would be audible about 33 minutes or about 4% of the day at a single point along the river, for a combined total from all rafts of 87 minutes and 12% time audible (an adverse, short-term, minor to moderate impact). That would leave over 80% of the day free of noise from river-related activity, with expected average noise-free intervals 1.5 to 3.5 hours when considering only river-related activity away from Whitmore. Other parts of the year would have less noise than the peak.

In addition, helicopter shuttle noise would be audible for up to two hours over a four-hour period on many days in the Whitmore area, a moderate to major intensity level localized in the 10–20 mile diameter around Whitmore. There would be additional off-river noise, but it is not quantifiable, and each motorized raft would run its motor about 3.5 hours to travel an average 40 miles with the noise impacts spreading out over that entire stretch of river during the course of each day.

Therefore, overall noise intrusions to the natural soundscape under this alternative would be localized, adverse, short term, and minor to moderate (at high-use areas and gathering points). If mitigation was instituted at a reasonable level, it is likely that impacts can be reduced to minor levels or less. Alternative E would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative E would be major adverse, long-term regional impacts primarily due to extensive aircraft overflights of the park, and are not likely to be able to be mitigated to minor intensity or less. Although Alternative E does contribute to the overall cumulative effects of noise on the park natural soundscape, even if all noise from all river

recreation was completely eliminated from the park, the cumulative effects of aircraft noise would still be a major adverse impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative F

Analysis. Under Alternative F, a six-month motor season would occur from January through June, and a six-month no-motor season from July through December (see Table 4-1). This is the only alternative that splits summer into motor and no-motor seasons.

Motorized Trips — For purposes of characterizing Alternative F, a typical peak day for a commercial motorized trip in May-June would consist of the following:

- The motorized raft would run its motor approximately 3.5 hours per day at typical river levels and trip lengths.
- The maximum group size would be 30, so there would be two rafts per motorized trip.
- Trips average 40 miles traveled per day and have similar trip lengths.
- Up to five motorized trips would launch per day, or up to 10 motorized rafts total per day.

This would result in motorboat noise passing by a single point on the river 10 times a day, at about 9 minutes audibility per boat, for a total of 90 minutes, or about 12.5% of the time audible, which over the 12-hour day is considered a moderate adverse impact. In addition, a person on the boat (or the natural soundscape alongside the boat) would experience noise from the boat's motor operating approximately 3.5 hours (210 minutes) per day. The total time the motor creates noise in the park's natural soundscape would be a regional impact over the average 40 miles of river that motorized rafts travel per day. However, the motor use would not be constant (i.e. there would be periods of no-motor use). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity during May-June, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 30 people per group, so six rafts per trip.
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft, 16 people per standard noncommercial group (so four rafts per trip), and 8 people per small noncommercial group (so two rafts per trip).
- Up to one non-motorized trip would launch on the busiest days, alternating days between one commercial group and one noncommercial standard group, so up to six non-motorized rafts launch per day in this scenario;

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or up to 18 minutes per trip (6 rafts × 3 minutes for noncommercial standard trips, 6 rafts × 3 minutes for commercial trips). With only one trip per

day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be up to 18 minutes of total human raft activity noise per day, or about 2.5% of the day audible (an adverse, short-term, negligible impact). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — Adding the noise expected at a single point on the river from both motorized (90 minutes) and non-motorized trips (18 minutes) under this scenario gives a total from floating rafts of 108 minutes, which is a bit less than 2 hours of the 12-hour day, or about 15% of the time audible, an adverse, short-term, moderate impact.

The human activity noise contribution off the river, (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops, etc.) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative F would have fewer launches per day and smaller group sizes than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 40 miles of river. It would not occur at the same time or place, but it could overlap (e.g., six different trips at six different locations).

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenarios. Average noise free intervals of 1 to 1.5 hours would be commonly expected when considering only the boat-related activities during the May–June peak period in Alternative F (an adverse, short-term, moderate impact), including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. The noise intrusions from all trips are expected to be adverse, short term, moderate, random to periodic in nature (i.e., at common gathering areas like trailheads and takeouts), and infrequent.

Whitmore Helicopters — For Alternative F, 3,400 passengers would fly in to Whitmore by helicopter each year, and 6,600 would fly out. Assuming that there were five passengers per flight, and that operators would carry the maximum number of people on every flight, a total of 2,640 flights would occur from this transfer location over the course of a year (i.e., 680 flights for 3,400 passengers in, plus 680 flights for 3,400 passengers out, plus 640 flights for the remaining 3,200 passengers out, plus 640 flights coming in empty to pick up those 3,200 passengers).

Because Alternative F would even out the launch patterns, as many as five groups of 30 passengers could need helicopter shuttles during most summer days. This would correspond to 60 flights per day (30 in and 30 out for the 150 passengers), and at 3.5 minutes audibility per flight would result in up to 210 minutes (about 3.5 hours) of helicopter audibility on many days. When helicopter shuttles occur, noise-free intervals would be less than 10 minutes. Helicopters exchanging river trip passengers at Whitmore have been measured at up to 83 dBA at a distance of 200 feet from the source. This is almost 50 dBA above existing natural ambient levels (34 dBA or less). Whitmore shuttle helicopters have also been observed on occasion to fly very low over the river rather than directly to their destination at Bar 10 Ranch. On the many days of

heavy helicopter use, major adverse impacts would occur to the natural soundscape localized in the Whitmore area, with helicopter shuttles audible almost 30% of the 12-hour day, and almost 90% of the morning hours. With so many motor launches in May-June, and generally the same number of motor launches per day, there would be few days during those months of low or no helicopter use. It should be noted that such flights are authorized by Public Law 100-91.

Non-Peak Periods — In terms of soundscape impacts, peak use in Alternative F would be in May and June, followed by March and April. While use levels would be relatively high during the rest of the year, it would be non-motorized, with no helicopters at Whitmore. Compared to Alternative A, the July–September period would have fewer soundscape impacts in Alternative F, while the October–April period would have greater soundscape impacts due primarily to correspondingly lower and higher use levels in those months. This would be partially offset, though, because Alternative F would have smaller group sizes.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. Implementation of these mitigation actions would require increased funding and staff, and a monitoring program with quick response to reduce impact as needed. Due to high motorized use levels, it is unlikely that impacts could be reduced by reasonable mitigation to minor levels or less in the peak months of May and June, but it is reasonable to expect that impacts the rest of the year could be reduced to minor.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative F would have moderate overall impacts during peak periods, a greater overall level than Alternative A, but it would contribute an adverse, negligible increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. Even if all river-related noise was removed from the park, the park would still experience major adverse effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusions. Even with more motor use in May and June than under any of the other alternatives (including Alternative A), the natural soundscape would benefit overall from adoption of Alternative F compared to Alternative A. Noise from commercial motorized trips would be audible about 90 minutes or 12% of the 12-hour day, and non-motorized trips would be audible about 18 minutes or about 2.5% of the day at a single point along the river, for a combined total from all rafts of 108 minutes and 15% time audible (a moderate intensity level) during the two heaviest use months of the year (May-June). Average noise-free intervals would be expected to be 1 to 1.5 hours (an adverse, short-term moderate impact) when considering only river-related activity away from Whitmore during May and June. Other parts of the year would have less noise than the peak.

In addition, helicopter shuttle noise would be audible for up to 3.5 hours over a 4-hour period on many days during May and June localized in a 10–20 mile diameter at Whitmore area, an adverse, short-term, major impact. There would be additional off-river noise, but it is not

quantifiable, and each motorized raft would run its motor about 3.5 hours to travel an average 40 miles with the noise impacts spreading out over that entire stretch of river during the course of each day.

Therefore, overall noise intrusions to the natural soundscape under this alternative would be localized and regional, adverse, generally short-term, and moderate (at high-use areas and gathering points). It is unlikely that impacts could be reduced to minor levels or less in May and June, but it is likely that they could be adequately reduced by mitigation the rest of the year. Alternative F would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative F would be major adverse, long-term regional impacts primarily due to extensive aircraft overflights of the park, and are not likely to be able to be mitigated to minor intensity or less. Although Alternative F does contribute to the overall cumulative effects of noise on the park natural soundscape, especially during May-June, even if all noise from all river recreation was completely eliminated from the park, the cumulative effects of aircraft noise would still be a major adverse impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative G

Analysis. Under Alternative G, the motorized season would be eight months (January–August), and the no-motor season would be four months (September–December). There would be considerable increases in March-October launches and user-days, with greatly increased use in the shoulder seasons (see Table 4-1).

Motorized Trips — For purposes of characterizing Alternative G, a typical peak day for a commercial motorized trip would consist of the following:

- The motorized raft would run its motor approximately 3.5 hours per day at typical river levels and trip lengths.
- The maximum group size would be 40, so there would be two rafts per motorized trip.
- Trips average 40 miles traveled per day and have similar trip lengths.
- Up to three motorized trips would launch per day, or up to six motorized rafts total per day.

This would result in motorboat noise passing by a single point on the river 6 times a day, at about 9 minutes audibility per boat, for a total of 54 minutes, or about 8% of the time audible, which over the 12-hour day is considered a minor adverse impact. In addition, a person on the boat (or the natural soundscape alongside the boat) would experience noise from the boat's motor operating approximately 3.5 hours (210 minutes) per day. The total time the motor creates noise in the park's natural soundscape would be a regional impact over the average 40 miles of river that motorized rafts travel per day. However, the motor use would not be constant (i.e. there

would be periods of no-motor use). For the single spot on the river, the noise intrusions would be random in nature and infrequent.

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 30 people per group, so six rafts per trip;
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft, 16 people per standard noncommercial group (so four rafts per trip), and 8 people per small noncommercial group (so two rafts per trip);
- Up to three non-motorized trips launch on the busiest days, including one commercial group, one noncommercial standard group, and one noncommercial small group, so up to 12 non-motorized rafts launch per day (6 + 4 + 2) in this scenario;

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or in the range of 6 to 18 minutes per trip (2 rafts × 3 minutes for noncommercial small trips, 4 rafts × 3 minutes for noncommercial standard trips, 6 rafts × 3 minutes for commercial trips). With three trips per day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be about 36 minutes of total human raft activity noise per day, or about 5% of the day audible (a negligible impact intensity level). The noise-free interval on the non-motorized raft itself is expected to be high. For the single spot on the river, noise intrusions would be random in nature and infrequent.

Combined Raft and Off-River Noise — Adding the noise expected at a single point on the river from both motorized (54 minutes) and non-motorized trips (36 minutes) under this scenario gives a total from floating rafts of 90 minutes, or 1.5 hours of the 12-hour day, or about 13% of the time audible, a moderate intensity level.

The human activity noise contribution off the river, (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops, etc.) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative G has fewer launches per day and smaller group sizes than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 40 miles of river. It would not occur at the same time or place, but it could overlap (e.g., five different trips at five different locations).

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenarios. Average noise-free intervals of 1 to 1.5 hours would be commonly expected when considering only the boat-related activities during the May–August peak period in Alternative G (an adverse, short-term, moderate impact), including the time audible plus the noise that cannot be quantified. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. The noise intrusions from all trips are expected to be adverse, short-term, moderate, and infrequent.

Whitmore Helicopters — For Alternative G, 3,700 passengers would fly in to Whitmore by helicopter each year, and 7,200 would fly out. Assuming that there were five passengers per flight, and that operators would carry the maximum number of people on every flight, a total of 2,640 flights would occur from this transfer location over the course of a year (i.e., 740 flights for 3,700 passengers in, plus 740 flights for 3,700 passengers out, plus 700 flights for the remaining 3,500 passengers out, plus 700 flights coming in empty to pick up those 3,500 passengers).

Because Alternative G evens out the launch patterns, as many as three groups of 40 passengers could need helicopter shuttles during most summer days. This would correspond to 48 flights per day (24 in and 24 out for the 120 passengers), and at 3.5 minutes audibility per flight would result in up to 168 minutes (a bit less than 3 hours or 25% of the day) of helicopter audibility on many days. When helicopter shuttles occur, noise-free intervals would be less than 10 minutes. Helicopters exchanging river trip passengers at Whitmore have been measured at up to 83 dBA at a distance of 200 feet from the source. This is almost 50 dBA above existing natural ambient levels (34 dBA or less). On the many days of heavy helicopter use, moderate to major adverse impacts would occur to the natural soundscape localized in the Whitmore area, with helicopter shuttles audible almost 25% of the 12-hour day, and almost 75% of the morning hours. With generally the same number of motor launches per day, there would be few days during summer months of low or no helicopter use. It should be noted that such flights are authorized by Public Law 100-91.

Non-Peak Periods — In terms of soundscape impacts, peak use in Alternative G would be from May through August, followed by March and April. Use levels would be among the highest of all the alternatives during the rest of the year, with motorized use and helicopters at Whitmore allowed from January through August (the only motorized use allowed in January and February would be noncommercial, which has been less than 10% of non-commercial use to date). Compared to Alternative A, almost all months would be expected to have greater soundscape impacts in Alternative G, due primarily to correspondingly higher use levels, and because Alternative G has only slightly smaller group sizes.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. The level of monitoring and mitigation required under Alternative G is such that it is unlikely that the actions would be implemented sufficiently to reduce impacts to minor levels or less.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative G would have adverse, short-term, moderate impacts during peak periods, a greater overall level than Alternative A, but it would contribute an adverse, negligible increment to cumulative effects. Aircraft overflights have a major adverse long-term cumulative effect on the park's natural soundscape. Even if all river-related noise was removed from the park, the park would still experience adverse, short-term, major effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusions. Even with high-use levels during all seasons, the natural soundscape would benefit overall from adoption of Alternative G compared to Alternative A (no action). Noise from commercial motorized trips would be audible about 54 minutes or 8% of the 12-hour day, and non-motorized trips would be audible about 36 minutes or about 5% of the day at a single point along the river, for a combined total from all rafts of 90 minutes and 13% of the time audible (a moderate intensity level) during the summer. Average noise-free intervals would be expected to be 1 to 1.5 hours (an adverse, short-term, moderate impact) when considering only river-related activity away from Whitmore from May through August. Other parts of the year would have less noise than the peak.

In addition, helicopter shuttle noise would be audible for a bit less than 3 hours (168 minutes) over a 4-hour period on many days from May through August localized in a 10–20 mile diameter area at Whitmore, an adverse, short-term, moderate to major impact. There would be additional off-river noise, but it is not quantifiable, and each motorized raft would run its motor about 3.5 hours to travel an average 40 miles with the noise impacts spreading out over that entire stretch of river during the course of each day.

Therefore, overall noise intrusions to the natural soundscape under this alternative would be adverse, localized and regional, generally short-term, and moderate intensity (at high-use areas and gathering points). It is unlikely that impacts can be reduced to minor levels or less. Alternative G would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative G would be major adverse, long-term regional impacts primarily due to extensive aircraft overflights of the park, and are not likely to be able to be mitigated to minor intensity or less. Although Alternative G does contribute to the overall cumulative effects of noise on the park natural soundscape, even if all noise from all river recreation was completely eliminated from the park, the cumulative effects of aircraft noise would still be a major adverse impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative H (NPS Preferred Alternative)

Analysis. Under Alternative H, recreational motor trips would be allowed for six months from March through August and non-motorized use from September through February (see Table 4-1).

Motorized Trips — For purposes of characterizing Alternative H, a typical peak day for a commercial motorized trip would consist of the following:

- The motorized raft would run its motor approximately 3.5 hours per day at typical river levels and trip lengths.
- The maximum group size would be 32 in summer (24 the rest of the year), so there would be two rafts per motorized trip.

- Trips average 40 miles traveled per day and have similar trip lengths.
- Up to three motorized trips would launch per day, or up to six motorized rafts total per day.

This would result in motorboat noise passing by a single point on the river 6 times a day, at about 9 minutes audibility per boat, for a total of 54 minutes, or about 8% of the time audible, which over the 12-hour day is considered a minor adverse impact. In addition, a person on the boat (or the natural soundscape alongside the boat) would experience noise from the boat's motor operating approximately 3.5 hours (210 minutes) per day. However, the motor use would not be constant (i.e. there would be periods of no-motor use). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Non-Motorized Trips — For purposes of estimating the noise contributed by non-motorized rafting activity, the following scenario is presented:

- For commercial non-motorized trips, calculations assume an average of 5 people per raft and up to 32 people per group, so seven rafts per trip.
- For noncommercial non-motorized trips, calculations assume an average of 4 people per raft, 16 people per standard noncommercial group (so four rafts per trip), and 8 people per small noncommercial group (so two rafts per trip).
- Up to three non-motorized trips launch on the busiest days, including one commercial group, one noncommercial standard group, and one noncommercial small group, so up to 13 non-motorized rafts launch per day (7 + 4 + 2) in this scenario.

Noise from non-motorized rafts as they float past a single point on the river is expected to be approximately 3 minutes per raft, or in the range of 6 to 21 minutes per trip (2 rafts × 3 minutes for noncommercial small trips, 4 rafts × 3 minutes for noncommercial standard trips, 7 rafts × 3 minutes for commercial trips). With three trips per day, and a water flow of 3 to 5 mph, the human noise at any one point is expected to be about 39 minutes of total human raft activity noise per day, or about 5% of the day audible (an adverse, short-term, negligible impact). For the single spot on the river, the noise intrusions are expected to be random in nature and infrequent.

Combined Raft and Off-River Noise — Adding the noise expected at a single point on the river from both motorized (54 minutes) and non-motorized trips (39 minutes) under this scenario gives a total from floating rafts of 93 minutes, or 1.5 hours of the 12-hour day, or about 13% of the day audible, an adverse, short-term, moderate impact.

The human activity noise contribution off the river, (e.g., at campsites, lunch areas, hiking trailheads, launch and takeout areas, river rapid scouting locations and other stops, etc.) cannot be quantified as discussed in the assumptions above, but relative comparisons can be made between alternatives primarily in terms of numbers of launches and group sizes. Alternative H would have fewer launches per day in the peak season than Alternative A, so less off-river noise would be expected. This noise would be spread out over 15 to 40 miles of river. It would not occur at the same time or place, but it could overlap (e.g., up to six different trips at six different locations).

Since human noise activity on the raft and in the off-river locations is not constant, or created in the same location at the same time, these values represent the worst case noise intrusion that could be reasonably expected from all types of river rafts and river activities, given the above scenarios. The noise intrusions from all trips are expected to be adverse, short-term, negligible to moderate, random to periodic in nature (i.e., at common gathering areas like trailheads and takeouts), and infrequent.

Whitmore Helicopters — For Alternative H, Whitmore helicopter exchanges would only occur during the peak use months of May-August, not during all motorized months. From May through August, a total of 5,000 passengers would fly in to Whitmore by helicopter, and 5,000 would fly out (additional river passengers could hike out during other months, but they do not contribute noise to this analysis). Assuming that there are five passengers per flight, and that operators carry the maximum number of people on every flight, a total of 2,000 flights would occur from this transfer location over the course of a year (i.e., 1,000 flights for 5,000 passengers in, plus 1,000 flights for 5,000 passengers out).

Because Alternative H evens out the launch patterns, as many as three groups of 32 passengers each could need helicopter shuttles during many summer days. This would correspond to 40 flights per day (20 in and 20 out for the 96 passengers), and at 3.5 minutes audibility per flight would result in up to 140 minutes (a bit less than 2.5 hours or 19% of the day) of helicopter audibility on many days. When helicopter shuttles occur, noise-free intervals would be less than 10 minutes. Helicopters exchanging river trip passengers at Whitmore have been measured at up to 83 dBA at a distance of 200 feet from the source. This is almost 50 dBA above existing natural ambient levels (34 dBA or less). On the many days of heavy helicopter use, moderate to major adverse impacts would occur to the natural soundscape localized in the Whitmore area, with helicopter shuttles audible 19% of the 12-hour day, and almost 2.5 of the 4 morning hours (62%). With generally the same number of motor launches per day, there would be few days during summer months of low or no helicopter use. It should be noted that such flights are authorized by Public Law 100-91.

Non-Peak Periods — In terms of soundscape impacts, peak use under Alternative H would be from May through August, followed by April then September. Helicopters at Whitmore would only be allowed in the peak season (May–August), and motorized use from March through August. Compared to Alternative A, the October–April period would have greater use levels so would be expected to have greater soundscape impacts. However, this would be offset by smaller group sizes, fewer helicopter months, and more non-motorized months under Alternative H.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. The level of monitoring and mitigation required under Alternative H is likely to be implemented sufficiently to reduce impacts to minor levels or less.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative H would have adverse, short-term, minor to moderate impacts during peak periods, the same overall level as Alternative A, and it would contribute an adverse, negligible increment to cumulative effects. Aircraft overflights have a adverse, long-term, major cumulative effect on the park's natural soundscape. Even if all river-related noise was removed from the park, the

park would still experience adverse, major effects from aircraft overflights independent of this river management plan. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, it is unlikely that mitigation could be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusions. The natural soundscape would benefit overall under Alternative H compared to Alternative A during the peak season, but impacts would be slightly greater in the shoulder and winter seasons, due primarily to increased use levels. Noise from commercial motorized trips during peak days would be audible about 54 minutes or 8% of the 12-hour day, and non-motorized trips would be audible about 36 minutes or about 5% of the day at a single point along the river, for a combined total from all rafts of 90 minutes and 13% of the time audible (a moderate intensity level) during the summer. Average noise-free intervals during the day would be expected to be 1.5 to 3.5 hours (an adverse, short-term, minor impact) when considering only river-related activity away from Whitmore during May-August. Other parts of the year would have less noise than the peak.

In addition, helicopter shuttle noise would be audible for a bit less than 2.5 hours (140 minutes) over a 4-hour period on many days from May through August localized in a 10–0 mile diameter area at Whitmore, an adverse, short-term, moderate to major impact. There would be additional off-river noise, but it is not quantifiable, and each motorized raft would run its motor about 3.5 hours to travel an average 40 miles with the noise impacts spreading out over that entire stretch of river during the course of each day.

Therefore, overall noise intrusions to the natural soundscape under this alternative would be adverse, localized and regional, generally short-term, and minor to moderate intensity (at high-use areas and gathering points). It is likely that impacts can be reduced to minor levels or less with adequate funding and staffing for a monitoring and mitigation program. Alternative H would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative H would be regional, adverse, long-term, and major primarily due to extensive aircraft overflights of the park, and they could probably not be mitigated to a minor intensity or less. Although Alternative H would contribute to the overall cumulative effects of noise on the park natural soundscape, even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still adverse, short term, and major. There would still be “significant adverse effects” on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and “substantial restoration of natural quiet” would not be achieved as required by Public Law 100-91 and other mandates.

IMPACT ANALYSIS — LOWER GORGE ALTERNATIVES

Methodology Considerations Specific to Lower Gorge Analysis

The Lower Gorge provides more open water, with fewer river rapids, than the upper stretch of river. When Lake Mead is full, water is backed up to Separation Canyon (RM 240) making motorboat tow-outs a more attractive option, and making upriver travel from Lake Mead easier.

Upriver travel is prohibited above RM 240. With Lake Mead levels currently well below full pool, the river flows about the same as the upper river past the park boundary at RM 277. Pearce Ferry is currently unusable as a takeout location, so boats are having to take out at South Cove, a longer trip.

Analysis of human noise impacts in this section rely on "typical peak use" scenarios defined for the alternative. Noise sources are not well documented for the area from Diamond Creek to Lake Mead. At the time the few referenced sound measurements were taken, much of the current river activity was not in operation, and Lake Mead was backed-up beyond several of the measurement site locations. The sound measurements conducted in 1993 showed that the natural ambient level was 22–29 dBA, and aircraft were audible for only 12% of the time, for the site 1-mile above the Diamond Creek takeout (HMMH 1993). Separation Canyon (RM 240) had a natural ambient background level of 11–21 dBA, with aircraft audible 20% of the time. The last location measured in the Lower Gorge was at Burnt Springs Canyon (RM 260), with a natural ambient of 13–17 dBA, and aircraft audible for 49% of the time. Helicopter noise, when exchanging river trip passengers at Whitmore, was measured at maximum noise levels of 83 dBA at a distance of 200 feet from the source. This is almost 60 dBA above natural ambient levels measured in 1993.

The typical water influenced natural ambient level in the upper reach has been measured at 51 dBA and can range up to 65 dBA, near river rapids and within the desert scrub vegetation environment. This measurement is applicable to Lower Gorge river sections (HMMH 1993). There are fewer river rapid sections of the river below RM 259 to mask human noise intrusions, so noise is expected to be somewhat more noticeable than in the upper sections of the river.

As described above in the "Methodology for Analyzing Soundscape Impacts," helicopter flights carrying passengers who are also river passengers (e.g., pontoon boat and HRR passengers) are analyzed under effects of the alternatives, but flights that carry passengers who are not also river passengers (e.g., look-and-leave flights) are part of cumulative effects. The Hualapai Tribe controls helicopter flights that land and takeoff solely on Hualapai tribal lands. In the case of Quartermaster operations, the Hualapai Tribe has indicated that approximately the same number of helicopter flights will occur in that area independent of the alternatives and independent of whether any of the helicopter passengers are river passengers.

Context plays a more prominent role in the analysis of Lower Gorge alternatives than for Lees Ferry alternatives, because the impact thresholds apply differently to the different management zones, with Zones 1 and 2 being more sensitive to noise impacts than Zones 3 and 4 (see page 338). The Lees Ferry alternatives all refer only to Zone 1, which ends at Diamond Creek. The analysis for Lower Gorge alternatives is separated into sections referring to Zone 2, which applies to the section from Diamond Creek (RM 226) to RM 260, and Zone 3, which applies to the section from RM 260 to the park boundary (RM 277). Zone 4 is outside the park in the upper reaches of Lake Mead National Recreation Area and is not analyzed in the same detail.

Continuation trips are those that launch at Lees Ferry but do not take out at Diamond Creek, continuing on to a take out on Lake Mead. For this analysis of Lower Gorge alternatives, four of the five commercial motorized trips in the Lees Ferry no-action scenario (Alternative A) are assumed to continue past Diamond Creek, and none of the no-motor trips are assumed to continue. This allows relative comparisons between the Lower Gorge alternatives using the same

basis for these inputs. It is considered a reasonable assumption based upon observations as Lake Mead levels have decreased over the past few years.

As discussed further in Methodology common to all the alternatives above, motorized rafts are assumed to be audible for 9 minutes and non-motorized rafts for 3 minutes. Jetboats are assumed to be audible for the same time as motorized rafts, because even though they produce more sound energy (i.e., are "louder") than motorized rafts, they travel at much greater speeds so they move out of audibility range quicker.

There are no data quantifying the number or noise produced by boats traveling upriver from Lake Mead, so a specific number of minutes of audibility is not presented, although it is a source of noise for the Lower Gorge. There is no information to indicate that numbers and types of these boats would change due to the Lower Gorge alternatives, so they are assumed to be a constant, not varying between alternatives, and they do not affect the relative differences among alternatives.

Alternative 1 (Current Conditions)

Analysis. *Zone 2* —. The section of river from Diamond Creek to RM 260 is classified in Zone 2. The following scenario presents typical peak use under Alternative 1 (current situation) for this zone and section of river, with minutes of audibility at a single point along the river:

- Continuation trips from Lees Ferry:
  - 4 motorized trips × 2 rafts/trip × 9 minutes = 72 minutes audible/day
- HRR Day trips:
  - 1 trip/day × 10 motorized boats/trip × 9 minutes/boat = 90 minutes audible/day
- HRR overnight trip:
  - 1 trip/day × 4 motorized boats/trip × 9 minutes/boat = 36 minutes audible/day once per week on average
- Noncommercial trips:
  - 2 trips/day × 4 non-motorized boats/trip × 3 minutes/boat = 24 minutes audible/day
- Jetboat pickups (to RM 240):
  - 2 boats/day × 2 passes (up and back) × 9 minutes/boat = 36 minutes/day
- Tow-outs (to RM 240):
  - This scenario does not include any non-motorized continuation trips desiring tow-outs. There is insufficient data to quantify such tow-outs, but they do occur, and like jetboats they would make two passes per day, one going upriver and the other going back downriver.
- Other upriver boats from Lake Mead continuing as far as Separation Canyon
  - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis."

For Zone 2 the total time audible at a single point along the river from all of the above sources is 222 minutes without the HRR overnight trips (about 31% of the 12-hour day), and 258 minutes

with the overnight trips (about 36% of the day audible), resulting in an adverse, short-term, major impact. This does not include other upriver traffic from Lake Mead or tow-outs.

The area of Zone 2 between Diamond Creek and Separation Canyon would be quieter than the area from Separation Canyon to RM 260, because jetboats and other boats from Lake Mead cannot travel past Separation Canyon. Noise-free intervals would average 1 to 1.5 hours during peak days (a moderate impact level). Overall, Alternative 1 would have a localized and regional, adverse, short- to long-term, moderate to major, random impact in Zone 2.

Zone 3 —. The section of river from RM 260 to the park boundary (RM 277) is classified in Zone 3. In addition to all of the elements listed above for Zone 2, the following would apply in Zone 3:

- Pontoon boat trips:
  - Average 188 passengers/day divided by 6 passengers/boat = 32 boats
    - Average 32 boats/day × 2 passes (up and back) × 9 minutes/boat = 576 minutes audible/day
  - Maximum 377 passengers/day divided by 6 passengers/boat = 63 boats
    - Maximum 63 boats/day × 2 passes (up and back) × 9 minutes/boat = 1,134 minutes audible/day
- Helicopter shuttles for pontoon boat passengers:
  - Average 188 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 228 minutes audible/day
  - Maximum 377 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 456 minutes audible/day
- Helicopter shuttles for HRR passengers:
  - Day trips: 100 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 120 minutes audible/day
  - Overnight trips: 34 passengers divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 42 minutes audible/day once per week on average.
- Upriver boats from Lake Mead that stay only in Zone 3:
  - Cannot be quantified as discussed above in Methodology Considerations Specific to Lower Gorge Analysis. However, more upriver boats would be expected in Zone 3 than in Zone 2, due to time and distance considerations.

For Zone 3 the total time audible at a single point along the river from all of the above sources (including those coming into Zone 3 from Zone 2) varies from a low of 1,146 minutes (using average pontoon boat numbers and no HRR overnight trips), to a high of 1,890 minutes (using maximum pontoon boat numbers and HRR overnight trips) (a major impact intensity level). Without the helicopters, audibility would vary from 798 minutes to 1,392 minutes, which would still be a major impact intensity level. Since there are only 720 minutes in a 12-hour day, much overlap of noise sources must occur (consistent with observations), but the natural soundscape would still be essentially saturated by noise with very few noise-free intervals on a busy day.

The helicopter noise in combination with the boat noise only occurs in a 15–30 mile diameter area centered on the helipads in the Quartermaster area, and only during times when all boats are present (which does occur in the afternoons when HRR passengers are about ready to be picked up). This also does not include other upriver traffic from Lake Mead, tow-outs or additional off-river noise, but this is not quantifiable as discussed above in "Methodology for Analyzing Soundscape Impacts." In addition, each motorboat would create regional impacts as it runs its motor for about 1.5 hours to travel the 18 miles through this zone. Noise-free intervals would average less than one hour during peak days. Overall, Alternative 1 would have a localized and regional, adverse, short- to long-term, frequent and periodic, major impact in Zone 3.

Zone 4 —. Zone 4 does not have any river recreation related helicopter or pontoon boat noise intrusions, but the continuing river activity (about the same as Zone 2) is added to by private watercraft on Lake Mead National Recreation Area, which may never enter Grand Canyon National Park.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above, but given the history of the current situation, it is unlikely that mitigations would be implemented at a level sufficient to reduce the impacts of Alternative 1 to the natural soundscape to a minor intensity or less in Zone 3. A large amount of effort, funding and staffing would be needed, but it is possible that mitigation could be reasonably implemented to reduce impacts in Zone 2 to minor levels or less.

Generator use is currently allowed and causes minor to major localized impacts to the natural soundscape, depending upon the amount of time generators are used. However, generator use is being restricted under all alternatives, including no-action, so is not further evaluated here. This restriction is an important mitigation for the natural soundscape.

Cumulative Effects. Cumulative impacts would be similar to those discussed under Alternative A, but the number of air tours and helicopter shuttle flights in the Quartermaster area exceed anything occurring anywhere else in the Grand Canyon. Alternative 1 would have adverse, major overall impacts during peak periods, but it would contribute an adverse, negligible to minor increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. If all river-related noise (primarily from boats and helicopters) was removed from the park, the park would still experience major adverse effects from aircraft overflights independent of this river management plan. Even in the Quartermaster area, the Hualapai Tribe expects about the same number of flights independent of the river alternatives. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. Alternative 1, the no-action alternative for the Lower Gorge, would result overall in adverse, primarily short-term, random, major impacts in zone 2, which could be reasonably mitigated, but adverse, short- to long-term, frequent, major impacts in Zone 3. The Quartermaster area would have the greatest soundscape impacts due to the combination of boats and helicopters. Noise from boats in Zone 2 would be audible about 222 minutes/day (or 31% of

the 12-hour day) without considering HRR overnight trips (which currently only occur an average of one trip per week), an adverse, major impact in that zone. Noise would be audible 258 minutes (36%) per day on busy days when HRR overnight trips operate. Also, each motorboat would create regional impacts as it runs its motor for about 3 hours to travel the 35 miles through this zone.

Noise from boats and helicopters in Zone 3 would be audible from 1,146 to 1,890 minutes/day (or essentially 100% of the 12-hour day with considerable overlap), considering pontoon boat and river-related helicopter trips plus all the boats assessed in Zone 2 floating down into Zone 3. During peak-use days, there would be very few noise-free intervals. This is an adverse, major impact in that zone with little likelihood that impacts would be able to be mitigated to a minor intensity level or less.

There would also be off-river noise and noise from upriver boats and tow-outs that is not quantifiable, and each motorized raft would run its motor up to 4 hours each in the course of its travels through all or part of the Lower Gorge, creating regional impacts over the area of travel (i.e., some rafts would travel the entire 53 miles from Diamond Creek to Lake Mead in a day, but others would travel shorter sections).

In summary, overall noise intrusions to the natural soundscape under Alternative ! would be localized and regional, adverse, short to long term, and major at high-use areas and gathering points. It is not likely that any reasonable mitigation could reduce impacts to a minor level or less. Alternative 1 would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative 1 would be major adverse, long-term regional impacts primarily due to extensive aircraft overflights of the park, and are not likely to be able to be mitigated to minor intensity or less. Alternative 1 contributes an adverse, minor increment to the overall cumulative effects of noise on the park natural soundscape, but even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be an adverse, major impact. There would still be “significant adverse effects” on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and “substantial restoration of natural quiet” would not be achieved as required by Public Law 100-91 and other mandates.

Alternative 2

Analysis. *Zone 2 —*. The following scenario presents typical peak use under Alternative 2 for this zone and section of river, with minutes of audibility at a single point along the river:

- Continuation trips from Lees Ferry:
  - 4 motorized trips × 2 rafts/trip × 9 minutes = 72 minutes audible/day
- HRR Day trips:
  - 30 passengers/trip divided by 10 passengers/boat = 3 boats/trip
  - 2 trips/day × 3 motorized boats/trip × 9 minutes/boat = 54 minutes audible/day
- HRR overnight trip:

  - 30 passengers/trip divided by 10 passengers/boat = 3 boats/trip
  - 1 trip/day × 3 motorized boats/trip × 9 minutes/boat = 27 minutes audible/day
- Noncommercial trips:
  - 2 trips/day × 4 non-motorized boats/trip × 3 minutes/boat = 24 minutes audible/day
- Jetboat pickups (to RM 240):
  - 2 boats/day × 2 passes (up and back) × 9 minutes/boat = 36 minutes/day
- Tow-outs (to RM 240):
  - This scenario does not include any non-motorized continuation trips desiring tow-outs. There is insufficient data to quantify such tow-outs, but they do occur, and like jetboats they would make two passes per day, one going upriver and the other going back downriver.
- Other upriver boats from Lake Mead continuing as far as Separation Canyon
  - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis."

For Zone 2 the total time audible at a single point along the river from all of the above sources would be 186 minutes without the HRR overnight trips (about 26% of the 12-hour day), and 213 minutes with the overnight trips (about 30% of the day audible), an adverse, short-term, major impact. This does not include other upriver traffic from Lake Mead or tow-outs as discussed above. In addition, each motorboat would create regional impacts at it runs its motor for about three hours to travel the 35 miles through this zone. The trips would create additional off-river noise, but this is not quantifiable. Noise-free intervals in Zone 2 would be expected to average 1 to 1.5 hours during peak days when considering only boats traveling in the zone (an adverse, short-term, moderate impact). However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. Overall, Alternative 2 would have a localized and regional, adverse, short- to long-term, moderate to major impact in Zone 2.

The area of Zone 2 between Diamond Creek and Separation Canyon would be quieter than the area from Separation Canyon to RM 260, because jetboats and other boats from Lake Mead cannot travel past Separation Canyon.

No commercial pickups would be allowed during the non-peak season,, which would reduce noise during that season.

Zone 3 —. In addition to all of the elements listed for Zone 2, the following would also occur in Zone 3:

- Alternative 2 would eliminate pontoon boat trips, so there would be no helicopter trips for pontoon boat passengers (but it is likely that cumulative effects would increase so that there would be about the same amount of total cumulative helicopter use in the Quartermaster area even with elimination of pontoon boats).
- Helicopter shuttles for HRR passengers:
  - Day trips: 60 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 72 minutes audible/day

  - Overnight trips: 30 passengers divided by 5 passengers/helicopter × 2 flights/ helicopter × 3 minutes/flight = 36 minutes audible/day
- Upriver boats from Lake Mead that stay only in Zone 3
  - Cannot be quantified as discussed above in Methodology Considerations Specific to Lower Gorge Analysis. However, more upriver boats would be expected in Zone 3 than in Zone 2, due to time and distance considerations.

For Zone 3 the total time audible at a single point along the river from all of the above sources (including those coming into Zone 3 from Zone 2) varies from a low of 294 minutes or 41% of the day (with no HRR Overnight trips), to a high of 321 minutes or 43% (with HRR overnight trips) (a major impact intensity level). There would be some opportunities even during peak days for noise-free intervals to be greater than 1 hour (a moderate impact intensity level).

The above does not include other upriver traffic from Lake Mead, tow-outs, or additional off-river noise, but this is not quantifiable. In addition, each motorboat would create regional impacts as it runs its motor for about 1.5 hours to travel the 18 miles through this zone. Noise-free intervals would average less than one hour during peak days. Overall, Alternative 2 would have a localized and regional, adverse, frequent and periodic, short- to long-term, major impact in Zone 3.

Zone 4 —. Zone 4 does not have any helicopter or pontoon boat noise intrusions related to this plan, but the continuing river activity (about the same as Zone 2) is added to by private watercraft on Lake Mead National Recreation Area, which may never enter Grand Canyon National Park.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. It is likely that reasonable implementation of mitigation measures could reduce impacts no less than a moderate level in Zone 3 due to the activity in the Quartermaster area, even though such activity would be reduced compared to the other alternatives. A larger amount of effort, funding, and staffing than for Alternative 1 would be needed, but it is possible that mitigation could be reasonably implemented to reduce impacts in Zone 2 to minor levels or less.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative 2 would reduce impacts compared to Alternative 1, but would still have adverse, short-term, major overall impacts during peak periods. Alternative 2 would contribute an adverse, negligible to minor increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. If all river-related noise (primarily from boats and helicopters) was removed from the park, the park would still experience major adverse effects from aircraft overflights independent of this river management plan. Even in the Quartermaster area, the Hualapai Tribe expects about the same number of flights independent of the river alternatives. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. Alternative 2 would result in fewer impacts to the natural soundscape than Alternative 1. It would have adverse, primarily short-term, random, major overall impacts in Zone 2, which could be reasonably mitigated, but adverse, short- to long-term, frequent, major impacts in Zone 3, especially in the Quartermaster area, which could not be reasonably mitigated to minor levels or less. Noise from boats in Zone 2 would be audible about 186 minutes/day (or 26% of the 12-hour day) without considering HRR overnight trips, which would be an adverse, major impact in this zone. Noise would be audible 213 minutes (30%) per day on busy days when HRR overnight trips operated. Also, each motorboat would create regional impacts as it runs its motor for about three hours to travel the 35 miles through Zone 2. Noise-free intervals would average 1 to 1.5 hours in Zone 2 (an adverse, moderate impact), but less than an hour in Zone 3 (an adverse, major impact).

Noise from boats and helicopters in Zone 3 would be audible from 294 to 321 minutes/day (or 41-43% of the 12-hour day) considering helicopter shuttles for HRR day and overnight trip passengers, plus all the boats assessed in Zone 2 floating down to Zone 3. This would be an adverse, major impact in that zone, with little likelihood that impacts could be mitigated to a minor intensity level or less.

There would also be off-river noise and noise from upriver boats and tow-outs that is not quantifiable, and each motorized raft would run its motor up to 4 hours each in the course of its travels through all or part of the Lower Gorge, creating regional impacts over the area of travel (i.e., some rafts would travel the entire 53 miles from Diamond Creek to Lake Mead in a day, but others would travel shorter sections).

In summary, overall noise intrusions to the natural soundscape under Alternative 2 would be adverse, localized and regional, short-term to long-term, and moderate to major intensity (at high-use areas and gathering points). Alternative 2 would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative 2 would be regional, adverse, long term, and major primarily due to extensive aircraft overflights of the park, and they could probably not be mitigated to minor intensity or less. Alternative 2 contributes to the overall cumulative effects of noise on the park's natural soundscape, but even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be an adverse, major impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative 3

Analysis. *Zone 2 —*. The following scenario presents typical peak use under Alternative 3 for this zone and section of river, with minutes of audibility at a single point along the river:

- Continuation trips from Lees Ferry:
  - 4 motorized trips × 2 rafts/trip × 9 minutes = 72 minutes audible/day
- HRR Day trips:
  - 30 passengers/trip divided by 10 passengers/boat = 3 boats/trip

    - 3 trips/day × 3 motorized boats/trip × 9 minutes/boat = 81 minutes audible/day
- HRR overnight trip:
    - 30 passengers/trip divided by 10 passengers/boat = 3 boats/trip
    - 2 trips/day × 3 motorized boats/trip × 9 minutes/boat = 54 minutes audible/day
- Noncommercial trips:
    - 2 trips/day × 4 non-motorized boats/trip × 3 minutes/boat = 24 minutes audible/day
- Jetboat pickups (to RM 240):
    - 4 boats/day × 2 passes (up and back) × 9 minutes/boat = 72 minutes/day
- Tow-outs (to RM 240):
    - This scenario does not include any non-motorized continuation trips desiring tow-outs. There is insufficient data to quantify such tow-outs, but they do occur, and like jetboats they would make two passes per day, one going upriver and the other going back downriver.
- Other upriver boats from Lake Mead continuing as far as Separation Canyon
    - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis."

For Zone 2 the total time audible at a single point along the river from all of the above sources would be 285 minutes without the HRR overnight trips (about 40% of the 12-hour day), and 339 minutes with the overnight trips (about 47% of the day audible) (a major impact intensity level). This does not include other upriver traffic from Lake Mead or tow-outs. In addition, each motorboat would create regional impacts at it runs its motor for about three hours to travel the 35 miles through this zone. The trips would create additional off-river noise, but this is not quantifiable. Noise-free intervals in Zone 2 would be expected to average 1 to 1.5 hours during peak days when considering only boats traveling in the zone (an adverse, short-term, moderate impact), even when considering that multiple boats would be audible at some times and no boats at other times. However, when cumulative effects are also considered (see below), such long noise-free intervals would probably be rare in most places. Overall, Alternative 3 would have a localized and regional, adverse, short- to long-term, major impact in Zone 2.

The area of Zone 2 between Diamond Creek and Separation Canyon would be quieter than the area from Separation Canyon to RM 260, because jetboats and other boats from Lake Mead cannot travel past Separation Canyon.

Zone 3 —. In addition to all of the elements listed for Zone 2, the following would occur under Alternative 3 for this zone and section of river:

- Pontoon boat trips:
    - Average 400 passengers/day divided by 6 passengers/boat = 67 boats
        - Average 67 boats/day × 2 passes (up and back) × 9 minutes/boat = 1,206 minutes audible/day
- Helicopter shuttles for pontoon boat passengers:
    - Maximum 400 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 480 minutes audible/day

- Helicopter shuttles for HRR passengers:
  - Day trips: 90 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 108 minutes audible/day
  - Overnight trips: 60 passengers divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 42 minutes audible/day
- Upriver boats from Lake Mead that stay only in Zone 3
  - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis." However, more upriver boats would be expected in Zone 3 than in Zone 2, due to time and distance considerations.

For Zone 3 the total time audible at a single point along the river from all of the above sources (including those coming into Zone 3 from Zone 2) varies from a low of 2,079 minutes (with no HRR Overnight trips), to a high of 2,205 minutes (with HRR overnight trips) (a major impact intensity level). Without the helicopters, audibility would vary from 1,491 minutes to 1,545 minutes, which would still be a major impact intensity level. Since there are only 720 minutes in a 12-hour use day, much overlap of noise sources would occur; consistent with current observations, multiple boats would be audible at some times and no boats at other times. However, the natural soundscape would be essentially saturated by noise, with very few noise-free intervals on a busy peak day.

Helicopter noise in combination with the boat noise would only occur in the Quartermaster area, and only during times when all boats are present (which does occur in the afternoons when HRR passengers are about ready to be picked up). This also does not include other upriver traffic from Lake Mead, tow-outs or additional off-river noise, but this is not quantifiable. In addition, each motorboat would create regional impacts as it runs its motor for about 1.5 hours to travel the 18 miles through this zone. Noise-free intervals would average less than one hour during peak days. Overall, Alternative 3 would have localized and regional, adverse, frequent and periodic, short- to long-term, major impacts in Zone 3.

Zone 4 —. Zone 4 does not have any plan-related helicopter or pontoon boat noise intrusions, but the continuing river activity (about the same as Zone 2) is added to by private watercraft on Lake Mead National Recreation Area, which may never enter Grand Canyon National Park.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. With the high level of visitor use in Alternative 3, it is very unlikely that mitigations would be implemented at a level sufficient to reduce the impacts to the natural soundscape to a minor intensity or less in Zone 3. A larger amount of effort, funding and staffing than for Alternative 1 would be needed in Zone 2 to implement the mitigation actions, but it is possible that impacts could be reasonably reduced to minor levels with mitigation.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative 3 would increase impacts compared to Alternative 1 and would have adverse, short-term, major overall impacts during peak periods. However, Alternative 2 would contribute an adverse, minor increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. If all river-related noise (primarily from boats and helicopters) was removed from the park, the park would still experience major

adverse effects from aircraft overflights independent of this river management plan. Even in the Quartermaster area, the Hualapai Tribe expects about the same number of flights independent of the river alternatives. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusion. Alternative 3 would increase impacts to the natural soundscape compared to Alternative 1. It would have adverse, primarily short-term, random, major overall impacts in Zone 2, which could be reasonably mitigated, but adverse short- to long-term, frequent and periodic, major impacts in Zone 3, especially in the Quartermaster area, which could not be reasonably mitigated to minor levels or less. Noise from boats in Zone 2 would be audible about 285 minutes/day (or 40% of the 12-hour day) without considering HRR overnight trips, which would be an adverse, major impact in that zone. Noise would be audible 339 minutes (47%) per day on busy days when HRR overnight trips operate. Also, each motorboat would create regional impacts as it runs its motor for about three hours to travel the 35 miles through Zone 2. Noise-free intervals would average 1 to 1.5 hours in Zone 2 (an adverse, moderate impact), but less than an hour in Zone 3 (an adverse, major impact).

Noise from boats and helicopters in Zone 3 would be audible from 2,079 to 2,205 minutes/day. Because this is more than 100% of the 12-hour day, there would be considerable overlap of noise events (i.e., more than one noise source audible much of the time). During peak-use days, there would be very little time for noise-free intervals in Zone 3.

There would also be additional off-river noise and noise from upriver boats and tow-outs that is not quantifiable, and each motorized raft would run its motor up to 4 hours each in the course of its travels through all or part of the Lower Gorge, creating regional impacts over the area of travel (i.e., some rafts would travel the entire 53 miles from Diamond Creek to Lake Mead in a day, but others would travel shorter sections).

In summary, overall noise intrusions to the natural soundscape under this alternative would be adverse, localized and regional, short-term to long-term, and major intensity. Alternative 3 would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative 3 would be regional, adverse, long term, and major, primarily due to extensive aircraft overflights of the park, and they could probably not be mitigated to minor intensity or less. Alternative 3 would contribute a minor increment to the overall cumulative effects of noise on the park natural soundscape, but even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be adverse and major. There would still be “significant adverse effects” on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and “substantial restoration of natural quiet” would not be achieved as required by Public Law 100-91 and other mandates.

Alternative 4 (NPS Preferred Alternative)

Analysis. *Zone 2 —*. The following scenario presents typical peak use under Alternative 4 for this zone and section of river, with minutes of audibility at a single point along the river:

- Continuation trips from Lees Ferry:
  - 4 motorized trips × 2 rafts/trip × 9 minutes = 72 minutes audible/day
- HRR Day trips:
  - 96 passengers/trip divided by 10 passengers/boat = 10 boats/trip
  - 10 motorized boats/day × 9 minutes/boat = 90 minutes audible/day
- HRR overnight trip:
  - 20 passengers/trip divided by 10 passengers/boat = 2 boats/trip
  - 3 trips/day × 2 motorized boats/trip × 9 minutes/boat = 54 minutes audible/day once per week on average
- Noncommercial trips:
  - 2 trips/day × 4 non-motorized boats/trip × 3 minutes/boat = 24 minutes audible/day
- Jetboat pickups (to RM 240):
  - 4 boats/day × 2 passes (up and back) × 9 minutes/boat = 72 minutes/day
- Tow-outs (to RM 240):
  - This scenario does not include any non-motorized continuation trips desiring tow-outs. There is insufficient data to quantify such tow-outs, but they do occur, and like jetboats they would make two passes per day, one going upriver and the other going back downriver.
- Other upriver boats from Lake Mead continuing as far as Separation Canyon
  - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis."

For Zone 2 the total time audible at a single point along the river from all of the above sources would be 258 minutes without the HRR overnight trips (about 36% of the 12-hour day), and 312 minutes with the overnight trips (about 43% of the day audible) (a major impact intensity level). This does not include other upriver traffic from Lake Mead or tow-outs as discussed above. In addition, each motorboat would create regional impacts as it runs its motor for about 3 hours to travel the 35 miles through this zone. The trips would create additional off-river noise, but this is not quantifiable. Noise free intervals in Zone 2 would be expected to average 1 to 1.5 hours during peak days when considering only boats traveling in the zone (an adverse, short-term, moderate impact), even when considering that multiple boats would be audible at some times and no boats at other times. However, when cumulative effects are also considered (see below), such long noise free intervals would probably be rare in most places. Overall, Alternative 4 would have a localized and regional, adverse, short- to long-term, moderate to major impact in Zone 2.

The area of Zone 2 between Diamond Creek and Separation Canyon would be quieter than the area from Separation Canyon to RM 260, because jetboats and other boats from Lake Mead cannot travel past Separation Canyon.

Zone 3 —. In addition to all of the elements listed for Zone 2, the following would occur under Alternative 4 for this zone and section of river:

- Pontoon boat trips:
  - Maximum 150 passengers/day divided by 6 passengers/boat = 25 boats
    - Average 25 boats/day × 2 passes (up and back) × 9 minutes/boat = 450 minutes audible/day
- Helicopter shuttles for pontoon boat passengers:
  - Maximum 150 passengers/day divided by 5 passengers/helicopter × 2 flights/ helicopter × 3 minutes/flight = 180 minutes audible/day
- Helicopter shuttles for HRR passengers:
  - Day trips: 96 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 120 minutes audible/day
  - Overnight trips: 60 passengers divided by 5 passengers/helicopter × 2 flights/ helicopter × 3 minutes/flight = 72 minutes audible/day
- Upriver boats from Lake Mead that stay only in Zone 3
  - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis." However, more upriver boats would be expected in Zone 3 than in Zone 2, due to time and distance considerations.

For Zone 3 the total time audible at a single point along the river from all of the above sources (including those coming into Zone 3 from Zone 2) would vary from a low of 1,008 minutes (with no HRR overnight trips), to a high of 1,134 minutes (with HRR overnight trips), resulting in an adverse, major impact. Without the helicopters, audibility would vary from 708 minutes to 762 minutes, which would still be an adverse, major impact. Since there are only 720 minutes in a 12-hour use day, much overlap of noise sources would occur; consistent with observations, multiple boats would be audible at some and no boats at other times. However, the natural soundscape would still be essentially saturated by noise, with very few noise-free intervals on a busy peak day.

The helicopter noise in combination with the boat noise would only occur in the Quartermaster area, and only during times when all boats were present (which would occur in the afternoons when HRR passengers were about ready to be picked up). This also would not include other upriver traffic from Lake Mead, tow-outs, or additional off-river noise, but this is not quantifiable. In addition, each motorboat would create regional impacts as it runs its motor for about 1.5 hours to travel the 18 miles through this zone. Noise-free intervals would average less than one hour during peak days. Overall, Alternative 4 would have a localized and regional, adverse, frequent and periodic, short- to long-term, major impact in Zone 3.

Zone 4 —. Zone 4 does not have any plan-related helicopter or pontoon boat noise intrusions, but the continuing river activity (about the same as Zone 2) is added to by private watercraft on Lake Mead National Recreation Area, which may never enter Grand Canyon National Park.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology: Mitigation of Effects" section above. For Alternative 4, a larger amount of effort, funding and staffing than for Alternative 1 would be needed in Zone 2 to implement the

mitigation actions, but it is likely that impacts could be reasonably reduced to minor levels with mitigation. In Zone 3, even with reductions in pontoon boats and associated helicopters, it not likely that sufficient mitigation could be implemented to reduce impacts to the natural soundscape to minor levels or less.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative 4 would have adverse, short-term, moderate to major overall impacts during peak periods, the same overall levels as Alternative 1. It would contribute a negligible to minor adverse increment to cumulative effects. Aircraft overflights have an adverse, long-term, major cumulative effect on the park's natural soundscape. If all river-related noise (primarily from boats and helicopters) was removed from the park, the park would still experience adverse, major effects from aircraft overflights independent of this river management plan. Even in the Quartermaster area, the Hualapai Tribe expects about the same number of flights independent of the river alternatives. Frequent overflights commonly reduce noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation is unlikely to be implemented that would reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusions. Alternative 4 slightly increases impacts on the natural soundscape in Zone 2 compared to Alternative 1, but it decreases impacts to Zone 3. It would have adverse, primarily short-term, random, moderate to major overall impacts in Zone 2, which could be reasonably mitigated, but adverse, short- to long-term, frequent and periodic, major, impacts in Zone 3, especially in the Quartermaster area, which would not be able to be reasonably mitigated to minor levels or less. Noise from boats in Zone 2 would be audible about 258 minutes/day (or 36% of the 12-hour day) without considering HRR overnight trips, and 312 minutes (43%) on busy days when HRR overnight trips operated. This would be an adverse, major impact in that zone. Noise-free intervals would average 1 to 1.5 hours in Zone 2 (an adverse, moderate impact), but less than an hour in Zone 3 (an adverse, major impact). Also, motorboat would create regional impacts as it runs its motor for about three hours to travel the 35 miles through Zone 2.

Noise from boats and helicopters in Zone would be audible from 1,008 to 1,134 minutes/day. Because this is more than 100% of the 12-hour day, there would be considerable overlap of noise events (i.e., more than one noise source audible much of the time). During peak-use days, there would be very little time for noise-free intervals in Zone 3. This would be an adverse, major impact in that zone, even though it is a reduction compared to Alternative 1.

There would also be off-river noise and noise from upriver boats and tow-outs that is not quantifiable, and each motorized raft would run its motor up to 4 hours each in the course of its travels through all or part of the Lower Gorge, creating regional impacts over the area of travel (i.e., some rafts would travel the entire 53 miles from Diamond Creek to Lake Mead in a day, but others would travel shorter sections).

Alternative 4 would not result in the impairment of the natural soundscape in Grand Canyon National Park.

The cumulative effects of Alternative 4 would be regional, adverse, long-term, major impacts primarily due to extensive aircraft overflights, which could probably not be mitigated to minor

intensity or less. Alternative 4 would contribute a negligible to minor increment to the overall cumulative effects of noise on the park's natural soundscape, but even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be a major adverse impact. There would still be "significant adverse effects" on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and "substantial restoration of natural quiet" would not be achieved as required by Public Law 100-91 and other mandates.

Alternative 5 (Hualapai Tribe Proposed Action)

Analysis. *Zone 2 —*. Management Zone 2 would be the same for Alternatives 4 and 5, except that upriver travel from Lake Mead would only be allowed to RM 273, so there would be no jetboats, tow-outs or pickups in Zone 2 for Alternative 5. So for Alternative 5, the totals for Alternative 4 Zone 2 would be reduced by 72 minutes audibility for jetboat passenger pickups. See the more detailed analysis in Alternative 4.

For Zone 2 the total time audible at a single point along the river from all of the above sources would be 186 minutes without the HRR Overnight trips (about 26% of the 12-hour day), and 240 minutes with the overnight trips (about 33% of the day audible), resulting in an adverse, major impact. In addition, each motorboat would create regional impacts as it runs its motor for about 3 hours to travel the 35 miles through this zone. The trips would create additional off-river noise, but this is not quantifiable. Noise-free intervals in Zone 2 would be expected to average 1 to 1.5 hours during peak days when considering only boats traveling in the zone (an adverse, short-term, moderate impact), even when considering that multiple boats would be audible at some times and no boats at other times. However, when cumulative effects are also considered (see below), such long noise free intervals would probably be rare in most places. Overall, Alternative 5 would have a localized and regional, adverse, short- to long-term, moderate to major impact in Zone 2.

The area of Zone 2 between Diamond Creek and Separation Canyon would be quieter than the area from Separation Canyon to RM 260, because jetboats and other boats from Lake Mead cannot travel past Separation Canyon.

Zone 3 —. In addition to all of the elements described under Alternative 4 for Zone 2, the following additional elements present typical peak use under Alternative 5 for this zone and section of river:

- Pontoon boat trips:
  - Maximum 960 passengers/day divided by 6 passengers/boat = 160 boats
    - Average 160 boats/day × 2 passes (up and back) × 9 minutes/boat = 2,880 minutes audible/day
- Helicopter shuttles for pontoon boat passengers:
  - Maximum 960 passengers/day divided by 5 passengers/helicopter × 2 flights/ helicopter × 3 minutes/flight = 1,152 minutes audible/day
- Helicopter shuttles for HRR passengers:

  - Day trips: 96 passengers/day divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 120 minutes audible/day
  - Overnight trips: 60 passengers divided by 5 passengers/helicopter × 2 flights/helicopter × 3 minutes/flight = 72 minutes audible/day
- Upriver boats from Lake Mead that stay only in Zone 3
  - Cannot be quantified as discussed above in "Methodology Considerations Specific to Lower Gorge Analysis." However, more upriver boats would be expected in Zone 3 than in Zone 2, due to time and distance considerations.

For Zone 3 the total time audible at a single point along the river from all of the above sources (including those coming into Zone 3 from Zone 2) varies from a low of 4,338 minutes (with no HRR Overnight trips), to a high of 4,464 minutes (with HRR overnight trips) (a major impact intensity level). Since there are only 720 minutes in a 12-hour day, multiple noise sources would be audible at the same time, and the natural soundscape would be essentially saturated by noise with very few noise-free intervals on a busy peak day.

The helicopter noise in combination with the boat noise would only occur in the Quartermaster area, and only during times when all boats were present (which would occur in the afternoons when HRR passengers were about ready to be picked up). This also would not include additional off-river noise, but this is not quantifiable. In addition, each motorboat would create regional impacts as it runs its motor for about 1.5 hours to travel the 18 miles through this zone. Noise-free intervals would average less than one hour during peak days. Overall, Alternative 5 would have a localized and regional, adverse, frequent and periodic, short- to long-term, major impact in Zone 3.

Zone 4 — Zone 4 does not have any plan-related helicopter or pontoon boat noise intrusions, but the continuing river activity (about the same as Zone 2) is added to by private watercraft on Lake Mead National Recreation Area, which may never enter Grand Canyon National Park.

Mitigation of Effects. Actions to mitigate effects would include all of the actions listed in the "Methodology for Analyzing Soundscape Impacts: Mitigation of Effects" section above. Compared to Alternative 1, Alternative 5 would reduce noise impacts in Zone 2 so less effort, staffing and funding would be needed to implement the mitigation actions. Therefore, it is likely that sufficient mitigation would be reasonably implemented in Zone 2 to reduce impacts to a minor level. However, the activity in the Quartermaster area in Zone 3 would make it unlikely that reasonable implementation of mitigation measures could reduce impacts to minor levels or less.

Cumulative Effects. Cumulative impacts would be similar to those discussed in Alternative A. Alternative 5 would have adverse, moderate to major overall impacts during peak periods, the same overall levels as Alternative 1. It would contribute an adverse, minor increment to cumulative effects, due primarily to increases in Quartermaster activity. Aircraft overflights have an adverse long-term, major cumulative effect on the park's natural soundscape. If all river-related noise (primarily from boats and helicopters) was removed from the park, the park would still experience adverse, major effects from aircraft overflights independent of this river management plan. Even in the Quartermaster area, the Hualapai Tribe expects about the same number of flights independent of the river alternatives. Frequent overflights commonly reduce

noise-free intervals to considerably less than an hour in many parts of the park. Given the history of aircraft overflights at Grand Canyon, mitigation would be unlikely to reduce cumulative impacts on the natural soundscape to a minor or lower intensity level.

Conclusions. Alternative 5 slightly reduces impacts on the natural soundscape in Zone 2 compared to Alternative 1, but major increases in impacts occur in Zone 3. It would have adverse, primarily short-term, and random, moderate to major overall impacts in Zone 2, which could be reasonably mitigated, but adverse, short- to long-term, frequent, periodic, major impacts in Zone 3, especially in the Quartermaster area, which could not be reasonably mitigated to minor levels or less. Noise from boats in Zone 2 would be audible about 186 minutes/day (or 26% of the 12-hour day) without considering HRR overnight trips, and 240 minutes (33%) on busy days when HRR overnight trips operate, an adverse, short-term, moderate impact. Noise-free intervals would average 1 to 1.5 hours in Zone 2 (an adverse, moderate impact), but less than an hour in Zone 3 (an adverse, major impact). Also, each motorboat would create regional impacts as it runs its motor for about three hours to travel the 35 miles through Zone 2.

Noise from boats and helicopters in Zone 3 would be audible from 4,338 to 4,464 minutes. Because this would be more than 100% of the 12-hour use day, there would be multiple noise sources audible much of the time. During peak-use days, there would be very little time for noise-free intervals in Zone 3. This would be an adverse, long-term, major impact in this zone, and a large increase in noise compared to Alternative 1.

There would also be off-river noise. Upriver boats and tow-outs would only be allowed to RM 273, so it is not likely there would be much of that traffic, and such noise is not quantifiable as discussed above. Each motorized raft would run its motor up to 4 hours each in the course of its travels through all or part of the Lower Gorge, creating regional impacts over the area of travel (i.e., some rafts would travel the entire 53 miles from Diamond Creek to Lake Mead in a day, but others would travel shorter sections). Alternative 5 would not result in impairment of the natural soundscape at Grand Canyon National Park.

The cumulative effects of Alternative 5 would be major adverse, long-term regional impacts primarily due to extensive aircraft overflights of the park, and are not likely to be able to be mitigated to minor intensity or less. Alternative 5 would contribute a minor increment to the overall cumulative effects of noise on the park natural soundscape, but even if all noise from all river recreation was eliminated from the park, the cumulative effects of aircraft noise would still be an adverse, major impact. There would still be “significant adverse effects” on the natural soundscape due to frequent, periodic and noticeable noise from overflights, and “substantial restoration of natural quiet” would not be achieved as required by Public Law 100-91 and other mandates.

CAVE AND PALEONTOLOGICAL RESOURCES

ISSUES

Cave and paleontological resources include atmospheric, geologic (i.e., mineralogical, lithologic, geomorphic, paleontological and hydrologic), biological, ecological, cultural, recreational, and

educational/scientific resources within caves, as well as fossil resources found outside caves. Impacts from visitation pose a serious threat to these resources, given that they are generally irreplaceable and nonrenewable. Numerous issues have been identified regarding these resources, both in public scoping and in internal review. The primary issues are described below.

While access to all caves, excluding Cave of the Domes, has been restricted by the "Superintendent's Compendium of Closures," several caves are accessible from the river and are thus vulnerable to impacts from unauthorized visitation by river runners. While the majority of visitors are conscientious about protecting cave and paleontological resources, a small percentage ignore park regulations and engage in acts that are destructive to the resource. Impacts to Grand Canyon caves by visitors (including researchers and managers) have been well documented.

Public education and appreciation for paleontological resources can have unintended consequences. Visitors have expressed a desire for increased information and access to paleontological resources; some visitors, however, have suggested that access to sensitive paleontological resources be restricted.

GUIDING REGULATIONS AND POLICIES

The Federal Cave Resources Protection Act of 1988 requires the U. S. Departments of Agriculture and the Interior federal agencies to identify "significant caves" on federal lands, to regulate or restrict use of those caves as appropriate, and to include significant caves in land management planning efforts. It imposes civil and criminal penalties for harming a cave or cave resources and authorizes information to be withheld about the specific location of a significant cave from a requester under the Freedom of Information Act.

The National Parks Omnibus Management Act of 1998 allows the National Park Service to protect the confidentiality of the nature and specific location of paleontological objects.

NPS regulations prohibit possessing, destroying, or disturbing mineral resources, cave resources, and paleontological specimens in park units (36 CFR 2.1).

The NPS *Management Policies 2001* require the agency to allow natural geologic processes to proceed unimpeded (sec. 4.8.1). The Park Service can intervene in these processes only when required by Congress, when necessary for saving human lives, or when there is no other feasible way to protect other natural resources/ park facilities/historic properties. Cave and paleontological resources are to be managed in such a way that the integrity of these resources is protected, while maintaining confidentiality of sensitive site locations and encouraging scientific research.

Cultural resources located in caves are protected by the Antiquities Act, the Archeological Resources Protection Act, the National Historic Preservation Act, CEQ regulations, and NPS Director's Order 28. These policies and regulations are discussed in detail under "Impacts on Cultural Resources."

Under the current *Cave Management Plan,* all caves but the Cave of the Domes are closed to the public (NPS 1986a). In accordance with a revision of that plan, NPS staff at Grand Canyon are

inventorying caves within the park and classifying them into five categories: Class 1 caves will be opened to the public without a permit; Class 2–5 caves will be restricted to use by permit only (NPS 2003a). Before entering any cave, individuals must determine the classification of the cave and apply for the requisite permit. With few exceptions, caving activity must be approved in advance through the Grand Canyon Science Center. Stanton's Cave has been gated to prevent unauthorized access by humans but still allow access for bats, other small mammals, and invertebrates.

MANAGEMENT OBJECTIVES FOR CAVE AND PALEONTOLOGICAL RESOURCES

Management objectives for cave and paleontological resources are included in Chapter 1. The objective for caves and paleontological resources as it relates to the management of recreational river use in the Grand Canyon is to provide for the protection of caves and paleontological resources from the impacts of visitation.

METHODOLOGY FOR ANALYZING EFFECTS TO CAVE AND PALEONTOLOGICAL RESOURCES

Effects specific to cave and paleontological resource were characterized for each alternative based on the impact thresholds presented below. Additionally, each alternative was evaluated to determine whether effects would be direct or indirect.

Intensity

Negligible — Any changes to cave resources, including mineral deposits, fossils, geologic features or human artifacts, that would not be measurable or perceptible.

Minor — Any changes to cave resources, including mineral deposits, fossils, geologic features, or human artifacts that would be measurable but slight, would not compromise the value of the feature, and would be possible to reverse or mitigate. Beneficial effects would be measurable but slight and would result in increased stability to individual cave and paleontological features.

Moderate — Any changes to cave resources, including mineral deposits, fossils, geologic features, or human artifacts, that would be measurable, perceptible, and of consequence to the value of the feature, but the impact might be possible to reverse or mitigate. Beneficial effects would be measurable and would contribute to an increase in the stability of resource features.

Major — Any changes to cave resources, including mineral deposits, fossils, geologic features, or human artifacts, that would be measurable, of severe consequence to the value of the feature, and impossible to reverse or expensive to mitigate. Beneficial effects would be measurable and would result in major stabilization of the resource.

Context

Localized — Impacts would be restricted to specific resource sites.

Regional — Impacts would occur to several specific resource sites within a management zone, Grand Canyon National Park, or the greater Grand Canyon region. This could also include impacts to a site that has regional significance in that it contains unique artifacts, species, or geologic formations.

Duration

Short term — Impacts would last less than five years, if the human disturbance was not repeated, and permanent, if human disturbance continued without interruption. The effect would no longer be detected in five years, so that the resource was returned to its predisturbance condition (for example, trash and other items could be removed).

Long term — Damage to paleontological, mineralogical, archeological, and historic resources would be permanent and irreversible. Archeological and historic materials that were rearranged, removed, or defaced would permanently lose their scientific value.

Timing

Impacts would vary depending on specific resource and their sensitivity to timing issues. For example, certain cave resources (bats) would be more susceptible to impacts during spring and summer months due to roosting, and fall and winter because of hibernation

Mitigation of Effects

Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to caves and paleontological resources if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Additional mitigation measures not already incorporated into the alternatives that could reduce impacts to these resources include the following:

- scheduled monitoring of resources relative to baseline data and site-specific mitigation of visitor impacts
- enhanced visitor education of park regulations and leave-no-trace ethics
- revegetation and retrailing near cave entrances and paleontological sites
- increased enforcement of site closures
- increased patrols
- data recovery for resources facing eminent destruction
- group size restrictions at sensitive sites
- temporary or permanent closures of exceptionally vulnerable sites

Cumulative Impacts

Cumulative impacts on cave and paleontological resources were determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future actions, as described in “Cumulative Impacts” on page 228. The most significant past action that has impacted cave resources has been authorized visitation prior to the implementation of closures

through the "Superintendent's Compendium" and the unauthorized visitation of caves since the closures. Research activities have also contributed to the effects from visitation. Since several types of cave resources are nonrenewable, even small incidents of visitation, authorized or unauthorized, can cumulatively diminish the resource. These losses are usually site-specific, but in cases where unique and diagnostic resources are present, the impact could be greater. Past visitation has resulted in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, cave and paleontological resources within the area of effect would continue to derive the benefit of protection from their location within Grand Canyon National Park, Lake Mead and Glen Canyon national recreation areas, and Hualapai tribal lands. Weighed against the impacts that come from visitation to these areas, this protection results in a beneficial, long-term, year-round, negligible to moderate effect.

Tools Used to Analyze Effects

In order to analyze the effect of each alternative on cultural resources, all available information on known cave and paleontological resources was compiled from NPS and Hualapai Tribe resource files. A map with locations of known caves, cultural and natural resources, and visitor stopping points (camps, lunch stops, and attractions), including data on use intensity, resulted in the identification of areas of resource concern, in which concentrations of sensitive resources overlapped with visitor use areas. Predictions about visitor impacts were based on predicted use levels from the Grand Canyon River Trip Simulator program.

Assumptions

In addition to general assumptions used for analysis of effects from each alternative (see page **Error! Bookmark not defined.**, assumptions that specifically relate to the alternatives presented in this document and their effects on cave and paleontological resources are presented below:

- Caves are attractive destinations during summer months for those seeking a reprieve from the heat of the day, although this visitation is generally restricted to caves close to the river. Very few caves are easily accessible from the river, and visitation is limited to those within a short hike, such as Stanton's Cave. Given that most true caves are found in the Redwall limestone layer of the canyon's strata, the accessibility of caves is further restricted by the canyon's geology. Caves and paleontological resources farther from the river corridor are actually more vulnerable during the shoulder seasons, when trip lengths and cooler weather are more conducive to exploration. The number of visitors who visit caves annually is a small percentage of those who travel the Colorado River, and most who do visit caves are generally conscientious about protecting cave and paleontological resources. As with all sensitive resources, a small percentage of visitors ignore park regulations and engage in acts that are destructive to the resource. Consequently, management variables that contribute to crowding, such as larger groups, more launches per day, and longer trips, can help to influence resource vulnerability.
- Variables that contribute to congestion (e.g., group size, trip length, number of passengers, user discretionary time, etc.) contribute to the vulnerability of cave and paleontological resources. However, all variables must be evaluated together.

- On longer trips visitors generally have more time to interact with the canyon environment, including sensitive cave and paleontological resources. This is particularly true for side canyons, as longer trips are designed to allow visitors opportunities to explore. Off-season hiking is also more conducive to exploring side canyons, as the extreme heat of the summer precludes hiking too far from the river itself.
- Increased visitor access to caves in the winter months adversely affects cave-dwelling bats. If hibernating bats are awakened, they can burn stored fat and might not be able to survive the winter (Thomas 1995). Population declines may be accelerated if numbers at maternity colonies are not sufficient to raise roost temperatures to the levels needed for healthy growth of young (Mohr 1972; Leslie, pers. comm. 2004a).
- The mode of travel (motor vs. oar) and trip type (commercial vs. noncommercial) are thought to have no effect on cave and paleontological resources. The assumption is that all individuals, whether on guided trips or noncommercial ones, could adversely interact with cave and/or paleontological resources.
- Impacts to cave and paleontological resources are generally long term or permanent, although mitigation measures may be employed that can lessen these impacts. For example, while the gating of Stanton's cave has been effective in mitigating visitor impacts, it is considered a last resort mitigation, given the cost and the aesthetic consequence (see Photo 4-4). Impact thresholds for gated caves are always negligible for intensity regardless of alternative.

PHOTO 4-4: GATE AT STANTON'S CAVE

- The number of pontoon boats and numbers of people on them will not directly affect cave and/or paleontological resources in the Lower Gorge because this type of trip does not offer visitors an opportunity to visit caves or paleontological resources.

IMPACT ANALYSIS — LEES FERRY ALTERNATIVES

Alternative A (Current Conditions)

Analysis. Under Alternative A recreational river use would be managed to continue to allow large group sizes, lengthy trips, and spikes in the number of trips and people at one time, as well as daily launches (see Table 4-1). User-days would remain capped at current levels, which would probably result in approximately the same number of total yearly passengers. Similarly, user discretionary time would remain similar to current levels.

The most noticeable effects on cave resources would be from continued unauthorized access to cave sites. While the number of caves accessible from the river is relatively small, sites that have sustained the most damage are those that are easily accessible to the river corridor. Several kinds of impacts have been documented. Impacts to fragile cave floor surfaces and soils include the rearrangement of natural and cultural material, footprints, trailing, soil compaction, and excavation. Impacts to cave formations (speleothems), rock and mineral resources, and paleontological resources include marks on surfaces, theft, vandalism, and inadvertent damage from trampling or excavating. Additional damage has occurred from the introduction of foreign objects and residues (oily residues from continuous touching, lint from clothing, wax from candles, smoke staining, toilet paper, odor, graffiti, etc.). Many of these impacts alter localized climate and hydrologic conditions that may alter or impede formation processes. Because cave and karst systems have a symbiotic relationship with local and regional hydrological systems, pollution or disruption of these natural systems can harm water supplies and water quality.

Biological resources that utilize caves are vulnerable to trampling and injury, as well as habitat destruction and damage that results in the abandonment of the cave. Human visitation in some caves may also disturb bats, not only through direct disturbance, but through changes in the micro-climate of the cave due to lights, increased humidity, gates, and other developments (Mann, Steidl, and Dalton 2002). Threatened species include but are not limited to several species of endangered bats and California condors, cave adapted invertebrates, and other small wildlife. Analyses of specific impacts to biological resources are detailed in specific sections of the natural resources impact analyses.

The integrity of cultural resources in caves have been compromised by the placement of fake split-twig figurines and other inappropriate material, as well as vandalism or theft of artifacts and other materials. Visitor access to cultural resources in caves has inadvertently disturbed significant features, thereby limiting the ability of some sites to convey their meaning. Analyses of specific impacts to cultural resources are detailed under “Impacts on Cultural Resources.” Human-caused fires have destroyed important natural and cultural artifacts, such as ground sloth and mountain goat dung, bones, hair, and other soft tissue that contain scientific material.

Impacts to paleontological resources outside of caves include polishing, marking, or removal of surfaces, rearrangement of material, theft, and damage to fossil material from attempted removal and/or vandalism.

Management variables such as group size, trip length, and launches per day affect crowding, congestion, and accessibility to cave and paleontological resources, and therefore they can

contribute to increases or decreases in resource vulnerability to impacts such as those above (trampling, resource disturbance). Under Alternative A in the summer season these variables are at their highest levels of any alternatives. Similarly the number of trips and people at one time in the corridor are at their highest levels, particularly since up to nine groups can launch in a single day. The long trip lengths in this alternative increase the level of accessibility of all sites, but particularly those in the side canyons. Large group sizes and spikes in launches increase the probability of congestion at attraction sites. This exacerbates the effects of unauthorized visitation of caves by concentrating large levels of foot traffic and associated trampling, surface contact, and breath emissions into a confined space. These variables can directly and indirectly affect impacts to cave and paleontological resources along the river corridor and side canyons. Thus, summer use results in localized, adverse, long-term, minor to moderate effects that are dependent on accessibility from the river.

Overall use levels under this alternative, as measured by user-days, total passengers, and total user discretionary time in the winter and shoulder seasons, would be at or near the lowest levels for all alternatives (see Table 4-2). While these variables indicate some of the lowest levels of off-season use, they would coincide with the highest allowable group sizes and trip lengths.

Longer trips under this alternative would increase the level of accessibility at all sites, but particularly those in the side canyons. Impacts, such as those discussed above, from winter and shoulder season use would be attributed primarily to the access afforded by these longer trips. Still, because use levels are low and off-season, impacts would be highly localized, adverse, long term, minor to moderate. Regional impacts would be negligible.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (e.g., increased monitoring, patrols, education, etc.), but because current management of the river corridor allows substantial spikes in use, as well as the longest allowable trip lengths of any of the alternatives, it is unlikely that mitigations would be implemented at a level sufficient to reduce impacts to a minor intensity. Cave gating would be a last resort but might be considered to prevent or correct major impacts.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in measurable changes to localized cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative A, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative A would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Conclusion. The majority of paleontological and cave resources are nonrenewable, thus most of the effects from visitation would be direct, adverse, and irreversible. Intensity of impacts would remain minor to moderate. However, because very few caves and paleontological resources are accessible to river runners along the river corridor, effects would not occur to the majority of caves and paleontological resources. Therefore, effects would be extremely localized and highly

dependent on accessibility. Effects would continue to occur year-round, with most impacts to resources adjacent to the river occurring during the summer months and most impacts to resources in less accessible areas occurring during the shoulder months when longer trips provide additional opportunities for side-canyon hiking. Because current management of the river corridor allows substantial spikes in use, as well as the longest allowable trip lengths of any of the alternatives, it is unlikely that mitigations would be implemented at a level sufficient to reduce impacts to a minor intensity. Alternative A would not result in the impairment of cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative A, when combined with other past, present, and reasonably foreseeable actions, would result in adverse, localized, long-term, minor to major effects to cave and paleontological resources. Alternative A would have a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Alternative B

Analysis. Under Alternative B recreational motor trips would be prohibited, and group sizes, maximum daily launches, and probable total yearly passengers would be the lowest of any of the alternatives (see Table 4-1). A launch-based system would eliminate spikes in use.

Summer use under this alternative in terms of total user-days would decrease to 107,418 (from 121,869 currently) and total passengers would go down to 8,492 (from 18,128 currently). These reduced use levels, along with reductions in group sizes, trip length, and maximum number of trips and people at one time, would help reduce crowding, thus decreasing the incidence of unintentional impacts to resources. Shorter trips, which would reduce the accessibility of side canyon resources, would be somewhat offset by an increase in user discretionary time (from 294,506 hours currently to 431,444 hours). As a result, access to all cave and paleontological resources, especially those in side canyons, could increase. While user discretionary time could represent an increase in sites per trip that river runners visited, it could also represent an increase the amount of time that visitors spent at fewer sites. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Effects such as those discussed above would continue to occur year-round, would be extremely localized, and would be highly dependent on accessibility, with most impacts to resources in and near the river occurring during the summer when visitors would have more time to explore sensitive resources. Overall, reductions in summer use would have beneficial, localized, long-term, negligible to minor effects compared to current use.

Under this alternative, overall use levels in the winter and shoulder seasons, as measured by user-days, total passengers, and user discretionary time, would increase above current levels, but would be much lower than the remainder of the alternatives. These levels of off-season use coincide with the lowest allowable group sizes and lower trip lengths. Compared to current use, these increases would potentially contribute to the accessibility and vulnerability of cave and paleontological resources, resulting in adverse, localized, long-term, negligible to minor effects.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased education, monitoring, patrols, site stabilization, etc.) and would be needed

primarily to mitigate new use in the winter and shoulder seasons. Use levels would generally be lower in the summer months, with the exception of user discretionary time. A monitoring and treatment plan to determine and mitigate impacts from potential visitation would be needed and sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative B, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative B would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Conclusion. Based on the reduction of use from current conditions, Alternative B would directly contribute to the long-term protection and stabilization of individual cave and paleontological resource sites, especially those along the mainstem of the Colorado River. This would result in beneficial, localized, negligible to minor effects that would depend on site accessibility and vulnerability. Effects from visitation would continue to cause measurable change to localized resources, however, and impacts would be direct, adverse, localized, negligible to minor, and irreversible. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Therefore, effects would be extremely localized and highly dependent on accessibility. Effects would continue to occur year-round, with most impacts to resources in and near the river occurring during the summer when an increase in user discretionary time would give visitors more time to explore sensitive resources. Most impacts to resources farther from the river would occur in the shoulder and winter seasons. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative B would not result in the impairment of the cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative B, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative B would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Alternative C

Analysis. Under Alternative C recreational motor trips would be prohibited. Group sizes and trip lengths would be at lower levels than now, but probable total user-days and user discretionary time would be the highest of any alternative (see Table 4-1). A launch-based system would eliminate spikes in use.

Lower summer use under this alternative in terms of user-days (down to 110,120 from 121,869 currently) and passengers (down to 11,252, from 18,128), along with moderate reductions in

group sizes, trip lengths, and the maximum number of trips and people at one time, would help reduce crowding and incidences of unintentional impacts (such as trampling, resource disturbance) at attraction sites, including cave or paleontological resources. These variables would be somewhat offset, however, by an increase in user discretionary time from 294,506 hours currently to 335,089, which might result in increased accessibility to all cave and paleontological resources, especially those in side canyons. While user discretionary time could represent an increase in sites per trip that river runners visited, it could also represent more time spent at fewer sites. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Overall, reduced summer use would have localized, beneficial, long-term, negligible to minor effects compared to existing conditions.

Under this alternative, overall use levels in the winter and shoulder seasons, as measured by user-days, total passengers, and user discretionary time, would increase considerably above current levels (see Table 4-2) and in most cases would be the highest use of all the alternatives. Allowable trip lengths would be reduced from 21 to 18 days in the shoulder season and from 30 to 21 days in the winter. Compared to current use, these off-season increases would potentially contribute to the accessibility and vulnerability of cave and paleontological resources, resulting in localized, adverse, long-term, minor to moderate effects.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased monitoring, patrols, site stabilization, etc.), and would be needed primarily to mitigate the considerable increases in winter and shoulder season use, as well as the highest yearly user-days and user discretionary time of any alternative. A monitoring and treatment plan to determine and mitigate impacts from potential visitation would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative C, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative C would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Based on the projected changes in use patterns from existing conditions, Alternative C would directly contribute to the long-term protection and stabilization of individual cave and paleontological resources by reducing some variables and indicators of crowding in the peak season. This would be offset, however, by an increase in user-days and user discretionary time in each season, particularly in the off-season. Compared to current conditions, this alternative would have direct, adverse, local, long-term, minor to moderate impacts. Effects from visitation would continue to cause measurable change to localized resources, however, resulting in direct,

adverse, local, moderate to major, and irreversible impacts at individual sites. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Therefore, long-term to permanent effects would be localized and highly dependent on accessibility. Effects would occur year-round, with the majority of new impacts occurring in the winter and shoulder seasons. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative C would not result in the impairment of cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative C, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative C would result in a localized, minor to moderate, long-term, adverse contribution to these cumulative effects.

Alternative D

Analysis. Under Alternative D recreational motor trips would be permitted two periods a year, from May to August and from December to February. Group sizes and trip lengths would be at lower levels than now, but user discretionary time would be among the highest of any of the alternatives (see Table 4-1). A launch-based system would eliminate spikes in use.

There would be a small summer user-day increase under this alternative (from 121,869 user-days now to 122,739), and total passengers would decrease to 13,765 from 18,128 currently; however, there would be a large increase in total user discretionary time (from 294,506 hours now to 461,641). This means that fewer people would have more time to interact with the environment, which could result in increased accessibility to all resources, especially in side canyons. Reductions in group sizes, trip length, and the maximum number of trips and people at one time would help reduce crowding, thus decreasing the incidence of unintentional impacts to sensitive resources. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Overall, summer use would have an adverse, localized, negligible to minor effect compared to existing conditions.

Overall use levels in the winter and shoulder seasons, as measured by user-days and total passengers, would increase above current levels (see Table 4-2). Allowable trip lengths would be reduced from current, with the exception of noncommercial oar trips, which remain at 30 days. Compared to current use, increased use would potentially contribute to the accessibility and vulnerability of cave and paleontological resources, resulting in adverse, localized, minor to moderate effects.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased monitoring, education, patrols, etc.) and would be needed primarily to mitigate considerable new use in the winter and shoulder seasons, as well as remarkably high user discretionary time levels. A monitoring and treatment plan to determine and mitigate impacts from potential visitation would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative D, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative D would result in a localized, adverse long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Based on the projected changes in use patterns from current condition, Alternative D would directly contribute to the long-term protection and stabilization of individual cave and paleontological resource sites by reducing crowding. This would be offset, however, by a substantial increase in user discretionary time throughout the year and an increase in user-days in the off-season. Compared to current conditions, this alternative would have direct, adverse, local, long-term, negligible to minor effects. Effects from visitation would continue to cause measurable change to localized resources, however, resulting in direct, adverse, local, long-term to permanent, minor to moderate impacts at individual sites. Because few resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Effects would occur year-round, with the greatest potential for new impacts occurring in the winter and shoulder seasons. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative D would not result in the impairment of the cave and paleontological resources of the Grand Canyon National Park. Cumulatively, the effects of Alternative D, when combined with other past, present, and reasonably foreseeable actions, would result in adverse, localized, long-term, minor to major effects to cave and paleontological resources. Alternative D would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Alternative E

Analysis. Under Alternative E recreational motor trips would be permitted April through September. Group sizes and trip lengths would be at lower levels than current, but user discretionary time would be among the highest (see Table 4-1). A launch-based system would eliminate spikes in use.

Under Alternative E summer use would decrease slightly (total user-days would fall to 121,836 from 121,869 now, and total passengers would decrease to 15,230 from 18,128); however total user discretionary time would increase to 373,761 hours (from 294,506 hours now). So fewer people would have more time to interact with the environment, resulting in greater access and vulnerability of resources to impacts, especially in side canyons. However, reductions in group sizes, trip lengths, and the maximum number of trips and people at one time would reduce crowding, thus reducing incidences of unintentional impacts to resources. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Overall, summer use would have a localized, adverse, long-term, negligible to minor effect compared to current use.

Overall use levels in the winter and shoulder seasons would increase from existing (see Table 4-2), but would be relatively low compared to the rest of the alternatives. These increases would potentially contribute to impacts on resources from greater access. Because of the vulnerability of resources, impacts would be localized, adverse, long term, and minor to moderate.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased education, monitoring, patrols, education, etc.), and would be needed primarily to mitigate new use in the winter and shoulder seasons. A monitoring and treatment plan to determine and mitigate impacts from visitation would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative E, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative E would result in a localized, adverse long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Based on the projected changes in use patterns from existing conditions, Alternative E would directly contribute to the long-term protection and stabilization of individual cave and paleontological resource sites by reducing crowding, especially in the peak summer season. This would be somewhat offset, however, by increases in user discretionary time throughout the year and an increase in user-days in the winter and shoulder seasons. Compared to current conditions, this alternative would have direct, adverse, local, long-term, negligible to minor effects. Effects from visitation would continue to cause measurable change to localized resources, however, resulting in direct, adverse, long-term to permanent, minor to moderate impacts at individual sites. Because few resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Effects would occur year-round, with the greatest potential for new impacts in the winter and shoulder seasons. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative E would not result in the impairment of cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative E, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative E would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Alternative F

Analysis. Under Alternative F recreational motor trips would be permitted January through June. Group sizes and trip lengths would be lower than now. User discretionary time would be higher

than existing conditions, but it would be relatively low compared to several other alternatives (see Table 4-1).

Summer use under this alternative represents a considerable reduction in total user-days (a decrease of 19,578 days), in total user discretionary time (a decrease of 24,999 hours), and total projected passengers (a decrease of 4,174). As a result, lower summer use, along with reductions in group size, trip lengths, and maximum number of trips and people at one time, would help prevent crowding, thus reducing the incidence of unintentional impacts to resources. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Overall, summer use would have localized, beneficial, long-term, negligible to minor effects compared to current use.

Use levels in the winter and shoulder seasons, as measured by user-days, total passengers, and user discretionary time, would increase considerably above current levels (see Table 4-2). These higher use levels could result in greater access to vulnerable cave and paleontological resources, with localized, adverse, long-term, minor to moderate effects.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased education, monitoring, patrols, site stabilization, etc.) and would be needed mitigate impacts from new use in the winter and shoulder seasons. A monitoring and treatment plan to determine and mitigate impacts from visitation would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative F, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative F would result in a localized, adverse long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Based on the projected changes in use patterns from existing conditions, Alternative F would directly contribute to the long-term protection and stabilization of individual cave and paleontological resource sites by reducing crowding, especially in the summer season. This would be somewhat offset, however, by an increase in user discretionary time, total projected passengers, and user-days in the winter and shoulder seasons. Compared to current conditions, this alternative would have a direct, adverse, local, long-term, and negligible to minor effect. Effects from visitation would continue to cause measurable change to localized resources, however, resulting in direct, adverse, long-term to permanent, minor to moderate impacts at individual sites. Because few resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Therefore, these effects would be localized and highly dependent on accessibility. Effects would occur year-round, with the greatest potential for new impacts in the winter and shoulder seasons. Impacts to

cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative F would not result in the impairment of cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative F, when combined with other past, present, and reasonably foreseeable actions, would result in adverse, localized, long-term, minor to major effects to cave and paleontological resources. Alternative F would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Alternative G

Analysis. Under Alternative G recreational motor trips would be permitted January through August. Group sizes would be somewhat lower than what is permitted now, but they would be higher than under any other alternative. Trip lengths would generally be at their lowest levels of all the alternatives except for noncommercial winter oar trips, which would still be reduced to 21 days from 30 days now. Yearly user discretionary time would be higher than current conditions, but it would be the of all the action alternatives (see Table 4-1). Probable yearly passengers would increase from 22,461 to 28,680, and probable total user-days would increase from 171,131 to 249,910. A launch-based system would eliminate spikes in use.

Summer use would decrease under this alternative. as indicated by total user-days (which would decrease to 101,984 from 121,869 now), total user discretionary time (down to 229,958 hours from 294,506), and total projected passengers (falling to 14,939 from 18,128). Lower summer use, particularly in the amount of user discretionary time that visitors would have to interact with the environment, would be lower in this alternative than in any other alternative. This would be offset, however, by the large group size (40) for commercial motor trips. Because these large groups would not have sufficient time to access side canyon sites, it is anticipated that the impacts would be generally restricted to the most easily accessible sites along the river. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Overall, summer use would have localized, beneficial, long-term, negligible to minor effects compared to current use.

Overall use levels in the winter and shoulder seasons, as measured by user-days and total passengers, would increase considerably above current levels and would be among the highest of all of the alternatives (see Table 4-2). Additionally, winter launches would be twice those currently allowed, and shoulder season launches would be reduced from current levels but would still be higher than any other alternative. While overall use levels in the winter and shoulder seasons would increase considerably above current levels, reductions in trip lengths would result in relatively low user discretionary time, particularly in the shoulder seasons. Less daylight in the off-season would somewhat restrict access to side canyon resources, and impacts would generally be restricted to the most easily accessible sites along the river. Compared to current use, resulting impacts to cave and paleontological resources would be highly localized, adverse, long term, and negligible to minor.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased education, monitoring, patrols, site stabilization, etc.) and would be needed

to mitigate impacts from new use in the winter and shoulder seasons. Because trip lengths would be substantially reduced, adverse effects from visitation by large groups would be generally restricted to easily accessible river corridor sites. A monitoring and treatment plan to determine and mitigate impacts from visitation would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative G, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative G would result in a localized, adverse long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Based on the projected changes in use patterns from current condition, Alternative G would directly contribute to the long-term protection and stabilization of individual cave and paleontological resource sites by reducing passengers and trip lengths in the summer season. This would be somewhat offset, however, by relatively large group sizes and increases in off-season use in terms of total projected passengers and user-days. Compared to current conditions, this alternative would have direct, adverse, local, long-term, and negligible to minor effects. Effects from visitation would continue to cause measurable change to localized resources, however, resulting in direct, adverse, long-term to permanent, minor to major effects at individual sites. Because few resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Therefore, these effects would dependent on accessibility. Effects would occur year-round with the greatest potential for new impacts occurring in the winter and shoulder seasons. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative G would not result in the impairment of the cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative G, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative G would have a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Alternative H (NPS Preferred Alternative)

Analysis. Under Alternative H recreational motor trips would be permitted from March through August. Group sizes in the summer would be lower than now, and they would be considerably lower in the shoulder seasons. Trip lengths would also be lower than current conditions, with some opportunities for longer trips during the winter. Yearly user discretionary time would be higher than current conditions, but lower than several other alternatives (see Table 4-1). Probable yearly passengers would increase from 22,461 now to 26,317, and probable total user-days would increase from 171,131 to 218,225. A launch-based system would eliminate spikes in use.

Alternative H would have the highest level of summer user-days (125,243) and total projected passengers (18,132) of all the alternatives, including Alternative A (121,869 user-days and 18,128 total passengers). User discretionary time would be relatively high (402,037 hours) compared to current conditions (294,506) and several other alternatives. An overall increase in summer user discretionary time would be offset by reductions in group sizes, trip lengths, and the maximum number of people and trips at one time, which would help reduce crowding and incidences of unintentional resource impacts. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Summer use would have adverse, localized, long-term, minor effects compared to existing conditions.

Use levels in the winter and shoulder seasons, as measured by user-days and total passengers, would be higher than current levels but among the lowest of all the alternatives (see Table 4-1). Off-season group sizes would be at the lowest level of all of the alternatives, with shoulder-season commercial trips reduced to 24 passengers and guides. Overall use levels in the winter and shoulder seasons would be higher than current levels, and trip lengths would be somewhat increased in the off-season. However, with reduced daylight it is anticipated that accessibility to side canyon resources would be somewhat restricted; instead the potential for impacts would be highest at the most easily accessible sites along the river. Compared to current use, these factors indicate that the effect to cave and paleontological resources would be highly localized, adverse, long term, and negligible to minor.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased education, monitoring, patrols, site stabilization, etc.) and would be needed mitigate impacts from new use in the winter and shoulder seasons. A monitoring and treatment plan to determine and mitigate impacts from visitation would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined based on the results of the monitoring program.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in localized, measurable changes to cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative H, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative H would result in a localized, adverse long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Based on the projected changes in use patterns from current conditions, Alternative H would directly contribute to the long-term protection and stabilization of individual cave and paleontological resource sites by reducing crowding, particularly in the peak summer season. This would be somewhat offset, however, by an increase in summer user discretionary time and increases in off-season total projected passengers and user-days. Off-season user discretionary time, however, would be relatively low as compared to Alternative A, and small group sizes would help reduce impacts from increased use. Compared to existing conditions, this alternative

would have direct, adverse, long-term, negligible to minor effect. Effects from visitation would continue to cause measurable change to localized resources, however, resulting in direct, adverse, long-term to permanent, minor to moderate impacts at individual sites. Because few resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources. Therefore, effects would be localized and highly dependent on accessibility. Effects would occur year-round, with the greatest potential for new impacts in the winter and shoulder seasons. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative H would not result in the impairment of the cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative H, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative H would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

IMPACT ANALYSIS — LOWER GORGE ALTERNATIVES

Methodology

Pontoon trips and HRR day and overnight trips under all Lower Gorge alternatives do not visit cave or paleontological sites, therefore these uses would have no effect on cave and paleontological resources.

Alternative 1 (Current Conditions)

Analysis. Caves and cave resources are more common in the Lower Gorge than in the upper portion of the Grand Canyon. Past disturbance of cave resources in the Lower Gorge are well documented, in particular the sloth caves such as Rampart and Muav. Rampart Cave was gated in the late 1990s to secure the remaining resources, but trespass into other caves in the Lower Gorge likely occurs.

Impacts to cave and paleontological resources would be essentially the same as those identified under Alternative A for Lees Ferry. They would consist primarily of damage to fragile resources, ranging from the inadvertent trampling and destruction of habitat, cultural resources, cave formations, and mineral and fossil resources to habitat abandonment and the deliberate theft and vandalism of nonrenewable resources. The intensity of the impacts would vary, however, since the Lower Gorge is a different use zone where the types and levels of use vary dramatically from what occurs in the Lees Ferry to Diamond Creek portion of the corridor.

Pontoon trips and HRR day and overnight trips do not visit cave or paleontological sites; therefore, this use has a negligible effect on cave and paleontological resources for all alternatives.

Depending on the surface elevation of Lake Mead, upriver recreational boating can vary. The amount of noncommercial upriver boating would not be regulated under this alternative (although personal watercraft or Jet skis would continue to be prohibited). Statistics on varying

use levels are not available. Consequently, effects from noncommercial upriver trips are not included in this analysis.

Currently there are no time restrictions for noncommercial trips launching from Diamond Creek or for continuation trips launching from Lees Ferry. This allows recreationists relatively unlimited access to cave and paleontological resources in the Lower Gorge. Of particular concern is the access to side canyon resources. Currently, noncommercial groups are relatively small, which decreases the likelihood of crowding and its associated effects. Large commercial continuation trips generally do not visit cave and paleontological resources and only spend one night in the Lower Gorge. Thus, impacts to these resources are from noncommercial trips that take several days to explore side canyons. These impacts, as discussed above, would result in measurable changes in the resource and would continue to have direct, adverse, long-term, minor to moderate effects on localized resources. These effects would be highly dependent on accessibility from the river corridor.

Mitigation of Effects. Actions that would serve to mitigate localized effects would include an increase in monitoring of popular cave and paleontological sites, with stabilization and/or data recovery measures in place to mitigate any moderate to severe impacts. However, because current management of the river got unlimited trip lengths and because no management and treatment plan is in place for these resources, it is unlikely that mitigations could be implemented at a level sufficient to reduce impacts to a minor intensity.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in measurable changes to localized cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative 1, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative 1 would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Conclusion. Impacts to individual cave and paleontological resources under Alternative 1 would be direct, adverse, and minor to moderate, depending on accessibility from the river. Effects would be localized and year-round, with most impacts occurring to resources located in side canyons. For the most part, these impacts would be long term to permanent. Because current management of the river corridor allows for unlimited trip lengths and because no management and treatment plan is in place for these resources, it is unlikely that mitigation could be implemented at a level sufficient to reduce impacts to a minor intensity. Alternative 1 would not result in the impairment of the cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative 1, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative 1 would result in a localized, adverse, long-term, minor to moderate contribution to these cumulative effects.

Alternative 2

Analysis. Under Alternative 2, group sizes, total number of daily passengers, and allowable upriver travel would be at the lowest levels of all of the alternatives (see Table 4-3). Additionally, pontoon use and all associated operations and facilities, would be eliminated.

The number of noncommercial trips allowed to launch from Diamond Creek would remain unchanged, but trip lengths would be limited to four nights in the peak season and five nights in the non-peak season. Shorter trips would help limit access to sensitive side canyons and their attendant resources. Compared to current conditions, restrictions on trip length would have a direct, beneficial, long-term, negligible to moderate effect on cave and paleontological resources. Effects from visitation would still be measurable, however. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Therefore, effects would be adverse, long term, and minor to moderate, but highly localized.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased monitoring, patrols, site stabilization, etc.). While use levels are relatively low in this alternative, a monitoring and treatment plan to determine and mitigate localized impacts from visitation, especially in high-use sites, would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols and site stabilization would be determined through the monitoring program. Installing gates on caves is always a last resort but could be considered to prevent or correct major impacts to caves.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in measurable changes to localized cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative 2, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative 2 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Conclusion. Under Alternative 2 limiting the length of trips launching from Diamond Creek would, compared to current conditions, directly contribute to the long-term protection and stabilization of individual cave and paleontological resources, especially sites in side canyons. This would result in a beneficial, localized, minor to moderate effect that would be highly dependent on site accessibility and vulnerability. However, effects from visitation to nonrenewable cave and paleontological resources would be direct, adverse, local, negligible to moderate, and irreversible. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Therefore, effects would be localized and highly dependent on accessibility. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative 2 would not result in the impairment of the cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of

Alternative 2, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative 2 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Alternative 3

Analysis. Under Alternative 3 group sizes and trip lengths would be at substantially lower levels than currently. The total number of pontoon passengers, HRR passengers, and upriver trips would be at or above current levels(see Table 4-3). The number of noncommercial trips allowed to launch from Diamond Creek would remain unchanged, but trip length would be limited to five nights in the peak season and eight nights in the non-peak season.

Decreasing allowable trip lengths would limit access to sensitive cave and paleontological resources in side canyons. Compared to current condition, restrictions on trip length would have a direct, beneficial, long-term, and negligible to minor effect on cave and paleontological resources. Effects from visitation would still be measurable, however. Because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Therefore, effects would be adverse, long term, and minor to moderate, but highly localized.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased monitoring, patrols, site stabilization, etc.). A monitoring and treatment plan to determine and mitigate localized impacts from visitation, especially at high-use sites, would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined through the monitoring program. Installing gates on caves gating is always a last resort but could be considered to prevent or correct major impacts to caves.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in measurable changes to localized cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative 3, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative 3 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Conclusion. Compared to current conditions, reducing the number of days that trips could spend in the Lower Gorge would directly contribute to the long-term protection and stabilization of individual cave and paleontological resources, especially sites in side canyons. This would result in a beneficial, localized, negligible to minor effect that would be highly dependent on site accessibility and vulnerability. However, effects from visitation to nonrenewable cave and paleontological resources would be direct, adverse, negligible to moderate, and irreversible. These effects would be localized and highly dependent on accessibility. However, because not

all cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative 3 would not result in the impairment of cave or paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative 3, when combined with other past, present, and reasonably foreseeable actions, would result in adverse, localized, long-term, minor to major effects to cave and paleontological resources. Alternative 3 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Alternative 4 (NPS Preferred Alternative)

Analysis. Alternative 4 is characterized by a redistribution of HRR operations and represents a consensus between the National Park Service and the Hualapai Tribe on levels of HRR use and other uses originating at Diamond Creek. This alternative represents the park's preferred lower levels of pontoon boat use compared to the current average. Under this alternative HRR group sizes and trip lengths would be substantially lower than now, and upriver trips would be below current levels (see Table 4-3).

The number of noncommercial trips allowed to launch from Diamond Creek would remain unchanged, but overnight trips would be limited to three nights in the peak season and five nights in the non-peak season.

Decreasing the number of nights that noncommercial trips could spend in the canyon would limits access to sensitive side canyon resources. Compared to current conditions, restrictions on trip length would have a direct, beneficial, long-term, and minor to moderate effect on cave and paleontological resources. Effects from visitation would still be measurable, however. But because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Therefore, effects would be averse, long term, and minor to moderate, but highly localized.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased monitoring, patrols, site stabilization, etc.). A monitoring and treatment plan to determine and mitigate localized impacts from visitation, especially in high-use sites, would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols and site stabilization would be determined through the monitoring program. Installing gates on caves is always a last resort but could be considered to prevent or correct major impacts to caves.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in measurable changes to localized cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative 4, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major

effects to cave and paleontological resources. Alternative 4 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Conclusion. Compared to current conditions, limiting the number of nights that trips traveling below Diamond Creek could spend in the canyon would directly contribute to the long-term protection and stabilization of individual cave and paleontological resources, especially sites in side canyons. This would result in beneficial, localized, minor to moderate effects that would be highly dependent on site accessibility and vulnerability. However, effects from visitation of nonrenewable cave and paleontological resources would be direct, adverse, negligible to moderate, and irreversible. However, effects would be localized and highly dependent on accessibility. Because not all cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Effects could continue year-round, with most impacts during summer when longer days offer visitors additional opportunities to access sensitive resources. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative 4 would not result in the impairment of cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative 4, when combined with other past, present, and reasonably foreseeable actions, would result in adverse, localized, long-term, minor to major effects to cave and paleontological resources. Alternative 4 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Alternative 5 (Hualapai Tribe Proposed Action)

Analysis. Alternative 5, similar to Alternative 4, is characterized by a redistribution of HRR operations and represents a consensus between the National Park Service and the Hualapai Tribe on levels of HRR use and other uses originating at Diamond Creek. This alternative, however, represents the Hualapai Tribe's proposed higher levels of pontoon boat use than occur now. Under this alternative HRR group sizes and trip lengths would be substantially lower than under current conditions, and upriver trips would be below current levels (see Table 4-3). The number of noncommercial trips allowed to launch from Diamond Creek would remain unchanged, but trip length is limited to three nights in the peak season and five nights in the non-peak season.

Decreasing the number of nights that noncommercial trips could spend in the canyon would limit access to sensitive resources in side canyons. Compared to current conditions, restrictions on trip length would have a direct, beneficial, long-term, and minor to moderate effect on cave and paleontological resources. Effects from visitation would still be measurable, however. But because few cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, the majority of resources would not be affected. Therefore, effects would be adverse, long term, and negligible to moderate, but highly localized.

Mitigation of Effects. Actions needed to mitigate effects would include all of those discussed on page 388 (increased monitoring, patrols, site stabilization, etc.). A monitoring and treatment plan to determine and mitigate localized impacts from visitation, especially in high-use sites, would be needed and would be sufficient to reduce localized impacts to a minor intensity. Levels of additional education, patrols, and site stabilization would be determined through the monitoring

program. Installing gates on caves is always a last resort but could be considered to prevent or correct major impacts to caves.

Cumulative Effects. Specific effects from past, present, and reasonably foreseeable actions are discussed earlier in this chapter. Cumulatively, past visitation, park management, and visitation by backcountry visitors and researchers results in measurable changes to localized cave and paleontological resources. This effect results in adverse, long-term, minor to major impacts that are highly localized.

Cumulatively, the effects of Alternative 5, when combined with other past, present, and reasonably foreseeable actions, would result in localized, adverse, long-term, minor to major effects to cave and paleontological resources. Alternative 5 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

Conclusion. Compared to current conditions, limiting the number of nights that trips below Diamond Creek could spend in the canyon would directly contribute to the long-term protection and stabilization of individual cave and paleontological resources, especially sites in side canyons. This would result in beneficial, localized, minor to moderate effects that would be highly dependent on site accessibility and vulnerability. However, effects from visitation to nonrenewable cave and paleontological resources would be direct, adverse, negligible to moderate, and irreversible. Because not all cave and paleontological resources along the river corridor are readily accessible (or recognizable) to river users, effects would not occur to the majority of resources, effects would be localized and highly dependent on accessibility. Effects could occur year-round, with most impacts during summer when more daylight offers visitors additional opportunities to explore sensitive resources. Impacts to cave and paleontological resources could be reduced to a minor intensity with reasonable mitigation. Alternative 5 would not result in the impairment of cave and paleontological resources in Grand Canyon National Park. Cumulatively, the effects of Alternative 5, when combined with other past, present, and reasonably foreseeable actions, would result in adverse, localized, long-term, minor to major effects to cave and paleontological resources. Alternative 5 would result in a localized, adverse, long-term, minor contribution to these cumulative effects.

VEGETATION

ISSUES

Vegetation was identified as an impact topic during both internal and public scoping sessions. The comments about vegetation were received:

- Protect ecological resources as the first priority.
- Use an adaptive management approach and improve resource monitoring.
- Consider closing areas experiencing excessive impacts.
- Mark and maintain trails because social trailing is a problem and should be reduced.
- Protect threatened and endangered species.

- Protect vegetation, including the old high-water zone and side canyons.
- Partially address the loss of camping beaches through the removal of invasive vegetation.
- Manage invasive exotic species.
- Restore natural conditions.
- Protect near-river springs and seeps, and tributaries, because they are valuable resources.

The vegetation resources throughout much of Grand Canyon National Park's remote backcountry are minimally impacted, with natural processes intact and functioning. However, throughout the river corridor and some side canyons, human impacts have directly and indirectly altered vegetation on individual plant and community levels, often disrupting the interactions between physical and biological processes. Activities related to recreation on the Colorado River that have contributed to vegetation impacts include trampling, damage, and the spread of exotic plant species. The variables within the alternatives that have the greatest potential to impact vegetation are group size, trip length, user discretionary time, launch schedule (including seasonal use levels), user-days, and the total number of yearly passengers.

River recreation impacts to vegetation are evident in three roughly parallel bands of riverside vegetation (the new and old high-water zones, and upland/desert scrub), and at attraction sites, which often have riparian vegetation. The trampling of vegetation has three initial effects: abrasion of vegetation (plants are crushed, sheared off, or uprooted), abrasion of soil organic layers, and compaction of soil (Hendee, Stankey, and Lucas 1990). Since soils and vegetation are highly interconnected, an impact to one often leads to an impact to the other. For plants, trampling leads to reduced vigor, cover and reproduction, and changes in species composition (Liddle 1975). Trampling of and damage to vegetation occurs in the new and old high-water zones as well as upland, and riparian areas when hikers use campsites and attraction areas and create new trails (social trailing). Much of this damage is a result of river runners moving about campsites, establishing sleeping or kitchen areas, exploring beyond campsite margins, finding comfortable (usually shady) areas to eat or rest during lunch breaks, hiking, and enjoying the attraction sites. In the early 1970sresearchers noted that the lack of marked and well-maintained trails caused hikers to create new trails, damaging vegetation and increasing topsoil erosion (Tomko and Karpiscak 1974). In a 1980 report researchers stated humans directly influence the stability of the old high-water zone and upland areas through the destruction of plants, with impacts evident at attraction sites in addition to camping areas (Turner and Karpiscak 1980). In 1974 recommendations were made to establish a single trail and to obliterate superfluous trails.

The compaction and disturbance of soils by humans can lead to erosion and loss of organic matter, indirectly affecting native vegetation and soil microbiota and thereby diminishing plant growth potential and the health and survival of vegetation resources (Hendee, Stankey, and Lucas 1990; Cole 1986). Impacts to vegetation in turn relate to the ability of plant roots and microbiota to help create soils in this arid environment. Researchers have described the relationship between the amount of use and the amount of impact, with low levels of use often causing large impacts and vegetation loss (Cole and Monz 2003). The ability of a particular area to sustain human impacts often depends on the condition and sustainability of the biological environment, and within the geographic extent of this analysis, the old high-water zone and upland areas are most susceptible to damage. In general, social trail impacts include the direct

and indirect described above, and most often lead to the complete loss of vegetation that existed prior to trail creation.

Higher numbers of total visitors present more opportunities for damage to vegetation and noncompliance with the park's current boating regulations. Larger groups are also more likely to disturb larger areas (Hendee, Stankey, and Lucas 1990). In Grand Canyon vegetation loss has been found to be equally severe in high- and low-use core areas, leading to rapid mineral soil exposure; vegetation loss is less pronounced on the perimeters of campsites (Cole 1986). Researchers have also observed that parties that stay longer at sites are more likely to develop or improve the site (Washburne and Cole 1983). Along the river corridor, site modification generally occurs in the new high-water zone, with rocks moved and vegetation altered in an intentional effort to enlarge or modify camp space or to create trails. Plants in the new high-water zone, which is intended to accommodate high-use, are often able to recover quickly from these impacts and other disturbances (Kearsley et al. 2003; Jackson Kennedy, and Phillips 2001). Damage to plants in the old high-water zone and upland areas have a greater effect because these plants require longer recovery time than those in the new zone. When large groups use medium or small sized camping beaches, people searching for privacy denude native vegetation in the old high-water zone to establish new tent sites, thereby expanding the campsite. Research in 1986 found that core campsite areas were devoid of vegetation (0% cover) compared to 60% cover in undisturbed areas (Cole 1986). Although camping is prohibited in most of the old high-water zone, campsite expansion into this area and the associated loss of vegetation has been exacerbated by the ongoing reduction in the size of camping beaches due to river erosion and plant encroachment.

Recreationists on longer trips that layover at sites have more time to explore the old high-water zone and upland areas and to hike to nearby attractions, increasing both the area of possible impact and the probability of impacts. Many attraction sites are near water and contain riparian vegetation, which is sensitive to human impacts but is also extremely variable and influenced by many environmental variables (Grand Canyon Wildlands Council 2003). One researcher stated that one of the most urgent threats to the biota of springs is current and future recreational activity (Spence 2004). Human impacts at springs include trampling and swimming, which damages vegetation, creases erosion, and allows exotic species to invade.

The spread of nonnative or exotic plant species directly affects native vegetation, causing changes in the composition of vegetative communities. The spread of exotics can be intentional (e.g. planting) or unintentional (e.g. humans unknowingly transporting seeds or propagules on their shoes, clothing, or equipment). The removal or damage of plants and soils in the new and old high-water zones and in upland areas provides an opportunity for exotic and invasive plant species, often with competitive advantages, to move in and occupy the sites. Uprooting invasive plants, such as the offensive camelthorn, can actually stimulate bud growth on the rhizome, spread seeds, and encourage the spread of exotics in some areas. When control actions are taken without direction of park management, the results can lead to an increase in exotic plant distribution. In addition, continual trampling can favor the most resilient species, which in Grand Canyon are often the invasive exotic plants.

Vegetation resources at Grand Canyon are typically more sensitive during the spring and early summer months because they are reproducing or germinating and flowering (Hammitt and Cole

1987). Ephemeral annuals often complete their life cycle in a relatively short period. Desert adaptations like thorns and thick, succulent leaves appear to promote resistance to trampling (Cole 1986). However, once recreationists trample or damage vegetation in the old high-water zone and upland areas, its resilience is very low.

Throughout much of the Colorado River corridor, boaters tie their rafts around vegetation. Tamarisk is the species most often tied to, due to its abundance and distribution. However, on some beaches with few to no tamarisk, boaters may tie to native vegetation such as seep willow, desert broom, and coyote willow rather than using a sand stake. Successive use can damage the vegetation. While this is typically an impact to individual plants, cumulatively over time and also combined with other vegetation impacts, this can be an issue. A good example of this potential is the damage that the large Gooding willow tree at Granite Park (RM 209 R) has suffered over the years. For years, the tree was the primary object to which boaters tied, causing damage from girdling. The tree also provides good shade, leading recreationists to gather beneath it. Human use, combined with shoreline erosion, has caused root injury, leading to severe declines in the tree's health. At 200 years old, the tree is not only historic, but also an important cultural and ethnobotanical resource to the Hualapai Tribe (HDCR 2002).

Colorado River "Commercial Operating Requirements" permit the collection of driftwood between October 1 and April 30 and prohibit the collection of wood from standing or fallen trees, dead or alive, native or exotic (NPS 2003g). Driftwood occurs primarily along beaches, but it can also be found in side canyons. Currently, only a small percentage of river use takes place during these colder months, but even with limited use, supplies of driftwood can be substantially reduced (Brown 2003). The loss of large quantities of driftwood could be detrimental to wildlife and macroinvertebrates that utilize it for habitat, but it would not directly affect the vegetation communities along the river (Haden et al. 1999; Maser and Sedell 1994). However, as limited driftwood supplies diminish, the use of standing or fallen trees near campsites may increase (Brown 2003). Decaying wood plays an important role in ecosystems, and the collection of standing or fallen dead material can lead to declines in site productivity, particularly on droughty and infertile soils, and it can also impact invertebrates, small mammals, and birds that utilize it for food and shelter (Hendee, Stankey, and Lucas 1990).

Lack of data, challenges with restoration in desert environments, and limitations in staff and funding contribute to the inability of park staff to mitigate current levels of impacts. Current mitigation measures are re-initiated annually; yet for many areas, the levels of impacts remain unacceptable for resource protection and preservation.

GUIDING REGULATIONS AND POLICIES

Overarching laws, including the NPS Organic Act of 1916, the National Environmental Policy Act of 1969 and the National Parks Omnibus Management Act of 1998, are described in the "Introduction" to Chapter 4. Threatened and endangered plant species are addressed separately.

The Organic Act directs parks to conserve scenery and natural objects unimpaired for future generations. The National Park Service interprets this to mean that native vegetation,

PHOTO 4-5: GOODING WILLOW AT GRANITE PARK USED TO TIE UP BOATS

ecosystems, and watersheds should be protected and perpetuated as part of Grand Canyon National Park's legacy for current and future generations.

The NPS *Management Policies 2001* (NPS 2000d) direct park managers to understand, maintain, restore, and protect the inherent integrity of natural resources, processes, systems, and values of the park. To the extent possible, the National Park Service shall allow natural processes, including the evolution of species, to control landscape and population level dynamics, assuming that all components of the natural systems remain intact. The preservation of fundamental physical and biological processes, as well as individual species, plant communities, and other components of naturally evolving ecosystems, is inherent in management direction. The *Management Policies* state that the Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals by:

- preserving and restoring the natural abundance, diversities, dynamics, distributions, genetic and ecological integrity, and behaviors of native plant populations and the communities and ecosystems in which they occur
- restoring native plant populations in parks when they have been extirpated by past human-caused actions
- initiating the return of human-disturbed areas to natural conditions (or the natural trajectory), including the processes characteristic of the ecology zone
- minimizing human impacts on native plants, communities, and ecosystems, and the processes that sustain them
- preventing the introduction of exotic species and removing established populations
- monitoring natural systems and human influences upon them to detect change and developing appropriate management actions

- protecting watersheds as complete hydrologic systems, primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded
- preserving, enhancing, and restoring the natural and beneficial values of wetlands

Executive Order 13112, "Invasive Species," states that any federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, subject to budgetary limitations:

- prevent the introduction of invasive species
- detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner
- monitor invasive species populations accurately and reliably
- provide for restoration of native species and habitat conditions in ecosystems that have been invaded
- conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species
- promote public education on invasive species and the means to address them

Section IV of Grand Canyon's "Commercial Operating Requirements" outline specific actions regarding multiple trailing, campsite impacts, and campfires (NPS 2003g). River guides must stress to passengers the need to stay on established trails to minimize multiple trailing and associated impacts to vegetation and soils. Group hikes must be led by guides who are knowledgeable about the trails and areas in order to ensure compliance. To minimize damage in the old high-water zone and pre-dam riparian plant communities, guides must conduct camp activities in post-dam sandbar areas (i.e., in the shoreline and new high-water zone) and should ensure that no one creates new routes or sleeping areas in the fragile desert environments (i.e. old high-water zone and upland areas). As previously stated, the operating requirements allow for the collection of driftwood from October 1 to April 30, but prohibit the gathering of wood from standing or fall trees, dead or alive, native or exotic.

MANAGEMENT OBJECTIVES FOR VEGETATION

As stated in Chapter 1, the management objective for vegetation as it relates to management of recreational river use in the Grand Canyon, is to manage river recreational activities to minimize human-caused impacts to native vegetation, reduce the spread of exotic plant species, and preserve fundamental biological and physical processes.

METHODOLOGY FOR ANALYZING EFFECTS TO VEGETATION RESOURCES

The general process for assessing impacts is discussed in the "Introduction" to Chapter 4. To analyze the effect of each alternative on vegetation resources, staff compiled all available information on the vegetation in the river corridor and side canyons (NPS, GCMRC, Hualapai Tribe resource files and personal communication with resource specialists) and used the best

available data for species locations, past documentation and studies of impacts, and the most recent research for species in the park. A map with locations of known cultural and natural resources and visitor stopping points (camp, lunch stops, and attraction sites), including data on use intensity, resulted in the identification of areas of resource concern, in which concentrations of sensitive resources overlapped with visitor use areas. The impact analysis was based on the interaction of context, duration, timing, and intensity of visitor impacts, which were defined using resource-specific impact thresholds.

Impact Thresholds

The general process for assessing impacts to the environment is discussed in the "Introduction" to Chapter 4. Effects specific to vegetation are characterized for each alternative based on the impact thresholds presented below. Additionally, each alternative was evaluated to determine whether effects would be direct or indirect. For intensity, the impacts to vegetation could be negligible, minor, moderate, or major, and they could be beneficial or adverse. Context, duration, and timing are resource based and are generally similar for each alternative. Impact intensity is more likely to vary by alternative. Impacts were measured against pre-established thresholds to determine the impact intensity.

Intensity

Negligible — Impacts to individual plants or plant communities would have no measurable or perceptible effect on size, viability, integrity, interrelationships, or function of the plant community. There would be no increase in or introduction of exotic plant species. No mitigation would be necessary.

Minor — Impacts to individual plants or plant communities would be measurable or perceptible but would not affect the size, viability, integrity, interrelationships, or function of the plant community. There could be slight and barely perceptible changes in number, density, or cover of exotic plants. Any mitigation necessary to offset adverse impacts would be minimal and effective.

Moderate — Impacts to plant communities would be measurable and perceptible and would affect the overall size, viability, integrity, interrelationships, or function of the plant community. There would be apparent and measurable changes in number, density, or cover of exotic plants. Mitigation to offset adverse impacts would be extensive, but most likely successful. The impacted area would require more than one year for recovery.

Major — Impacts to plant communities would be substantial, highly noticeable, and have the potential of becoming permanent. They would affect the overall size, viability, integrity, interrelationships and/or function of the plant community. Exotic plants would outnumber native plants. Mitigation to offset adverse impacts would be extensive, and success would not be guaranteed.

Context

Localized — Impacts would be considered localized if they occurred only in areas where people congregate (campsites, attraction sites) and affected individual plants or small patches within plant communities.

Regional — Impacts could be considered regional if they were spread along the entire reach of a resource management zone and into the adjacent vegetation zones (new and old high-water zones, and uplands). Regional impacts would affect the entire range of the population or species within Grand Canyon National Park, the mainstem of the Colorado River, or all side canyons along the river.

Duration

Short term — Impacts to an individual plant or community would last less than one year.

Long term — Impacts to an individual plant or community would last more than one year or result in permanent change.

Timing

Impacts to vegetation could occur year-round, but the plants are most sensitive from spring into summer, when there is the most germination and emergence.

The analysis area includes the Colorado River corridor from Lees Ferry through Grand Canyon National Park and adjacent tribal lands to Lake Mead. The analysis area includes areas commonly visited by river runners hiking off the river. Except for the cumulative impact analysis or as specifically stated in the text, the analysis area does not include areas upstream from Lees Ferry (including Glen Canyon Dam), Lees Ferry itself (which is part of Glen Canyon National Recreation Area), or areas in Lake Mead National Recreation Area (including Pearce Ferry and South Cove).

Mitigation of Effects

Common to all alternatives is the development of a monitoring and implementation plan as part of an adaptive management program to monitor and evaluate resources and identify mitigation actions. Within the plan, indicators of the limits of acceptable change (as defined in the 1989 *Colorado River Management Plan)* will be revised in accordance with the revised river management plan evaluated in this environmental impact statement. In addition to the other general mitigation measures described in the “Introduction” that would help protect and restore vegetation resources, current reasonable mitigations for impacts to vegetation include the following:

- Increase education efforts to teach park visitors to avoid impacts to vegetation, and increase enforcement efforts to improve compliance with regulations.
- Provide a map of small, medium, and large campsites to river runners and require parties of 12 or less to use small campsites, 13–24 to use medium campsites, and 24 or more to use large campsites.
- Implement a site-specific multi-resource monitoring program (i.e., one that takes into account soils, water quality, vegetation, wildlife, and archeological resources) to identify at-risk areas and to prioritize mitigation efforts; compare indicator species abundance, richness, and diversity in and near camping and attraction sites with areas seldom visited by recreationists.

- Identify protocols for hardening, resting, or rehabilitating campsites or attraction sites and link them to the systematic monitoring program.
- Delineate and stabilize campsites and trails, harden selected sites, and clear native and nonnative vegetation to create campsites in the new high-water zone.
- Maintain or construct trails in desirable areas (i.e., where they mitigate impacts or protect sensitive areas), move or obliterate trails in undesirable areas (e.g., social trailing, or trails over cultural / sensitive sites), and initiate closures when necessary.
- Build and/or maintain erosion control structures as needed to protect sensitive resources and stabilize soils. Recontour ground surfaces to promote drainage to appropriate areas.
- Actively revegetate impacted areas, restore biological and physical components, and accelerate the recovery of the biological community's structure and function.
- Conduct additional research into restoration methods and techniques for desert environments.
- Remove invasive exotic plant species and monitor removal efforts.

Cumulative Impacts

Cumulative impacts on vegetation were determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future action, as described in the "Introduction" to Chapter 4. The most significant action that has affected, and will continue to affect, vegetation resources in the river corridor is the operation of Glen Canyon Dam. Flows in the mainstem of the Colorado River directly affect the health, vigor, and composition of plant communities along the river corridor, and indirectly in side canyons. However, the increased distribution of invasive exotic plant species in the river corridor provides an ample seed source for their continued spread throughout the corridor, and it also paves the way for colonization of side canyons. Similarly, the presence of exotic plant species upstream from Lees Ferry, including on private and non-NPS administered lands, provides a seed source for the spread of exotic plant species in the park. The Glen Canyon Dam and the spread of exotic plant species have localized to regional, adverse, long-term, year-round, moderate to major effects on vegetation.

Researchers documented vegetation impacts from feral burros as early as 1974, noting vegetation destruction and decreases in species diversity. These impacts, along with impacts to soils, remain visible on the landscape today with very little vegetation recovery (Leslie, per. comm. 2004). Past feral burro impacts on vegetation have been localized, adverse, long term, year-round, and moderate to major.

Backcountry hikers and anglers, as well as feral burros, have created trails and have added to the loss of vegetation in upland and old high-water zone areas. The intentional or unintentional spread of exotic plant species by humans in areas outside the area of effect contributes to the current levels of impacts. This can have localized, adverse, short- to long-term, year-round, minor to major effects on vegetation.

Natural events, such as floods in side canyons and rockfalls, denude vegetation, which can add to the loss of diverse and intact native vegetation and contribute to the spread of invasive, exotic

plant species. Cumulatively, impacts to vegetation would be adverse, localized to regional, short to long term, and minor to major.

Assumptions

General assumptions used to analyze the impacts of each alternative are discussed in the "Introduction" to Chapter 4. Assumptions that specifically relate to the alternatives in this document and their effect on vegetation are presented below:

- The geographic area evaluated for vegetation impacts includes the river corridor from Lees Ferry to Lake Mead, the three vegetation zones (new and old high-water zones and the upland zone) at campsites, and areas accessible to river users for a distance of 2 miles from the river corridor, including off-river attraction sites, side canyons, and uplands.
- As there are no data to empirically support or refute the position that commercial trips cause less resource damage than noncommercial trips, the assumption is made that all individuals could equally adversely affect or benefit vegetation resources.
- The mode of travel (i.e., motor vs. oar) has no direct impact on vegetation; however, on a daily basis motor trips spend less time on the river and have more time at campsites, which will be evaluated through user discretionary time.
- Longer trips have, by their nature, increased amounts of time (i.e., user discretionary time) for visitors to interact with the canyon environment. This increased time has the potential to allow greater access to sensitive vegetation resources. This is particularly true for side canyons, as longer trips are designed to allow visitors opportunities to hike the many side canyons of the Colorado River. Off-season hiking (in the shoulder and winter months) is more conducive to exploring side canyons, as the extreme heat of the summer precludes hiking too far from the Colorado River.
- Not all visitor impacts to vegetation resources in and accessible to the river corridor are from river runners; other backcountry users contribute to impacts in areas that offer reasonable access. While the effect from river runners to sites in these areas would be additive, it would be indistinguishable from damage caused by visitors using other means of access.
- Mitigation measures to achieve ecological restoration in some areas, particularly the old high-water zone and uplands, might not be attainable, and the goal of the mitigation measures may be to simply disguise the impacts or to revegetate areas, possibly not achieving the true restoration of the biological and physical properties present prior to impact.
- Wetlands and dense thickets or riparian vegetation in the Colorado River corridor are rarely visited or disturbed by river runners. Recreation impacts on these types of vegetation would be negligible because they would have no measurable effect on the plant community and would not contribute to the expansion of exotic species. Wetlands in the corridor would more likely be impacted by fluctuating river levels than river runners because their dense vegetation and muddy soils make the areas unattractive to visitors. Wetlands and riparian areas in side canyons, however, show signs of impacts from recreationists.

- Water quality contamination is most common in side canyons and along the river where personal care products and human waste are disposed of in the water. While changes in the water quality of the tributaries could adversely affect vegetation along the streams, there is no quantitative data to support this conclusion, and the overall impact to vegetation is thought to be inconsequential.

IMPACT ANALYSIS — LEES FERRY ALTERNATIVES

The potential for impacts for the eight Lees Ferry alternatives are based on a comparison to Alternative A, which describes the impacts of existing conditions.

Alternative A (Current Conditions)

Analysis. Under Alternative A large group sizes (43 for commercial motor, 39 commercial oar), lengthy trips, and spikes in the number of trips and people at one time, and daily launches would continue (see Table 4-1). User-days would remain capped at current levels, which would probably result in approximately the same number of total yearly passengers. Similarly, user discretionary time would remain relatively stable, with the greatest number of hours in the summer season (294,506). Winter use would remain very low with only 6,855 hours of user discretionary time, and spring and fall levels would remain at 24,177 hours and 29,544 hours, respectively.

The 1989 *Colorado River Management Plan* defined limits of acceptable change as standards that indicate the change in resource conditions that would instigate action. The limits of acceptable change for vegetation analysis are:

- *New high-water zone* — There should be no long-term modification of plant community development as a result of recreational use in areas outside campsites and trails; no more than one primary trail from a mooring location to a destination site; no more than 10% encroachment of the camping area into vegetation as a result of visitor related uses.
- *Old high-water zone* — There should be no disturbance exceeding 225 square feet at any site; no loss of trees due to human activity; no destruction of dead, standing vegetation; no less than a 20% decline in mature age classes between high activity areas and control sites; and no campsites.
- *Upland / Desert Scrub* — There should be no disturbance exceeding 225 square feet at any site; no long-term modification of natural succession; no more than one trail to an attraction site; and no campsites.

Grand Canyon National Park's "Commercial Operating Requirements" (NPS 2003g) set forth the following guidelines to protect vegetation resources:

- River guides should stress the need to stay on established trails.
- Removal of wood from standing or fallen trees, dead or alive, is prohibited.
- Passengers should be instructed not to blaze new hiking routes or sleeping areas in fragile desert zones (old high-water zone and upland areas).

- Camp activities should be conducted in the more resistant post-dam sandbar areas (new high-water zone).
- Special use requirements for the Nankoweap area were designed to minimize multiple trailing, crowding, and campsite competition.

Despite the above regulations, current enforcement levels, visitor education, and mitigation measures, impacts to vegetation under current conditions exceed the limits of acceptable change and have lead to damaged vegetation. This damage can also impact soils, wildlife, and cultural resources since these resources are interconnected.

The Colorado River Human Impact Monitoring Program provides managers with baseline data with which to make informed management decisions (Brown and Jalbert 2003). The data provide a view of resource conditions under current use levels and can be used to describe current levels of vegetation impacts. The monitoring program, based on the limits of acceptable change, uses quantifiable biophysical indicators to document resource conditions and changes at sites along the Colorado River through the Grand Canyon.

Although there are 47 total sites in the monitoring program, site inventory occurs on an annual rotating basis. Data on 25 sites collected in July and October 2003 provide the most current data set. Under current conditions 96% of the 25 campsites monitored had more than 10 social trails per campsite (see Table 4-4 on page 238); one campsite had 88 social trails. The 1989 *Colorado River Management Plan* set a limit of one trail from mooring, through the campsite, and into the old high-water zone.

The study also demonstrated a relationship between beach size and vegetation impacts; as beach size decreases, impacts to soils and vegetation in the old high-water zone increase. The campsite in the study with the fewest social trails (RM 118 camp) had a beach area that could accommodate large trip sizes, but even that site had nine social trails under current use levels. At this time, the monitoring program does not provide quantitative data on the amount of ground area that has been disturbed solely by the social trails; however, the creation of social trails causes direct trampling of vegetation, most often resulting in complete loss of plant life, and indirect impacts to vegetation from soil compaction and disturbance.

Under current conditions, the Grand Canyon National Park Science Center has data on mitigation efforts in the river corridor that conservatively show that social trail need to be obliterated at 60% of the 148 sites that have been part of the mitigation program over the past two decades. The impacts are severe enough to require native plant revegetation at 46% of the sites, and just blocking access to the trail is insufficient to begin the process of natural recovery.

Despite NPS efforts to obliterate and revegetate unnecessary trails over the past two decades, efforts have been minimally successful. Current mitigation measures for soils and vegetation combined have not accomplished the ultimate goal of restoration; rather they have served as short-term efforts to prevent further damage to resources pending the start of long-term natural recovery. The limited success of the treatments is partially due to lack of funding and resources, but also indicates that current use levels exceed the ability of NPS staff to mitigate the impacts.

Recreation-caused impacts to vegetation in both the new and old high-water zones has been documented (Brown and Jalbert 2003). While the upland, wetland, and seep / spring areas are not specifically included in the current program, these areas (particularly those near attraction sites) display damage under current use levels. Of 25 campsites studied in 2003, only 8% did not have trails entering the old high-water zone, and 75% had more than one trail into the old high-water zone. Under current conditions, 38% of the overall sites surveyed in the program (47 total sites) had more than 225 square feet of disturbance, exceeding the limit of acceptable change standard set in the 1989 *Colorado River Management Plan*.

During evaluations of Hualapai traditional cultural properties, heavy to severe human impacts were found (HDCR 2002; Jackson et al. 2001). One example is Granite Park, where evaluators noted that trails into the old high-water zone that had been obliterated by park staff were still being heavily used, with the brush and revegetation being bypassed and ignored. Researchers noted that there was still heavy on-site camping in the old high-water zone in some areas, leading to further clearing of and damage to vegetation (HDCR 2002). Of the 18 traditional cultural properties between Lees Ferry and Diamond Creek, only two did not have any human impacts.

Based on the 25 sites surveyed in 2003, 63% had campsites in the old high-water zone, with a maximum of 16 campsites (Brown and Jalbert, 2003). There is a correlation between the number of vegetation islands and the number of campsites and social trails. Researchers documented as many as 53 vegetation islands at one site, with 96% of the 25 sites having vegetation islands (Brown and Jalbert 2003). While the vegetation in the islands may be intact, the surrounding perimeters of the islands are devoid of vegetation, contributing to the overall loss of vegetation at campsites in the river corridor. Current Colorado River boating regulations prohibit camping activities in the old high-water zone (NPS 2003g), yet impacts in the old high-water zone from camping activities are widespread under current use levels.

Some of the indicators measured by Brown and Jalbert (2003) define site quality, but present marginal value regarding the ecological integrity of the site. For example, the monitoring program records damage to tamarisk (occurring at 100% of the sites with tamarisk presence), which may create an aesthetic impact, but would not adversely affect the health and vigor of native vegetation. Of the 25 sites surveyed in 2003, all had damage to native woody vegetation in the new high-water zone, and 65% of the sites had more than 50 individual fractures. In the old high-water zone, 52% had damage to native woody vegetation (mesquite and acacia), with a maximum of 147 fractures. Under current management, these impacts are primarily restricted to campsites and along trails, contributing to vegetation damage, but overall they present more of a quality or aesthetic impact rather than a larger scale ecological impact. Nevertheless, woody vegetation in the old high-water zone is a non-renewing resource in the short term, and possibly the long term, and damage to trees could lead to declines in long-term health and vigor. In addition to woody vegetation damage, 35% of the sites with cactus displayed human-caused damage from campsite expansion and social trailing.

Exotic vegetation is present at 52% of the 25 sites surveyed in 2003 (Brown and Jalbert 2003). This percentage is likely very low because observers only looked for camelthorn, Bermuda grass, and Russian thistle, the species that are easiest to identify. There are currently 120 known exotic plant species in the inner canyon, and with more extensive documentation, the number of sites with exotic plants present would very likely increase. Some of these species (e.g., red brome and

Bermuda grass) have been present in the Colorado River corridor and at campsites for decades, with human impacts in addition to dam-related impacts aiding in their spread (Tomko and Karpiscak 1974). Under current conditions people unintentionally distribute seeds from one location to another, exacerbating the spread of these species. Recreationists also manually remove certain species (e.g., camelthorn), typically to improve campsite quality, but often they exacerbate the problem since pulling this species stimulates the growth buds and spreads seeds. In addition, the removal of both native and exotic plants, whether intentional or not, provides an opportunity for exotic and invasive plant species to move into the vacated seedbed without competition.

Driftwood supplies are currently limited in certain portions of the river corridor. At some campsites, despite current regulations prohibiting these actions, woody material from standing vegetation, both native and exotic, is collected for firewood. In 2003, 59% of the campsites with firewood piles had locally collected vegetation in them, despite the current prohibition on collecting any non-driftwood material (Brown and Jalbert 2003).

Mitigation of Effects. Actions required to mitigate effects would include all of the mitigation measures defined on page 415. To attempt to reduce impacts to minor levels, the following measures would be required:

- an increase in the number of NPS staff to educate users about vegetation impacts
- an increase in NPS patrols at campsites to ensure that river runners do not camp in the old high-water zone or otherwise damage vegetation
- an increase in full-time science center and trail maintenance staff to revegetate barren areas, block undesirable social trails, and initiate restoration actions.

These measures would be reasonable and attainable in the new high-water zone, but they would require additional funding and staff. It is unlikely that mitigation would be implemented at a level sufficient to reduce impacts in the old high-water zone to a minor level due to the spikes in use, high user discretionary time levels, long trip lengths, and large group sizes.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative A on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Under Alternative A adverse impacts to vegetation in the new high-water zone would be perceptible and measurable at the majority of campsites and attractions. Impacts would occur year-round, with the most extensive impacts during the summer due to the high-use levels. Current levels of mitigation have been shown to be insufficient to reduce the impacts. Overall, impacts would be considered adverse, localized, short term, seasonal to year-round, and minor to moderate in intensity.

In the old high-water zone, including uplands and side canyons, vegetation impacts are often long term. Direct and indirect impacts occur year-round, but are specific to campsites, attractions, and trails leading into side canyons. Although year-round impacts are perceptible, the majority of user discretionary time under present levels of use is spent in the late spring and summer, when plants are most susceptible to damage. Long trips under this alternative would increase the level of accessibility to attraction sites and side canyons. Vegetation trampling, injury, and loss, combined with the spread of exotic plant species and indirect impacts, have changed the character and health of vegetation. Damage to woody vegetation, the number of social trails, and the number of campsites all exceed levels prescribed in the 1989 *Colorado River Management Plan.* Given the steady reduction in the number and size of beaches, the large group sizes in this alternative would pose the greatest threat to vegetation resources in the old high-water zone, where visitors camp when beach areas are limited. Current levels of mitigation are insufficient to repair these impacts, and even with additional mitigation, the damage is considered long-term and may be irreversible in some areas. Therefore, vegetation impacts in the old high-water zone would be considered adverse, localized, long term, year-round, and moderate to major in intensity.

Under current conditions, NPS mitigation measures create beneficial, localized, short-term effects; however, these measures are incapable of mitigating the current levels of adverse impacts in order to reduce the impact intensity to negligible levels in the new high-water zone, the old high-water zone, or upland areas.

In summary, the overall impacts to vegetation under Alternative A would be adverse, localized, seasonal to year-round, short to long term, and minor to major in intensity. Alternative A would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative A on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative B

Analysis. Under Alternative B recreational motor trips would be prohibited and group sizes, trips and people at one time, daily launches, user-days, and probable total yearly passengers would be at their lowest levels (see Table 4-1). Trip lengths would be reduced, and maximum commercial group sizes would be reduced from 43 to 25 people. An eight-person noncommercial trip would be added. Total user discretionary time would increase in all seasons due to the lack of shorter motor trips. Total user-days would be about the same as current; however, the total number of passengers per year would decrease by about 10,000.

Under this alternative launches per day would be capped at four during the summer, two during the shoulder seasons, and one in the winter. This would reduce crowding at attraction sites and the likelihood of new social trails being developed. Total user-days and yearly passengers would be at their lowest under this alternative, resulting in the lowest level of potential impacts to vegetation from visitor use impacts and the spread of invasive exotic species. In addition, smaller groups would likely benefit the preservation, protection, and restoration of vegetation resources

in all three vegetation zones. Small private trips with a group size of eight could use small beaches, and the reduction from maximum group size from 43 to 25 would decrease the likelihood of impacts from social trailing and campsite expansion in the old high-water zone and upland areas. Together these actions have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions.

Management actions aimed at keeping use levels on individual campsites low would likely be beneficial to the resources (Cole 1986). However, under Alternative B use levels would be higher in the spring, when vegetation resources are most susceptible to impacts. Under this alternative, shorter trips would require that trips move through the canyon faster, with less time for layover days and hikes in side canyons and to attraction sites. Overall user discretionary time would increase due to the absence of short motor trips, resulting in an increase in the opportunity for recreationists to damage vegetation resources as discussed in Alternative A. However, when balanced with the reductions in the maximum number of trips and people at one time, total yearly passengers, launches, and user-days, vegetation impacts would likely be reduced, and Alternative B would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions.

Mitigation of Effects. Mitigation measures would be the same as Alternative A. These measures would require additional funding and staff, and it is unlikely they would be implemented at a level sufficient to reduce impacts to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the plant community.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative B on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative B a beneficial change from current conditions would be expected in all three vegetation zones —the new high-water zone, the old high-water zone, and upland areas. Vegetative conditions in the river corridor and side canyons could improve, but they would not return to pre-use conditions. Smaller groups, fewer launches, shorter trips, and reduced numbers of trips and people at one time would all be beneficial for the protection of vegetation resources. While use would still be highest in the summer, use in the shoulder and winter seasons would increase; nevertheless, coupled with the other reductions, vegetation conditions would likely improve. Direct and indirect adverse impacts to vegetation would remain. Mitigation would still be required, with increases in staff and funding necessary to implement the measures. Even with these increases, it is unlikely that mitigation measures would be able to reduce the adverse impacts from recreational use to negligible levels in any of the vegetation zones.

In summary, Alternative B would have beneficial, localized, short- to long-term, seasonal to year-round, minor to moderate effects compared to current conditions. However, this alternative would still have adverse, localized, short- to long-term, seasonal to year-round, minor to moderate impacts to vegetation resources. Alternative B would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative B on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative C

Analysis. Under Alternative C motor boats would be eliminated, but total annual user discretionary time would more than double to 752,496 hours, the highest level of all alternatives. Winter user discretionary time would increase from 6,855 hours currently to 223,891 hours. User discretionary time in early spring would increase fourfold to 118,296 total hours. Maximum group size would be reduced to 30 people and maximum trip length to 21 days. User-day levels would double in the shoulder seasons. Daily launches would be reduced to four in the summer, three in the shoulder seasons, but would increase to two in the winter months. There would be approximately 3,000 more passengers per year, but group sizes and the maximum number of trips and people at one time would decrease.

Smaller groups and shorter trips would benefit vegetation in all three zones, similar to Alternative B. This would decrease the potential for trampling, social trailing, and campsite expansion, thereby resulting in less damage to vegetation in all three vegetation zones, including riparian areas in side canyons and near attraction sites. Reducing group sizes and trip lengths would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions. However, user-day levels would double in the shoulder seasons, including spring when plants are most susceptible to damage. The annual increase in user-days and total passengers would result in more use of the limited number of campsites, with direct and indirect impacts to vegetation resources. The increase in total passengers per year would also increase the likelihood of exotic plant species being spread, the use of wood for campfires that was not driftwood (in violation of the park's current boating requirements), and the potential for damage to vegetation. Increased use in critical months would have localized, adverse, short- to long-term, seasonal, moderate impacts to vegetation.

This alternative would double annual user discretionary time, the highest of any alternative. As a result, there would be a greater potential for direct and indirect adverse impacts to vegetation, particularly in the old high-water zone and upland areas, as a result of social trail creation and general exploration of side canyons and attraction sites. The increase in user discretionary time would have localized, adverse, year-round, short- to long-term, minor to moderate effects from current conditions. The large increase in winter user discretionary time would likely result in the depletion of driftwood supplies during that season. As previously discussed, as driftwood supplies diminish, campers use standing or fallen trees near campsites, although this is prohibited in the "Commercial Operating Requirements"; these impacts would likely increase and have localized, adverse, short-term, seasonal, minor impacts.

Mitigation of Effects. Mitigation measures would be the same as Alternative A. One additional measure to mitigate impacts to vegetation would be to further reduce the season in which fires are permitted. These measures might be beyond a level that would be reasonable and attainable and could not be implemented at a level sufficient to reduce impact to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the plant community.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative C on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative C would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Similar to Alternative B, vegetation conditions in the new high-water zone, old high-water zone and uplands areas in the river corridor and side canyons could improve, but none would return to pre-use conditions. Smaller group sizes, shorter trips, and reductions in trips and people at one time would be beneficial for short- and long-term protection and restoration of vegetation resources. However, use levels would increase in the spring, leading to additional vegetation damage during the most susceptible season and also when mitigation measures are usually implemented. The increase in total numbers of users and user discretionary time would have direct and indirect, adverse, short- and long-term effects on vegetation. Mitigation would be required, with large increases in staff and funding necessary to implement the measures. Even with these increases, mitigation measures would be unable to reduce the adverse impacts from recreational use to negligible or minor levels in the river vegetation zones.

In summary, this alternative would overall have adverse, localized, short- to long-term, year-round, moderate effects on vegetation resources. The beneficial aspects of this alternative would be offset by the tremendous increase in user discretionary time and total number of users. Alternative C would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative C on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative C would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative D

Analysis. Alternative D is a mixed-use alternative, with two periods of no-motor use — March and April and September and October. Commercial group sizes would decrease to a maximum of 25, while noncommercial groups would remain at 16. The maximum trip length would be 30 days, and trip lengths would be reduced from current levels in the summer and shoulder seasons. An eight-person noncommercial trip would be added. Total annual user-days would increase to

183,555 (see Table 4-1). This alternative would have the second highest total user discretionary time (710,079 hours), double the present level (355,081 hours). There would be a substantial increase in user discretionary time in early and late spring, as well as winter. The maximum number of trips and people at one time, as well as total passengers, would be reduced from current levels. Commercial motor and oar trips would be allowed in the winter.

Similar to Alternatives B and C, the reduction in group sizes and trip lengths would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions in all three river corridor zones by decreasing the potential for trampling, social trailing, and campsite expansion. Potential damage to vegetation would be reduced in all three vegetation zones, including riparian areas in side canyons and near attraction sites. Shorter trips in the shoulder seasons, especially in spring, would benefit vegetation during the critical reproductive months by reducing layover days and opportunities for hiking into the old high-water zone and side canyons. However, there would be an overall increase in spring user discretionary time, reducing some of the beneficial effects from shorter trips. Longer trips would continue in some seasons, with increased layovers and hiking opportunities and associated damage to vegetation. Allowing five launches per day in the summer, three in the shoulder seasons, and one in the winter would result in more launches per day than under Alternative B, but crowding and subsequent impacts at attraction sites would still be reduced. The increase in total annual user-days would result in more use of the limited number of campsites, with more overall direct and indirect, localized, adverse, short- to long-term, year-round, minor to moderate impacts to vegetation. The reduction in total passengers per year would decrease the likelihood of the spread of exotic plant species, the use of wood for campfires that was not driftwood, and the potential for damage to vegetation, having localized, beneficial, short-term, seasonal, minor effects.

This alternative would have the second highest total user discretionary time, increasing the potential for direct and indirect impacts to vegetation, particularly in the old high-water zone and upland areas, through social trail creation and general exploration of side canyons and attraction sites. The increase in winter use, although only half that of Alternative C, would likely result in the depletion of driftwood supplies during that season. As described in the "Issues," as driftwood supplies diminish, the use of standing or fallen trees near campsites, although prohibited, would likely increase. Together these actions would have localized, adverse, short- to long-term, seasonal to year-round, minor to moderate effects.

Mitigation of Effects. Mitigation measures would be the same as Alternative B. These measures would require additional funding and staff, and it is unlikely they would be implemented at a level sufficient to reduce impact to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the communities.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative D on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to

long-term, seasonal to year-round, and minor to major. Alternative D would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Similar to Alternatives B and C, vegetation conditions in the new high-water zone, old high-water zone, and uplands areas of the river corridor and side canyons might improve, but no areas would return to pre-use conditions. Smaller groups, shorter trips, and reduced numbers of trips and people at one time would be beneficial for short- and long-term protection and restoration of vegetation resources. However, increased user discretionary time levels in the spring would likely result in additional vegetation damage during the most susceptible season and also when mitigation measures are usually implemented. While the reduction in total passengers each year would have direct and indirect, beneficial, short- and long-term effects on vegetation, these impacts which would be offset by adverse, short- and long-term, minor to moderate impacts from increases in total user discretionary time. Mitigation would be required, with large increases in staff and funding necessary to implement the measures. Even with these increases, mitigation measures would be unable to reduce the adverse impacts from recreational use to negligible levels in the new high-water zone, old high-water zone, or upland areas.

Overall, this alternative would have adverse, localized, short- to long-term, year-round, minor to moderate effects on vegetation resources. The beneficial aspects of this alternative would be offset by the tremendous increase in user discretionary time. Alternative D would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative D on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative D would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative E

Analysis. Alternative E is also a mixed-use alternative, equal motor and no-motor seasons (October through March). Maximum commercial group sizes would be reduced to 30 people for motor trips and 25 for oar trips. An eight-person noncommercial trip would be added. Maximum trip lengths in all seasons would be reduced from current levels, as would the maximum number of trips and people at one time. Total annual user-days increase by approximately 60,000. The total number of yearly passengers would be slightly higher than now. The maximum number of launches per day would be reduced, with six launches in the summer, three in the shoulder seasons, and two in winter. Overall user discretionary time would increase by an additional 220,000 hours. However, rises in spring user discretionary time hours would be more moderate (from 24,177 hours to 69,836) than in the previous two alternatives, as would the increase in summer and winter user discretionary time.

Similar to the previous three alternatives, smaller groups and shorter trips would benefit vegetation in all three river corridor zones. These reductions would decrease the potential for trampling, social trailing, and campsite expansion and resulting damage to vegetation in all three vegetation zones, including riparian areas in side canyons and near attraction sites. Shorter trips in the shoulder seasons, particularly in spring, would benefit vegetation during the critical

reproductive months by reducing layover days and opportunities for hiking into the old high-water zone and side canyons. These actions would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions. However, there would be an overall, but more moderate, increase in spring user discretionary time, reducing some of the beneficial effects associated with shorter trips. The launch pattern would allow for a greater number of launches per day than Alternative B, but would still reduce crowding and subsequent impacts at attraction sites from current levels, having localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects. The increase in total annual user-days would result in more use of the limited number of campsites, increasing overall direct and indirect impacts on vegetation. The increase in total passengers per year would increase the likelihood of the spread of exotic plant species, the likelihood that recreationists would use wood for campfires that was not driftwood, and the potential for damage to vegetation.

The overall increase in user discretionary time would raise the potential for direct and indirect adverse impacts to vegetation resources (as discussed in Alternative A), particularly in the old high-water zone and upland areas, through social trail creation and general exploration of side canyons and attraction sites. The increase in winter use could likely result in the depletion of driftwood supplies during that season. As described in the "Issues" section, as driftwood supplies diminish, campers tend to use standing or fallen trees near campsites. Together these actions would have localized, adverse, short- to long-term, seasonal to year-round, minor to moderate effects.

Mitigation of Effects. Mitigation measures would be the same as Alternative B. These measures would require additional funding and staff, and it is unlikely they would be implemented at a level sufficient to reduce impact to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the communities.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative E on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Similar to Alternatives B, C, and D, vegetation conditions in zones along the river corridor and in side canyons might improve, but none would return to pre-use conditions. Smaller groups, shorter trips, and fewer trips and people at one time would be beneficial for the short- and long-term protection and restoration of vegetation resources. However, more user discretionary time in the spring would likely result in additional vegetation damage during the most susceptible season and also when mitigation measures are usually implemented. The annual increase in total passengers and total user discretionary time would have direct and indirect, adverse, short- and long-term, moderate effects on vegetation. Mitigation would be required,

with large increases in staff and funding necessary to implement the measures. Even with these increases, mitigation measures would be unable to reduce the adverse impacts from recreational use to negligible or minor levels in the new high-water zone, old high-water zone, or upland areas.

In summary, this alternative overall would have adverse, localized, short- to long-term, year-round, minor to moderate effects on vegetation resources. Alternative E would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative E on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative F

Analysis. Alternative F would also have equal motor and no-motor seasons, with no motors allowed from July through December. Maximum trip sizes would be decreased to 30 people, and trip lengths would be reduced in all seasons. The maximum number of trips at one time would drop from 70 to 54, and the maximum number of people at one time would drop from 1,095 to 972. Six launches per day would be allowed in the summer, four in the shoulder seasons, and two in the winter. An eight-person noncommercial trip would be added. Total annual user discretionary time would increase to 518,889 hours, the second lowest for the action alternatives. Early spring user discretionary time would increase substantially, but late spring and summer time would actually decrease. Total yearly passengers would increase by about 3,000.

The effects of this alternative would be similar to those described in Alternative E in terms of smaller groups, shorter trips, and fewer launches per day, as well as increased user-days and total user discretionary time. An increase in spring user discretionary time would raise the probability of vegetation impacts during the critical time for plant reproduction, having localized, adverse, short- to long-term, seasonal, moderate effects from current conditions.

Mitigation of Effects. Mitigation measures would be the same as Alternative B. These measures would require additional funding and staff, and it is unlikely they would be implemented at a level sufficient to reduce impact to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the communities.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in “Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts.” The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative F on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Similar to the previous alternatives, vegetation conditions in the new high-water zone, old high-water zone and uplands areas in the river corridor and side canyons might improve, but none would return to pre-use conditions. Smaller groups, shorter trips, fewer trips and people at one time would be beneficial for short- and long-term protection and restoration of vegetation resources. However, increased user discretionary time levels in the early spring would likely lead to additional vegetation damage during the most susceptible season and also when mitigation measures are usually implemented. More annual total passengers and total user discretionary time would have a direct and indirect, adverse, short- and long-term, moderate effect on vegetation resources; however, total annual user discretionary time hours would be the second lowest for the new alternatives. Mitigation would be required, with large increases in staff and funding necessary to implement the measures. Even with these increases, mitigation measures would be unable to reduce the adverse impacts from recreational use to negligible or minor levels in the new high-water zone, old high-water zone, or upland areas.

In summary, this alternative overall would have adverse, localized, short- to long-term, year-round, minor to moderate effects on vegetation resources. Alternative F would not result in impairment of the vegetation resources of the Grand Canyon National Park. Cumulative effects of Alternative F on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative G

Analysis. Alternative G would allow an eight-month motor season and a four-month no-motor season (September to December). The maximum group size for commercial motor trips would be 40 people, similar to current conditions. Commercial oar trips would have a maximum of 30 people. Maximum trip lengths would be reduced from the current level in all seasons. Six launches per day would be allowed in the summer, five in the shoulder months (the highest of any alternative other than A), and two in the winter. Total annual user-days would increase by about 78,000, with a slight decrease during the summer, doubling in the spring and a tenfold increase in the winter. The maximum number of trips at one time would decrease substantially, with a modest reduction in people at one time from current levels. User discretionary time would be the second lowest of all alternatives, with an increase of only about 66,000 hours from current levels. Late spring and summer user discretionary time would decrease by about 64,500 hours to 229,958. Early spring user discretionary time would have a modest increase to 49,416 hours. Total annual passengers would increase by 6,000.

Adverse effects on vegetation due to large group sizes would be similar to those described in Alternative A, localized, adverse, short- to long-term, seasonal to year-round, and minor to major. They would occur in all three vegetation zones, with short-term impacts in the new high-water zone and long-term impacts in the old high-water zone and upland areas. With less user discretionary time there would be less time for recreationists to layover and hike to attraction sites and side canyons. Combined with the decreases in the maximum number of rips and people at one time, this would help reduce the adverse impacts to vegetation; however, impacts to vegetation at and around campsites would remain high. Only 25% of the campsites along the

river can accommodate group of 36 or larger. When large groups utilize the more abundant medium size beaches, impacts extend into the old high-water zone, creating direct and indirect, long-term, adverse impacts to vegetation. The increase in total annual user-days would also result in more use of the limited number of campsites, increasing the overall vegetation impacts. Reductions in trip lengths, particularly in spring, would have localized, beneficial, short- to long-term, seasonal, minor to moderate effect on vegetation during the critical reproductive months by reducing layover days and opportunities for hiking into the old high-water zone and side canyons. However, there would be an increase in early spring user discretionary time and launches, thereby reducing some of the beneficial effects of the shorter trips. More launches per day would be allowed than under Alternative B, but crowding and subsequent impacts at attraction sites would still be reduced compared to current levels. The increase in total passengers per year would increase the likelihood of the spread of exotic plant species, the likelihood that recreationists would use wood for campfires that was not driftwood, and the potential for damage to vegetation. Together these actions would have localized, adverse, short- to long-term, seasonal to year-round, minor to moderate effects.

Mitigation of Effects. Mitigation measures would be the same as Alternative B. These measures would require additional funding and staff, and it is unlikely they would be implemented at a level sufficient to reduce impact to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the communities.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative G on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative G adverse impacts to vegetation would be similar to Alternative A, with impacts to new high-water zone, old high-water zone and upland vegetation perceptible and measurable at the majority of campsites and attractions. Impacts in the new high-water zone would be localized, short term, and of minor to moderate intensity. In the old high-water zone and upland areas, large groups would lead to adverse, long-term, moderate to major impacts to vegetation. A comparatively low amount of user discretionary time, along with decreases in the maximum number of trips and people at one time, would decrease the potential for vegetation damage and loss, but the increase in spring user discretionary time would raise increase the overall potential for damage during the critical reproductive time for many plants. The increase in total passengers and total user discretionary time each year would have direct and indirect, adverse, short- and long-term, moderate to major effects on vegetation resources, even though total annual user discretionary time hours would be the lowest for the new alternatives. Mitigation would be required, with large increases in staff and funding necessary to implement the measures, but measures might not be able to reduce the adverse impacts from recreational use to negligible or minor levels in the new high-water zone, old high-water zone, or upland areas.

In summary, this alternative overall would have adverse, localized, short- to long-term, year-round, minor to major effects on vegetation resources. Alternative G would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative G on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative H (NPS Preferred Alternative)

Analysis. Under Alternative H would have equal motor and no-motor use seasons. Total annual user discretionary time would increase by about 200,000 hours to 554,103. Early spring user discretionary time would show a modest increase to 47,523 hours, but late spring and summer hours would increase from 294,506 hours to 402,037 hours, while the change in winter use would be intermediate. Trip sizes would decrease for commercial groups and would remain the same for noncommercial trips, with fewer trips and people at one time and fewer launches per day. Total yearly passengers and total user-days would increase over current levels. Trip length in all seasons would decrease.

Similar to previous alternatives, smaller groups and shorter trips would benefit vegetation in all three river corridor vegetation zones, with a decreased potential for trampling, social trailing, and campsite expansion. The potential for damage to vegetation in all three vegetation zones would be reduced, including riparian areas in side canyons and near attraction sites. Shorter trips in the shoulder seasons, particularly in spring, would benefit vegetation during the critical reproductive months by reducing layover days and opportunities for hiking into the old high-water zone and side canyons. These actions would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions. However, there would be an overall, but more moderate, increase in spring user discretionary time, reducing some of the beneficial effects of shorter trips. Fewer launches per day would be allowed than under Alternative A, which would reduce crowding and subsequent impacts at attraction sites from current levels. This would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects. The increase in total annual user-days and total passengers per year would result in more use of the limited number of campsites, increasing overall direct and indirect adverse impacts to vegetation, the likelihood of the spread of exotic plant species, the likelihood that recreationists would use wood for campfires that was not driftwood, and the potential for damage to vegetation. Together these actions would have localized, adverse, short- to long-term, seasonal to year-round, minor to moderate effects.

The increase in overall user discretionary time over current conditions would increase the potential for direct and indirect adverse impacts to vegetation, particularly in the old high-water zone and upland areas, as a result of social trail creation and general exploration of side canyons and attraction sites. A lower increase in user discretionary time during spring would benefit plants. Increased winter use could likely result in the depletion of driftwood supplies during that season, likely resulting in the use of standing or fallen trees near campsites for firewood, in violation of regulations.

Mitigation of Effects. Mitigation measures would be the same as Alternative B. These measures would require additional funding and staff, and it is unlikely they would be implemented at a level sufficient to reduce impact to a sustainable negligible intensity. Impacts to individual plants or plant communities would still have a measurable effect on the size, viability, integrity, interrelationships, or function of the communities.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative H on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under this alternative conditions in the new high-water zone, old high-water zone, and upland areas in the river corridor and side canyons might improve, but none would return to pre-use conditions. Smaller groups, shorter trips, and fewer trips and people at one time would be beneficial for the short- and long-term protection and restoration of vegetation resources. The increase in total passengers and total user discretionary time each year would have direct and indirect, adverse, short- and long-term, moderate effects on vegetation resources. Mitigation would be required, with large increases in staff and funding necessary to implement the measures. Even with these increases, mitigation measures would be unable to reduce the adverse impacts from recreational use to negligible levels in the new high-water zone, old high-water zone, or upland areas.

In summary, this alternative overall would have adverse, localized, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation resources. Alternative H would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative H on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

IMPACT ANALYSIS — LOWER GORGE ALTERNATIVES

Alternative 1 (Current Conditions)

Analysis. Alternative 1 represents the current diverse mix of recreational activities on the Colorado River from Diamond Creek to Lake Mead within the Grand Canyon. Uses include private and commercial trips, pontoon boat tours, and upriver takeouts. Current maximum group size for HRR day trips is 100, with an average launch of one per day of up to 10 boats at a time. Overnight trips average one launch per week, with a maximum group size of 34. The current number of 15 campsites would remain, and no new ones would be added. The two small floating docks at Quartermaster would also remain, with no additional docks proposed. For the pontoon

operations, a maximum of 188 passengers would continue to be allowed during the peak season and 160 during the off-season. Upriver travel would be unlimited below Separation Canyon (RM 239.5).

Recreational impacts to vegetation between Diamond Creek and Lake Mead are similar to those discussed under Alternative A for the Lees Ferry to Diamond Creek reach — localized, adverse, short to long term, seasonal to year-round, and minor to major. Vegetation trampling, injury, and loss, combined with the spread of exotic plant species and the indirect impacts discussed under "Issues," have changed the character and health of vegetation. The variables that would have the greatest potential to impact vegetation are group size, number of launches, and the number of total passengers for the various uses.

The vegetation data for the Lower Gorge are more limited than those for the Lees Ferry to Diamond Creek reach. The National Park Service currently does not implement actions to mitigate damage to the vegetation resources in this reach; however, under current use levels extensive impacts have been documented. At Bridge Canyon the human impacts are reported to be heavy, with modification of the campsite area (HDCR 2002). Traditional cultural property evaluators also noted increased trailing and moderate to heavy vegetation clearing and on-site camping in the upper portions of the site, heavily impacting vegetation, which is a traditional cultural property. Similarly at Spencer Canyon, evaluators observed moderate to heavy human impacts from trailing in the new high-water zone and old high-water zone areas, especially around a portable toilet (HDCR 2002). At Travertine Falls there were also moderate to heavy impacts from trailing along the spring and up to the ledge, and also on the upstream side of the spring and in front of the falls. They also noted broken and damaged vegetation along the trail. In 2002 the recommendation was to obliterate the social trails to protect resources.

Adverse effects on vegetation, similar to those described under Alternative A, would continue to occur in all three vegetation zones, with short-term impacts in the new high-water zone and long-term impacts in the old high-water zone and upland areas. Current campsites would not be able to accommodate large groups. When the number of people exceeded the capacity of a site, the impacts would extend into the old high-water zone, creating adverse, direct and indirect, long-term, moderate to major impacts to vegetation. Large numbers of passengers participating in day trips under this alternative (up to 100 people) would continue to have localized, adverse, short- to long-term, year-round, moderate to major effects on vegetation at attraction sites. The number of passengers would also increase the likelihood of the spread of exotic plant species, the likelihood that recreationists would use wood for campfires that was not driftwood, and the potential for damage to vegetation.

Mitigation of Effects. Actions required to mitigate effects would include all of the mitigation measures defined on page 415. To attempt to reduce impacts, the following actions would be required:

- an increase in the number of NPS and Hualapai staff to educate users about vegetation impacts
- an increase in NPS patrols at campsites to ensure that river runners did not camp in the old high-water zone or otherwise damage vegetation

- an increase in full-time science center and trail maintenance staff to revegetate barren areas, block undesirable social trails, and initiate restoration actions

It is unlikely that mitigation would be implemented at a level sufficient to reduce overall vegetation impacts to a minor or negligible intensity due to the number of passengers and group size.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 1 on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under this alternative vegetation in the new high-water zone, old high-water zone, and upland areas in the river corridor and side canyons would continue to be adversely impacted. The number of passengers and group sizes would continue to have direct and indirect, adverse, short- and long-term, moderate to major effects on vegetation. Mitigation would be required, with large increases in staff and funding necessary to implement the measures. Even with these increases, mitigation measures would be unable to reduce the adverse impacts from recreational use to minor or negligible levels.

In summary, this alternative overall would have adverse, localized, short- to long-term, seasonal to year-round, moderate to major effects on vegetation resources. Alternative 1 would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative 1 on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 2

Analysis. Under Alternative 2 recreational use of the Lower Gorge would be reduced from current levels. The maximum group size for HRR day trips would be 30 (down from the current maximum of 100), with two launches per day during the peak season (instead of one currently) and one launch per day during the non-peak season. Overnight trips would have a slightly smaller group size than under current conditions, down to 30 from 34. One additional campsite would be created, requiring vegetation removal. There would be no change in the docks at Quartermaster. Pontoon boat tours and their associated helicopter shuttles would be eliminated. Jetboats would be used for commercial takeouts, but at reduced levels compared to Alternative 1. Upriver travel would be restricted to below RM 262.

Reducing the size of day trips to 30 people would reduce the number of people at attraction sites at one time, minimizing the damage to vegetation as a result of social trailing. The group size for

overnight trips would be reduced, producing a lower level of potential impacts to vegetation from campsite expansion and social trailing. The decrease in group sizes would likely produce small benefits for the preservation, protection, and restoration of vegetation resources in all three vegetation zones. Capping the total numbers of daily passengers would also reduce the potential for spreading exotic plant species. These actions would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions.

Creating one additional campsite would result in the direct loss of vegetation in the new high-water zone and possibly the old high-water zone; however, this vegetation would likely by comprised of nonnative species, such as tamarisk, or extensively distributed native species. Impacts would be adverse, short and long term, and minor to moderate.

The lack of pontoon boat operations would have a beneficial effect on the vegetation resources by reducing foot traffic in the vicinity of the Quartermaster launch site. This would have localized, beneficial, long-term, year-round, minor to moderate effects on vegetation from current conditions.

Mitigation of Effects. Mitigation measures would the same as Alternative 1. Increased funding and staff would be needed. Mitigation could be implemented at a level sufficient to reduce overall vegetation impacts to minor.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 2 on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative 2 lower levels of use would benefit vegetation in all three zones along the river. Vegetation conditions in the new high-water zone, old high-water zone, and upland areas in the river corridor and side canyons might improve, but none would return to pre-use conditions. Direct and indirect adverse impacts to vegetation would remain. Mitigation would still be required, with increases in staff and funding necessary to implement the measures. Even with these increases, it is unlikely that mitigation measures would be able to reduce the adverse impacts from recreational use to negligible levels.

In summary, Alternative 2 would have beneficial, localized, short- to long-term, seasonal to year-round, minor to moderate effects compared to current conditions. However, this alternative would still have adverse, localized, short- to long-term, seasonal to year-round, minor to moderate impacts to vegetation resources. Alternative 2 would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative 2 on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative 3

Analysis. Alternative 3 would allow the same mix of recreational opportunities as current conditions, but at different levels. The maximum group size for HRR day trips would be 30 (down from a maximum of 100 currently), with three launches per day during the peak season and two per day during the non-peak season. Group sizes for overnight trips would be slightly smaller than now, down to 30 from 34, but one additional launch would be added each day. Two additional campsites with supply storage would be created, requiring vegetation removal. A small floating dock would be constructed added at RM 263. Pontoon tours in the Quartermaster area would increase, as would commercial takeouts. A new use under Alternative 3 would be jetboat tours of the Lower Gorge.

Similar to Alternative 2, decreasing the maximum number of people on HRR day trips under this alternative would reduce the number of people at attraction sites at one time, minimizing damage to vegetation from social trailing. However, this would be somewhat offset by having two additional day trip launches. The slight reduction in overnight group sizes would somewhat lower the level of potential impacts to vegetation from campsite expansion and social trailing; however, one additional overnight launch per day would slightly increase the opportunity for vegetation damage. The decrease in group sizes would likely produce small benefits to the preservation, protection, and restoration of vegetation resources in all three vegetation zones. The total numbers of daily passengers would also reduce the potential for spreading exotic plant species. These actions would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions.

Providing two additional campsites would result in the loss of new high-water zone and possibly some old high-water zone vegetation; however, this vegetation would likely be comprised of nonnative species, such as tamarisk, or extensively distributed native species. Impacts would be adverse, short and long term, and moderate. The creation of supply storage would also directly contribute to vegetation loss.

The continuation of pontoon boat operations and more than doubling of maximum daily passengers, combined with the addition of upriver jetboat tours, would have adverse, direct and indirect, short and long term, seasonal to year-round, moderate effects on the vegetation resources by increasing foot traffic in the pontoon launch area and at resting sites.

Mitigation of Effects. Mitigation measures would be the same as Alternative 1. Increased funding and staff would be needed. Mitigation could be implemented at a level sufficient to reduce overall vegetation impacts to minor.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in “Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts.” The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 3 on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized,

adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative 3 a small beneficial change from current conditions would be expected in all three vegetation zones due to reductions in group sizes; however, the increase in pontoon operations and an increase in overnight trips would offset the beneficial changes at localized sites. Adding two new campsites would cause direct, adverse, long-term, year-round, moderate impacts to the vegetation in those areas. Direct and indirect, adverse, short- to long-term, localized, moderate impacts to vegetation would remain due to the number of recreationists in the area of analysis. Mitigation would still be required, with increases in staff and funding necessary to implement the measures. Even with these increases, it is unlikely that adverse impacts from recreational use would be reduced to negligible levels.

In summary, Alternative 3 would have adverse, localized, short- to long-term, seasonal to year-round, moderate impacts to vegetation resources. Alternative 3 would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative 3 on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative 4 (NPS Preferred Alternative)

Analysis. Under Alternative 4 HRR trips (both day and overnight) would be redistributed throughout the year. The maximum group size for day trips would be 40 people during the peak season with up to 96 passengers per day (compared to the current maximum of 100), and 35 people during non-peak with two launches per day. Overnight trips would have a smaller group size than under current conditions, down to 20 from 34 during peak season, and 20 during the non-peak season. There would be three overnight launches per day during the peak season and one during the non-peak season. Three campsites would be added, requiring vegetation. A small floating dock would be provided at RM 263. Pontoon tours in the Quartermaster area would decrease slightly below current levels, as would commercial takeouts.

Under this alternative there would be no limit on day trip launches during the peak season, but there would be a limit of two launches per day in the non-peak season. Reducing group sizes would reduce the number of people at attraction sites at one time, minimizing the damage to vegetation through social trailing; however, 40 people at one site at one time would still exceed the capacity of most sites, but HRR trips would be using designated sites. The effect from current conditions would be negligible to minor. Reducing the group size for overnight trips, as well as total trip length, would decrease potential impacts to vegetation from campsite expansion and social trailing. The decrease in overnight and day trip group sizes would likely produce benefits to the preservation, protection, and restoration of vegetation resources in all three vegetation zones. The total numbers of daily passengers would also reduce the potential for spreading exotic plant species. These actions would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on vegetation from current conditions.

Adding three campsites would result in the loss of vegetation in the new high-water zone and possibly the old high-water zone; however, the vegetation would likely by comprised of non-native species, such as tamarisk, or extensively distributed native species. Impacts would be direct, adverse, long term, and moderate.

The continuation of pontoon boat operations, but with a slight reduction in the number of passengers compared to existing conditions, would have adverse, direct and indirect, short and long-term, seasonal to year-round, minor effects on the vegetation resources at the launch site.

Mitigation of Effects. Mitigating measures would be the same as Alternative 1. Increased funding and staff would be needed. Mitigation could be implemented at a level sufficient to reduce overall vegetation impacts to minor.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 4 on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Under Alternative 4 a small beneficial change from current conditions would be expected in all three vegetation zones due to reductions in group sizes. Adding three new campsites would cause direct, localized adverse, long-term, year-round, moderate impacts to the vegetation in those areas. Direct and indirect adverse impacts to vegetation would remain under this alternative. Mitigation would still be required, with increases in staff and funding necessary to implement the measures. Even with these increases, it is unlikely that mitigation measures would be able to reduce the adverse impacts from recreational use to negligible levels.

In summary, Alternative 4 would have adverse, localized, short- to long-term, seasonal to year-round, moderate impacts to vegetation resources. Alternative 4 would not result in the impairment of vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative 4 on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative 5 (Hualapai Tribe Proposed Action)

Analysis. Alternative 5 would include the same group sizes, launches, and campsite additions as Alternative 4. A large floating dock would be added at RM 263. Pontoon tours in the Quartermaster area would increase to 960 passengers per day.

As described for Alternative 4, reducing group sizes for day and overnight trips would reduce the number of people at attraction sites at one time, minimizing the damage to vegetation from social

trailing; however, 40 people at one site at one time would still exceed the capacity of most sites, but HRR trips would be using designated sites. The effect would be negligible to minor from current conditions. Smaller overnight groups would reduce the level of potential impacts to vegetation from campsite expansion and social trailing. The decreases in overnight and day trip group sizes would likely have localized, beneficial, year-round, short- to long-term, minor to moderate effects to the preservation, protection, and restoration of vegetation resources in all three vegetation zones.

Adding three campsites would result in the direct, adverse, long-term, moderate loss of vegetation in the new high-water zone and possibly the old high-water zone; however, the vegetation would likely by comprised of nonnative species, such as tamarisk, or extensively distributed native species.

Increasing daily passengers for pontoon boat operations from 188 to 960 would increase the potential for adverse, direct and indirect, short- and long-term, seasonal to year-round, moderate effects on the vegetation resources.

Mitigation of Effects. Mitigation measures would be the same as Alternative 1. Increased funding and staff would be needed. It is unlikely that mitigation would be implemented at a level sufficient to reduce overall vegetation impacts to a minor or negligible intensity due to the increase in the number of passengers.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Vegetation Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 5 on vegetation, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Similar to Alternative 4, Alternative 5 would have a small beneficial effect compared to current conditions in all three vegetation zones due to reductions in group sizes. Adding three new campsites would cause direct, localized adverse, long-term, year-round, moderate impacts to the vegetation in those areas. A fivefold increase in daily passengers for pontoon boat operations would increase the potential for adverse, direct and indirect, short- and long-term, seasonal to year-round, moderate effects on vegetation at the launch site. Mitigation would still be required, with increases in staff and funding necessary to implement the measures. Even with these increases, it is unlikely that mitigation measures would be able to reduce the adverse impacts from recreational use to negligible levels.

Alternative 5 would have adverse, localized, short- to long-term, seasonal to year-round, moderate impacts to vegetation resources. Alternative 5 would not result in the impairment of the vegetation resources in Grand Canyon National Park. Cumulative effects of Alternative 5 on vegetation, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major.

Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

TERRESTRIAL WILDLIFE

ISSUES

Internal and external scoping meetings identified a number of issues that pertain to biological resources:

- Protection of ecological resources should be the National Park Service's first priority.
- Resources should be monitored for impacts.
- The National Park Service should consider closing areas experiencing excessive impacts.
- Social trailing is a problem and should be reduced; the National Park Service should mark and maintain trails.
- Vegetation, including in the old high-water zone and side canyons, should be protected.
- Reduce visitor impacts resulting in behavioral modification of wildlife species.
- Dam impacts as they relate to cumulative effects (both Glen Canyon Dam and Hoover Dam).
- Wildlife habitat degradation/enhancement/restoration.
- Invasive species spread (loss of habitat and exotic fauna).
- Noise impacts (helicopter, motor and visitor's vocalizations).
- Pollution.
- Restore natural conditions.

Potential human-caused impacts to terrestrial wildlife and wildlife habitat associated with boating and recreational use include habitat degradation or modification, introduction of pollutants and contaminants into the environment, and disturbances to individuals or groups of wildlife. These potential impacts are described briefly below.

Habitat modification indirectly affects terrestrial wildlife. Recreational use can result in the direct destruction of vegetation through uprooting or crushing of plants, causing reduction of plant cover, leaf biomass, carbohydrate reserves, and reductions of seed and flower production (Liddle 1975). Soil compaction on sites and on maintained or social trails reduces populations of soil invertebrates (Chappell et al. 1971; Duffey 1975). Removal of native vegetation and low trophic level organisms at and near campsites decreases natural food supply and can result in a trophic cascade throughout an animal community. Reduction of driftwood piles by river runners for use as firewood eliminates cover and shelter for a variety of smaller wildlife species.

Pollutants introduced into the environment by river runners can lead to direct and indirect impacts to terrestrial wildlife. In this case, human food is considered a pollutant, and intentional feeding of wildlife or unintentional littering of food scraps and trash attract wildlife to campsites

and attraction areas, creating a food base for lizards and rodents by attracting invertebrates. This increased food base indirectly affects populations of small carnivores, such as coyotes, gray foxes, ringtails, and spotted skunks, by increasing rodents as a food source. Large ungulates have been known to ingest food wrappers and other trash left at camps (see Photo 4-6; Valdez et al. 1998). Ingestion of trash, such as pop-tops and aluminum foil, can cause injury or death.

PHOTO 4-6: TRASH ON BEACH AT RM 24

Disturbances by humans can directly and indirectly affect terrestrial wildlife. The impacts associated with disturbances include:

- Avoidance of an area
- Abandonment of a nest or den site
- Flushing of animals
- Behavior modifications and habituation to humans
- Injury or possibly mortality
- Exposure to predation

Disturbances tend to be a direct result of the presence of humans, especially when they attempt to photograph or view wildlife or cross through an animal's territory (Knight and Cole 1991). The presence of boats on the river, hikers in the side canyons, swimmers in tributaries, river runners on the beaches, and helicopters in the air can disturb nearby wildlife. Most wildlife will disperse if they sense humans nearby. This can disrupt the behavior of wildlife and cause animals to temporarily stop foraging, abandon nest or den sites, and abandon protective cover, thereby increasing the risk of predation and disrupting breeding efforts.

GUIDING REGULATIONS AND POLICIES

The NPS Organic Act (16 U.S.C. 1 et seq.) directs parks to conserve wildlife unimpaired for future generations. The NPS *Management Policies 2001* (NPS 2000d, sec. 4.4.1) state that "the National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The service will achieve this through:

- Preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur.
- Restoring native plant and animal populations in parks when they have been extirpated by past human-caused actions.
- Minimizing human impacts on native plants, animal populations, communities, and ecosystems, and the processes that sustain them.

Natural processes are relied on to control populations of native species to the greatest extent possible. Native species are protected from harvest, harassment, or harm by human activities.

Threatened and endangered species and their designated critical habitats are addressed beginning on page 482.

MANAGEMENT OBJECTIVES FOR TERRESTRIAL WILDLIFE RESOURCES

Management objectives for the *General Management Plan* and the *Colorado River Management Plan* are included in Table 2 in Chapter 1. The objective for terrestrial wildlife as it relates to management of recreational river use in the Grand Canyon is to manage river recreational use in a manner which protects native terrestrial wildlife and their habitats, and preserves wildlife populations by minimizing human caused wildlife disturbance and reducing habitat alteration.

METHODOLOGY FOR ANALYZING EFFECTS TO TERRESTRIAL WILDLIFE RESOURCES

The general process for assessing impacts to the environment is discussed in the "Introduction" to Chapter 4. Effects specific to terrestrial wildlife and habitat are characterized for each alternative based on the impact thresholds presented below.

Because 400 to 500 vertebrate species occur in Grand Canyon National Park, information gathering and analysis was focused on wildlife groups, species, and habitats that would most likely be affected by river recreational use. Impacts on terrestrial wildlife were analyzed using the best site-specific data available for species locations and distributions within the park. This information included, but was not limited to, inventories and research conducted by park biologists, personal communications with resource specialists, Arizona Game and Fish Department data, Hualapai tribal data, and Grand Canyon Monitoring and Research Center studies. Species information was then compared with campsite use intensity tables and the Human Impacts Monitoring Database (Brown and Jalbert 2003). It should be noted that there is a distinct lack of recreational disturbance and habitat alteration impact research specific to the Grand Canyon river corridor. Therefore, considerable use was made of research conducted in other

areas and extrapolated to the present conditions in the Grand Canyon. This technical literature was used to determine the most susceptible aspects of a particular species' or group of species' life cycle and habitat use areas. This information was then used to direct the collection of quantitative and qualitative data regarding the presence and status of these features within the park. In the absence of hard data, best professional judgment was utilized after consulting with technical experts.

Impact Thresholds

The analysis of an impact to a particular species or group of species involves a complex examination of the interaction of the context, duration, timing, and intensity of each identified impact. These measures are defined below.

Intensity

Negligible — Impacts to wildlife and/or habitat would not be perceptible or measurable; impacts would not be of any measurable or perceptible consequence to wildlife populations or the ecosystems supporting them.

Minor — Impacts to wildlife and/or habitat would be perceptible or measurable, but the severity and timing of changes to parameter measurements would not be expected to be outside the natural variability and would not be expected to have effects on wildlife populations or ecosystems. Population numbers, population structure, genetic variability, and other demographic factors for species might have slight changes, but characteristics would remain stable. Key ecosystem processes might have slight disruptions that would be within natural variability, and habitat for all species would remain functional.

Moderate — Breeding animals of concern are present and would be impacted; animals are present during particularly vulnerable life stages. Impacts to wildlife and/or habitat would be perceptible and measurable, and the severity and timing of changes to parameter measurements would be expected to be sometimes outside of natural variability, and changes within natural variability might be long term. Population numbers, population structure, genetic variability, and other demographic factors for species would have measurable changes creating declines, which could be from displacement, but would be expected to rebound to pre-impact numbers. No species would be at risk of being extirpated from the park, key ecosystem processes might have slight disruptions that would be outside natural variability (but would be expected to return to natural variability) and habitat for all species would remain functional.

Major — Impacts to wildlife and/or habitat would be perceptible and measurable, and the severity and timing of changes to parameter measurements would be outside of natural variability for long time periods, and changes within natural variability might be long term or permanent. Population numbers, population structure, genetic variability, and other demographic factors for species might have large, short-term declines with long-term population numbers considerably depressed. In extreme cases, species might be extirpated from the park, key ecosystem processes like nutrient cycling might be disrupted, or habitat for any species might be rendered not functional.

Context

Regional — Regional impacts would affect a widespread area of suitable habitats or the range of the population or species within Grand Canyon National Park, such as the entire mainstem of the river, or would be widespread among suitable tributaries or side canyons along the river.

Localized — Localized impacts would be confined to a small part of the population or to a small part of a habitat or range, such as a single campsite, spring, or side canyon.

Duration

Short term — Short-term impacts to an individual or habitat area would be one day up to one year; long-term impacts would be greater than one year. Short-term impacts to a population would last up to five years.

Long term — Long-term impacts would be greater than five years.

Timing

Impacts could occur year-round, but wildlife resources would be most sensitive during the spring and summer when mating (spawning), birthing, and hatching occur.

Mitigation of Effects

Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions to consider under all alternatives for reducing or eliminating impacts to terrestrial wildlife include the following:

- Conduct a regularly scheduled monitoring program.
- Increase the number of patrol trips and the level of resource protection enforcement activities.
- Increase the level of resource education that each river recreation participant receives.
- Compare indicator species abundance, richness, and diversity in and near camping and attraction sites with areas seldom visited by recreationists.
- Measure vegetation change through time by means of remote sensing imagery, as a less expensive, but less precise, surrogate for direct monitoring of populations.
- Institute site closures of sensitive and impacted areas.
- Actively manage impacted areas through revegetation efforts.
- Construct official trails and aggressively close and rehabilitate all other trails.
- Limit or prohibit use of down woody material including driftwood for firewood.

Cumulative Impacts

Cumulative impacts on terrestrial wildlife were determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future actions (see the "Introduction" to Chapter 4 for a detailed list of such actions).

Cumulative Effects for Lees Ferry to Diamond Creek

The major factor affecting terrestrial wildlife resources in the river corridor is the operation of Glen Canyon Dam. The dam's effects far outweigh the effects of river recreationists on the vegetation, and consequently the wildlife, of the river corridor. The dam has created a new vegetative structure that should remain relatively stable under current operations. The ongoing erosion of beaches under current operating parameters, however, can result in additional impacts to terrestrial wildlife resources. As beaches erode, river recreationists are forced into vegetated areas to accommodate camping needs, resulting in additional wildlife habitat degradation. The dam has localized to regional, adverse, long-term, year-round, moderate to major effects in the new high-water zone.

If drastic changes in the dam's operation were made, there would likely be substantial consequences to the terrestrial wildlife resources of the corridor.

Other cumulative effects include the additive nature of impacts generated by recreational hikers who visit the river and the effects of researchers who study various aspects of the canyon's physical and biological nature. These users have localized, adverse, short- to long-term, year-round, moderate effects in all hydrologic zones and up side canyons.

Assumptions

General assumptions used to analyze the effects of each alternative are discussed in the "Introduction" to Chapter 4. Assumptions that specifically relate to the alternatives considered in this document and their effect on terrestrial wildlife are as follows:

- As there are no data to empirically support or refute the position that guided trips are better controlled and result in less resource damage, this analysis assumes that all individuals, whether on guided tours or noncommercial trips, would have an equal chance of adversely interacting with wildlife and its habitat.
- User discretionary time provides an indicator of the opportunity for a certain proportion of river recreationists to adversely interact with individual animals and their habitat.
- Hunting is illegal. Fishing requires compliance with Arizona Department of Fish and Game regulations.
- Present conditions in the river corridor are significantly different from historical conditions. Ecosystem conditions have changed because of anthropogenic influences (Fradkin 1981; Pacey and Marsh 1998). The introduction of nonnative plants has modified the riparian community and its wildlife habitat quality. Salt cedar, which was introduced into the United States as an ornamental tree, escaped cultivation by the late

1800s. It appeared along the mainstem of the Colorado River in 1920 (Ohmart, Anderson, and Hunter 1988), though rapid expansion of its range along the river did not occur until 1935 to 1955 (DeLoach 1989). Salt cedar is well suited to the changed riverine ecosystem and displaced native riparian species throughout the river corridor. Important wildlife habitats, including cottonwood-willow gallery forests, all but disappeared from the Lower Colorado River and were replaced by this less desirable invader (Anderson and Ohmart 1984a).

- Overall, Glen Canyon Dam has provided the most significant effects on Grand Canyon biota. For the most part, the dam has controlled high volume, beach-scouring floods, and the riparian area throughout the corridor has increased at a relatively rapid rate. The increase in vegetation growth and habitat brings with it a concomitant increase in the density and diversity of animal life. It is unknown how the recent lowering of Lake Mead influences the riparian ecosystem in lower Grand Canyon in the long term.
- The impacts of river runners are generally concentrated in a very small unit area at the campsites, except when they are involved in side canyon or special interest hikes. These side-canyon hikes probably result in the greatest impacts in terms of vegetation trampling and disturbance to sensitive biological resources.
- All caves are currently closed to visitation except through a permitting process. Rampart Cave and Stanton's Cave are closed and gated.

IMPACT ANALYSIS — LEES FERRY ALTERNATIVES

Alternative A (Current Conditions)

Analysis. Alternative A would continue the current river management practices, which allow large group sizes (43 for commercial motor, 39 commercial oar) lengthy trips, and spikes in trips at one time, people at one time, and daily launches (see Table 4-1). User-days would remain capped at current levels, which would result in approximately the same number of total yearly passengers. Similarly, user discretionary time would remain at current levels. The greatest amount of user discretionary time (294,506 hours) would continue to be available in the summer, while winter use would remain very low at 6,855hours, and spring and fall levels would remain at 24,177 hours and 29,544 hours, respectively (see Table 4-2).

Reptiles and Amphibians — Impacts to reptiles and amphibians generally take the form of occasional opportunistic collecting or harassment by river recreationists. Direct human contact, especially handling, can result in stress, injury, or mortality of an individual. Rattlesnakes are occasionally relocated to prevent potentially dangerous confrontations, which can result in disturbance of a population's genetic integrity. Removed individuals suffer a loss of home range, increased competition, and increased potential for predation. Tadpoles and juvenile amphibians in springs and tributaries may be trampled by recreationists during the spring and summer, and aquatic habitat may be permanently disrupted. Much of this sporadic damage is offset at individual camping beaches by increased invertebrate prey sources created by food sources left by recreationists.

In 2003 researchers found 16 species of reptiles and amphibians in the old high-water zone, 15 in the new high-water zone, and 10 in the shore zone (Kearsley et al. 2003). They also noted that the seven most common species in the river corridor occurred in all three zones, but different species were using the zones in different proportions. The two toad species were most common in the new high-water zone, but also occupied the shore zone; they were seldom trapped in the old high-water zone. Sideblotched and spiney lizards are common in both the old and new high-water zones, but whiptails were most abundant in the new zone. At the present level of recreational use, herpetofauna in the river corridor appears to be abundant, but increases in recreational activity that lead to habitat modification and disturbance would have an adverse effect on these species.

In summary, impacts to reptiles and amphibians from the current use level and pattern would be adverse, short term, and negligible to minor.

Birds — Prior to Glen Canyon Dam, the riparian vegetation along the Colorado River was extremely limited due to frequent flooding (Turner and Karpiscak 1980). Since the completion of Glen Canyon Dam, substantial amounts of new riparian vegetation have become established in the river corridor, and bird densities have increased (Brown, Carothers, and Johnson 1985). However, the removal or modification of the newly created riparian vegetation by recreationists is an ongoing source of impacts to birdlife in the corridor. Habitat modification occurs in both the vegetation of the new and old high-water zones (GRCA campsite monitoring database 2003).

The importance of old high-water zone vegetation to bird species in the canyon has been well documented in recent years (Yard 1996; Yard and Cobb 2001), especially for the production of prey items for this species group. Removal or disturbance of vegetation in this zone by river recreationists would therefore result in the loss of habitat substrate for birds' prey base.

Research also confirmed a particular nonnative leaf-hopper in the diets of several of the bird species investigated (Yard 1996). This species is associated only with tamarisk of the new high-water zone (Stevens 1985), and its presence in the diet of all six species studied illustrates the importance of the vegetation in this zone. Yard (2004) determined that the diet of Lucy's warbler, a species that has expanded its population after construction of the dam, consisted of 49% of the tamarisk-associated leaf-hopper.

Sogge (1998) studied the relationship between riparian vegetation / habitat characteristics and measures of the resident breeding bird community in the river corridor, and determined that covariants associated with large vegetation structures (tree area and volume, new high-water area) and tamarisk area and volume were the best predictors of bird community response variables (abundance, richness and diversity index). Other research indicates that there is a strong positive correlation between breeding bird density and vegetation density as measured by total vegetative volume along the river corridor (Kearsley et al. 2003). Disturbance or destruction of vegetation in either the old or new high-water zone would therefore adversely affect avian species.

In the analysis of 42 frequently used campsites in the river corridor associated with vegetation in the old high-water zone (Brown and Jalbert 2003), only 6 did not have trails into the zone. The vast majority had more than two trails into this area of high importance to breeding bird species.

Of the 30 commonly used river stops, individual sites in the old high-water zone ranged from 1 to 30, with an average of 6.4 sites. At the current level of use all but 2 sites had human-caused tree damage in both zones, with 30 sites having over 100 trees damaged. A large portion of the tree damage was minor, but disturbance to shrubs and the removal of vegetation for trails and campsites totally eliminates potential habitat for breeding birds. If each of the approximately 200 river campsites between Lees Ferry and Diamond Creek had an average of only 0.5 acre of habitat removed for campsites and social trails, then 100 acres of vegetation in the new high-water zone has been removed from avian habitat. This is 8% of the approximately 1,235 acres of new habitat created since the construction of Glen Canyon Dam (Brown and Trosset 1989). Direct removal of that amount of potential habitat must have a measurable negative impact on avian species abundance, richness, and diversity.

Direct disturbance to avian species from noise and the presence of humans at the present level of river use is an ongoing adverse, short-term, moderate impact. This conclusion is based primarily on a review of the literature as no studies have been undertaken in Grand Canyon to measure the disturbance effects on avian species in the canyon environment. The effect of noise on avian species other than waterfowl and raptors has been given little research attention. Waterfowl are demonstrably more overtly responsive to noise than other species (Edwards et al. 1979), but reports of impacts on raptors are somewhat more ambiguous. A limited number of studies have evaluated the effects of human-induced disturbance and noise on raptors. Predictably, raptor responses to noise and disturbance in these studies have varied. Most studies reported relatively minor impacts and many of these found effects to be temporary (e.g., Lamp 1987). In the few cases where reproductive success was evaluated, reproductive parameters were sometimes affected, but not to a large degree. Researchers have reported that nesting raptors were more sensitive to ground-based activities than to aircraft (Frazer, Franzel, and Mathisen 1985; Grubb and King 1991). But researchers also reported that animals showed a greater response to helicopters than to fixed-wing aircraft (Grubb and King 1991).

Most research has involved helicopters or other aircraft, and the decibel levels tested are substantially greater than those generated by current state-of-the-art, four-stroke outboard motors used in the Grand Canyon. One researcher compared flushing responses in brent geese and determined that noisy outboards induced flight at 1–2 kilometers, but quieter boats would not induce flight outside of 500 meters (Owens 1977). In a river corridor environment like the Grand Canyon it is not unusual to observe waterfowl and shorebirds repeatedly disrupted by the approach of boats, but no studies have been undertaken to empirically determine the difference in responses to oar-powered and motor-powered craft in the Grand Canyon. It is obvious, however, that the flushing of birds along the river can result in several direct impacts. These include the expenditure of energy as they fly from the crafts, an increase in the vulnerability to predation, and reduced foraging efficiency. Wakes from motorized rafts may also drown young birds or flood nests in riparian thickets along the river.

Human presence in breeding areas of various birds can alter species richness, abundance and composition. In a 1984 study it was determined that the abundance of 11 of 12 bird species was lower in areas of high recreation intensity than in areas less frequented by visitors (Van der Zande et al. 1984). The areas of high visitor use were those where 8 to 37 people per hectare were present at one time. This density of people would frequently be present on most camping beaches in the summer throughout the river corridor.

Changes in species richness and community composition can be brought about by the activity of recreationists. In campgrounds environmental structure and complexity are usually reduced, which can decrease species diversity (Hammitt and Cole 1987). Researchers found seven bird species positively associated with campgrounds and another seven species associated with non-campground areas (Blakesley and Reese 1988). Changes in habitat structure (tree and shrub density, volume of down woody vegetation) provided likely explanations for differential species response.

In summary, impacts to birds generated by the current use pattern would be adverse, long term, and moderate.

Mammals — Ungulates and Carnivores. Many bighorn concentration areas do not contain significant camp or attraction sites, and the few that do occur in these areas are used by humans in the low to moderate intensity range, resulting in low human impact ratings (GRCA recreation database). A few areas such as Kanab Creek and Nankoweap, however, do contain concentrations of bighorn, deer, and their associated predators, and habitat disturbance can be observed that is directly related to human utilization levels in the moderate to high range (Grand Canyon National Park campsite use intensity database). The major physical modification of habitat associated with these campsites has already occurred, and continued degradation (removal of forage plants, creation of new social trails) would continue to occur, but the rate is not expected to accelerate under current use levels. Despite degradation of habitat immediately adjacent to camping areas and attractions, these highly mobile large mammals are capable of dispersing to undisturbed areas and spend relatively little time in the vicinity of camps. The presence of humans in these camps for extended periods effectively eliminates them as suitable habitat during those periods, but large mammals generally make use of these areas shortly after the departure of humans (Van Dyke et al. 1986; Edge et al. 1985; Edge and Marcum 1985). These disruptions would occasionally reach the moderate threshold of measurable declines in population numbers, but the mobility and fecundity of these species should result in rebounds to pre-impact levels.

Direct disturbance to large mammals from noise and the presence of humans would also result in minor to moderate, short term, adverse impacts. Anecdotal observations (GRCA wildlife files) indicate that adult bighorn and deer seldom react to observations of boats on the river, but young-of-the-year react vigorously and unpredictably. Research conducted with simulated low-level aircraft on these species indicate that noise levels have to be significant to induce flight responses (Krausmen et al. 1996), but the mere presence of humans on shore will produce the same effect as high-decibel noise. Researchers studied the reaction of mountain sheep approached by humans and noted increased heart rates and flight responses (MacArthur, Geist, and Johnston 1982). The reaction to humans on foot was greater than reactions to road traffic, helicopters, or fixed-wing aircraft.

A variety of studies on ungulates have shown that this group is relatively flexible with respect to habitat use when confronted with noise disturbance. When regularly presented with a disturbance on a scheduled basis deer, elk and sheep avoid areas when noise is present and return when the disturbance subsides (Van Dyke et al. 1986; Edge and Marcum 1985; Leslie and Douglas 1980). When exposure is brief or if sufficient hiding cover is available, changes in home range size have been undetectable (Eckstein et al. 1979; Edge et al 1985). At the current level of operations, it is

anticipated that daily exposure to noise from motors would consist of brief, repeated bouts in the summer, and that ungulates would occasionally be subject to stress, but would, for the most part, continue to adapt and habituate to the present level of disturbance.

In the Whitmore area, where helicopter exchanges are made, disturbance effects are anticipated to be at least in the moderate range. Researchers studied the effects of helicopters on bighorn sheep in Grand Canyon National Park and found that helicopter activity reduced the foraging efficiency of adult sheep by 43% (Stockwell, Bateman, and Berger 1991). Foraging efficiency has been suggested as a factor in determining physical condition and reproductive success in bighorn sheep (Bleich et al. 1994). Helicopter activity has been shown to alter the movement and habitat use of wild sheep, and low-flying helicopters (270 to 750 feet above the ground) increased the heart rate in ewes 2.5 to 3 times above normal (Bleich et al. 1994; MacArthur, Geist, and Johnston 1982). While bighorn sheep can become habituated to some types of repeated human disturbance, researchers found that they do not habituate or become desensitized to repeated helicopter flights (Bleich et al. 1994).

The effect on large mammals from the introduction of contaminants and pollutants into the corridor environment is expected to be an adverse, short-term, negligible impact. Several reasons support this conclusion. Of primary importance is the fact that the enormous volume of the Colorado River will dilute the contaminant concentrations to a very low level. Fuel discharges from motorized boats will be diluted well below the toxicity threshold for most mammalian species, which are typically in the tens of thousands of parts per million (ppm). The ingestion of human food items can be a problem in localized areas.

In summary, present levels of river recreational use would result in adverse, short-term, minor to moderate impacts to larger mammals such as bighorn sheep, mule deer, and coyote in the area of analysis.

Small Mammals. By serving as a major prey base for bird, reptile, and mammal predators, as well as fulfilling an important role in soil aeration and seed dispersal, rodents and their population dynamics can serve as a tool for making assessments of general ecosystem health.

Within the riparian zone of the river corridor, rodents are the most common small mammals, with at least 14 species representing seven genera (Carothers and Aitchison 1976; GRCA wildlife date files). The deer mouse is the only rodent that depends directly on the riparian zone for its existence (BOR 1995). The removal or modification of riparian vegetation by recreationists is an ongoing source of impacts to small mammals throughout the corridor. The modification of habitats occurs in both the vegetation of the new and old high-water zones (GRCA campsite monitoring database 2003).

Of the 219 camping areas monitored by the NPS staff in the river corridor down to Diamond Creek, 58% have human impacts in the moderate to high range. A more detailed analysis of 47 frequently used campsites in the river corridor determined that of the 42 sites associated with vegetation in the old high-water zone, only 6 did not have trails into that zone (Jalbert and Brown 2002). This habitat supports the majority of breeding small mammals encountered in the corridor (Kearsley et al. 2003). Of these commonly used river stops, 30 had campsites in the old high-water zone with from 1 to 30 individual sites. All but 2 sites had human-caused tree damage in

both zones, and 30 sites had over 100 trees damaged or removed. Much of the tree damage is minor, but disturbance to understory shrubs and large down woody debris is a major component of habitat modification. The removal of vegetation for campfires, campsite grooming, and social trail restoration reduces potential habitat for small mammals.

Disturbance impacts on small mammals by recreationists include injury, mortality, and stress resulting from handling, removal or displacement of habitat, or displacement of young or nursing females from nursery areas. Small mammals that use driftwood piles and understory for shelter and forage areas may be negatively affected when river runners remove wood to make fires or when woody debris is removed for trail restoration and campsite grooming. Indirect impacts on small mammal populations are likely to be more substantial than direct impacts. Negative effects of recreational activity on small mammals have been documented in the literature (Knight and Gutzwiller 1995; GRCA wildlife files). These include

- disruption of foraging or breeding behavior
- reduced parental attentiveness to young
- soil compaction at campsites and trails affecting burrows of some small mammals
- use of driftwood for campfires, temporarily reducing habitat for small mammals at some locations
- feeding unsuitable food to animals, particularly rock squirrels, resulting in individual animals habituating to frequently used camp and attraction sites

In 2003 studies more small mammals were captured in the old high-water zone, which is often associated with the steeper sides of the canyons that afford more structure for small mammals, than in other zones (Kearsley et al. 2003). In addition, two rare species *(Perognathus formosus, Dipodomys ordi*i) have only been captured in this zone. Researchers determined that spring abundance of small mammals in the river corridor was relatively constant for the three years studied (Kearsley et al. 2003)). Annual abundance did, however, differ. The annual difference in total numbers of small mammals captured from 2001 to 2003 was primarily due to annual variations in recruitment during the growing season. Fall relative abundance across the three years was significantly different and all were higher than during the preceding spring. The old high-water zone has the highest abundance and richness of mammals; some species have only been detected in this zone. Increases in recreational disturbance or loss of habitat during the growing season, particularly in the old high-water zone, could result in decreases in small mammal population numbers and species richness.

In summary, current use patterns would result adverse, long-term, moderate impacts to small mammals in the area of analysis.

Bats. Habitat modification from river recreationists visiting bat roosting areas would produce negligible to minor adverse impacts to crack and crevice dwelling bat species for a short duration until new roost sites have been located and occupied. Grand Canyon National Park provides abundant habitat for crack and crevice dwelling bats. However, habitat modification to caves where bats are present in maternity colonies or are hibernating can have adverse, long-term, moderate to major impacts. Some bat species (cave myotis and Arizona myotis) have declined or

disappeared from areas along the Lower Colorado River where habitat conversion and flooding due to dam construction have occurred over the past 60 years (Leslie, pers. comm. 2004a).

Human disturbance is probably the biggest threat to roosting bats. While vandalism and direct aggression toward roosting bats definitely occur and can cause large amounts of damage, even "responsible" cave visitors may unknowingly cause harm to roosting bats simply by being present (GRCA wildlife files). Repeated disturbance at a roost site may cause bats to abandon the roost and move into a less favorable (but less disturbed) alternative roost (Leslie, pers. comm. 2004a). Disturbance during hibernation may wake the bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). Population declines may be accelerated if numbers at maternity colonies are not sufficient to raise roost temperatures to the levels needed for healthy growth of young (Mohr 1972; Leslie, pers. comm. 2004a).

Human visitation in some caves may also cause changes in the micro-climate of the cave due to lights, increased humidity, gates and other developments (Mann, Steidl, and Dalton 2002). These direct and indirect disturbances by human visitors have been well documented in Stanton's Cave (RM 30.5) and Bat Cave (RM 266.5), and in cave research in Marble Canyon (Chambers et al. 2004). Human visitation impacts on crack and crevice dwelling species would be less than those of cave-dwelling species because the former are more diffuse throughout the environment.

The effect on bat species from the introduction of contaminants and pollutants is expected to be an adverse, short-term, negligible impact. Of primary importance is the fact that the enormous volume of the Colorado River will dilute the contaminant concentrations to a very low level. Fuel discharges from motorized boats will be diluted well below the toxicity threshold for most terrestrial species (typically in the tens of thousands ppm). Invertebrate insects are more susceptible, however, because bats glean from the wing and would rarely if ever forage on insect carcasses.

In summary, river recreation at the present level would result in adverse, long-term, moderate impacts to bat species in the area of analysis.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative A on terrestrial wildlife, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. The majority of river recreational access occurs in the late spring, when breeding and brooding for a variety of species is still underway, and summer. Fortunately, the early spring breeding season experiences less recreational access, and disturbance impacts during this period are probably at a low level. Overall, however, most terrestrial species would continue to experience adverse, long-term, moderate impacts. Under some conditions impacts from habitat modification at campsites, disturbance from boats and individuals on shore, and ingestion of pollutants would be observable and measurable and would occur when breeding animals were present. Population numbers and structure, genetic variability, and other demographic factors for species could have measurable changes resulting in declines, which could be from displacement, but eventually a rebound would be expected. Despite the population declines, no species would be at risk of being extirpated from the park; key ecosystem processes might have slight disruptions that would be outside natural variability (but would be expected to return to natural variability), and habitat for all species would remain functional.

Under Alternative A the impacts to terrestrial wildlife would be adverse, regional and local, short and long term, and negligible to moderate. Alternative A result in the impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative B

Analysis. Under Alternative B, recreational motor trips would be prohibited and group sizes, the maximum number of trips and people at one time, daily launches, user-days, and probable total yearly passengers would be at their lowest (see Table 4-1). Trip lengths would be substantially reduced from current conditions, but user discretionary time would increase from current levels (see Table 4-2).

Reptiles and Amphibians — Greater access would increase the occurrence of adverse interactions with reptiles and amphibians, providing additional opportunities for habitat damage, but it is doubtful that the impacts would rise to a level beyond an adverse, short-term, negligible to minor level.

Birds — Increased use levels in early and late spring (e.g., as indicated by greater user discretionary time) would increase disturbance impacts to breeding birds, but not to such an extent that impacts would rise beyond adverse, long term, and moderate. Increased access in winter would result in additional impacts to wintering waterfowl. Increased user discretionary time could indicate more opportunities for recreationists to adversely impact critical habitat components as discussed under Alternative A. Eliminating helicopter exchanges would benefit raptors in the Whitmore area.

Mammals — User discretionary time would increase in all seasons, resulting in more potential for adverse habitat modification and disturbance of mammals, but this would be partially offset by the substantial decrease in the maximum number of trips and people at one time. Smaller group sizes might result in a reduction of camping sites in the old high-water zone, which would

benefit all species groups. Large mammals would be able to return more quickly to areas from which they had been dispersed, and it is likely that the interval to the next trip passing a given point or arriving for camping would be increased. Eliminating helicopter exchanges would benefit large mammals in the Whitmore area. Prohibiting motorized uses would decrease noise impacts; however, it is unknown whether animals are responding to noise or visual cues from the presence of any type of boat on the river. Alternative B impacts to large mammals would be minor to moderate, adverse, and short term.

Increased winter use levels could result in adverse, long-term, moderate impacts, particularly to cave-dwelling bats. Disturbance at hibernacula might wake hibernating bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). Population declines could be accelerated if numbers at maternity colonies were not sufficient to raise roost temperatures to the levels needed for healthy growth of young (Mohr 1972; Leslie, pers. comm. 2004a). An increase in user discretionary time along the river corridor would likely allow recreationists to increase their exploration of the canyon. Generally, visitors are attracted to caves and shelters that also provide critical bat habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long-term, major, and often irreversible impacts.

For all mammal species, under some conditions impacts from habitat modification at campsites, disturbance from boats and individuals on shore, and ingestion of pollutants would be observable and measurable and would occur when breeding animals were present. Population numbers, population structure, genetic variability, and other demographic factors for species would have measurable changes creating declines, which could be from displacement, but eventually a rebound would be expected. Despite the population declines, no species would be at risk of being extirpated from the park. Key ecosystem processes might have slight disruptions that would be outside natural variability (but would be expected to return to natural variability), and habitat for all species would remain functional.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative B on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Under Alternative B recreational use would increase throughout the entirety of spring and summer. In late spring, breeding and brooding for a variety of species is still under way. Disturbances as a result of greater user discretionary time would increase during critical

periods in spring and summer, but noise levels would decrease and most mammal species would benefit from the reduced trip size and a lower number of trips at one time. Increased winter use would result in greater disturbance to wintering waterfowl. Overall, most terrestrial species would experience adverse, long-term, moderate impacts. Some wildlife populations could decline due to habitat modification at campsites, disturbance from boats and individuals on shore, ingestion of pollutants, and displacement; but under this alternative a rebound would be expected. No species would be at risk of being extirpated from the park. Habitat for all species would remain functional.

In summary, under Alternative B impacts to terrestrial wildlife would be adverse, regional and local, short and long term, and negligible to major. Alternative B would not result in the impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative C

Analysis. Under Alternative C motorized river use would be eliminated. Total annual user discretionary time would increase greatly in all seasons compared to existing conditions, while user-days and passengers would increase greatly in all seasons except summer, where use indicators would show decreases (see Table 4-2). Group sizes would decrease, as would the maximum number of trips and people at one time.

Reptiles and Amphibians — Doubling user discretionary time would substantially increase potential adverse impacts to reptilian habitat. As described for mammals, increased winter use would likely result in the rapid depletion of driftwood, which provides habitat and food sources for reptiles and amphibians. This increased use would result in adverse, short-term, moderate impacts to herpetofauna.

Birds — A fourfold increase in early spring user discretionary time would increase opportunities for disturbance pressure on nesting avian species during a very critical life stage. Simply walking near a nest can attract predators to an area (e.g., Keith 1961). The level of spring visitation under Alternative C could result in major population disruptions that would exceed the normal range of variability. Certain species that must nest in riparian area could be extirpated from the river corridor. The huge increase in winter use would have a major adverse effect on wintering waterfowl. These factors indicated that this level of recreational use would likely cause adverse, long-term, major impacts to bird species.

Mammals — A doubling of the annual user discretionary time would substantially increase the potential for adverse impacts to mammalian habitat by recreational users of campsites and hiking and social trails. The increase in winter use would likely result in a rapid depletion of driftwood fuel supplies. Users would then turn to local down, woody vegetation and eventually live vegetation for winter fuel wood. A general deterioration of mammalian habitat would result in impacts increasing to at least the adverse, long-term, moderate level.

Increased use in winter could result in adverse, long-term, moderate to major impacts to bat species, particularly to cave-dwelling bats. Disturbance of hibernating bats would likely wake them, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). Population declines might be accelerated if numbers at maternity colonies were not sufficient to raise roost temperatures to the levels needed for healthy growth of young (Mohr 1972; Leslie, pers. comm. 2004a). An increase in user discretionary time would likely allow recreationists to explore more of the canyon, including caves and shelters that also provide critical habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long term, major, and often irreversible impacts.

For all terrestrial wildlife, changes in wildlife population parameters could approach the limits of the range of natural variability. Population numbers of certain species groups could show large declines at this level of river use. Given enough habitat degradation and virtually constant direct disturbance, population numbers and diversity could decrease significantly and could remain depressed for the long term.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures were maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative C on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative C would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. The great increase in early spring use (and associated user discretionary time) would lead to increased opportunities for disturbance of a majority of mammalian and avian species at critical stages in their life cycles, which can lead to adverse impacts on population numbers and species diversity. Any gain resulting to wildlife from decreased levels of motor noise would be more or less offset by the increase in human presence in limited habitat areas throughout the breeding season. Recreational use under Alternative C would result in the potential for adverse, long-term, moderate to major impacts to terrestrial wildlife species in the entire river corridor. The changes in wildlife population parameters could approach the limits of the range of natural variability, and population numbers of certain species groups could show large declines at this level of river use. Given enough habitat degradation and virtually constant direct disturbance, population numbers and diversity would decrease significantly and could remain depressed for the long term. Present species that must nest in riparian areas could be extirpated from the river corridor.

In summary, under Alternative C the impacts to terrestrial wildlife would be adverse, regional and local, short and long term, and moderate to major. Alternative C would not result in the

impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative C would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative D

Analysis. Under Alternative D, there would be two periods of no-motor use, March and April, and September and October. Annual user discretionary time would double from the present level (see Table 4-2), but group sizes would decrease. There would be a substantial increase in early and late spring user discretionary time, as well as a huge increase in winter user discretionary time.

Reptiles and Amphibians — A doubling of user discretionary time would substantially increase the potential for adverse impacts to reptilian habitat as a result of the recreational use of campsites and hiking and social trails. Increase winter use would likely result in the rapid depletion of driftwood fuel supplies that also provide habitat and food sources for reptiles and amphibians. Greater user discretionary time would result in adverse, short-term, moderate impacts to herpetofauna.

Birds — Greater use in early and late spring would increase the potential for disturbance of nesting avian species during a very critical life stage. This level of spring visitation could result in major population disruptions that would approach the limits of the normal range of variability. Certain uncommon species associated with the new high-water zone could be extirpated in the river corridor. The huge increase in winter use would have a major adverse effect on wintering waterfowl. Consequently, recreational use under Alternative D would cause adverse, long-term, moderate to major impacts.

Mammals — Similar to Alternative C, doubling annual user discretionary time would vastly increase the opportunity for adverse impacts to mammalian habitat by recreational users of campsites and hiking and social trails. The increase in winter use, although only half that of Alternative C, would result in increased use of driftwood supplies, which provide important habitat for small mammals. A general depletion of mammalian habitat would result in impacts increasing to at least the adverse, long-term, moderate range.

Increased winter use could result in adverse, long-term, moderate to major impacts to bat species, particularly to cave dwelling bats. Disturbance at hibernacula could wake hibernating bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). Population declines could be accelerated if numbers at maternity colonies were not sufficient to raise roost temperatures to the levels needed for healthy growth of young (Mohr 1972; Leslie, pers. comm. 2004a). An increase in user discretionary time would likely allow recreationists to more thoroughly explore the canyon, including caves and shelters that also provide critical habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long-term, major, and often irreversible impacts.

Similar to Alternative C for all terrestrial wildlife, changes in wildlife population parameters could approach the limits of the range of natural variability, and population numbers of certain

species groups could show large declines. Given enough habitat degradation and virtually constant direct disturbance, population numbers and diversity could decrease significantly and remain depressed for the long term.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative D on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative D would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. A substantial increase in early spring use would lead to an increased potential for disturbance of a majority of mammalian and avian species at critical stages in their life cycles, which can substantially impact population numbers and species diversity. Eliminating motors in March and April might have some beneficial impacts to breeding species, but recreational use would still have adverse, long-term, moderate to major impacts to terrestrial wildlife species in the entire river corridor. Similar to Alternative C, changes in wildlife population parameters could approach the limits of the range of natural variability, and population numbers of certain species groups could show large declines. Given enough habitat degradation and virtually constant direct disturbance, population numbers and diversity could decrease significantly and remain depressed for the long term. Present uncommon species that must nest in riparian areas could become extirpated from the river corridor.

In summary Alternative D would have adverse, regional and local, short- and long-term, moderate to major impacts on terrestrial wildlife. Alternative D would not result in the impairment of the terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative D would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative E

Analysis. Under Alternative E there would be a no-motor season from October through March, and group sizes would decrease. Increases in spring user discretionary time would be more moderate (24,177 to 69,836) compared to the previous two alternatives, as would the increase in summer and winter user discretionary time (see Table 4-2).

Reptiles and Amphibians — Greater use would increase opportunities for adverse interactions with reptiles and amphibians and provide additional opportunities for habitat damage, but adverse impacts would likely remain in the short-term, negligible to minor range.

Birds — Higher use levels in early and late spring would increase opportunities for disturbance impacts to breeding birds, but not to such an extent as to rise beyond an adverse, long-term, moderate impact. Increased winter use would result in additional impacts to wintering waterfowl. Not allowing motorized use in March would have a somewhat beneficial effect on nesting birds. More user discretionary time would allow recreationists more time to explore and possibly damage critical habitat components, as discussed in Alternative A. Reduction of helicopter exchanges would benefit raptors in the Whitmore area.

Mammals — More user discretionary time would increase the potential for adverse habitat modification and disturbance of mammals, but this would be partially offset by substantial decreases in the maximum number of trips and people at one time. Reducing group size might reduce the expansion of campsites in the old high-water zone. Large mammals would be able to return more quickly to areas from which they had been dispersed, and it is likely there would be longer intervals between trips passing a given point or arriving at a specific site to camp. Small mammals would experience habitat degradation as fuel wood were used by an increased number of winter visitors. Additional use would result in opportunities for recreationists to spend more time in the old high-water zone, resulting in more damage and disturbance in this important area for rodents. Reduction of helicopter exchanges would benefit large mammals in the Whitmore area. A six-month no-motor season would decrease noise impacts. However, it is unknown whether animals are responding to noise or simply to visual cues from the presence of any type of boat on the river. Under Alternative E impacts to large and small mammals would be adverse, short term, and minor to moderate.

Increased winter use could result in adverse, long-term, minor to moderate impacts to bat species, particularly to cave-dwelling bats. Disturbance at hibernacula could wake hibernating bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). An increase in user discretionary time would likely allow recreationists to more thoroughly explore the canyon, including caves and shelters that also provide critical habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long-term, moderate, and often irreversible impacts.

For all terrestrial wildlife in the impact area, under some conditions impacts from habitat modification at campsites, disturbance from boats and individuals on shore, and ingestion of pollutants would be observable and measurable and would occur when breeding animals were present. Population numbers, population structure, genetic variability, and other demographic factors for species would have measurable changes, resulting in declines, which could be from displacement, but eventually a rebound would be expected. Despite population declines, no species would be at risk of being extirpated from the park. Key ecosystem processes might have slight disruptions that would be outside natural variability (but would be expected to return to natural variability). Habitat for all species would remain functional.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and

implementation of the measures are maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative E on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative E increased river recreational use through the spring and summer would result in adverse impacts to various wildlife species. Nesting birds could be especially affected during early spring, when decreased noise levels during March would be somewhat beneficial, but use would likely increase in late spring when breeding and brooding are still underway for various species. Most mammal species would benefit from reduced trip sizes and lower numbers of trips at one time. Increased winter use would result in greater disturbance to wintering waterfowl. Overall, most terrestrial species would experience adverse, long-term, moderate impacts. Some wildlife populations could decline due to habitat modification at campsites, disturbance from boats and individuals on shore, ingestion of pollutants, and displacement; but under this alternative a rebound would be expected. No species would be at risk of being extirpated from the park. Habitat for all species would remain functional.

In summary, under Alternative E the impacts to terrestrial wildlife would be adverse, regional and local, short and long term, and minor to moderate. Alternative E would not result in the impairment of the terrestrial resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative F

Analysis. Under Alternative F the no-motor season would be from July through December, maximum trip sizes would decrease, and the maximum number of trips and people at one time would drop (see Table 4-1). Annual user discretionary time would increase, but it would be the second lowest for the new alternatives. Early spring user discretionary time, passengers, and user-days would increase substantially, but all use indicators for May through August would decrease, due to the change to no-motors and fewer launches in July and August (see Table 4-2).

Reptiles and Amphibians — Greater use would increase the occurrence of adverse interactions with reptiles and amphibians, with additional opportunities for habitat damage. It is likely that impacts would continue to be adverse, negligible to minor, and short term.

Birds — More use in the early spring use would increase opportunities for disturbance impacts to breeding birds, but not to such an extent that the impact would be more than an adverse, long-

term, moderate impact. Reduced user discretionary time in the late spring and summer suggest fewer recreational use impacts during this critical time period. More winter use would result in additional impacts to wintering waterfowl. Overall increased annual user discretionary time would result in more opportunities for recreationists to damage critical habitat components as discussed in Alternative A. Reducing helicopter exchanges would benefit raptors in the Whitmore area.

Mammals — The increase in overall use would increase the potential for adverse habitat modification and disturbance of mammals, but this would be partially offset by substantial decreases in the maximum number of trips and people at one time. Reduced trip sizes could result in less camping in the new high-water zone. Large mammals would be able to return more quickly to areas from which they had been dispersed, and it is likely intervals would be longer between the next trip passing a given point or arriving at a site to camp. The use of fuel wood by campers would degrade habitat for small mammals. More user discretionary time would give recreationists more opportunities to explore areas in the old high-water zone, increasing damage and disturbance in this area of importance to rodents. Reducing helicopter exchanges would benefit large mammals in the Whitmore area. A six-months no-motor season would decrease noise impacts, but it is unknown whether animals respond to noise or simply to visual cues from the presence of any type of boat on the river. Under Alternative F impacts to large and small mammals would be adverse, short term, and minor to moderate.

Increased winter use could result in adverse, long-term, minor to moderate impacts to bat species, particularly to cave dwelling bats. Disturbance at hibernacula could wake hibernating bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). An increase in user discretionary time would likely allow recreationists to more thoroughly explore the canyon, including caves and shelters that also provide critical habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long-term, moderate, and often irreversible impacts.

For all terrestrial wildlife species in the impact area, under some conditions impacts from habitat modification at campsites, disturbance from boats and individuals on shore, and ingestion of pollutants would be observable and measurable and would occur when breeding animals were present. Population numbers and structure, genetic variability, and other demographic factors for species would have measurable changes, resulting in declines, which could be from displacement, but eventually a rebound would be expected. Despite population declines, no species would be at risk of being extirpated from the park. Key ecosystem processes might have slight disruptions that would be outside natural variability, but they would be expected to return to natural variability. Habitat for all species would remain functional.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is

regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative F on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Recreational use levels under Alternative F would be about equal to current levels in the spring and would be reduced in the summer. In late spring, breeding and brooding for a variety of species is still underway, and disturbance impacts to birds during this critical time period would increase. Noise levels would decrease from July through December, along with reduced trip sizes and fewer trips at one time, would benefit most bird and mammal species. Increased winter use would result in greater disturbance to wintering waterfowl. Overall, most terrestrial species would experience adverse, long-term, moderate impacts. Some wildlife populations could decline due to habitat modification at campsites, disturbance from boats and individuals on shore, ingestion of pollutants, and displacement; but under this alternative a rebound would be expected. No species would be at risk of being extirpated from the park. Habitat for all species would remain functional.

In summary, Alternative F would have adverse, regional and local, short- and long-term, negligible to moderate impacts to terrestrial wildlife. Alternative F would not result in the impairment of terrestrial resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative G

Analysis. Under Alternative G generally larger, shorter trips would occur, with all indicators of access increased in winter and shoulder seasons, but decreased in summer. All indicators of access would increase in the winter and shoulder seasons, but decrease in summer (see Table 4-1).

Reptiles and Amphibians — More user discretionary time would increase the occurrence of adverse interactions with reptiles and amphibians and provide additional opportunities for habitat damage, but it is likely that adverse impacts would remain in negligible to minor.

Birds — The substantial decrease in late spring and summer user discretionary time would decrease disturbance impacts to breeding birds, and that combined with only modest increases in early spring use could result in adverse, long-term, minor to moderate impacts to avian species. Increased user discretionary time in winter would result in additional impacts to wintering waterfowl. The comparatively small increase in annual user discretionary time would slightly increase opportunities for recreationists to damage critical habitat components as discussed in Alternative A.

Mammals — More annual use would slightly increase the potential for adverse habitat modification and disturbance of mammals, but this would be partially offset by substantial decreases in

the maximum number of trips and people at one time. Large mammals would be able to return more quickly to areas from which they had been dispersed, and the interval between trips passing a given point or arriving at a site to camp would be increased. Small mammals would experience habitat degradation as fuel wood was used by the increased number of winter visitors. Additional user discretionary time suggests that recreationists would have more time to explore the canyon, including the old high-water zone, with increased damage and disturbance in this important area for rodents. Under Alternative G impacts to large and small mammals would be adverse, short term, minor to moderate.

Increased winter use could result in adverse, long-term, minor to moderate impacts to bat species, particularly to cave dwelling bats. Disturbance at hibernacula could wake hibernating bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). An increase in user discretionary time would likely allow recreationists to more thoroughly explore the canyon, including caves and shelters that also provide critical habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long-term, moderate, and often irreversible impacts.

For all terrestrial wildlife in the impact area, under some conditions impacts from habitat modification at campsites, disturbance from boats and individuals on shore, and ingestion of pollutants would be observable and measurable and would occur when breeding animals were present. Population numbers and structure, genetic variability, and other demographic factors for species could have measurable changes creating declines, which could be from displacement, but eventually a rebound would be expected. Despite the population declines, no species would be at risk of being extirpated from the park. Key ecosystem processes might have slight disruptions that would be outside natural variability, but would be expected to return to natural variability. Habitat for all species would remain functional.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative G on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative G slightly increased access in March and April, but reduced access from May through August would benefit a variety of species who breed and raise their young in the late spring. Disturbance impacts to birds during the critical time period in the March-April period would increase slightly, but the decrease in the May-June period should off-set this. Fewer trips at one time should benefit most species. The increase in winter access would

result in greater opportunities for disturbance to wintering waterfowl. Overall, most terrestrial species would experience adverse, long-term, minor to moderate impacts. Some wildlife populations could decline due to habitat modification at campsites, disturbance from boats and individuals on shore, ingestion of pollutants, and displacement; but under this alternative a rebound would be expected. No species would be at risk of being extirpated from the park. Habitat for all species would remain functional.

In summary, under Alternative G impacts to terrestrial wildlife would be adverse, regional and local, short and long term, and negligible to moderate. Alternative G would not result in the impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative H (NPS Preferred Alternative)

Analysis. Under Alternative H a six-month no-motor season would extend from September through February. Total annual user discretionary time would increase substantially to 554,103 hours from 355,081. User discretionary time in early spring would increase modestly to 47,523 hours, while in late spring and summer it would increase to 402,037 hours (from 294,506 hours now). Compared to the other alternatives, winter user discretionary time would increase by a moderate amount (see Table 4-1). Trip sizes would decrease for commercial groups, and the maximum number of trips and people at one time would decrease.

Reptiles and Amphibians — Increased user discretionary time would provide additional opportunities for adverse interactions with reptiles and amphibians and resulting habitat damage, but it is likely that adverse, short-term impacts would remain in the negligible to minor range.

Birds — The substantial increase in user discretionary time from May through August would increase opportunities for disturbance impacts to breeding birds, and that combined with more modest use increases in March and April could result in adverse, long-term, moderate impacts to avian species. Increased winter use would result in additional potential for impacts to wintering waterfowl. The increased annual user discretionary time would increase opportunities for recreationists to damage critical habitat components, as discussed in Alternative A.

Mammals — More user discretionary time would increase the potential for adverse habitat modification and disturbance of mammals, but this would be partially offset by the substantial decreases in the maximum number of trips and people at one time. Reduced trip sizes might result in less camping in the new high-water zone. Large mammals would be able to return more quickly to areas from which they had been dispersed, and it is likely that there would be longer intervals between trips passing a given point or arriving at a certain site to camp. Small mammals would experience habitat degradation with the greater use of driftwood as fuel wood by more winter visitors. With additional user discretionary time, recreationists could spend more time exploring the old high-water zone, increasing damage and disturbance in this important area for rodents. Under this alternative impacts to large and small mammals would be adverse, short term, and minor to moderate.

Increased winter use could result in adverse, long-term, minor to moderate impacts to bat species, particularly to cave dwelling bats. Disturbance at hibernacula could wake hibernating bats, causing them to burn stored fat and perhaps preventing them from being able to survive the winter (Thomas 1995). An increase in user discretionary time would likely allow recreationists to more thoroughly explore the canyon, including caves and shelters that also provide critical habitat for roosting, hibernating, and rearing young. Even a small group disturbing cave bats could have adverse, long-term, moderate, and often irreversible impacts.

For all terrestrial wildlife in the area of impact, under some conditions impacts from habitat modification at campsites, disturbance from boats and individuals on shore, and ingestion of pollutants would be observable and measurable and would occur when breeding animals are present. Population numbers and structure, genetic variability, and other demographic factors for species would have measurable changes creating declines, which could be from displacement, but eventually a rebound would be expected. Despite the population declines, no species would be at risk of being extirpated from the park. Key ecosystem processes may have slight disruptions that would be outside natural variability, but would be expected to return to natural variability. Habitat for all species would remain functional.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigation actions would be the same for all alternatives and are listed on page 445.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects to Terrestrial Wildlife Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Cumulatively, the effects of Alternative H on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative H moderate recreational use increases in March and April, and substantial increases from May through August, would affect a variety of wildlife species. In late spring breeding and brooding is still underway for numerous species, and summer is an important phase in many species' breeding cycles. Reduced trip sizes and fewer trips at one time should benefit some species, but increased winter use would result in greater opportunities for disturbance to wintering waterfowl. Overall, most terrestrial species would experience adverse, long-term, moderate impacts. Some wildlife populations could decline due to habitat modification at campsites, disturbance from boats and individuals on shore, ingestion of pollutants, and displacement; but under this alternative a rebound would be expected. No species would be at risk of being extirpated from the park. Habitat for all species would remain functional.

In summary, under Alternative H impacts to terrestrial wildlife would be adverse, regional and local, short and long term, and negligible to moderate. Alternative H would not result in the

impairment of the terrestrial resources in Grand Canyon National Park. Cumulative effects would be adverse, regional to localized, long term, year-round, and moderate to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

IMPACT ANALYSIS — LOWER GORGE ALTERNATIVES

Methodology and Assumptions

In addition to the assumptions listed for all alternatives on page 446, assumptions specific to the Lower Gorge include the following:

- Personal watercraft from Lake Mead National Recreation Area are prohibited upstream of the Grand Canyon National Park boundary buoy. There are no restrictions on upriver travel below Separation Canyon at the present time.
- The Lower Gorge ecosystem is delicate and fragile, and the Colorado River supports some of the most abundant and diverse riparian vegetation and wildlife communities in the southwestern United States (Christensen 1997). Consequently, habitat loss, the proximity of other disturbing activities (areas typically avoided by wildlife, particularly large mammals), the limited availability of undisturbed habitat nearby, and the degree of restoration after construction must all be taken into account in the analysis.

Impacts on threatened, endangered, and sensitive species (including the southwest river otter, the bald eagle, the California condor, and the American peregrine falcon) are discussed at the end of "Impacts on Natural Resources."

Alternative 1 (Current Conditions)

Analysis. Recreational use of the Lower Gorge under Alternative 1 would continue to be unregulated except noncommercial launches would be limited to two per day, with a maximum of 16 people each (including guides). There are an average 100 trips per year (including educational and administrative trips) and generally last only a few days. HRR would continue to offer one day trip per day during the March-October season, with up to 10 boats (100 people) launching at the same time, and three overnight trips per month. No additional campsites would be developed.

The pontoon boat operation at Quartermaster would continue with seven boats in continuous operation throughout the day from May through September, with an average of 188 passengers per day. Pontoon passengers arrive and leave by helicopter, while passengers arriving for HRR day and overnight trips only leave by helicopter. For pontoon boat passengers, helicopter use would continue to average about 75 flights per day (37.6 in and out), and for HRR day tip passengers, there would be an additional 32 flights each day, for a total daily average of 107 flights.

Invertebrates — Terrestrial riparian insect, which serve as a critical terrestrial food base for many wildlife species, were probably not as diverse and abundant before the construction of

Glen Canyon Dam due to the scouring effects of floods and the limited amount of beach vegetation. Riparian vegetation has grown substantially in the Lower Gorge in the last decade, which has likely increased the invertebrate diversity and abundance. The Colorado River in Lower Grand Canyon supports some of the most abundant and diverse riparian vegetation and wildlife communities in the southwestern United States (Christensen 1997). This may be the very reason for the diversity of birds and bats documented in recent years within the park (GRCA wildlife files; Christensen 2003), as described in Chapter 3 under "Terrestrial Wildlife."

Several specific insect problems are occurring along the Colorado River corridor and in the Lower Gorge region. Harvester ants, also known as red ants, usually occur in low densities along the beach and terrace interfaces near the river. However, on the few heavily used beaches in the Lower Gorge, ant densities are much higher than at relatively unused beach areas. Investigations indicate that this problem is directly relates to human activity and improper organic garbage disposal. Because of their increasing numbers and painful sting, this presents a health hazard to particularly to persons sensitive to the toxins.

The flesh fly and blow fly populations have also shown an increase in density at heavily used campsites. These populations are generally linked with sanitation problems, particularly in regards to fecal and organic waste disposal. These insects could definitely be the source of some fly-vectored health issues in the Lower Gorge, as many of the boats traveling upriver do not have sanitation facilities.

With the continued high levels of use in the area of analysis and the increase in established campsites, woody riparian vegetation can be expected to decrease. In addition, driftwood serving as habitat would likely decrease, slightly impacting terrestrial invertebrate species and over time possibly bird and bat species occupying the area.

Direct impacts to invertebrate species from river recreation at the present level would result in adverse, local, short-term, minor impacts. Indirect impacts to invertebrate species from disturbance at current use patterns would likely result in adverse, local, short-term, minor to moderate impacts.

Reptiles and Amphibians — Amphibians are not well represented in the Lower Gorge due to generally arid surface conditions (NPS 1979c), although toads such as the Woodhouse's toad and red-spotted toad have been documented (GRCA wildlife files). Tree frogs are common in warmer tributaries. (The leopard frog is discussed under "Threatened, Endangered, and Sensitive Species.") No impacts are expected on the Sonoran desert tortoise population in Grand Canyon National Park because it occurs in the upland habitat in the Lower Gorge. The park is currently undertaking comprehensive studies to further document presence of Mohave desert tortoise within the park boundaries.

Sixteen species of reptiles have been identified along the Colorado River (Carpenter 2001) as described further in Chapter 3. Direct impacts to reptiles are brought about through changes in the available food at the most impacted campsites. Ants, flies, and gnats make up a large portion of lizards' diets. These insects thrive on organic garbage and fecal waste products. Where these insects are present in unusually high densities, there is a corresponding increase in lizard densities. Many species of lizards use dwindling supplies of available driftwood for foraging,

display, basking areas, and cover, particularly the spiny lizard; these areas are scarcer along the Lower Gorge than in the upper reaches of the river corridor.

At the present level of recreational use, there appears to be minimal impact to reptiles in the Lower Gorge, but substantial impacts to amphibians. An increase in recreational activity that leads to habitat modification and disturbance would have moderate adverse effects on these species.

Birds — Based on surveys in 2001 and 2002 (Christensen 2002), the most common bird species in the Lower Gorge include the yellow-breasted chat, Bell's vireo, song sparrow, yellow warbler, blue-gray gnatcatcher, and Bewick's wren. Song sparrows appear to be increasing in the Lower Gorge (Christensen 2002). At Burnt Springs, Bat Cave, and Spencer Creek (RM 264.0) appreciable numbers of birds are supported relative to Surprise Creek and the Quartermaster area. These areas resemble stream riparian and stream communities, with vegetation such as willows, cottonwood, sedges, and rushes that provide excellent habitat to a variety of bird species, including the endangered Southwestern willow flycatcher and several species of shorebirds, herons, and egrets. Peregrine falcons were once numerous in the area of analysis, but declines have been documented. A survey of this area in 2002 indicated that the mean number of birds observed was extremely low compared to previous years' survey data (Christensen 2002). One explanation would be that the habitat is deteriorating due to a lack of water and that the number of birds that can be supported has declined.

Many impacts on wildlife from the continued use of helicopters and motorized vessels throughout the river corridor have been documented. Such species as migratory hawks, peregrine falcons, and California condors are disturbed by helicopter noise and proximity to use (Olson 2003). (Impacts on condors and falcons are discussed under "Threatened, Endangered, and Sensitive Species.") Park biologists have noted through field observations that bird species can be disturbed by the operation of motorized vessels because they create noise that flushes the birds and create wakes that disrupt nests (Burger 1998). Motorized vessel noise can also flush birds from their nests, which can be harmful or fatal to unfledged chicks. Keeping adults away from the nest can disrupt proper development of the young and prevent them from defending the nest against predators.

The nesting season for neotropical migrants is from May to September. However, many birds, like the herons and some species using the lower elevation of the Lower Gorge, start nesting earlier. Therefore, the primary nesting season directly correlates to the high-visitor-use season. While motorized boat use can disturb bird species, there have been conflicting reports on how this use most impacts birds. In general, boats can create a large wake that can damage nest sites and create noise that can flush birds from their nests. However, most boaters tend to avoid shoreline and vegetated areas or decrease speed when in these areas except when off-loading for side canyon hikes.

Overall, impacts on birds from motorized vessels would be considered a major impact because use occurs at critical periods during nesting season and migration periods. Habitat in this area is limited, and there could be an increase in mortality of these species based on greater use of motorized vessels in the inflow areas and around important nesting areas. In particular, grebes, including Clark's grebes, build floating nests that could be damaged or flooded by the wake of a

motorized vessel. Clark's grebes have been documented in the Pearce Ferry delta. Studies have shown that high recreational use can disturb wintering waterfowl and some raptors (Stalmaster and Kaiser 1997).

In heavily used camping areas, three species of birds — the starling, common raven, and the house sparrow — are affected by human activities along the river corridor. At every major campsite, habituated ravens have been documented. Organic garbage left intentionally (specifically for the purpose of feeding wildlife) and unintentionally generally most influence ravens. All indications are that ravens and starlings are in higher densities along the river corridor in the Lower Gorge than they would be normally if not fed.

The effect on bird species from the introduction of contaminants and pollutants is expected to be an adverse, short-term, negligible impact. Visitation and recreation along the Lower Gorge have steadily increased in the past, a trend that is likely to continue. Future increases in the use of motorized vehicles could result in increased spills of petroleum products and other contaminants, adversely affecting water quality. Decreases in water quality could affect bird species that use marsh and backwater vegetation types (e.g., the western least bittern and Yuma clapper rail) to forage on invertebrates (USFWS 1993).

Direct disturbance and impacts to avian species from noise (helicopter and motorized watercraft) and the presence of humans at the present level of use would be adverse, short- and long-term, and major.

Mammals — By serving as a major prey base for bird, reptile, and mammal predators, as well as fulfilling an important role in soil aeration and seed dispersal, nocturnal rodents and their population dynamics can serve as a tool for making assessments of general ecosystem health. Small mammal species in the lower gorge are typical of those in the upper reaches of the river corridor (Christensen 1996, 1997; Kearsley, Cobb, and Yard 2001; Osborn and Kincaid 2004) as further described in Chapter 3. Upland studies in Burnt, Spencer, and Quartermaster Canyons indicate a higher number of species and individuals compared to the riparian transects (Christensen 2002; Osborn and Kincaid 2004; GRCA wildlife files). These results are similar to those found previously (Christensen 1996, 1997) and to those reported by Yard et al. (2001).

The Journal of the Arizona Academy of Science (1977) noted that coyotes were preying on predominantly desert cottontails and pocket mice, as well as foraging on woodrats and various *Peromyscus* spp. These studies indicated that these species were more plentiful at sampling sites on the north side of the river.

Firewood collection can affect small mammal populations by altering food sources and living places and eliminating protected sites. Organic trash around campsites also attracts animals, ranging from invertebrates to small rodents, certain birds, and small mammals. Although such changes in habitat, including removal or modification of riparian vegetation, are the major source of impact on smaller wildlife species, most of these changes are highly localized, with the exception of pest species. The modification of habitats occurs in both the vegetation of the new high and old high-water zones (GRCA campsite monitoring database 2003). The most heavily used sites by visitors include Bridge (RM 243) and the Quartermaster area. Inventories and

monitoring at these sites have shown a recent decline in species diversity and abundance (Christensen 2003, 1997; Kearsley, Cobb, and Yard 2001; Osborn and Kincaid 2004).

The removal of vegetation for campfires, campsite establishment, and grooming reduces potential habitat for small mammals. Impacts on small mammals include injury, mortality, and stress resulting from handling; changes in living spaces and food sources; removal or displacement of habitat; or displacement of young or nursing female from nursery areas.

Direct impacts on mammals from current use patterns would result in adverse, regional and local, short- and long-term, major impacts. Indirect impacts on small mammal populations would likely be more substantial than those of direct impacts but on a localized level.

Aquatic Furbearers — Relatively little is known about the historic semi-aquatic furbearers in the Grand Canyon (i.e., beavers, river otters, and muskrats). Sighting records prior to the construction of Glen Canyon Dam indicate that river otters and beavers were present, but that their occurrence was sporadic and their densities low (Hoffmeister and Durham 1971; Hoffmeister 1986). Since the completion of the dam in 1963, muskrats have rarely been observed along the river corridor (GRCA wildlife files; Breck and Kellett 2000), and may be extirpated from the park. The southwestern river otter, a species of concern, is thought to be extirpated from the park.

According to Carothers and Brown (1991), beaver populations within the Grand Canyon began to expand after the completion of Glen Canyon Dam. They attributed the increase to the cessation of spring floods and the post-dam development of extensive riparian vegetation. The 2000 inventory conducted by Breck and Kellet recorded beaver signs at 23 sites from RM 0.8 to RM 208.5. Five of these sites were identified as river runner campsites. NPS surveys during the same year indicated that beavers are evenly distributed along the river in suitable habitat (Leslie 2000b). Beavers have an important effect on the riparian ecosystem, as described in Chapter 3.

The harassment of wildlife by recreationists produces excitement or stress in animals. This may lead to panic, exertion, and disruption of essential functions such as breeding, displacement, and sometimes death. Animals that are healthy and have ample food and places to escape are more capable of withstanding harassment than animals that harassment than animals that are underfed, parasitized, or lacking secure areas for escape (Ream 1979). It is difficult to make generalizations about harassment are because of the considerable variability between and within species. Beavers in the Lower Gorge have been documented as slapping tails and being "pushed" downriver. Disturbance and loss of woody vegetation at the current levels may have minor to moderate impacts on the Lower Gorge beaver population. Due to a direct correlation between beaver and otter habitat, this could impact future river otter restoration efforts.

Mammals — Ungulates and Carnivores. Bighorn sheep use has been documented on both the north and south sides of the river corridor in the Lower Gorge. On the Hualapai tribal lands, bighorns are hunted generally along the rim areas, likely pushing them seasonally down onto the river corridor. There are few campsites in this area. However, pontoon and jetboat use, as well as helicopter traffic, likely impact large mammal distribution and, consequently, their predators.

Direct disturbance to large mammals from noise and the presence of humans can result in moderate to major adverse impacts. Limited research on these species conducted using simulated low-level aircraft indicate that noise levels have to be significant to induce flight responses (Krausmen et al. 1996), but the mere presence of humans on shore will produce the same effect as high decibel noise. Researchers studied the reaction of mountain sheep approached by humans and noted increased heart rates and flight responses (MacArthur, Geist, and Johnston 1982). The reaction to humans on foot was greater than reactions to road traffic, helicopters, or fixed-wing aircraft in some circumstances.

Wild ungulates and carnivores change their movement patterns in response to aircraft over-flights, construction noise, and walking park visitors (e.g. Krausman et al. 1986; Eckstein et al 1979; Edge and Marcum 1985; Richens and Lavigne 1978). All of these sounds are associated with approaches or human activity. The authors concluded that frequent alerting affected food intake of bighorn sheep.

Helicopter activity has been shown to alter the movement and use of habitat by wild sheep, and low-flying helicopters (270 to 750 feet above the ground) increased the heart rate in ewes 2.5 to 3 times above normal (Bleich et al. 1994; MacArthur, Geist, and Johnston 1982). While bighorn sheep can become habituated to some types of repeated human disturbance, researchers found that they do not habituate or become desensitized to repeated helicopter flights (Bleich et al. 1994).

Noise is suspected to cause stress-related illness in both humans and animals, but the causal link has been difficult to prove (NRC 1981; Federal Interagency Committee on Noise 1992). High noise levels may cause wild animals to become irritable, affecting feeding intake, energy expenditure, social interactions, and parenting and nurturing. All of these effects can result in population declines. Even if populations are unaffected, genetically determined differences in susceptibility might exert subtle selection that could eventually affect fitness.

If animals respond as soon as they detect a sound, then noisy vehicles will affect them at a much greater distance than humans. However, if they are habituated to vehicle noise (motors, including pontoon boats and jetboats, and helicopters in the Lower Gorge) at levels that are not aversive, then humans laughing and yelling can arouse response at greater ranges than vehicle noise. The potential effect of noise on animals along the river corridor has not been well studied; however, many of these impacts have been anecdotally noted in bighorn sheep (GRCA wildlife files) and some bird species along the river.

Wildlife, in general, move away from disturbances such as approaching motorized vessels. However, the National Park Service has observed unpredictable responses from bighorn sheep near the shoreline (NPS 2002b). At times they will move away when a vessel is approaching and return when it moves away. At other times they will ignore the approaching vessel and not move. This indicates that effects on bighorn sheep of motorized watercraft at present levels is minimal.

The effect on large mammals from the introduction of contaminants and pollutants into the corridor environment is expected to be an adverse, short-term, negligible impact. Several reasons support this conclusion. Of primary importance is the fact that the enormous volume of the Colorado River will dilute contaminant concentrations to a very low level. Fuel discharges from

motorized boats will be diluted well below the toxicity threshold for most mammalian species (typically in the tens of thousands ppm).

Ingestion of human food items or litter can be a problem, particularly in areas where human visitation is frequent, in high numbers, and poorly regulated (e.g., Carothers and Aitchison 1976; GRCA wildlife files). Litter may affect vertebrate populations by being eaten and causing injury or mortality or through indirect impacts by producing higher densities of insects. Some litter articles may be used as improper nesting materials. It is likely that river runners, visitors helicoptering in, and upstream travelers all contribute to this problem, particularly in the high-use campsites and attraction sites, resulting in moderate short-term impacts on a localized level.

Bats. Habitat modification and human disturbance are probably the greatest threat to roosting bats. Human visitation in Lower Gorge caves disturbs bat species not only through direct disturbance, but also through changes in the microclimate of caves they inhabit due to noise disturbance, lights, and increase in humidity (Mann, Steidl, and Dalton 2002). Also, hikers can disturb the cave floor, which provides habitat for the protected Grand Canyon cave pseudoscorpion and other invertebrate species, also disrupting the food base for small mammals such as ringtail cats. These direct and indirect disturbances by human visitors have been well documented Rampart, Stanton's, and Bat caves (Leslie, pers. comm. 2004a).

Disturbance of roosting bats in Bat Cave, a very important habitat for Mexican free-tailed bats, as described in Chapter 3, continues to be a management concern. Although the cave is officially closed, visitors have easy access to the point of roosting by means of a short technical climb and a long boardwalk. Multiple social trailing along the slope first appeared in 1996 and has steadily increased even with the closure in place. Prior to that, one trail directly south of the cave on a steep talus slope was the only visible trail to the towers.

Use of motorized vehicles on the river may result in increased spills of petroleum products and other contaminants, adversely affecting water quality. Decreases in water quality could affect bird and mammal species that use marsh and backwater vegetation types (e.g., California leaf-nosed bat, pale Townsend's big-eared bat, western red bat) to forage on invertebrates (USFWS 1993). The effect on bat species from contaminants and pollutants is expected to be an adverse, short-term, negligible impact.

As human activity in riparian zones along the Lower Gorge increases, fire frequency is also likely to increase (Busch 1995). As fire frequency increases, and as salt cedar and arrowweed continue to dominate areas after fires, more disturbances of species that use riparian vegetation types for forage (e.g., pale Townsend's big-eared bat, western red bat, Mexican and pocket free-tailed bats) would likely occur.

Human disturbance at current use levels would have localized, adverse, short- to long-term, year-round, moderate impacts on bat species.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures could be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures were maintained. Reasonable mitigation actions would be the

same as those listed on page 445. In addition the following mitigations would be applicable to all the Lower Gorge alternatives:

- Conduct surveys and research, as appropriate, to collect information necessary to better define the species habitat requirements.
- Design and implement inventory and long term monitoring plans for ungulates and their habitats.
- Maintain existing important yellow-billed cuckoo habitat areas.
- Avoid disturbance of bird species during the breeding season.
- Reduce risk of loss of established habitat to wildfire.
- Conduct surveys to determine the distribution of bat species.
- Provide funding to support existing leopard frog surveys and long-term monitoring and protection efforts.
- Design and implement monitoring protocols that permit coordinated database management, as well as database compatibility with other conservation planning efforts (e.g., databases developed, maintained, and managed in the Glen Canyon Dam Adaptive Management Program and the Little Colorado River Multi-Species Conservation Program).
- As data gaps are identified, design and implement monitoring actions that are primarily directed toward species for which little is known from the Lower Gorge (i.e., mammals, amphibians, insects) .
- Develop and use consistent monitoring and research protocols.

Cumulative Effects. In addition to the cumulative actions described above in "Methodology for Analyzing Effects to Terrestrial Wildlife: Cumulative Effects," two additional effects are applicable in the Lower Gorge. Development on Hualapai tribal lands in the Quartermaster area would continue to have moderate to major adverse impacts on use of the area as wildlife habitat, and some species and individuals have likely already been displaced from the area. However, based on the amount of available habitat adjacent to or near the developed area, it is unlikely that there are more than localized, adverse, short- to long-term, year-round, moderate effects and regional, adverse, short- to long-term, year-round, minor effects on wildlife and wildlife habitat.

Extensive helicopter and motorized boat use in the Quartermaster area could cause localized, adverse, short- to long-term, seasonal to year-round, major impacts to wildlife populations in this area because bird and ungulate species could abandon this habitat due to the increased disturbance, resulting in a loss of bird species diversity within the area. However, helicopter use in this area, which is under Hualapai tribal control, is expected to continue at current or increased levels independent of the alternatives analyzed in this document.

The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of alternative 1 on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and

minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative 1 the majority of visitor access would continue to occur in the spring and summer. Overall, most terrestrial species would continue to experience adverse, long-term, moderate to major impacts. Under some conditions impacts from habitat modification at campsites, disturbance from boats and helicopter traffic, and ingestion of pollutants would be observable and measurable. There could be moderate to major impacts on nesting bird habitat from the continued unregulated use of motorized vessels within sensitive roosting and nesting areas in the area.

In summary, alternative 1 would result in continued adverse, regional and local, short- and long-term, moderate to major impacts to invertebrates, mammals (ungulates, beavers, and bats), reptiles and amphibians, and birds in the area of analysis. Alternative 1 would not result in the impairment of terrestrial wildlife resources of Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 2

Analysis. This alternative would eliminate the use of the pontoon operation in the Quartermaster area and associated helicopter flights. HRR would be restricted to two day trips per day in the peak season, with a maximum of 30 people each, and one trip per day in the non-peak season. One additional campsite would be constructed (requiring vegetation clearing) on Hualapai tribal land for HRR use. HRR overnight trips would be increased to one per day, with a maximum group size of 30 people.

Invertebrates — On the few heavily used beaches in the Lower Gorge ant densities would continue to persist at the levels described in Alternative 1. As this problem is directly related to human activity and improper organic garbage disposal, the increase in HRR overnight trips would increase potential for higher ant densities..

Reptiles and Amphibians / Mammals — Habitat modification, as discussed in Alternative 1, and human disturbance would probably be the greatest threats to mammals in the Lower Gorge. With the increase in HRR overnight trips there would be a parallel increase in remote side canyon hiking and possible trampling of amphibian habitat and young. There would also be an increase in the displacement of woody material due to campfire fuel use, campsite establishment, and grooming that would likely further affect small mammal and reptile local populations.

There would likely continue to be minor impacts to reptiles in the Lower Gorge but major impacts to amphibians. An increase in recreational activity that leads to habitat modification and disturbance would have adverse effects on these species.

Birds — Eliminating pontoon boat operations and associated helicopter flights could benefit certain bird species, such as migratory hawks, in the Quartermaster and Burnt Springs area.

This alternative would reduce recreation-related impacts on migratory hawks, as well as peregrine falcons, to the minor level. Recreational use impacts to neotropicals are primarily due to habitat destruction and nesting disturbance but would be greatly reduced under this alternative.

Overall, the impact on birds from an increase in motorized vessels would meet the major impact threshold. Motorized use would occur at critical times during nesting season and migration periods. Habitat in this area is limited, and there could be an increase in mortality of these species based on the increasing use of motorized vessels in the inflow areas and around important nesting areas. However, the decrease in helicopter traffic would likely benefit most raptor species. The benefits associated with the elimination of helicopter flights and pontoon boats would likely be negated by continued helicopter use outside the park.

Mitigation of Effects. As described for Alternative 1, previous mitigation efforts indicate that specific measures could be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures were maintained. Reasonable mitigation actions would be the same as those listed on pages 445 and 473.

Cumulative Effects. Under Alternative 2 it is expected that the overall number of helicopter flights in the Quartermaster area would remain at about the same levels as now, even though they would not be transporting pontoon boat passengers under this alternative. Compared to Alternative 1 there would be little or no change in the cumulative effect on bird species from helicopters. This would result in adverse, localized, short- to long-term, major cumulative impacts in the Quartermaster area on lands adjacent to the park in the river corridor.

As described for Alternative 1, development on Hualapai tribal lands in the Quartermaster area would continue to have moderate to major adverse impacts on use of the area as wildlife habitat, and some species and individuals have likely already been displaced from the area. Based on the amount of available habitat nearby, it is unlikely that there would be more than localized, adverse, short- to long-term, year-round, moderate effects and regional, adverse, short- to long-term, year-round, minor effects on wildlife and wildlife habitat.

The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative 2 on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Due to the construction of a campsite, surface compaction, and human disturbance, additional nesting habitat would be lost, resulting in adverse, minor to moderate impacts to birds. Adverse impacts to mammals would remain at the moderate to major levels for cave-dwelling bats and small mammals. The increase in overnight passenger launches could increase adverse impacts from disturbance to such species as beaver, ungulates, and carnivores.

In summary, Alternative 2 would result in adverse, regional and local, short- and long-term, minor to major impacts to terrestrial wildlife species. Alternative 2 would not result in the impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects

would be regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative 3

Analysis. Alternative 3 is characterized by a slight decrease in average daily HRR use (from one day trip of 100 people to three day trips with 30 people each), but up to 400 pontoon boat passengers per day. On peak days this would require 160 helicopter flights (80 round trips) for pontoon boat passengers and up to 60 flights (30 round trips) for HHRR day and overnight passengers. HRR overnight trips would increase from an average of three trips per month to two trips per day all year long. Upriver trip takeouts would be allowed based on continuation of trip takeout needs. An additional commercial use, jetboat tours, would be allowed, with a maximum of two tours per day. A floating, formal dock would be allowed at RM 262, contingent on environmental compliance and removal of the "informal" docks at RM 262 and 263.

Invertebrates — Increased HRR overnight use, and a possible increase in day use by jetboat tours at beaches and campsites, would likely increase organic attractants to some invertebrate species such as ants, causing a nuisance. Increased activity at these sites would likely have localized, adverse, short-term, year-round, minor effects on invertebrate species.

Amphibians and Reptiles / Mammals — As discussed in Alternative 1, habitat modification and human disturbance would continue to be the greatest threats to amphibians, reptiles, and mammals. Due to an increase in HRR overnight trips, there would also be a greater loss of woody material being used for campfires, as well as displacement for campsite establishment and grooming, which would likely further affect small mammal and reptile local populations. Noise from motorized vessels would also cause disturbance. There would be an increase in remote side canyon hiking and possible trampling of amphibian habitat and young if closures were not established and enforced during the critical breeding and rearing periods.

An increase in interactions between humans and wildlife would be expected from increased visitation at he picnic and pontoon sites, as well as by the addition of jetboats and visitors to previously less impacted sites.

The effect on large mammals from contaminants, pollutants, and noise in the corridor environment would likely increase with the addition of jetboat tours. Although the enormous volume of the Colorado River would dilute the contaminant concentrations to a very low level, fuel discharges from motorized boats and the potential for accidents involving oil and fuel spills would be greater.

Aquatic mammal species have been documented as not only being disturbed by watercraft, but also subject to mortalities (Serfass, pers. comm. 2002). The addition of jetboats, which typically operate at much higher speeds that pontoon craft, could be expected to injure or kill beavers utilizing the Lower Gorge.

Birds — As described for Alternative 1, motorized use would occur at critical times during nesting season and migration periods. Habitat in this area is limited, and there could be an

increase in mortality of these species as a result of more motorized vessels in the inflow areas and around important nesting areas. An increase of winter passengers on pontoon boats to 400 per day would substantially increase the flushing of overwintering and migratory birds, resulting in an adverse, moderate impact. Ravens and starlings would likely expand their range of habituation to more sites where attractants were available. Overall, the impact on birds from increased motor vessel use would be considered an adverse, major impact.

Mitigation of Effects. As described for Alternative 1, previous mitigation efforts indicate that specific measures could be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures were maintained. Reasonable mitigation actions would be the same as those listed on pages 445 and 473.

Cumulative Effects. As described for Alternative 1, development on Hualapai tribal lands in the Quartermaster area would continue to have moderate to major adverse impacts on use of the area as wildlife habitat, and some species and individuals have likely already been displaced from the area. Based on the amount of available habitat nearby, it is unlikely that there would be more than localized, adverse, short- to long-term, year-round, moderate effects and regional, adverse, short- to long-term, year-round, minor effects on wildlife and wildlife habitat.

The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative 3 on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. An increase in HRR overnight trips would result in more adverse human/wildlife interactions. An increase of winter passengers on pontoon boats to 400 per day would substantially increase the flushing of overwintering and migratory birds, resulting in an adverse, moderate impact. The addition of jetboat tours would adversely impact bird and mammal species. An increase in visitation into remote side canyons would likely impact amphibians, ungulates, and carnivores due to increased disturbance to wildlife utilizing these once-remote side canyon areas and secluded shorelines. More visitors flying in by helicopter and the addition of jetboat tours would increase the potential for impacts on species such as ravens, starlings, some invertebrate ant species, and perhaps even coyotes, as experienced elsewhere in the park, particularly at picnic areas. Impacts would be adverse and major for migratory raptors.

In summary, Alternative 3 would have regional and local, adverse, short- and long-term, minor to major impacts on wildlife species. Alternative 3 would not result in the impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 4 (NPS Preferred Alternative)

Analysis. Alternative 4 would have a variable number of trips per day, with up to 40 people (including guides) per trip during the peak season and a variable number of trips per day with up to 35 people during the non-peak season. For pontoon operations six boats would be allowed in the Quartermaster area, with a maximum daily capacity of 150 passengers, plus associated helicopter operations. Four upriver trip takeouts per day would be allowed, plus tow-outs. A floating, formal dock would be allowed at RM 262.5.

Invertebrates — A large increase in overnight HRR use at beach and campsites would likely result in organic attractants to some invertebrate species such as ants, causing a nuisance. Habitat modification would likely result in a reduction in species diversity and breeding habitat. The level of activity proposed in this alternative would have an adverse, minor effect on invertebrate species.

Amphibians and Reptiles / Mammals — As discussed in Alternative 1, habitat modification and human disturbance would continue to be the greatest threat to mammals at campsites and in remote side canyons in the Lower Gorge. With an increase in HRR overnight trips, there would continue to be an adverse effect on woody material being used for campfires, as well as being displaced for campsite establishment and grooming, which would likely further adversely affect local small mammal and reptile populations. Increased disturbance from motorized vessels might also affect some ungulate species and aquatic mammals using the shoreline due to longer trips. There would likely be an increase in remote side canyon hiking, resulting in the possible trampling of amphibian habitat and young if closures were not set in place and enforced during critical breeding and rearing periods.

Interactions between humans and wildlife would likely increase only slightly at campsites, the helipad, and picnic area sites.

The effect on large mammals from the introduction of contaminants and pollutants into the corridor environment could be expected to remain adverse, short term, minor, the same as Alternative 1.

Birds — Bird species would continue to be affected by the use of motorized vessels during nesting and migration periods. Habitat in the Lower Gorge is limited, and there could be adverse impacts to breeding birds based on increased use of motorized vessels in the inflow areas and around important nesting areas. Overall, the impact on birds would be considered adverse and major.

Mitigation of Effects. As described for Alternative 1, previous mitigation efforts indicate that specific measures could be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures were maintained. Reasonable mitigation actions would be the same as those listed on pages 445 and 473.

Cumulative Effects. As described for Alternative 1, development on Hualapai tribal lands in the Quartermaster area would continue to have moderate to major adverse impacts on use of the area as wildlife habitat, and some species and individuals have likely already been displaced from the area. Based on the amount of available habitat nearby, it is unlikely that there would be more

than localized, adverse, short- to long-term, year-round, moderate effects and regional, adverse, short- to long-term, year-round, minor effects on wildlife and wildlife habitat.

The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative 4 on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Alternative 4 would have adverse, short- and long-term, moderate to major impacts to wildlife species both regionally and locally. Alternative 4 would not result in the impairment of terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 5 (Hualapai Tribe Proposed Action)

Analysis. Alternative 5 would be the same as Alternative 4 except for pontoon boat operations and upriver travel. Under Alternative 5 there would be a dramatic increase in pontoon operations, with a maximum of seven boats carrying a maximum of 960 passengers each day in the Quartermaster area, plus associated helicopter flights. Upriver travel would be allowed only below RM 273, and no jetboat tours would be allowed.

Invertebrates — Insect problems would likely increase substantially because of proposed use levels under this alternative. Ant densities would be much higher on heavily used beaches than at relatively unused beach areas because of human activity and improper organic garbage disposal. Flesh and blow fly populations would also show an increase in density at heavily used campsites, particularly at sites with improper fecal and organic waste disposal, as many vessels traveling upriver from Lake Mead do not have sanitation facilities. With high levels of use and the increase in established campsites, woody riparian vegetation, which provides habitat for invertebrate species would be expected to decrease. Impacts to invertebrates would likely be adverse, short term, and minor to moderate.

Amphibians and Reptiles / Mammals — As discussed in Alternative 1, habitat modification and human disturbance would continue to be the greatest threat to mammals at campsites and in remote side canyons in the Lower Gorge. With an increase in HRR overnight trips, there would continue to be an adverse effect on woody material being used for campfires, as well as being displaced for campsite establishment and grooming, which would likely further adversely affect local small mammal and reptile populations. Increased disturbance from motorized vessels might also affect some ungulate species and aquatic mammals using the shoreline due to longer trips. There would likely be an increase in remote side canyon hiking, resulting in the possible trampling of amphibian habitat and young if closures were not set in place and enforced during critical breeding and rearing periods.

Under Alternative 5 the increase in pontoon and associated helicopter traffic would likely have an increased adverse impact on large mammal distribution and, consequently, their predators. As described for Alternative 1, ungulates and carnivores would likely change their movement patterns in response to increased aircraft overflights, construction noise, and park visitors. With the large number of helicopter flights per day in the Quartermaster area, large mammal could be completely displaced for several surrounding miles.

It is likely that Alternative 5 would substantially increase the interactions between humans and wildlife, possibly resulting in management actions to minimize conflicts. These management actions could result in the direct reduction of some wildlife species such as coyotes, squirrels, and deer (GRCA wildlife files).

The effect on large mammals from the introduction of contaminants and pollutants into the corridor environment could be expected to remain adverse, short term, minor, the same as Alternative 1.

Overall impacts on reptiles, amphibians, and mammals at the proposed level of use would be adverse, long term, and major.

Birds — Bird species would continue to be affected by the use of motorized vessels during nesting and migration periods. Habitat in the Lower Gorge is limited, and there could be adverse impacts to breeding birds based on increased use of motorized vessels in the inflow areas and around important nesting areas. Overall, the impact on birds would be considered adverse and major.

Mitigation of Effects. As described for Alternative 1, previous mitigation efforts indicate that specific measures could be effective in reducing impacts to terrestrial wildlife, if adequate funding, staffing, monitoring, and implementation of the measures were maintained. Reasonable mitigation actions would be the same as those listed on pages 445 and 473.

Cumulative Effects. As described for Alternative 1, development on Hualapai tribal lands in the Quartermaster area would continue to have moderate to major adverse impacts on use of the area as wildlife habitat, and some species and individuals have likely already been displaced from the area. Based on the amount of available habitat nearby, it is unlikely that there would be more than localized, adverse, short- to long-term, year-round, moderate effects and regional, adverse, short- to long-term, year-round, minor effects on wildlife and wildlife habitat.

The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative 5 on terrestrial wildlife, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate to major contribution to these cumulative effects.

Conclusion. Under alternative 5 the large number of helicopter flights in the Quartermaster area would greatly impact and likely displace migratory raptors and large mammals, causing adverse, major impacts. Impacts to amphibians and reptiles would likely remain at a major level under this alternative. The impacts of recreational use on neotropical migrants due to disturbance by

the large number of motorized boats passing nesting areas could result in adverse and moderate impacts. Winter use of pontoons and the constant flushing and harassment of over wintering raptors and waterfowl would be an adverse, major impact.

In summary, Alternative 5 would have regional and local, minor to major, adverse, long-term impacts to wildlife species. Alternative 5 would not result in the impairment of the terrestrial wildlife resources in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate to major contribution to these cumulative effects.

AQUATIC RESOURCES

ISSUES

The following resource comments were received during public scoping:

- Protect ecological resources is the National Park Service's first priority.
- Protect near-river springs and seeps, and tributaries, because they are valuable resources.
- Protect threatened and endangered species.
- Close off areas experiencing excessive impacts.
- Use an adaptive management approach and improve resource monitoring.
- Manage invasive exotic species.
- Restore natural conditions.
- Eliminate motor use to protect aquatic resources.

Aquatic resources occur in both the Colorado River mainstem and in the numerous side canyon streams and springs that make up the river system. Although Glen Canyon Dam fundamentally changed the character of the Colorado River in Grand Canyon from a flood-prone river with a wide range of water temperatures and sediment loads to dam-controlled flows with a narrow range of water temperatures and reduced sediment loads, the system does retain important elements of the predam river.

Four native fish species occur in the Colorado River in Grand Canyon National Park: the humpback chub (an endangered species), the flannelmouth sucker (a candidate species), the bluehead sucker, and the speckled dace. The tributaries in the Grand Canyon are vital for the persistence of native fish populations; the tributaries are spawning grounds for adult fish and rearing areas for juveniles.

Protection of the ecological resources of the canyon, particularly the near river springs, seeps, and tributaries are an important aspect of NPS management of the river corridor. Side canyon tributaries and springs are attraction sites for river runners throughout the year, although most use occurs during the summer. Minimizing visitor impacts to fragile aquatic resources is necessary to ensure the continued success of the resource.

PHOTO 4-7: RECREATIONISTS ROIL SUBSTRATES

Recreational impacts on aquatic resources are well documented in many national parks. Recreational impacts on streams have been documented in Great Smoky Mountains National Park (Larson and Hammitt, 1981) and in springs in Death Valley National Park, where areas have been closed to recreationists due to impacts (USFWS 1980). Wright and Li (1998) reported that river runners reduced aquatic insect abundance in an Oregon stream of similar size to Bright Angel Creek. Aquatic communities are relatively resilient and generally recover in 30 days after most types of disturbance (flooding, road construction, etc.) end (Yount and Niemi 1990); however, park streams and springs can have sustained, repetitive seasonal impacts that to date have not been evaluated. Sappington (1998) found that recreational activities in the Virgin River in Zion National Park reduced fish abundance of native fishes, particularly young fish. Gorman and Stone (1999) reported a reduction in catch rates over the past decade in the Little Colorado River near the confluence with the Colorado River; recreational activity is a suspected cause.

Although more field experiments are needed, outboard engine exhaust (Tjarnlund et al. 1995) and noise (Schoilk and Yan 2002) are deleterious to fish health and alter behavioral patterns. The New Zealand mudsnail, an exotic pest species, has recently been found in several tributaries which are popular river runner attractions. These visitors may be inadvertently spreading these snails up tributaries (Shannon et al. 2003). Trailing across established trails along stream banks and bottoms increases impacts of erosion and sedimentation. Disturbance of substrates by walking in streams through fish, amphibian, and invertebrate egg masses can affect these resources, as does the creation of dams and channels with rocks. Dams disturb aquatic habitat and impede stream flow, and can block migrating fishes. Recreational activities such as playing in tributaries can alter fish behavior (spawning, rearing, and feeding) and alter water quality from lotions and bug spray. Wakes from motorized boats can create bank erosion and dislodge riparian vegetation which provides shade and an abundance of insect life for aquatic species. Native fish can be caught during recreational angling. Pollution from camp and lunch stop waste (primarily food scraps) and human fecal waste that wash into tributaries, mainstem backwaters,

and springs can affect water quality and the aquatic resources that depend on them. Recreationists have indirect impacts on aquatic resources by adversely affecting water quality (see the "Water Quality" section), water discharge, physical substratum, trophic biomass, and community composition.

GUIDING REGULATIONS AND POLICIES

The aquatic resources in Grand Canyon National Park are protected and managed in a manner according to the mandates established by the following; The NPS Organic Act of 1916, the Clean Water Act of 1948, the Wilderness Act of 1964, the Wild and Scenic Rivers Act of 1968, the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, Exotic Organisms Act of 1977, Protection of Wetlands Act of 1977, Federal Compliance with Pollution Control Standards Act of 1978, Pollution Prevention Act of 1990, Grand Canyon Protection Act of 1994, and Executive Order 13112, "Invasive Species."

NPS *Management Policies 2001* (NPS 2000d) direct park management to understand, maintain, restore, and protect the inherent integrity of natural resources, processes, systems and values of the park. To the extent possible, the NPS allows natural processes, including the evolution of species, to control landscape and population level dynamics, assuming that all of the components of the natural systems remain intact. The preservation of fundamental physical and biological processes, as well as individual species, plant communities, and other components of naturally evolving ecosystems, is inherent in management direction. The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals through:

- Preserving and restoring the natural abundance, diversities, dynamics, distributions, genetic and ecological integrity, and behaviors of native species and the communities and ecosystems in which they occur.
- Restoring native species in parks when they have been extirpated by past human-caused actions.
- Initiating the return of human-disturbed areas to natural conditions (or the natural trajectory), including the processes characteristic of the ecology zone.
- Minimizing human impacts on native species, communities, and ecosystems, and the processes that sustain them.
- Preventing the introduction of exotic species and removing established populations.
- Monitoring natural systems and human influences upon them to detect change and developing appropriate management actions.

PHOTO 4-8: STREAM AT DEER CREEK

- Protecting watersheds, as complete hydrologic systems, primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded.
- Preserving, enhancing and restoring the natural and beneficial values of wetlands.

"Grand Canyon National Park 2004 Commercial Operating Requirements IV":

A. 1. Cans, rubbish and other refuse may not be discarded in the water or along the shore of the river, in side canyon, on trials, along escape routes, or in any other portions of the canyon. All refuse material must be carried out.

   2. The use of soap is restricted to the mainstem of the Colorado River only. Use of soap in side streams or within 100 yards of the confluence of any side stream and the main river is prohibited.

B. Each boat party must carry a washable/reusable toilet system capable of containing and removing solid human waste from the canyon. A washable/reusable toilet must be accessible during the day.

"Superintendent's Compendium": Areas restricted to day-use only include the following tributaries, springs and seeps

- Little Colorado River confluence (RM left 60–65)
- Shinumo Creek (RM 109)
- Elves Chasm (RM 116.5)
- Deer Creek confluence (1/2 mile upstream or downstream on the north side of the river at RM 136)
- Columbine Falls (within 200 yards of the bay at RM 274.3)

MANAGEMENT OBJECTIVE FOR AQUATIC RESOURCES

The management objective for aquatic resources, as stated in Chapter 1, is to manage river recreation use in a manner that protects native aquatic organisms, reduces aquatic habitat alteration, and minimizes the spread of exotic species.

METHODOLOGY FOR ANALYZING IMPACTS TO AQUATIC RESOURCES

The general process for assessing impacts to the environment is discussed in the "Introduction" to Chapter 4. Effects specific to aquatic resources are characterized for each alternative based on the impact thresholds presented below. The overall impact rating depends upon the interaction of context, duration, timing, and intensity of each identified impact. Impacts on aquatic resources were analyzed using the best available data for species locations, past aquatic monitoring reports, and the most recent published research on aquatic communities in Grand Canyon National Park and similar streams in the region. Impacts to aquatic resources could be negligible, minor, moderate, and major. Context, duration, and timing are resource based and are generally similar for each of the alternatives. Intensity is more likely to vary by alternative.

Impact Thresholds

Intensity

Negligible — Impacts to the aquatic environment would not result in detectable effects to aquatic organisms or populations in the Colorado River, tributaries, or springs.

Minor — Adverse: Impacts to the aquatic environment would result in detectable effects to aquatic organisms or populations in the Colorado River, tributaries, or springs. These changes would be temporary and the resource would return to pre-impact condition within a few days.

Beneficial: Impacts would result in short-term improvements in the aquatic habitat.

Moderate — Adverse: Impacts to the aquatic environment would result in detectable effects to aquatic organisms or populations in the Colorado River, tributaries, or springs. These changes would not be permanent, and the resource would rebound to pre-impact numbers after one season.

Beneficial: Impacts would result in habitat improvement and a reduction in invasive species.

Major — Adverse: Impacts to the aquatic environment would result in detectable effects to aquatic organisms or populations in the Colorado River, tributaries, or springs, which would likely result in long-term to permanent changes. In extreme cases, species may be extirpated from the park.

Beneficial: Impact that would result in the restoration of native species and elimination of invasive species.

Context

Localized — Impacts would occur to aquatic resources at attraction sites with aquatic features, in tributaries, or at seeps or springs.

Regional — Impacts would occur in the mainstem Colorado River within a management zone.

Duration

Short term — Impacts would occur to an individual, population, or habitat and would range from one day to a season, with no lingering results.

Long term — Impacts would occur to an individual, population, or habitat and would last longer than one season and longer than the life span of an individual animal.

Timing

Impacts to aquatic resources can be time sensitive. There is no dormant period in aquatic ecosystems. Mainstem impacts would likely be more pronounced during low-volume discharge months (such as May and October) than high volume months (July and January). Spawning and growth of young-of-the-year fish in tributaries are also sensitive periods. Summer is a period of low discharge, peak water temperatures, and the lowest dissolved

oxygen levels, so fish are more easily stressed. Monsoon storms (summer-fall) can cause flooding that impacts aquatic resources.

Mitigation of Effects

Reasonable mitigation efforts that could be effective in reducing impacts to aquatic resources if adequate funding, staffing, monitoring, and implementation of the measures were maintained include the following:

- Increase visitor education and awareness.
- Develop baseline data for impact detection and restoration.
- Develop and implement aquatic resource monitoring program to access impacts.
- Close sensitive sites and impacted areas.
- Consistent with the 1989 *Colorado River Management Plan* Limits of Acceptable Change standards: restrict activities in known humpback chub habitat. This includes the mouth of the Little Colorado River during critical time periods.
- Restrict river runner use of Tapeats and Kanab creeks to day use only; no camping at the mouths of these creeks.
- Use limited site closures to assess impacts of visitation.
- Construct and maintain trails along tributaries and springs getting use out of the streambeds.
- Prohibit the construction of man-made rock obstructions (dams) and actively remove them.
- Reduce use of tributaries for swimming and wading.
- Restrict angling in areas inhabited by sensitive, threatened, or endangered fishes.
- Remove exotic aquatic species where feasible and monitor recovery.
- Enforce Commercial Operating Regulations regarding sanitation procedures, camp kitchen waste disposal and use of the day tripper.
- Limit the number of motor trips per day in critical seasons in all management zones.

Current NPS management efforts to mitigate impacts to aquatic resources include restricting recreational angling within 1 mile of the Little Colorado River, removal of trout from Bright Angel Creek, and surveys of native and introduced fishes in several side canyon tributaries. The effectiveness of management actions in Bright Angel Creek will be evaluated over the next several years by monitoring the native fish populations in the creek and through estimates of trends in the brown trout population in the mainstem by the Glen Canyon Dam Adaptive Management Program. Lack of scientific data, challenges with working in remote desert environments, the need to balance access with protection of species, and limitations in park staff and funding contribute to the difficulty park staff have in mitigating current levels of impacts to aquatic resources.

Cumulative Impacts

Cumulative impacts on aquatic resources were determined by combining the impacts within each alternative with other past, present, and reasonably foreseeable future action (see the "Introduction" to Chapter 4 for a detailed list of all actions.

Mainstem. Impacts on native fishes from angling are caused primarily by backcountry users in the Marble Canyon area and near Bright Angel Creek. Angling has a cumulative adverse, minor to moderate, short-term, effect. The major factor affecting aquatic resources in the mainstem and wetlands along the Colorado River is the existence and operation of Glen Canyon Dam. The effects of the dam far outweigh the effects of river recreationists on aquatic resources in the river corridor. The dam has favored the formation of new cold-water aquatic habitats that should remain relatively stable under current operating conditions. Federal and state agencies have introduced non-native cool-water, invertebrates and fishes, which compete with and prey on native species. Cumulative impacts from Glen Canyon Dam and the introduction of exotic species are adverse, regional, long-term, year-round and major.

Regional drought, which could result in reduced base flow of tributaries, could intensify the negative impacts of recreational activity at attraction sites. Regional drought can also affect the level of Lake Mead and reduce the level of the mainstem Colorado River in the Lower Gorge. Regional drought has regional, adverse, short-term, year round, moderate to major effects on aquatic resources.

Tributaries and Springs. Federal and state agencies have introduced non-native fishes, primarily trout, into several tributaries. Trout compete with and prey on native fishes. Recreational angling is common only in Bright Angel Creek primarily by backcountry users. Cumulatively, impacts to aquatic resources in side canyon tributaries and springs are adverse, localized to regional, short- to long-term, and moderate to major. In addition to river runner use, the major factors affecting aquatic resources in side canyon tributaries are backcountry hikers and researchers. Impacts to aquatic resources in these areas are likely to be adverse, moderate to major, short to long term, seasonal and localized. The lower reaches of most tributaries would be more heavily impacted by river runners while the upper reaches would be more heavily impacted by backcountry hikers. Backcountry hikers and commercial mule riders probably dominate the use of Bright Angel Creek. Watershed management plans, such as tributary flow regulation, ground water pumping, and controlled burns, could also alter tributary water quality and flows.

Assumptions

General assumptions used in the analysis of effects for each alternative are discussed in the "Introduction" to Chapter 4. Assumptions that specifically relate to alternatives presented in this document and their effect on aquatic resources are presented below.

- The existence and operation of Glen Canyon Dam and the elevation of Lake Mead are the dominant impacts on aquatic resources in the mainstem Colorado River in Grand Canyon National Park.
- The influence of Lake Mead extends 36 miles up into the Lower Gorge at full pool.

- Regionally, recreational impacts to aquatic resources are generally negligible to minor due to the large area of the mainstem Colorado River and short-term nature of the effects.

- Aquatic resources in tributaries and springs are more sensitive and prone to recreational impacts than the mainstem.
- At least 62 of 261 recreational sites in Grand Canyon National Park have an aquatic feature (Appendix C, Table 1), and are visited on a daily basis during summer months.
- The probability of impacts to aquatic resources occurring in tributaries and springs increases as the level of visitation increases.
- Decreasing trip lengths and group size and shifting use to the fall and winter can mitigate increasing visitor access (total probable user-days).
- Longer trips have, by their nature, increased amounts of time for visitors to interact with the canyon environment. This increased time has the potential to allow greater interaction with aquatic resources. This is particularly true for side canyon hiking during spring and fall, and shelter seeking and the desire to cool off in water during hot summer months. Off-season hiking (shoulder and winter months) are more conducive to exploring side canyons, as the extreme heat of the summer precludes hiking too far from the river itself, but users are less likely to get into the water to swim.
- Backcountry users contribute to visitor impacts in the backwaters and wetlands along the mainstem and in side canyon tributaries and springs. Their effects would be additive.
- Contamination by personal care products and human waste occurs along the river and in side canyons. Changes in the water quality could adversely affect aquatic resources, but there are no data to support this conclusion; the overall impact is probably negligible.
- An increase in numbers of motor boats operating within a localized area increases motor related impacts to aquatic resources.

IMPACT ANALYSIS — LEES FERRY ALTERNATIVES

Alternative A (Current Conditions)

Analysis. Under Alternative A, management of recreational use would continue to allow large group sizes with a maximum commercial group size of 43, long trips with a maximum winter trip length of 30 days, and spikes in trips and people at one time, and daily launches (see Table 4-1). User-days would remain capped at current levels, which would result in approximately 22,500 passengers per year. Highest use occurs in the summer months and lowest use in the winter months. User discretionary time would remain relatively similar to current levels (the lowest of all the alternatives). Whitmore exchanges would occur year-round and there would be a three month no-motor season in the fall. Both motor and oar commercial trips would be allowed in the winter.

Erratic launch patterns (with a maximum of nine launches per day in summer) and the highest number of trips and people at one time create crowding at attraction sites. The major attraction sites with aquatic features would continue to experience many 100+ and 150+ visitor days in the

TABLE 4-21: PREDICTED VISITATION LEVELS AT MAJOR ATTRACTION SITES WITH AQUATIC FEATURES (MAY–AUGUST)

	Alternatives							
	A	B	C	D	E	F	G	H
Days with 100+ Visitors								
Little Colorado River	28	0	1	11	0	0	0	0
Shinumo Creek	53	0	5	86	0	2	3	0
Elves Chasm	75	0	80	98	2	11	5	0
Deer Creek	66	1	64	109	12	4	8	0
Matkatamiba	4	0	48	3	0	0	0	0
Havasu Creek	79	0	73	102	11	0	4	0
Days with 150+ Visitors								
Little Colorado River	11	0	0	0	0	0	0	0
Shinumo Creek	14	0	2	11	0	0	0	0
Elves Chasm	18	0	8	30	0	1	0	0
Deer Creek	24	0	27	32	0	0	0	0
Matkatamiba	0	0	9	0	0	0	0	0
Havasu Creek	36	0	39	31	0	0	0	0

Note: Based on data from the Grand Canyon River Trip Simulator.

summer (Table 4-21). Large numbers of visitors per day repeatedly using tributaries and seeps and springs in the late spring and summer months can have significant impacts on aquatic resources and habitat during critical months of the year. This has localized, adverse, seasonal, short- to long-term, moderate to major effects on aquatic resources.

This alternative also allows for large group sizes up to 43 people, which increases the probability that a larger surface area of the tributary streambed would be impacted. Larger groups are more likely to disturb larger areas (Hendee, Stankey, and Lucas 1990). When several large groups visit attraction sites at the same time, the probability of impacting aquatic resources magnifies and impacts such as roiling substrates, bank erosion, trampling of riparian vegetation, disturbing food sources and egg masses, dam building, polluting water with personal care products and creating multiple trailing are more likely to occur. This has localized, adverse, seasonal, short- to long-term, moderate to major effects on aquatic resources.

Many campsites are located near tributaries, and camp and lunch waste (primarily food scraps) and human fecal waste can wash into tributaries, mainstem backwaters, and springs affecting water quality and the aquatic resources that depend on them. Under current condition, results from the Colorado River Human Impact Monitoring Program (Brown and Jalbert 2003) showed evidence of human waste at 18 of the 25 sites monitored during July and October 2003. Although all river trips are required to carry out all solid human waste, these regulations do not have 100% compliance. Camp-related pollution has localized, adverse, seasonal, short-term, negligible to minor effects.

Low user discretionary time and low use in the spring are beneficial to aquatic resources, but longer trip lengths that encourage layover days and allow people more time to hike further up tributaries, make sensitive side canyon resources more vulnerable to impacts. The probability of spreading of exotic species farther up into side canyons increases with large groups of people with more time to hike further up tributaries. Longer trip lengths have localized, adverse, short- to long-term, seasonal to year-round, moderate effects on aquatic resources.

Under this alternative, there is a three-month no-motor season in the fall. The benefits of a no-motor season are a reduction in pollution from motor fuel and exhaust and the removal of disturbance to fish from motor noise. These benefits are not likely to significantly improve aquatic resource conditions, since fish spawn in the spring and young-of-the-year need protection in early to mid summer. A motor season in the spring and summer adversely affects aquatic resources in the mainstem. Motor pollution and noise has regional to localized, adverse, short- to long-term, seasonal, negligible to minor effects.

Mainstem (Regional) — Recreational impacts to aquatic resources in the Colorado River are negligible to minor, short-term, and seasonal. Research in other parks indicates that noise and petroleum contaminants from motor boats adversely affect aquatic resources at detectable levels, but are short-term. Recreational impacts to native fishes in the mainstem could result from anglers inadvertently catching native fishes while angling for trout; however there are no recreational fishing river trips along this stretch of river and angling is not a common river running activity.

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs (roiling substrates, disturbing bank sediments and vegetation, dislodging fish eggs, etc.) are adverse and moderate to major. Impacts would be detectable and in some cases, aquatic resources would not return to pre-impact conditions within one season. High use in the summer season when river runners seek shade and cool water in side canyons during the summer heat adversely affects aquatic resources during critical summer months. These impacts would be localized to attractions with aquatic features, short-term, and seasonal (summer). Repeated annual heavy use of sensitive side canyon tributaries or springs could lead to long-term impacts on species abundances and diversity. The low number of users in the spring helps protect fish during the spawning season.

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the Mitigation of Effects section above. Site restrictions and increased funding for monitoring and law enforcement would be essential. Given the crowding and congestion that occurs at attraction sites due to erratic launch patterns, large group sizes and long trip lengths inherent in this alternative, excessive tributary closures would be needed to reduce impacts to minor. Since excluding visitors from numerous aquatic attractions is not feasible or desirable, these mitigations are not reasonable or attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short term to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative A on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Alternative A would have adverse, regional to localized, short-term to long-term, seasonal, negligible to major effects on aquatic resources. There would be negligible effects from current conditions. Alternative A would not result in the impairment of aquatic resources in Grand Canyon National Park. Cumulatively, the effects of Alternative A on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative B

Analysis. Under Alternative B recreational motor trips would be prohibited and group sizes, trips at one time, people at one time, daily launches, user-days, and probable total yearly passengers at their lowest levels (see Table 4-1). Maximum trip length would be substantially reduced from current condition down to 18 days and maximum commercial group size would be reduced from 43 to 25 people. An eight person noncommercial trip would be added. Total user discretionary time increases in all seasons due to the lack of shorter motor trips. There would be no Whitmore Helicopter exchanges. Total user-days would be about the same as current; however total number of passengers per year decreases by around 10,000. No commercial trips would be allowed in the winter.

Controlling the number and types of trips that can launch each day helps reduce trips at one time and people at one time and thereby reduces crowding and congestion at attraction sites in the summer (Table 4-21). By reducing group sizes, fewer people would be recreating in streams at one time and the area of impact would occur over a smaller area. This alternative reduces the number of passengers in the spring and summer, protecting aquatic resources during critical months. This would have localized, beneficial, short- to long-term, seasonal, minor to moderate effects on aquatic resources from current conditions.

Although user discretionary time goes up, reducing total user-days and total number of feet in the streams would have beneficial effects to aquatic resources. Reducing trip length would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. The reduced trip lengths in conjunction with the increased user discretionary time would mean that users would be spending much of their time at sites along the river corridor, thereby protecting tributary sites. Users would be less likely to spread exotic species farther up into side canyons. Reducing trip length would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions.

Under this alternative, there would be no motors year-round. This would have localized to regional, beneficial, short- to long-term, seasonal, negligible to minor effects on aquatic resources from current conditions by reducing pollution from fuel and exhaust, as well as lowering disturbance to aquatic life from motor noise.

Mainstem (Regional) — Same as Alternative A, except pollution from motor fuel and noise from motor boats would not be an issue, reducing impacts to negligible.

Tributaries and Springs (Localized) — Reduced number of launches per day, consistent launch patterns, a reduction in trips at one time and people at one time, and reduced group size and trip length would all be beneficial to aquatic resources and improve conditions over current. Allowing public access to aquatic attraction sites even at the reduced numbers proposed under Alternative B would still cause adverse, seasonal, short-term to long-term, minor to moderate effects on tributary and spring aquatic resources. Impacts would be detectable, but resources would likely return to pre-impact conditions after one season.

Mitigation of Effects. Actions required to mitigate effects would include all of the mitigation measures identified in the Mitigation of Effects section above. Levels of mitigation required would be less than A due to the reduction in use. This level would be reasonable and attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative B on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Alternative B would have adverse, regional to localized, short-term to long-term, seasonal, and negligible to moderate effects on aquatic resources. There would be beneficial, regional to localized, short-term, year-round, minor to moderate effects on aquatic resources from current conditions**.** Alternative B would not result in the impairment of aquatic resources in Grand Canyon National Park. Cumulatively, the effects of Alternative B on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative C

Analysis. Under Alternative C, motors would be eliminated, maximum group size would be reduced to 30 people and maximum trip length to 21 days. Trips at one time and people at one time would be reduced, while total annual user-days would increase by around 100,000 (see Table 4-1). User-day levels double in the shoulder seasons. Total user discretionary time would also double, with the greatest increase in winter and shoulder seasons. Launches per day would be reduced to four in the summer, three in the shoulder seasons, but increased to two in the winter months. There would be approximately 3,000 more passengers per year. Commercial oar trips would be allowed in the winter.

Controlling the number of trips that could launch each day would help reduce trips at one time and people at one time and could relieve crowding and congestion at attraction sites. However under the high-use levels proposed in Alternative C and with all trips moving at about the same pace, the numbers of people visiting attraction sites per day in the summer would be still about as

high as under current condition (Table 4-21). So the new launch pattern would have a negligible effect on aquatic resources from current conditions. By reducing group sizes, fewer people would be recreating in streams at one time and the area of impact would occur over a smaller area. Reducing trip length would minimize the number of days users laying over at sites, as well as time to impact sensitive sites up side canyons. Users would less likely to spread exotic species farther up into side canyons. Reducing group size and trip length would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions.

Unlike Alternative B, this alternative doubles the number of passengers in the spring which would make aquatic resources more vulnerable during this critical time. Annual user discretionary time would substantially increase, as would total number of user-days and total number of passengers. This would have localized, adverse, short- to long-term, seasonal, moderate to major effects on aquatic resources. A large increase in user-days, people at one time, and user discretionary time in the winter would represent new use at a time of year when aquatic resources are probably less sensitive to disturbance and when river runners are not playing in the water. This new winter use would probably have negligible effects on aquatic resources.

Under this alternative there would be no motors year-round. This would be beneficial to aquatic resources by reducing amount of petroleum contamination, as well as disturbance to aquatic life from motor noise.

Mainstem (Regional) — Same as Alternative A with the benefits of no motors year-round

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate to major because of the large increases in spring and summer user discretionary time as well as the high numbers of trips all traveling at the same speed. Changes to aquatic resources would be detectable. In some instances, aquatic resources would return to pre-impact condition within a season, but in other cases, impacts would be long term and permanent. Summer is the peak river running season when visitors swim in tributaries. This alternative retains high summer use during the critical season, which would have adverse effects. Impacts would be localized to attractions with aquatic features, short-term, and seasonal (spring and summer). Repeated heavy annual use of sensitive side canyon tributaries and springs would lead to long-term adverse impacts on species abundances and diversity.

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the Mitigation of Effects section above. Site restrictions and increased funding for monitoring and law enforcement would be essential. Reductions in group size and trip length would be offset by high increases in use and user discretionary time. The level of mitigation needed to reduce impacts to minor would not be reasonable or attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative C on aquatic resources, when combined with these other past, present,

and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative C would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Alternative C would have adverse, regional to localized, short-term to long-term, seasonal, and negligible to major effects on aquatic resources. There would be beneficial, regional to localized, short-term, year-round, negligible to moderate effects on aquatic resources from current conditions**.** Alternative C would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative C on aquatic resources, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative C would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative D

Analysis. Alternative D is a mixed use alternative. Under this alternative, maximum commercial group size is 25. Trip lengths are reduced from current in the summer and shoulder seasons, but a maximum trip length of 30 days is allowed in the winter. An eight person noncommercial trip would be added. Total annual user-days increase by about 50,000 (see Table 4-1). This alternative has the highest total user discretionary time. There are four no-motor months that occur in the shoulder seasons to coincide with the high backcountry use season. Trips at one time and people at one time and total passengers are reduced from current. Motor trips are allowed in the winter. There would be no Whitmore helicopter exchanges. Commercial motor and oar trips are allowed in the winter.

Controlling the number of trips that can launch each day helps reduce trips at one time and people at one time and can relieve crowding and congestion at attraction sites. However under the particular mix of trip types numbers of people visiting aquatic attraction sites per day in the summer is higher than current at some sites (Table 4-21). This would have localized, adverse, short- to long-term, seasonal, negligible to minor effects on aquatic resources from current conditions. Similar to Alternatives B and C, by reducing group sizes, fewer people would be recreating in streams at one time and the area of impact would occur over a smaller area. The reduction in group size would have localized, beneficial, short- to long-term, seasonal, minor to moderate effects on aquatic resources from current conditions.

Reducing trip length would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Although user discretionary time increases, users would most likely spend more time at sites adjacent to the river since trip lengths are shorter. Users are less likely to spread exotic species farther up into side canyons. Shorter trip lengths would have localized, beneficial, short- to long-term, seasonal, minor to moderate effects on aquatic resources from current conditions. Noncommercial winter trip lengths would still be 30 days, but aquatic resources are less vulnerable in the winter months and fewer people play in the water due to colder temperatures, thus having negligible effects.

The number of passengers in the spring would remain relatively low, and no motors would be allowed in the spring. These actions would protect aquatic resources during this critical season. This would have localized to regional, beneficial, short- to long-term, seasonal, moderate effects.

Mainstem (Regional) — Same as Alternative A, except the no-motor season in the spring would be beneficial over current conditions.

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate because there would be detectable changes but not permanent. Adverse impacts would occur due to the increases in user discretionary time and the number of days that major attraction sites with aquatic features would experience an increase in the number visitors. Summer continues to have high use and is the peak river running season and river runners seek shade and cool water in side canyons during the summer heat. However, in the spring season, aquatic resources are protected with low numbers of passengers and small group sizes. Impacts would be localized to attraction sites with aquatic features, short-term to long-term, and seasonal (spring and summer).

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the Mitigation of Effects section above. An increase in funding and staff over current levels would be needed, especially in the summer months. The increase in mitigations would be at a reasonable and attainable level.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative D on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative D would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Alternative D would have adverse, regional to localized, short-term to long-term, seasonal, and negligible to moderate effects on aquatic resources. There would be beneficial, minor to moderate effects from current conditions. Alternative D would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative D on aquatic resources, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative D would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative E

Analysis. Alternative E is a mixed use alternative. Under this alternative, maximum commercial group sizes are reduced to 30 people for motor trips and 25 people for oar trips. An eight person noncommercial trip would be added. Maximum trip lengths in all seasons are reduced from current. There is a six month no-motor season from October to March (see Table 4-1). Helicopters at Whitmore only operate from April to September. Maximum trips at one time and

people at one time are reduced from current, while total annual user-days increases by approximately 60,000. Launch patterns allow six launches in the summer, three during shoulder seasons and two in the winter. There are no commercial trips allowed in the winter.

Under the mix of use types and launch pattern proposed in Alternative E, there is a reduction in trips at one time and people at one time and numbers of people visiting aquatic attractions per day in summer (Table 4-21). This helps to relieve crowding and congestion at attraction sites and would indirectly reduce impacts to aquatic resources, having localized, beneficial, short- to long-term, seasonal, minor to moderate effects from current conditions. By reducing group sizes, fewer people would be recreating in streams at one time and the area of impact would occur over a smaller area. Reducing trip length would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Users would be less likely to spread exotic species farther up into side canyons. Reducing group size and trip length would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions.

User-days and user discretionary time in the spring increase, but total number of passengers during the shoulder season remains low and trip lengths are the shortest of all alternatives. Although river recreationists may have more user discretionary time, the use would likely occur within the river corridor and not up side canyons because they would not be staying as long at river stops. This would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions. An increase in user-days, passengers, and user discretionary time in the winter represents new use at a time of year when aquatic resources are probably less sensitive to disturbance and when river runners are not playing in the water and intentionally seeking out side canyon tributaries to escape high air temperatures, would have a negligible effect on aquatic resources.

The no-motor season would be October to March. Eliminating motor boat noise and fuel contaminants in March would benefit aquatic species at the beginning of the spawning season. In April, motor trips would be limited to one launch per day. This would have localized to regional, beneficial, short- to long-term, seasonal, negligible to minor effects.

Mainstem (Regional) — Same as Alternative A, with some benefit to aquatic resources having the no-motor season in March.

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate because there would be detectable changes but not permanent. The new launch pattern, group size and trip length reduction would benefit aquatic resources over current condition since fewer people at one time would be visiting aquatic attractions. Summer continues to have high use and is the peak river running season and river runners seek shade and cool water in side canyons during the summer heat. Impacts would be localized to attraction sites with aquatic features. Impacts would be long-term when impacts affect species abundances and diversity.

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the “Mitigation of Effects”

section above. An increase in funding and staff over current levels would be needed year-round. The increase in mitigations would be at a reasonable and attainable level.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative E on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Alternative E would have adverse, regional to localized, short-term to long-term, seasonal, and negligible to moderate effects on aquatic. There would be negligible to moderate effects from current conditions. Alternative E would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative E on aquatic resources, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative F

Analysis. Alternative F is a mixed use alternative with six months each for motorized and non-motorized uses. The no-motor season would occur July through December (see Table 4-1). Daily launch patterns would allow a maximum of six trips per day in the summer, four in the shoulder seasons and two in the winter. Helicopter exchanges at Whitmore would occur only during the January to June motor season. Commercial winter trips would be allowed. Maximum commercial group size would be 30 people and trip lengths would be reduced in all seasons. An eight person noncommercial trip would be added. Trips at one time and people at one time are reduced, while annual user discretionary time increases and number of total passengers per year rises by around 3,000.

Similar to Alternative E, the mix of use types and launch pattern proposed would reduce trips and people at one time and numbers of people visiting aquatic attractions per day in summer (Table 4-21). This would help relieve crowding and congestion at attraction sites and would indirectly reduce impacts to aquatic resources. By reducing commercial group size to 30, fewer people would be recreating in streams at one time and the area of impact would occur over a smaller area. These actions would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions.

Reducing trip length would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Although user discretionary time would increase, users would most likely spend more time at sites adjacent to the river because of shorter trips. Users would be less likely to spread exotic species farther up into side canyons. Reducing trip

length would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions.

Under this alternative, user-days and number passengers would double in the spring, and five motorboat launches per day would occur in May and June. Together these actions would have localized to regional, adverse, short- to long-term, seasonal, minor to moderate effects on aquatic resources, especially fish.

Mainstem (Regional) — Increased spring/early summer use would have greater adverse effects on aquatic resources than in Alternative A, making regional impacts negligible to moderate.

Tributaries and Springs (Local) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate to major because there would be detectable and possible permanent changes to the resource. Large increases in spring user discretionary time and shoulder season passengers adversely affect aquatic resources during a critical time period. Summer use is still high during the season when aquatic resources are vulnerable and visitors are most likely to swim in the water. Impacts would be localized to attractions with aquatic features, short-term to long-term, and seasonal (spring and summer).

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the Mitigation of Effects section above. In addition, changing the six month motor season to July through December would reduce impacts to aquatic resources in the critical seasons. Impacts from the high motor use in the spring/early summer could not be mitigated without altering the launch pattern in the alternative. Mitigations to reduce impacts from the doubling of spring user-days and passengers would need to be employed at increased levels which would not be reasonable or attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative F on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Alternative F would have adverse, regional to localized, short-term to long-term, seasonal, and negligible to major effects on aquatic resources in tributaries and springs. There would be negligible to moderate effects from current conditions. Alternative F would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative F on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative G

Analysis. Alternative G is a mixed use alternative. Maximum group size for commercial motor trips would be large, similar to current, at 40 people. Commercial oar trips would have a maximum group size of 30 people. Maximum trip lengths would be reduced from current in all seasons. Launch patterns would allow for six trips to launch in the summer, five in the shoulder months and two in the winter. Shoulder month launches are the highest of all alternatives aside from Alternative A. There would be a four month non-motor season that would occur from September to December. Total annual user-days would increase by around 78,000 with a slight decrease during summer, doubling in the spring and a ten fold increase in the winter. Trips at one time would decrease significantly with a modest reduction in people at one time from current. User discretionary time is the second lowest. This alternative allows for around a 6,000 increase in number of passengers annually. Winter commercial use is not allowed and Whitmore helicopter exchanges occur from January to August.

Under the mix of use types and launch pattern proposed in Alternative G, trips and people at one time would be reduced, along with the number of people visiting aquatic attractions per day in summer (Table 4-21). This would help relieve crowding and congestion at attraction sites and would indirectly reduce impacts to aquatic resources, having localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic resources from current conditions.

This alternative would preserve the large group sizes similar to current conditions. Large groups have greater adverse effects on aquatic resources in tributaries and at springs because people spread out more, disturb larger areas, create more access trails, and increase the level of pollutants. This would have localized, adverse, short- to long-term, seasonal to year-round, moderate to major effects on aquatic resources similar to current conditions.

Alternative G would have a low summer user discretionary time combined with shorter trip lengths, so use would likely be concentrated at sites along the river and not up side canyons. This would have localized, beneficial, short- to long-term, seasonal to year-round, minor to moderate effects on aquatic life in tributaries, affording sensitive, off-river sites some protection.

A doubling of user-days, an increase in the number of passengers by 6,000 people, and five launches per day (the highest of all alternatives) would have localized, adverse, short- to long-term, seasonal, moderate to major effects to aquatic resources in the critical spring months.

There would only be a four month no-motor season which would occur in the fall affording negligible benefits to aquatic resources.

Mainstem (Regional) — Same as Alternative A, but with all motor use in spring and summer and significantly greater number of passengers in the spring. Impact level would be elevated to negligible to moderate.

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate to major because there would be detectable and possible permanent changes to the resource. A large increase in shoulder season passengers, in conjunction with a doubling of spring user-days and large group sizes, adversely affect aquatic

resources during a critical time period. Summer use is still high during the season when aquatic resources are vulnerable and visitors are most likely to swim in the water. Impacts would be localized to attractions with aquatic features, short-term to long-term, and seasonal (spring and summer).

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the Mitigation of Effects section above. Since all the motor use occurs in the spring and summer, impacts from motor use on aquatic resources would be almost impossible to mitigate along the mainstem. Closures and restrictions would have to be put into place and enforced to prevent large groups and significantly higher numbers of passengers in spring from impacting sensitive aquatic resources in tributaries and springs. Since excluding visitors from numerous aquatic attractions is not feasible or desirable, these mitigations are not reasonable or attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative G on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Alternative G would have adverse, regional to localized, short-term, seasonal, and negligible to major effects on aquatic resources. There would be negligible to moderate effects from current conditions. Alternative G would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulative effects of Alternative G on aquatic resources, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative H (NPS Preferred Alternative)

Analysis. Alternative H is a mixed use alternative, with a six-month no-motor season from September to February. This alternative would allow daily launches of six trips in the summer, three in the shoulder seasons, and one in the winter. Summer maximum commercial group size would be 32 people and shoulder seasons 24. No commercial trips would be allowed in the winter. An 8-person noncommercial trip would be added. Trip lengths would be reduced from current levels in all seasons. Whitmore helicopter exchanges would occur only in the summer months, but hiking exchanges would be allowed in the shoulder seasons. User-days for both commercial and noncommercial users would increase (total increase of around 37,000), with noncommercial user-days almost doubling. Total number of passengers would increase by around 4,000, and user discretionary time would increase in all seasons.

Under the mix of use types and launch pattern proposed in Alternative H, trips and people at one time would be reduced, along with numbers of people visiting aquatic attractions per day in summer (Table 4-21). No aquatic attractions would receive more than 100 people per day. The proposed launch pattern would be effective in relieving crowding and congestion at attraction sites and would indirectly reduce impacts to aquatic resources, having localized, beneficial, short- to long-term, seasonal, moderate effects from current conditions. Group size is reduced to 32 in the peak season and 24 in the shoulder seasons, to help minimize impacts. Fewer people would be recreating in streams at one time and the area of impact would occur over a smaller area. Reduced group size, especially in the spring, would have localized, beneficial, short- to long-term, seasonal to year-round, moderate effects from current conditions.

Reducing trip length in the high-use season would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Although user discretionary time would increase, users would most likely spend more time at sites adjacent to the river since trip lengths are shorter. They would be less likely to spread exotic species farther up into side canyons. Shorter trip lengths would have localized, beneficial, short- to long-term, seasonal, minor to moderate effects from current condition. Noncommercial winter trip lengths would still be long at 25 days, but aquatic resources would be less vulnerable in the winter because fewer people play in the water due to colder temperatures.

Under this alternative there would be a modest increase in the number of passengers and user-days in the spring. Motor use would be allowed in the spring, but would be limited to one launch per day. These actions would have localized to regional, adverse, seasonal, short- to long-term, negligible to minor effects to aquatic resources, but at lower levels than either Alternative F or G, and resources would be likely to return to pre-impact levels more quickly.

Mainstem (Regional) — Same as Alternative A, but motor use is limited to one launch per day in the spring.

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate because there would be detectable changes but not permanent. The new launch pattern, group size and trip length reduction would benefit aquatic resources over current condition since fewer people at one time would be visiting aquatic attractions. Summer continues to have high use and is the peak river running season and river runners seek shade and cool water in side canyons during the summer heat. Impacts would be localized to attraction sites with aquatic features. Impacts would be long-term when impacts affect species abundances and diversity.

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the "Mitigation of Effects" section above. An increase in funding and staff over current levels would be needed year-round. The increase in mitigations would be at a reasonable and attainable level.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively,

the effects of Alternative H on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Alternative H would have adverse, regional to localized, short-term to long-term, seasonal, and negligible to moderate effects on aquatic resources. There would be beneficial, short-term, seasonal, negligible to moderate effects from current conditions. Alternative H would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulative effects of Alternative H, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

IMPACT ANALYSIS — LOWER GORGE ALTERNATIVES

Aquatic resource data for the Lower Gorge are more limited than for Lees Ferry to Diamond Creek. Grand Canyon National Park does not have aquatic resource monitoring or mitigation programs in this reach. Some work on aquatic resources is being conducted by the Hualapai Tribe and the Grand Canyon Monitoring and Research Center.

Alternative 1 (Current Conditions)

Analysis. River recreational use below Diamond Creek includes commercial and noncommercial oar and motor downriver trips continuing to Lake Mead from Lees Ferry, noncommercial and HRR trips launching from Diamond Creek, private boaters traveling upriver from Lake Mead, Hualapai/ Oriental Tour pontoon boats operating in the Quartermaster area, and jetboats that run upriver for passenger take outs, and noncommercial boat tow-outs. The maximum group size for HRR day trips is 100 people year-round; on average, one trip launches per day. Overnight trips average one launch per week and have a maximum group size of 34. Pontoon operations average 188 passengers per day during peak season and 160 during non-peak season. Commercial downriver trips continuing on to Lake Mead have a maximum group size of 43. There are two small floating docks in the Quartermaster area for pontoon boat and HRR operations. Upriver travel is unlimited below Separation Canyon. There are no restrictions on the length of stay for commercial or noncommercial users.

Very little recreational impact research has been conducted by park staff between Diamond Creek and Lake Mead; however the Hualapai Division of Cultural Resources (HDCR) documented recreational impacts to various Traditional Cultural Properties (TCPs) in 2001 and 2002. At five of the properties evaluated in 2001 (Whitmore Canyon, Granite Park, Pumpkin Springs, Three Springs Canyon and RM 223), impacts from trailing and on-site camping were observed to be heavy to severe (HDCR 2002).

At Spencer Canyon and Travertine Falls the resource staff observed moderate to heavy human impacts from trailing. Trailing impacts at Travertine were located along the spring and up to the

ledge, and also on the upstream side of the spring and in front of the falls. In 2002, the recommendation was to obliterate the social trails to protect resources.

Alternative 1 would continue to allow group sizes up to 100 people. Larger groups are more likely to disturb larger areas (Hendee, Stankey, and Lucas 1990) and the probability is high that a larger surface area of tributary stream beds would be impacted. When several large groups visit attraction sites at the same time (HRR trips and continuing commercial trips), the probability of impacting aquatic resources magnifies and impacts such as roiling substrates, bank erosion, trampling of riparian vegetation, disturbing food sources and egg masses, dam building and creating multiple trailing are more likely to occur. Large numbers of visitors per day repeatedly using aquatic attraction sites (such as Travertine) in the late spring and early summer months can have significant impacts on aquatic resources and habitat during critical months of the year. Repeated annual heavy use of aquatic attractions could lead to long-term impacts on species abundances and diversity. Large group sizes have localized, adverse, year-round, short- to long-term, moderate to major effects on aquatic resources.

Pollution from camp and lunch waste (primarily food scraps) and human fecal waste can wash into tributaries, mainstem backwaters, and springs, affecting water quality and the aquatic resources that depend on them. Under current conditions larger groups and longer trips would increase the chance for pollution from personal care products. Although silt and thick nonnative vegetation make access to side canyons more difficult, unrestricted trip lengths allow visitors more opportunity to hike up tributaries and access sensitive sites. Pollution and unrestricted trip lengths would have localized, adverse, seasonal to year-round, short- to long-term, minor to moderate effects on aquatic resources.

Use zones in the Lower Gorge (Zones 2 and 3) are considered semi-primitive and rural natural respectively. These zones allow for an increase in total use over Zone 1 in the upper canyon, as well as different types of use, including upriver jetboats, pontoon boat tours, and private boaters using two-stroke motors. Because the temperatures are milder at the west end of the Grand Canyon, use occurs year-round. Jetboat and private boat use is unrestricted. Pontoon boat use currently can reach up to 500 passengers per day, but averages 188 per day. Pontoon boats average 10 people per boat, so there is currently up to 50 pontoon boat trips per day running in a two mile stretch between RM 262.5 and RM 260. Impacts to aquatic life from outboard engine exhaust (Tjarnlund et al. 1995) and noise (Schoilk and Yan 2002) are deleterious to fish health and alter behavioral patterns, and have localized to regional, adverse, short- to long-term, year-round, negligible to minor effects on aquatic resources.

With the drop in Lake Mead water levels, silt banks and mud flats have become prevalent along the river's edge. Wakes from all motor and jetboats contribute to erosion of these newly exposed deposits, changing gentle slopes to sharply cut banks Figure 4.1.1-1 (Mengel pers comm. 2004). The Hualapai Tribe is especially concerned about impacts to aquatic habitat from wakes from the 40-foot-long jetboats equipped with engines generating up to 1,050 horsepower per boat, and traveling at high speeds (Christensen, pers. comm. 2003). Motorboat and jetboat wakes have localized, adverse, short- to long-term, year-round, minor to moderate effects on aquatic habitat.

Mainstem (Regional) — Recreational impacts to the mainstem would be adverse, short-term, year-round, and negligible to moderate because changes to aquatic resources would be

detectable. Due to a lack of data it is unknown whether this impact is permanent. Research in other parks indicates that noise and petroleum contaminants from motor boats adversely affect aquatic resources at detectable levels, but are short-term.

Tributaries and Springs (Localized) — Recreational impacts to aquatic resources in tributaries and springs would be adverse and minor to major because changes to the resource would be detectable and possibly permanent due to large groups and longer trips. Repeated annual heavy use of sensitive side canyon tributaries or springs could lead to long-term impacts on species abundances and diversity.

Mitigation of Effects. Actions required to mitigate effects in an attempt to reduce impacts to minor, would include all of the mitigation measures identified in the Mitigation of Effects section above.

To attempt to reduce impacts to minor levels, a significant increase in the number of NPS staff to educate users about impacts to aquatic resources, NPS patrols at day use sites to ensure that river runners do not camp there, and several more full time Science Center staff to monitor the effects of recreational use on aquatic resources would be needed. This would take a significant increase in funding specifically designed for these purposes. This increase would not be reasonable or attainable.

In addition, the Hualapai Tribe has considered creating a Visitor Management Plan to address use patterns at heavily used sites, such as Diamond Creek, Quartermaster and Travertine Falls. In cooperation with the Hualapai Tribe, Grand Canyon National Park should develop Limits of Acceptable Change thresholds which would trigger mitigations and management actions at all Lower Gorge aquatic sites. A cooperative monitoring and site rehabilitation program should be initiated. The Hualapai Tribe is considering plans to regulate human waste disposal and employ use restrictions at Travertine Canyon. They have also proposed that HRR boatman monitor client activities so that natural resources are not impacted by visitors. The Hualapai Tribe would abide by EPA regulations and develop a hazardous material containment plan and properly storing pontoon boat fuel. They would also outline procedures to follow in the event of a fuel spill at RM 262.5.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 1 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Alternative 1 would have adverse, regional to localized, short-term to long-term, seasonal to year-round, and negligible to major effects on aquatic resources. There would be negligible effects from current conditions. Alternative 1 would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulative effects of alternative 1 on aquatic

resources, when combined with other past, present and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 2

Analysis. Recreational use would be at the lowest levels under Alternative 2. Maximum group size for HRR day trips would be reduced from 100 to 30. There would be two HRR day trip launches per day during peak season and one per day during non-peak season. Maximum group size for overnight trips would be reduced from 34 to 30, and one trip would launch per day. Total number of HRR passengers per day would be 48 in the peak season and 24 in the non-peak season, compared to 100 passengers per day throughout the year. There would be no docks at Quartermaster and no pontoon boat tours. Two jetboats would be allowed to travel upstream to RM 262 to pick up commercial passengers. Trip lengths for all users would be reduced to four days.

A reduction in group size to 30 people and a cap on the number of launches from Diamond Creek per day would have would have localized, beneficial, short- to long-term, year-round, moderate effects on aquatic resources from current conditions, especially in the tributaries and springs, the primary attraction sites. The number of HRR day trips would increase to two in the peak season, but these would be much smaller groups with a substantial reduction in total number of daily passengers per day. HRR overnight trips would be limited to one per day with a group size of 30 and one campsite on river left would be designated for this use. Fuel pollutants and noise from pontoon boats would be eliminated, having a localized, beneficial, long-term, year-round, minor to moderate effect from current conditions. Jetboats would be limited to two commercial pick ups per day during the peak season and none during the non-peak season, limiting adverse effects from jetboats and having regional to localized, short- to long-term, seasonal, negligible to minor benefits from current conditions. Upriver travel including jetboats and private motor boats would only be allowed to travel up to RM 262, which could provide some benefit to aquatic resources in Zone 3.

All groups would be limited to a maximum trip length of four days. Reducing trip length would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Users would be less likely to spread exotic species farther up into side canyons. Limiting trip length would have localized, beneficial, short- to long-term, seasonal to year-round, moderate effects from current conditions.

Mainstem (Regional) — Recreational impacts to aquatic resources in the Colorado River would be reduced from current and adverse effects would likely be short-term, year-round and negligible to minor primarily due to the elimination of pontoon boats.

Tributaries and Springs — Recreational impacts to aquatic resources in tributaries and springs would be adverse and minor to moderate. River running occurs throughout the year in the Lower Gorge and river runners seek shade and cool water in side canyons on hot days. Impacts would be localized at attraction sites with aquatic features, but would be short to long-term if continued

daily use lead to adverse impacts on species abundances and diversity. There would be beneficial, minor to moderate impacts to tributaries and springs relative to current conditions because of smaller groups and less overall use.

Mitigation of Effects. Since impacts would not be higher than minor, mitigation measure could continue at current levels. Mitigations may be any of the mitigation measures identified in the Mitigation of Effects section above.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 2 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Alternative 2 would have adverse, regional to localized, short-term to long-term, seasonal to year-round, and negligible to moderate effects on aquatic resources. There would be beneficial, localized, short-term, minor to moderate effects on aquatic resources from current conditions. Alternative 2 would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative 2 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative 3

Analysis. The mix of recreational use in Alternative 3 would be similar to current conditions. Maximum group size for HRR day trips would be reduced from 100 to 30. There would be three HRR day trip launches per day during peak season and two per day during non-peak season. Maximum group size for overnight trips would be reduced to 30 from 34 and two trips would launch per day. There would be one dock at Quartermaster and pontoon boat tours would carry up to 400 passengers per day. Four jetboats would be allowed to travel upstream to Separation Rapids to pick up commercial passengers.

A reduction in group size to 30 people and a cap on the number of launches from Diamond Creek per day would have beneficial effects on aquatic resources, especially in the tributaries and springs, the primary attraction sites. The number of HRR day trips would increase to three in the peak season, but these would be much smaller groups with a total number of daily passengers reduced slightly. HRR overnight trips would be increased to two per day with a group size of 30, but these groups would be utilizing two campsites on river left designated for this use. Reduced group size would have localized, beneficial, short- to long-term, year-round, moderate effects on aquatic resources from current conditions. All groups would be limited to a maximum trip length

of eight days. Reducing trip length would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Users would be less likely to spread exotic species farther up into side canyons. Limiting trip lengths would have localized, beneficial, short- to long-term, seasonal to year-round, moderate effects from current conditions.

Fuel pollutants and noise from pontoon boats, as well as boat wakes, would double since the number of passengers per day would go from 188 to 400. This would adversely affect aquatic resources in the mainstem. Along with the increase in number of boats there would be an increase in the amount of pontoon boat fuel stored at RM 262. Currently, this fuel is sling-loaded into the Quartermaster area and stored in gasoline containers in the tamarisk below the old high water mark. The increase in the number of fuel storage containers would increase the possibility of a fuel spill, further adding contaminants to the water and indirectly affecting aquatic resources. Impacts from pollutants and boat wakes would be localized, adverse, short to long term, year-round, and moderate.

Four jetboats would be allowed to pick up commercial passengers all the way up to Separation. Impacts from jetboats would be adverse and similar to Alternative 1. There would continue to be no restrictions on private day users coming up from Lake Mead, so impacts from private users would be similar to Alternative 1.

The Hualapai Tribe believes that the creation of a new dock at RM 262.5 would have localized, beneficial, year-round, long-term, minor effects to fish by providing shade.

Mainstem — Same as Alternative 1 with a benefit over current due to smaller group sizes, which is offset by a doubling of pontoon boats.

Tributaries and Springs — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate because there would be detectable, but not likely permanent changes to the resource. Smaller group sizes would be beneficial, but the total number of day use passengers per day would be about the same as Alternative 1. Overnight use would double. Repeated annual heavy use of sensitive side canyon tributaries or springs (such as Travertine) could lead to long-term impacts on species abundances and diversity.

Mitigation of Effects. Same as Alternative 1; however the level of mitigation needed would likely be reasonable and attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 3 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Alternative 3 would have adverse, regional to localized, short-term to long-term, seasonal to year-round, and minor to moderate effects on aquatic resources. There would be

localized, beneficial, year-round, short- to long-term minor to moderate effects from current conditions. Alternative 3 would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative 3 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative 4 (NPS Preferred Alternative)

Analysis. Alternative 4 is a consensus between Grand Canyon National Park and the Hualapai Tribe on levels of HRR use in the Lower Gorge and would be similar to current conditions. This is the NPS preferred alternative for pontoon and jetboat use. Maximum group size for HRR day trips would be reduced from 100 to 40 during peak season. There would be a variable number of HRR day trip launching each day during peak season and they could carry a maximum of 96 passengers per day. There would be two HRR day trip launches per day during non-peak season with a maximum group size of 35. Group size for overnight trips would be reduced from 34 to 20; three trips would launch per day in the peak season and one in the non-peak season. There would be one small floating dock at Quartermaster and pontoon boat tours would carry up to 150 passengers per day. Four jetboats would be allowed to travel upstream to Separation Rapids to pick up commercial passengers if Lake Mead were at full pool; otherwise, upstream travel would not be allowed above RM 260. Downriver kayak/canoe trips would be allowed below RM 273.

The reduction in pontoon boat use to 150 passengers per day would reduce the amount of erosion created by pontoon boat wakes as well as fuel pollutants and noise. This would have a localized, beneficial, short- to long-term, year-round, minor to moderate effect on aquatic resources in the mainstem. The increase in the total number of HRR passengers and overnight use would offset the localized, beneficial, year-round, short- to long-term, minor to moderate effects of reducing group size from 100 people to 40. This group size is higher than what has been proposed as appropriate in the Lees Ferry preferred alternative H, but this higher use would be more appropriate in Zone 3. The creation of specific designated camps for HRR overnight trips may help limit impacts to aquatic species, if these camps are not located near the mouths of tributaries. The one-day kayak/canoe trips would begin at RM 273 and would have a negligible effect on aquatic resources in the tributaries and springs.

Trip lengths would be reduced to three nights. This would reduce crowding and congestion and would minimize the number of days users can layover at sites, as well as time to impact sensitive sites up side canyons. Users would be less likely to spread exotic species farther up into side canyons. Limiting trip length would have localized, beneficial, short- to long-term, seasonal to year-round, moderate effects from current conditions.

Four jetboats would be allowed to pick up commercial passengers all the way up to RM 260. Impacts from jetboats would still be adverse and similar to Alternative 1. There would continue to be no restrictions on private day users coming up from Lake Mead, so impacts from private users would be similar to Alternative 1.

The Hualapai Tribe believes that the creation of a new dock at RM 262.5 would have localized, beneficial, year-round, long-term, minor effects to fish by providing shade.

Mainstem (Regional) — Recreational impacts to aquatic resources in the Colorado River would be reduced from current and adverse effects would likely be short-term, year-round and negligible to minor.

Tributaries and Springs — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate because of the group size of 40. River running occurs throughout the year in the Lower Gorge and river runners seek shade and cool water in side canyons on hot days. Impacts would be localized to attraction sites with aquatic features, but would be short-term to long-term if continued daily use lead to adverse impacts on species abundances and diversity. There would be minor beneficial impacts to tributaries and springs relative to current conditions because of smaller group sizes and shorter trip lengths.

Mitigation of Effects. Same as Alternative 1; however the level of mitigation needed would be higher due to increased HRR use, but it would likely be reasonable and attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 4 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Alternative 4 would have adverse, regional to localized, short-term to long-term, seasonal to year-round, and negligible to moderate effects on aquatic resources. There would be localized, beneficial, year-round, short- to long-term, minor to moderate effects from current conditions. Alternative 4 would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulatively, the effects of Alternative 4 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative 5 (Hualapai Tribe Proposed Action)

Analysis. Alternative 5 is a consensus between Grand Canyon National Park and the Hualapai Tribe on levels of HRR use in the Lower Gorge and would be similar to current conditions. This alternative is the Hualapai Tribe's proposed alternative for pontoon and jetboat use. Alternative 5 would have the same level of HRR use described in Alternative 4. There would be one large floating dock at Quartermaster and pontoon boat tours would carry up to 960 passengers per day. Jetboat pick ups would not be allowed and noncommercial tow-outs could only travel upriver to RM 273. There would be no kayak/canoe upriver delivery.

HRR use is exactly the same as in Alternative 4, so impacts to aquatic resources would be similar to those described in Alternative 4. This includes beneficial effects from a reduction in group size and trip length, but adverse effects from the total increase in use.

Substantially increasing the number and level of pontoon boat use to 960 passengers per day would increase the amount of erosion created by pontoon boat wakes as well as pollution from fuel and disturbance due to motor noise. This use is concentrated in a two mile stretch and under this alternative would occur constantly for a period of six to eight hours. This high use would have an increased level of adverse impact on aquatic resources in the mainstem. This level may be high enough to displace or affect the health of populations of native fish, but minimal research exists especially at lowering lake levels. Along with this increase in pontoon boat use would be an increase in fuel storage at RM 262.5 which increases the probability of a fuel spill. Impacts to aquatic resources from a large increase in pontoon boat use would be localized, adverse, short- to long-term, year-round, and moderate.

Commercial jetboat pickups would be eliminated, which would eliminate the effects of jetboat wakes on aquatic habitat along the riverbanks. This would have localized to regional, beneficial, short- to long-term, seasonal, minor to moderate effects on aquatic resources from current conditions.

The Hualapai Tribe believes that the creation of a new dock at RM 262.5 would have localized, beneficial, long-term, year-round, minor effects to fish by providing shade.

Mainstem — Impacts to the main stem would increase under this alternative and be adverse short-term, year-round, moderate.

Tributaries and Springs — Recreational impacts to aquatic resources in tributaries and springs would be adverse and moderate because of the group size of 40, but with reduced trip length, passengers would have less time to hike up into side canyons. River running occurs throughout the year in the Lower Gorge and river runners seek shade and cool water in side canyons on hot days. Impacts would be localized to attraction sites with aquatic features, but would be short-term to long-term if continued daily use lead to adverse impacts on species abundances and diversity. Some beneficial effects to tributaries and springs may occur over current condition because of smaller group sizes and shorter trip lengths.

Mitigation of Effects. Same as Alternative 1: Mitigations to reduce impacts to minor would be extensive and at levels that are not reasonable or attainable.

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Impacts to Aquatic Resources: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 5 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Alternative 5 would have adverse, regional to localized, short-term to long-term, seasonal to year-round, and moderate effects on aquatic resources. There would be localized, beneficial, short- to long-term, year-round, minor to moderate effects from current conditions. Alternative 5 would not result in impairment of the aquatic resources of Grand Canyon National Park. Cumulative effects of Alternative 5 on aquatic resources, when combined with these other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short- to long-term, seasonal to year-round, and minor to major. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

THREATENED, ENDANGERED, AND SENSITIVE SPECIES

ISSUES

The issues identified during internal and external scoping meetings pertaining to threatened, endangered, and sensitive species include all the issues identified for terrestrial wildlife and vegetation, plus the following:

- Threatened, endangered, and sensitive species should be protected.
- Human-caused impacts to threatened, endangered, and sensitive wildlife species associated with boating and recreational use include habitat degradation or modification, introduction of pollutants and contaminants into the environment, and disturbances to individuals or groups of wildlife as described for terrestrial wildlife.

GUIDING REGULATIONS AND POLICIES

The guiding regulations and policies for threatened, endangered, and sensitive species and their habitats are the same as those for terrestrial wildlife and vegetation with the following addition.

The Endangered Species Act (16 U.S.C. 1531 et seq.) defines the terms and conditions of the federal status of species in a park and requires an examination of impacts on all species federally listed or proposed for listing, and designated critical habitats for threatened or endangered species. The park is working with the U. S. Fish and Wildlife Service in compliance with section 7 of the Endangered species Act to prepare a biological evaluation of the effects of the preferred alternatives for Lees Ferry and the Lower Gorge on threatened and endangered species. That document would make the park's official determination of effects on species and would be incorporated by reference into the final environmental impact statement for the revised Colorado River management plan when completed.

The NPS *Management Policies 2001* state that the agency would consider potential effects of actions on state or locally listed species (NPS 2000d). The service is required to perpetuate the natural distribution and abundance of these species and the ecosystems on which they depend.

Arizona does not have a threatened or endangered fish and wildlife statute, but the state does list wildlife species of special concern (ADGF 1998c). State sensitive species within the park were determined from this list.

MANAGEMENT OBJECTIVES

As stated in Chapter 1, the management objectives for threatened, endangered, and sensitive species in relation to recreational river use is

- Protect all threatened, endangered, sensitive and candidate species and their habitats from impacts associated with river recreational activities.

METHODOLOGY FOR ANALYZING EFFECTS

Impact Thresholds

The process for assessing impacts to threatened, endangered, and sensitive species is essentially the same as that described for terrestrial wildlife, except it is focused on the particular species listed in Chapter 3.

The analysis of an impact to a particular species or group of species involves examination of the interaction of the context, duration, timing, and intensity of each identified impact, as defined below.

Intensity

Negligible — Sensitive species would not be affected, or the effects would be at or below the level of detection.

A negligible effect would equate with a "no effect" determination under section 7 of the Endangered Species Act regulations for threatened or endangered species.

Minor — Impacts to sensitive species would be perceptible or measurable, but the severity and timing of changes to parameter measurements are not expected to be outside natural variability and are not expected to have effects on populations of sensitive species. Impacts would be outside critical periods.

A minor effect would equate with a determination of "likely to adversely affect" or "not likely to adversely affect" under section 7 of the Endangered Species Act regulations for threatened or endangered species.

Moderate — Impacts to sensitive species would be perceptible and measurable, and the severity and timing of changes to parameter measurements are expected to be sometimes outside natural variability, and changes within natural variability might be long term. Populations of sensitive species might have small to moderate declines, but they are expected to rebound to pre-impact numbers. No species would be at risk of being extirpated from the park. Some impacts might occur during key time periods.

A moderate effect would in most cases equate with a determination of "likely to adversely effect" under section 7 of the Endangered Species Act regulations for threatened or endangered species.

Major — Impacts to sensitive species would be measurable, and the severity and timing of changes to parameter measurements are expected to be outside natural variability for long periods of time or even be permanent; changes within natural variability might be long

term or permanent. Populations of sensitive species might have large declines, with population numbers significantly depressed. In extreme cases, a species might be at risk of being extirpated from the park, key ecosystem processes like nutrient cycling might be disrupted, or habitat for any species might be rendered not functional. Substantive impacts would occur during key time periods. Impacts would be long term to permanent..

A major effect would equate with an "adversely affect with/without a jeopardy opinion" under section 7 of the Endangered Species Act regulations.

Context

Localized — Impacts would occur in a small part of a habitat or range, such as a single campsite, spring, or side canyon.

Regional — Impacts would affect a widespread area of suitable habitats or the range of the population or species within Grand Canyon National Park, such as the entire mainstem of the Colorado River, or widespread among suitable tributaries or side canyons along the river.

Duration

Short term — Impacts to an individual or habitat area would last from one day up to one year. Short-term impacts to a population would last up to one year.

Long term — Impacts would be greater than one year. Long-term impacts to a population would be longer than one year.

Timing

Impacts could occur year-round, but generally resources are most sensitive during the spring and summer, when mating (spawning), birthing, and hatching occur.

Mitigation of Effects

Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to threatened, endangered, or sensitive species, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include all of those listed under "Terrestrial Wildlife" and "Vegetation," plus the following:

- Develop and implement monitoring programs for threatened, endangered, or sensitive species.
- Close southwestern willow flycatcher nesting habitats to recreational users.
- Restrict recreational use of tributaries during reproductive seasons of native fishes.
- Close Vasey's Paradise and Elves Chasm.
- Close all caves to visitation until the park's bat inventory has been completed.

Cumulative Impacts

Cumulative impacts on threatened, endangered, and sensitive species were determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future actions, as described in the "Introduction" to Chapter 4.

Because the Colorado River corridor is managed as recommended wilderness, there are few anthropogenic factors that would combine to increase the cumulative effects of river recreation. The major factor cumulatively affecting threatened, endangered, and sensitive species in the river corridor is the operation of Glen Canyon Dam. The effects of the dam far outweigh the effects of river recreationists on aquatic and terrestrial habitats, and consequently fish and wildlife, in the river corridor. The dam has created a new vegetative structure that should remain relatively stable under current operations. The ongoing erosion of beaches under current operating parameters, however, could result in additional impacts to fish and wildlife resources. As beaches erode, river recreationists tend to move into vegetated areas to accommodate camping needs, resulting in additional wildlife habitat degradation. The impacts to threatened, endangered, and sensitive species would be increased as the loss or degradation of habitat accelerated. The effects of habitat alteration and increasing populations of exotic fishes could result in significant impacts on the humpback chub, possibly leading to its extirpation from Grand Canyon National Park. The dam has localized to regional, adverse, long-term, year-round, moderate to major effects on threatened, endangered, and sensitive species.

If there were significant changes in the operation of Glen Canyon Dam, there would be substantial consequences to the threatened, endangered, and sensitive fish and wildlife resources in the river corridor.

Numerous aircraft overflights occur in flight corridors between Lees Ferry and Diamond Creek (see "Natural Soundscapes"). Because the flight corridors are several thousand feet above the river corridor, the main cumulative effect is the potential for aircraft to collide with a protected bird species, such as a condor. In addition, the high level of helicopter traffic at Whitmore and Quartermaster could cumulatively affect bird species because of noise and potential collisions. This could have localized to regional, adverse, short- to long-term, seasonal to year-round, minor to moderate effects.

Other cumulative effects include the additive nature of impacts generated by recreational hikers who visit the river and the effects of researchers who study various aspects of the canyon's physical and biological nature. These users have localized, adverse, short- to long-term, year-round, moderate effects in all hydrologic zones and up side canyons.

Together, cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major.

Assumptions

General assumptions used for the analysis of effects of each alternative are discussed in the "Introduction" to Chapter 4. Specific assumptions related to the alternatives and their effect on

threatened, endangered, or sensitive species include all those listed under the "Terrestrial Wildlife" section, plus the following:

- Alternatives for Diamond Creek to Lake Mead are analyzed for the maximum limits presented in the alternatives.
- There are no threatened or endangered plant species in the area of effect. Impacts to rare plants are discussed in the "Vegetation" section.

IMPACT ANALYSIS — LEES FERRY ALTERNATIVES

Impact ratings for individual threatened, endangered, or sensitive species are summarized in Table 4-22; listed and sensitive species not likely to be affected by the alternatives are listed in Table 4-23. The Lees Ferry alternatives are not compared to the Lower Gorge alternatives due to differences in management, density of users, and the length of the river (226 miles from Lees Ferry to Diamond Creek and 50 miles from Diamond Creek to Lake Mead).

TABLE 4-22: SUMMARY IMPACT RATINGS FOR INDIVIDUAL THREATENED, ENDANGERED, OR SENSITIVE SPECIES — LEES FERRY ALTERNATIVES

Common Name	Alternatives							
	A	B	C	D	E	F	G	H
Kanab Ambersnail	Moderate	Moderate	Major	Major	Moderate	Moderate	Moderate	Moderate
Humpback Chub	Moderate	Moderate	Major	Major	Moderate	Major	Major	Moderate
American Peregrine Falcon	Minor	Moderate	Moderate	Moderate	Minor	Minor	Minor	Minor
Bald Eagle	Minor	Minor	Major	Major	Moderate	Major	Moderate	Moderate
California Condor	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Mexican Spotted Owl	Minor	Moderate	Moderate	Moderate	Minor	Minor	Minor	Moderate
Southwestern Willow Flycatcher	Moderate	Major	Major	Major	Moderate	Moderate	Moderate	Major
Allen's Lappet-browed Bat	Moderate	Moderate	Major	Major	Moderate	Moderate	Moderate	Major
Mexican Long-tongued Bat	Moderate	Moderate	Major	Major	Moderate	Moderate	Moderate	Major
Pale Townsend's Big-eared Bat	Moderate	Moderate	Major	Major	Moderate	Moderate	Moderate	Major
Spotted Bat	Moderate	Moderate	Major	Major	Moderate	Moderate	Moderate	Major
Long-legged Myotis	Moderate	Moderate	Major	Major	Moderate	Moderate	Moderate	Major

TABLE 4-23: LISTED AND SENSITIVE SPECIES NOT LIKELY TO BE AFFECTED — LEES FERRY ALTERNATIVES

Common Name	Reason Not Likely to be Affected
Wildlife	
Grand Canyon Cave Pseudoscorpion	Occurs in areas where human visitation is rare.
Razorback Sucker	Presumed extirpated between Lees Ferry and Diamond Creek; last collected in the Lower Gorge in the early 1990s.
Northern Leopard Frog	Although potential habitat is present, a historic population has not been confirmed between Lees Ferry and Diamond Creek.
Relict Leopard Frog	Presence not confirmed above Diamond Creek.
Desert Tortoise	Known only to occur in upland habitats in the Lower Gorge, which are rarely visited.
California Brown Pelican	Rare winter transient; no known recreation-related impacts.
Yellow-billed Cuckoo	Not known to occur from Lees Ferry to Diamond Creek; suitable habitat occurs below Diamond Creek.

Common Name	Reason Not Likely to be Affected
Yuma Clapper Rail	Not known to occur from Lees Ferry to Diamond Creek.
Western Red Bat	Occurs in areas where river-based human visitation is rare.
Southwestern Myotis	One isolated record from park.
Pocket Free-Tailed Bat	One isolated record from park.
Greater Western Mastiff Bat	Occurs in areas where river-based human visitation is rare.
Southwest River Otter	Extirpated from the Grand Canyon.
Plants	
McDougall's yellowtops, Kaibab agave, and Grand Canyon beavertail cactus	No longer considered for listing.

Alternative A (Current Conditions)

Analysis. Under Alternative A management of recreational use would continue to allow large group sizes, lengthy trips, and spikes in the numbers of trips and people at one time, as well as daily launches (see Table 4-1). User-days would remain capped at current levels, which would probably result in approximately the same number of total yearly passengers. Similarly, user discretionary time would remain similar to current levels.

All of the impacts discussed in the "Terrestrial Wildlife" section (habitat modification, disturbances, and pollutants/contaminants) could affect listed and sensitive species in the same ways they would affect nonsensitive species. However, these impacts could be greater for sensitive species due to their smaller and sometimes localized populations and specialized habitat requirements. Most of these impacts could result in a "take" of a federally listed species.* In some cases, an entire Grand Canyon population might be affected because the species only occurs at a few sites along the river.

Impacts to Grand Canyon populations of the Kanab ambersnail, southwestern willow flycatcher, and humpback chub would be regional because those species are concentrated in localized areas and any effects in these areas would affect the entire Grand Canyon population.

Impacts on localized populations and sensitive individuals would vary by season. Sensitive plants and wildlife are most vulnerable during the spring and summer, so the loss or alteration of habitat and disturbances of individuals during these times would be detectable and could be significant. Some sensitive species, such as the southwestern willow flycatcher and peregrine falcon, do not occur in the Grand canyon in fall and winter. Others, such as the bald eagle, are present only in winter.

Kanab Ambersnail — The Kanab ambersnail is vulnerable to trampling and incidental molestation, particularly from April through August at Vasey's Paradise and Elves Chasm, both of which are popular attractions for river recreationists. Although lush growths of poison ivy discourage use of most of the Vasey's site, river runners often stop to draw water from the spring or fish in the eddy. At upper Elves Chasm the snails were originally purposefully released in areas that were not likely to be affected by foot traffic, but the snails are mobile, and the site receives moderate

* The Endangered Species Act defines the term "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

visitation. The ambersnail habitat itself may also be impacted, resulting in population declines during higher visitor use months. Impacts to the Kanab ambersnail would be adverse, regional, short term, and moderate.

Humpback Chub — Impacts to the humpback chub would occur spring through fall due to the high potential for people to visit and swim in the lower reaches of the Little Colorado River, which is the primary spawning and nursery area in the Grand canyon and in the Colorado River below Glen Canyon Dam. Recent population estimates for the humpback chub in and near the Little Colorado River indicate a significant decline in numbers over the last decade (Van Haverbeke and Coggins 2003; Van Haverbeke 2003; GCMRC 2003a) due to habitat modification by the dam and predation and competition from nonnative fishes. The effect of river running on humpback chub is unknown; however, recreationists make heavy use of the lower Little Colorado River from mid-April through mid-October, with the heaviest use from May to September. This coincides with spawning activity and the presence of young-of-the-year chub in the Little Colorado. Recreationists could directly affect chub eggs, fry, and young by roiling substrates and altering feeding and shelter-seeking behaviors, and indirectly by disturbing nearshore habitats and introducing suntan lotion into the water. Humpback chub display modified behavior patterns in the Little Colorado River; they are not captured as frequently in the lower 2 kilometers of the reach as they were historically (Minckley 1989, 1990). Chub might avoid this area because of human disturbances. In the Virgin River in Zion National Park, recreational activities (boating, tubing, wading, and swimming) increased the patchiness of native fishes, reduced the diversity of their assemblages, and reduced the abundance of young native fishes (Sappington 1998). Additional impacts may result from the fact that popular camps occur within known mainstream humpack chub aggregation sites, and anglers fishing for trout accidentally catch this species. Currently, the park does not allow angling in the Colorado River within 1 mile of the confluence with the Little Colorado River. Impacts to the humpback chub would be adverse, regional, long term, and moderate.

American Peregrine Falcon — Peregrine falcon populations in the Grand Canyon have remained stable or increased slightly from 1988 to 1999 (Ward 2000). Direct interaction between peregrine falcons and river recreationists would be unlikely. Noise levels could indirectly affect peregrines, causing them to temporarily leave an area. Falcons may be disturbed by helicopters or river runners while nesting or foraging, but they would be able to return to the activity once the disturbance was gone, or they would relocate to a less disturbed area. Helicopter exchanges in the Whitmore area could impact peregrine falcons. Ritchie (1987) reported that peregrine falcon responses varied from no response to flushing when helicopters were within 2,000 feet of the birds. Craig and Craig (1984) reported that prairie falcons, red-tailed hawks, and golden eagles exhibited varied responses when helicopters passed nearby. As helicopters approach, individual bird responses range from no response to abandonment of perches. Impacts to the American peregrine falcon would be adverse, localized, short term, and minor.

Bald Eagle — Researchers who studied the effects of non-motorized recreational boating on non-breeding bald eagles in Alaska noted that 58% flushed in response to rafts approaching (Steidl and Anthony 1995). The flush distance was related to the distance that the boats were first sighted — only 23% flushed at distances greater than 100 meters. Other researchers studied bald eagle distribution in relation to human activity in Grand Canyon National Park and determined that eagle distribution was negatively correlated with the amount of activity (Brown and Stevens

1997). Eagles are flushed in the Grand Canyon as boats pass hunting perches and roosts, but at the low level of present winter use, the effects on the eagle population are probably within the range of natural variability. Researchers also found that people camping near nesting eagles caused significant behavior modifications, such as declines in feeding and reduced attentiveness to young (Steidl and Anthony 1995). Although eagles do not nest in the Grand Canyon, it is probable that camping near roosting bald eagles in the canyon results in behavioral changes. A strong negative correlation has been found between eagle distribution and human activity, even at low levels of winter use (Brown and Stevens 1997). Noise also impacts eagles. Since the motor season currently begins December 15 and wintering eagles are present into March, eagles are subject to boat motor noise (GRCA wildlife files). With the present low level of winter use, impacts to the bald eagle would be adverse, localized, short term, and minor.

California Condor — Numerous encounters between river runners and hikers and California condors have been reported since condors were released in 1996. Condor / human conflicts have occurred in Marble Canyon, especially at the Badger campsite. Impacts occur when humans approach, feed, or harass these curious birds. This species is extremely vulnerable throughout the year because of its small population size. Each reproductive season is key to establishing the population. Although their preferred roosting habitat is rock cliffs, snags, and stands of live conifers, condors scavenge and roost along the Colorado River and its tributaries (NPS 2002c; Osborn 2003). They are attracted to trash left behind by river runners, such as pop-tops and pieces of aluminum foil, and can be harmed if they ingest these items. Condors scavenging in occupied campsites have come into conflict with river runners (Leslie, pers. comm. 2003). These interactions can increase habituation to humans. Recreationists would be more likely to encounter or attempt to interact with condors during the higher use months, but adverse encounters have occurred in winter (GRCA wildlife files). Impacts to the California condor would be adverse, localized, short term, and moderate.

Mexican Spotted Owl — Recent surveys have located approximately 40 Mexican spotted owl protected activity centers within Grand Canyon National Park (Willey, Ward, and Spotskey 2002; Willey and Ward 2003). Five protection activity centers are within 3 miles of the river. Day hikers could reach these areas, but the areas are not in frequently traveled canyons. Mexican spotted owls are relatively tolerant of hikers. Researchers tested owls in narrow canyon habitat similar to that encountered in Grand Canyon and determined that birds rarely flushed at distances of greater than 24 meters (Swarthout and Steidl 2001). Beyond 55 meters birds were unlikely to alter their behavior when hikers approached. It is probable that some owls would be flushed by day hikers, but this impact is not expected to cause a decline in population numbers as it would be short term and would rarely occur. Impacts to the Mexican spotted owl would be adverse, localized, short term, and minor.

Southwestern Willow Flycatcher — Surveys in June 2003 found two pairs of flycatchers at different locations along the river in the upper canyon (Yard, pers. comm. 2003a). Nesting or breeding birds may be disturbed by river runners as they create trails through, or expand camps into, dense stands of tamarisk. This impact could cause a decline in the population and result in a moderate impact. Impacts would not occur during the fall and winter because the flycatcher is not present in the Grand Canyon at that time. Impacts to the southwestern willow flycatcher would be adverse, regional, short term, and moderate during the spring and summer when visitor use is highest.

Bats — Grand Canyon National Park provides abundant habitat for crack and crevice dwelling bats. Local populations of the long-legged myotis, Allen's lappet-browed bat, spotted bat, Mexican long-tongued bat, and pale Townsend's big-eared bat within a cave or series of caves could be moderately impacted and might experience population declines if reproductive success was reduced. Habitat modification would produce negligible to minor adverse impacts to crack and crevice dwelling bat species for a short duration until new roost sites were located and occupied. However, habitat modification to caves that contain maternity colonies or hibernacula could have moderate to major adverse and long-term impacts. Populations of some bat species have declined or disappeared along the Lower Colorado River, where habitat changes have occurred. Also see the discussion of human-caused impacts on bats under "Terrestrial Wildlife" for Alternative A.

Mitigation of Effects. Previous mitigation efforts indicate that specific measures can be effective in reducing impacts to threatened, endangered, or sensitive species, if adequate funding, staffing, monitoring, and implementation of the measures are maintained. Reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include all of those listed under "Terrestrial Wildlife" and "Vegetation," plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative A, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Impacts to populations of Kanab ambersnail, humpback chub, and southwestern willow flycatcher are likely to be regional because they are concentrated in localized areas and any effects in those areas would affect the entire population of these species. Any amount of use during the reproductive season could affect a local population of sensitive species due to their small populations and specific habitat preferences. Impacts on other threatened, endangered, or sensitive species would be localized. Helicopter exchanges in the Whitmore area could impact peregrine falcons, with adverse, localized, short-term, minor effects. Low levels of winter use could have adverse, localized, short-term, minor effects on the bald eagle. The California condor is extremely vulnerable throughout the year because of its small population size. Impacts, which occur when humans approach, feed, or harass these curious birds, would be adverse, localized, short term, and moderate. Some Mexican spotted owls would be flushed by day hikers, but this would be a short-term, rare occurrence, and impacts would be adverse, localized, short term, and minor. Impacts on bats would range from minor to moderate if caves that contain maternity colonies or hibernacula were modified.

In summary, under Alternative A impacts to threatened, endangered, and sensitive species would be adverse, short and long term, regional and localized, seasonal to year-round, and minor to

moderate. Alternative A would not result in the impairment of threatened, endangered, and sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative A would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative B

Analysis. Under Alternative B recreational motor trips would be prohibited, and group sizes, the number of trips and people at one time, daily launches, user-days, and probable total yearly passengers would be the lowest of any alternative (see Table 4-1). Trip lengths would be substantially reduced from current conditions, although user discretionary time would increase from current levels.

The types of impacts described under Alternative A would be similar under Alternative B. Increases in annual user discretionary time indicate increased potential opportunities for adverse impacts on the Kanab ambersnail (possibly exceeding the moderate threshold), but that increase would likely be offset by reductions in access.

The increase in user discretionary time in March and April (from 24,177 hours to 52,491 hours) could increase the potential for recreationists to interrupt humpback chub reproductive activities at the Little Colorado River, but probably not to the extent it would exceed the moderate impact threshold.

A large increase in summer user discretionary time (from 294,506 hours to 431,444 hours) could result in substantially more foot traffic in side canyons. Such activity could increase flushing occurrences of Mexican spotted owls, with resulting decreases in production of young and moderate impacts to this species. As the southwestern willow flycatcher is a late nester, the very large increase in late spring and early summer user discretionary time could increase the potential for impacts that might begin to approach the major impact level if mitigation measures such as closures or restrictions on access to nesting areas were not instituted. More winter use would increase impacts to the bald eagle, but not beyond the minor threshold. No impacts from motorboat or helicopter use would occur under this alternative. Peregrine falcon would benefit from the decrease in helicopter activity.

The increased summer user discretionary time could also increase opportunities for disturbance impacts to bat species in maternity colonies, but probably not beyond the moderate threshold.

Mitigation of Effects. As discussed for Alternative A, reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include those listed under “Terrestrial Wildlife” and “Vegetation,” plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in “Methodology for Analyzing Effects: Cumulative Impacts.” The impact rating from all cumulative actions is regional to localized, adverse, short to

long term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative B, when combined with other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Similar to Alternative A, impacts to populations of Kanab ambersnail, southwestern willow flycatcher, and humpback chub are likely to be regional because they are concentrated in localized areas and any effects in those areas would affect the entire population of these species. Impacts on localized populations and sensitive individuals would be similar to Alternative A. Any amount of use during the reproductive season could affect a local population of sensitive species due to their small populations and specific habitat preferences. Even though helicopters and motorboats would not be used under this alternative, river use would increase during the winter, but impacts to bald eagles would still be minor. Impacts to peregrine falcons would be beneficial and negligible throughout the year. There might be increased potential for disturbance to several species during the summer, but probably not beyond the moderate threshold.

In summary, under Alternative B the impacts to threatened, endangered, and sensitive species would be adverse, regional and local, seasonal to year-round, short and long term, and minor to moderate. and major if mitigation measures were not instituted. Alternative B would not result in the impairment of threatened, endangered, and sensitive species in Grand Canyon National Park. Cumulative effects, when combined with other past, present, and reasonably foreseeable actions, would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative B would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternatives C and D

Analysis. Under Alternative C motorized use would be eliminated; however, total annual user discretionary time would increase greatly in all seasons compared to Alternative A. User-days and passengers would increase greatly in all seasons but summer, where those indicators of use would decrease. Group sizes would decrease, as would maximum numbers of trips and people at one time.

Under Alternative D, there would be two periods of no-motor use — March–April and September–October. Annual user discretionary time would double from the present level, but group sizes would decrease. There would be a substantial increase in user discretionary time during early and late spring, as well as a large increase in winter.

The type of impacts under Alternative C would be similar to Alternatives A and B, but the intensity would be much greater. A doubling of annual user discretionary time suggests vastly increased potential for adverse impacts to habitat by recreational users of campsites and hiking trails, including the potential to adversely affect Kanab ambersnail habitat at Vasey's Paradise. If this area was not closed or closely monitored, impacts could reach the major threshold.

A substantial increase in user discretionary time from 24,177 hours to 118,296 hours in March and April could increase opportunities for recreationists to interrupt humpback chub reproductive activities in the Little Colorado River, possibly to the major threshold as the present population continues to decline and additional disruption of reproductive activity, destruction of eggs and fry, and disturbance of young-of-the-year may further depress the population.

A fourfold increase in early spring user discretionary time also suggests increased opportunities for disturbance pressure on nesting avian species, such as the peregrine falcon and southwestern willow flycatcher, during a critical life stage. There could be major population disruptions to willow flycatcher that would exceed the normal range of variability if mitigation measures (closures or restrictions on access to nesting areas) were not instituted. The peregrine falcon would probably not be impacted beyond the moderate threshold, but if bird and bat prey species were severely impacted this could change. The large increase in summer user discretionary time suggests potential for increased foot traffic in side canyons, which could increase flushing occurrences of Mexican spotted owls, reaching the moderate impact threshold.

A substantial increase in winter use would result in adverse, long-term, moderate to major impacts to the bald eagles and various bat species, particularly cave dwelling bats, due to the same type of impacts discussed for bats in Alternative A of "Terrestrial Wildlife."

Mitigation of Effects. As discussed for Alternative A, reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include those listed under "Terrestrial Wildlife" and "Vegetation," plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternatives C and D, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, moderate to major effects on threatened, endangered, and sensitive wildlife species. Alternatives C and D would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternatives C and D the impacts to threatened, endangered, and sensitive species would be regional and local, moderate to major, adverse, seasonal to year-round and short-term and long-term. Neither Alternative C nor Alternative D would result in impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and moderate to major. Alternatives C and D would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative E

Analysis. Under Alternative E there would be a no-motor season from October through March, and group sizes would decrease. Increases in spring user discretionary time would be more moderate (from 24,177 hours now to 69,836 hours) than in the previous two alternatives, as would increases in summer and winter user discretionary time.

Alternative E would have similar types of impacts as those described under Alternative A, but the intensities would differ. Increases in user discretionary time suggest the potential for greater impacts on the Kanab ambersnail, but they would not exceed the moderate threshold.

The increase in user discretionary time during the March–April period suggests increased opportunities for recreationists to interrupt humpback chub reproductive activities in the Little Colorado River, but impacts would probably not exceed the moderate threshold.

No impacts from motor use for six months in fall and winter would benefit American peregrine falcon prey species. Reducing helicopter activity in the Whitmore area would benefit falcons in the area, and impacts overall to the population should remain minor. Increased winter use would increase opportunities for impacts to the bald eagle, but this might be partially offset by the no-motor season extending into March. The impacts would probably still reach the moderate threshold if bald eagle distributions were disrupted through increased human activity on the river and in camps near roosting areas. Increased foot traffic in canyons brought about by the moderate increase in summer access could increase flushing occurrences of Mexican spotted owls, but below the moderate impact threshold because the protected activity centers are 3 miles from the river and it would take a large increase in several indicators of use to increase the potential for adverse interactions. Since the southwestern willow flycatcher is a late nester, the more modest increase in late spring and early summer use would maintain impacts at the moderate threshold level. This would be assured if mitigation measures (closures or restrictions to nesting areas) were instituted. Increased summer use would increase potential for impacts to bat species in maternity colonies, but probably not beyond the moderate threshold.

Impacts to populations of Kanab ambersnail, humpback chub, and southwestern willow flycatcher would be regional because those species are concentrated in localized areas, and any effects in that area would affect the entire population.

Mitigation of Effects. As discussed for Alternative A, reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include those listed under "Terrestrial Wildlife" and "Vegetation," plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative E, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major

effects on threatened, endangered, and sensitive wildlife species. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Conclusion. Under Alternative E impacts to threatened, endangered, and sensitive species would be adverse, regional and local, seasonal to year-round, short and long term, and minor to moderate. Alternative E would not result in the impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative E would result in a localized, adverse, short- to long-term, seasonal to year-round, minor contribution to these cumulative effects.

Alternative F

Analysis. Under Alternative F the no-motor season would extend from July through December, maximum trip sizes would be decreased, the maximum number of trips at one time would drop from 70 to 54, and the maximum number of people at one time would drop from 1,095 to 972. Annual user discretionary time would increase, but it would be the second lowest of the alternatives. All indicators of access would increase in the March-April period but would decrease in the May–August period compared to Alternative A as a result of prohibiting motors and allowing fewer launches in July and August.

Alternative F would have the same types of impacts as those described under Alternative A; however, intensities would differ. Increases in user discretionary time suggest the potential for greater impacts on the Kanab ambersnail, but they would not exceed the moderate threshold, and overall summer use decreases would lower the potential for impacts during this period.

The increase in access during March and April suggests a greater potential for recreationists to interrupt humpback chub reproductive activities at the Little Colorado River. Impacts could be adverse and major if the present population continued to decline; additional disruption of reproductive activity, destruction of eggs and fry, and disturbance of young-of-the-year could further depress the population.

No impacts from motor use would occur for a six-month July to December period and this would benefit a variety of prey species for the American peregrine falcon. Reducing helicopter activity in the Whitmore area would also benefit peregrine falcons, and overall impacts to the population should remain minor. Increased winter use and the no-motor season ending in December would increase the potential for impacts on bald eagles. The impacts could reach the major threshold if eagle distributions were disrupted through increased human activity on the river and in camps near roosting areas. Decreased foot traffic in canyons resulting from the decrease in summer use could decrease flushing occurrences of Mexican spotted owls, but not below the minor impact threshold. Since the southwestern willow flycatcher is a late nester, use patterns in Alternative F would reduce opportunities for impacts, but not below the moderate threshold level. Decreased summer use would decrease the potential for impacts to bat species in maternity colonies, but probably not below the moderate threshold.

Impacts to populations of Kanab ambersnail, humpback chub, and southwestern willow flycatcher would affect the entire Grand Canyon population because they are concentrated in localized areas.

Impacts on localized populations and sensitive individuals would be similar to Alternative A. Any amount of use during the reproductive season could affect a local population of sensitive species due to their small populations and usually specific habitat preferences.

Mitigation of Effects. As discussed for Alternative A, reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include those listed under "Terrestrial Wildlife" and "Vegetation," plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative F, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Under Alternative F the impacts to threatened, endangered, and sensitive species would be adverse, regional and local, seasonal to year-round, short and long term, and minor to major. Alternative F would not result in the impairment of threatened, endangered, and sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative F would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative G

Analysis. Under Alternative G, generally larger, shorter trips would be offered, with all indicators of access increased in winter and shoulder seasons, but decreased in summer.

Alternative G would have the same types of impacts as those described under Alternative A, but intensities would differ. Increases in annual user discretionary time would be the lowest of all the new alternatives. Increased use could lead to greater impacts on the Kanab ambersnail, but they would not exceed the moderate threshold.

The increase in access during March and April would increase the potential for recreationists to interrupt humpback chub reproductive activities in the Little Colorado River. Impacts would probably reach the moderate threshold, but the impact of recreation on this population is not known. If the present population continued to decline, any additional disruption of reproductive activity could result in major adverse impacts.

Helicopter activity in the Whitmore area would be about the same as now, with the same impacts on American peregrine falcons as described for Alternative A. Increased winter use and the no-motor season ending in December would increase opportunities for impacts to the bald eagle. The impacts could reach the major threshold if distributions were disrupted through increased human activity on the river and in camps near roosting areas. Decreased foot traffic in canyons from the moderate decrease in user discretionary time during summer would decrease potential for flushing occurrences of Mexican spotted owls, but not below the minor impact threshold. Since the southwestern willow flycatcher is a late nester, use patterns in Alternative G would reduce impacts, but not below the moderate threshold level. Decreased summer use would decrease opportunities for impacts to bat species in maternity colonies, but probably not below the moderate threshold.

Impacts to populations of Kanab ambersnail, humpback chub, and southwestern willow flycatcher would affect the entire Grand Canyon population since they are concentrated in localized areas.

Impacts on localized populations and sensitive individuals would be similar to Alternative A. Any amount of use during the reproductive season could affect a local population of sensitive species due to their small populations and usually specific habitat preferences.

Mitigation of Effects. As discussed for Alternative A, reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include those listed under "Terrestrial Wildlife" and "Vegetation," plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in "Methodology for Analyzing Effects: Cumulative Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative G, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusions. Under Alternative G impacts to threatened, endangered, and sensitive species would be adverse, regional and local, seasonal to year-round, short and long term, and minor to major. Alternative G would not result in the impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative G would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Alternative H (NPS Preferred Alternative)

Analysis. Under Alternative H total annual would increase from 355,081 hours to 554,103 hours. User discretionary time in early spring would increase modestly to 47,523 hours, while from May to August it would increase substantially from 294,506 hours to 402,037 hours. Winter user discretionary time would also increase. Trip sizes would decrease for commercial groups, and the maximum number of trips and people at one time would decrease. The no-motor season from would be increased to 6 months.

Alternative H would have the same types of impacts as those described under Alternative A, but intensities would differ. Increases in most annual use indicators suggest more opportunities for impacts on the Kanab ambersnail, but they would still not exceed the moderate threshold.

The modest increase in access during March and April suggests increased opportunities for recreationists to interrupt humpback chub reproductive activities in the Little Colorado River, but impacts would probably not exceed the moderate threshold.

No impacts from motor use would occur during the fall and winter, which would benefit a variety of peregrine falcon prey species. Reducing helicopter activity in the Whitmore area would benefit peregrine falcons and impacts to the population should remain minor. Increased winter use would increase opportunities for impacts to the bald eagle, but this might be partially offset by the no-motor season extending into February. The impacts would probably still reach the moderate threshold, if distributions were disrupted through increased human activity on the river and in camps near roosting areas. Increased foot traffic in canyons brought about by the large increase in summer access could increase flushing occurrences of Mexican spotted owls up to the moderate impact threshold. Alternative H would have the third largest summer user discretionary time, implying substantially more opportunities for day hikes into Mexican spotted owl protected activity centers, where the chances of disturbance to nesting owls would increase. Since the southwestern willow flycatcher is a late nester, the increase in May-June use might raise impacts to the major threshold level; with mitigation measures (closures or restrictions on access to nesting areas) these impacts would be reduced.

The large increase in summer use might result in increased impacts to bats in maternity colonies and cave roosts. If caves are not closed, these impacts could exceed the moderate threshold and significant population declines could occur.

Impacts to populations of Kanab ambersnail, humpback chub, and southwestern willow flycatcher would affect the entire Grand Canyon population because they are concentrated in localized areas.

Mitigation of Effects. As discussed for Alternative A, reasonable mitigations to consider for reducing or eliminating impacts to threatened, endangered, and sensitive species include those listed under “Terrestrial Wildlife” and “Vegetation,” plus those listed on page 514 (such as closing habitats to recreational users and restricting use of tributaries during reproductive seasons of native fishes).

Cumulative Effects. The impact ratings from individual past, present, and reasonably foreseeable actions are discussed above in “Methodology for Analyzing Effects: Cumulative

Impacts." The impact rating from all cumulative actions is regional to localized, adverse, short to long term, seasonal to year-round, minor to major. Cumulatively, the effects of Alternative H, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

Conclusion. Under Alternative H the impacts to threatened, endangered, and sensitive species would be adverse, regional and local, seasonal to year-round, short and long term, and minor to major. Alternative H would not result in the impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative H would result in a localized, adverse, short- to long-term, seasonal to year-round, minor to moderate contribution to these cumulative effects.

IMPACT ANALYSIS — LOWER GORGE ALTERNATIVES

Potential impacts on individual species are summarized in Table 4-24, and species that are not likely to be affected by the alternatives are listed in Table 4-25. The differences among alternatives are described in the following sections.

TABLE 4-24: SUMMARY OF IMPACTS ON THREATENED, ENDANGERED, AND SENSITIVE SPECIES — LOWER GORGE ALTERNATIVES

Common Name	Alternatives				
	1	2	3	4	5
Relict Leopard Frog	Major	Major	Major	Major	Major
American Peregrine Falcon	Moderate	Minor	Moderate	Moderate	Major
Bald Eagle	Minor	Minor	Moderate	Minor	Major
California Condor	Moderate	Minor	Major	Moderate	Major
Mexican Spotted Owl	Negligible	Negligible	Negligible	Negligible	Negligible
Southwestern Willow Flycatcher	Moderate	Moderate	Moderate	Moderate	Moderate
Mexican Long-tongued Bat	Moderate	Moderate	Moderate	Moderate	Moderate
Spotted Bat	Minor	Minor	Minor	Minor	Minor
Allen's Lappet-browed Bat	Moderate	Moderate	Moderate	Moderate	Moderate
Long-legged Myotis	Minor	Minor	Minor	Minor	Minor
Pale Townsend's Big-eared Bat	Moderate	Moderate	Moderate	Moderate	Moderate

TABLE 4-25: SENSITIVE AND LISTED SPECIES NOT LIKELY TO BE AFFECTED BY LOWER GORGE ALTERNATIVES

Common Name	Reasoning
Grand Canyon Cave Pseudoscorpion	Occurs in areas where human visitation is rare.
Razorback Sucker	Presumed extirpated below Diamond Creek; last known collection in the Lower Gorge was in the early 1990s.
Humpback Chub	Rarely occur below Diamond Creek; main spawning population is associated with the Little Colorado River in Marble Canyon.
Northern Leopard Frog	Although potential habitat is present, historic population not confirmed to exist below Diamond Creek.
Desert Tortoise	Known only to occur in upland habitats in the Lower Gorge, which

Common Name	Reasoning
	are rarely visited.
California Brown Pelican	Rare winter transient: no known recreation-related impacts.
Yellow-billed Cuckoo	Habitat exists in Lower Gorge, but only a few isolated records exist for this species.
Yuma Clapper Rail	Nesting rails not confirmed in Grand Canyon National Park, although individuals have been infrequently sighted in Lower Gorge.
Western Red Bat	Occurs in areas where river-based human visitation is rare.
Southwestern Myotis	One isolated record from park.
Pocket Free Tail	One isolated record from park.
Greater Western Mastiff Bat	Occurs in areas where river-based human visitation is rare.
Southwest River Otter	Extirpated from Grand Canyon National Park.
Cave-dwelling Primrose and Kaibab Suncup	Primrose — no longer considered for listing (3c) and suncup — isolated up side canyons (SC).

Alternative 1 (Current Conditions)

Analysis. Components of Alternative 1 likely to affect threatened, endangered, or sensitive wildlife species are discussed under "Terrestrial Wildlife."

Relict Leopard Frog — In spring of 2004, leopard frogs were discovered in Surprise Canyon above the river. These frogs were morphologically identified as relict leopard frogs, but a DNA analysis from one specimen suggests that they could be intermediate between relict leopard frogs and lowland leopard frogs (Drost, pers. comm. 2004). Both species are designated as species of concern by the U. S. Fish and Wildlife Service and Arizona. Breeding occurs in spring, and tadpoles transform to frogs June through August (Miller et al. 1982), when visitation is at its peak in the Lower Gorge. Recreation-related impacts could cause the frog to be extirpated from the area (major impact) due to its extremely small and localized known population. Cattle and burros have not been recently documented in this particular canyon but are known to be present in adjacent canyons. Collection or destruction of a few frogs, or wading in the single, small, isolated pool, could reduce the population below viable numbers. Since this is the only known population in Grand Canyon National Park, impacts from day hikers could be adverse, regional, long term, and major.

American Peregrine Falcon — Since a 1989 survey of a portion of the region below Diamond Creek (Brown 1989), the number of peregrine falcon territories appears to have decreased based on limited survey data (Ward 2000; GRCA wildlife files). Human activity in the Lower Gorge since 1989 has increased significantly due to the start of pontoon trips in the Quartermaster area, HRR river trips, and increased upriver travel from Lake Mead. No conclusion can be drawn regarding the causative factors responsible for the absence of peregrines from the formerly occupied territories. However, there is little doubt that the large number of helicopter flights per day in the Quartermaster area are likely to cause adverse, localized, long-term, moderate impacts to the species. Peregrines might tolerate a great deal of river-based activity in the remainder of the Lower Gorge; they can adapt to a variety of activity filled environments (Ellis 1981; Ellis, Ellis, and Mindell 1991). However, if disturbances began to affect their bird and bat prey base, impacts could increase significantly.

Bald Eagle — The threatened bald eagle is an occasional winter visitor to the Lower Gorge, but population numbers are much greater in the upper reaches of the Grand Canyon. Eagles exhibit a wide range of tolerance to humans, and numerous variables can affect eagle response to human disturbance. High levels of recreational use can disturb wintering bald eagles (Stalmaster and Kaiser 1997). The main impact of foot traffic and motorboats on wintering bald eagles is disruption of feeding activities. During the early morning hours, flushing can interrupt feeding activities and displace eagles. Stevens (1997) determined that eagle distribution in the Grand Canyon was negatively correlated with the amount of human activity. Eagles are flushed in the canyon as boats pass hunting perches and roosts, but at the low level of present winter use, the effects are probably not outside the range of natural variability. Given the low level of winter use, the present amount of disturbance probably results in an adverse, localized, short-term, minor impact to the bald eagle.

California Condor — California condors have visited the Lower Gorge infrequently, but the potential for adverse interactions with recreationists does exist (GRCA wildlife files). In all areas besides Quartermaster, the potential would be low for two reasons: (1) condors spend less than 5% of their time in the Grand Canyon below Diamond Creek, and (2) only a small portion of the overall Grand Canyon population has ventured into the area. The large number of helicopter flights in the Quartermaster area must be given special consideration, however, based on the potential for collisions between aircraft and condors. The potential for collisions was recognized by the National Park Service and the U. S. Fish and Wildlife Service in the "Biological Assessment" and resultant "Biological Opinion" for aircraft overflights in Grand Canyon National Park. This concern resulted in an "incidental take statement" in which it was acknowledged that potentially one bird could be killed in aircraft collisions in five years (USFWS 1999). The total number of scenic aircraft flights is considerably greater in the upper regions of Grand Canyon than in the Quartermaster area, but the concentration of flights in such a small area is cause for concern. The fact that flights at this level of intensity have been occurring in the Quartermaster area during the past few years while condors have been in the canyon suggests that impacts are presently at the moderate threshold and should remain there.

Mexican Spotted Owl — Mexican spotted owls have not been found in the Lower Gorge, but the area has not been intensively surveyed (Willey and Ward 2003). There is a Mexican spotted owl territory 15–20 miles up river from Diamond Creek in an area that exhibits some of the characteristics of Lower Gorge habitats. Suitable habitat in the Lower Gorge is very limited and is generally 2–5 miles from the river, in areas with little attractiveness to day hikers (Willey, Ward, and Spotskey 2002). It is unlikely that the areas would be visited frequently, and impacts would likely be adverse, localized, short term, and negligible under the current level of river use.

Southwestern Willow Flycatcher — The southwestern willow flycatcher occurs infrequently in the Lower Gorge, but generally one to two pairs nest above Lake Mead. Nesting periods coincide with the peak recreational use period (June and July). Nesting or breeding birds may be disturbed by river runners when they create trails through or expand camps into willow or dense tamarisk stands. The effects of recreational use near willow flycatcher habitat include nest disruption and noise. Some level of motorized use close to willow flycatcher habitat could disturb this species and cause them to abandon the area. Noise from motorized vessels could cause nest abandonment. Nests are generally located over the water, possibly rendering them susceptible to large wakes from motorboats. These impacts could cause a decline in the local population, resulting in

an adverse, localized, long-term, moderate impact to this species at this level of recreational activity.

Bats — Bats are more common in the Lower Gorge than in the upper portion of the Grand Canyon because there are more caves there. Over half of the Mexican long-tongued bats encountered in surveys have been found in the Lower Gorge. Other species, which are not listed as threatened, endangered, or sensitive species (such as the Mexican free-tailed bat) are much more prevalent in the Lower Gorge than in the upper portion of Grand Canyon. Bat Cave at RM 266 is home to a summer maternity colony of about 300,000–500,000 Mexican free-tailed bats and a smaller number of over-wintering bats (Bat Conservation International 1998).

Cave dwelling bats such as Townsend's big-eared bat, Mexican long-tongued bat, and Allen's lappet-browed bat are likely to be disturbed by river runners exploring side canyon caves at the current level of use. Populations of some species (cave myotis and Arizona myotis) have declined or disappeared from areas along the lower Colorado River where habitat changes and flooding due to dam construction have occurred over the past 60 years (Leslie, pers. comm. 2004a). Human disturbance is probably the biggest threat to roosting bats. While vandalism and direct aggression toward roosting bats can cause significant damage, even "responsible" cave visitors might unknowingly cause harm to roosting bats simply by their presence (GRCA wildlife files). Repeated disturbance at a roost site might cause bats to abandon the roost and move to a less favorable (but less disturbed) roost (Leslie, pers. comm. 2004a). Hikers in caves can impact bats year-round by causing them to temporarily or permanently abandon roosting sites, maternity colonies, and hibernacula. Disturbance at hibernacula may wake hibernating bats, causing them to burn stored fat and decreasing winter survival (Thomas 1995). Population declines may be accelerated if numbers at maternity colonies are not sufficient to raise roost temperatures to the levels needed for healthy growth of young (Mohr 1972; Leslie, pers. comm. 2004a). This impact would reach the adverse, short-term, moderate threshold, unless repeated visits to the same cave occurred, in which case the impacts could reach the adverse, long-term, major threshold.

With crack and crevice dwelling bats, such as the spotted bat and long-legged myotis, habitat modification would produce negligible to minor impacts since Grand Canyon National Park has abundant habitats. They would still be subjected to disturbance by recreationists exploring side canyons, but these disturbances would be adverse, short term, and minor. These species are more dispersed compared to cave dwelling species, so the potential for disturbing large numbers is less. This differs from the situation in the upper canyon where there are more recreationists on the river at one time and the time recreationists have to explore side canyons is generally greater than in the Lower Gorge.

Mitigation of Effects. Reasonable mitigation actions to consider for reducing or eliminating impacts to threatened, endangered, and sensitive wildlife species include all of those listed for Lower Gorge alternatives under "Terrestrial Wildlife" plus the following:

- Develop and implement threatened, endangered, and sensitive wildlife species monitoring programs
- Close southwestern willow flycatcher nesting habitats
- Close relict leopard frog habitat

- Close all caves to visitation until the park's bat inventory has been completed

Cumulative Effects. The major factor affecting threatened, endangered, and sensitive wildlife species in the river corridor are the existence and operation of Glen Canyon Dam, as previously described on page 515. Additional cumulative effects that are applicable in the Lower Gorge are described below:

Development on Hualapai tribal lands in the Quartermaster area would continue to have adverse, moderate to major impacts on use of the area as wildlife habitat, and use has likely already displaced some species and individuals from the area. However, based on the amount of available habitat adjacent to or near the developed area, impacts would likely be localized, adverse, short to long term, year-round, and moderate, and regional, adverse, short to long term, year-round, and minor on threatened, endangered, and sensitive wildlife species and habitat.

Extensive helicopter and motorized boat use in the Quartermaster area could cause localized, adverse, short- to long-term, seasonal to year-round, major impacts to wildlife populations both inside and outside the park. This area has by far the most helicopter activity and impacts of any other location in or near the park. Bird and ungulate species could abandon this habitat due to the increased disturbance by motorized vessels and helicopters, and this could result in a loss of bird species diversity within the area. Also, as condors continue to expand their range across the Colorado Plateau and likely reoccupy historical roosting and nesting areas, the potential to collide with aircraft increases. However, helicopter use in this area is under Hualapai Tribe control, and the tribe has indicated that they expect the helicopter use to continue at current or increased levels.

The Lower Gorge also experiences high levels of air tour overflights in established flight corridors as described for "Natural Soundscapes"; however, these flights are several thousand feet above the river corridor and would have much less effect than flights in the Quartermaster area.

The lowering of water levels in Lake Mead during the current drought, although not anthropogenic in nature, could benefit the southwestern willow flycatcher as more shoreline vegetation is created as potential nesting habitat. This would have regional, beneficial, short-term, seasonal, minor effects.

The impact rating from all cumulative actions on a regional basis is beneficial, short term, seasonal, and minor, and on a local basis adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 1, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative 1 impacts to threatened, endangered, and sensitive species would be adverse, regional and local, short and long term, and negligible to major. Alternative 1 would not result in the impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short- to long-term,

seasonal to year-round, and minor to major. Alternative 1 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 2

Analysis. Elements of Alternative 2 likely to affect threatened, endangered, and sensitive wildlife species are discussed under "Terrestrial Wildlife."

As the major impact to the relict leopard frog is the chance of destruction of individuals or habitat at Surprise Canyon, and the amount of day and overnight use is still substantial, impacts on this species would not decrease from the major level under Alternative 2.

Eliminating pontoon trips and associated helicopter use would by itself greatly increase the chance that American peregrine falcons would reoccupy aeries in the Quartermaster area. However, there would still be impacts from helicopter trips used to ferry out the HRR day and overnight trip passengers. This level of disturbance would probably be tolerated by peregrines in the area; it is doubtful that the HRR trips would impact peregrines elsewhere in the corridor. Consequently, this alternative would reduce impacts to the peregrine falcon to the minor level (but adverse cumulative effects from numerous helicopter flights not associated with river trips would probably negate this reduction).

This alternative would eliminate winter pontoon trips, which would benefit the bald eagle. Impacts to this species would still be expected from winter noncommercial use and a small amount of HRR activity in March, but these levels would be low enough to have a negligible adverse effect on this species.

Eliminating pontoon helicopter flights would greatly reduce the chance for helicopter collisions with California condors. The chance for adverse human interactions would still exist with this level of HRR activity, but the overall impacts would probably be minor (but see the cumulative effects discussion below).

Impacts to Mexican spotted owls would remain at the negligible level.

The impacts of recreational river use on the southwestern willow flycatcher would be similar to those discussed for Alternative 1, but eliminating the pontoon operation could make it possible for southwestern willow flycatchers to colonize the tamarisk thickets in this area. It is likely, however, that the reduction in passenger numbers and the subsequent reduction in disturbance would be too small to reduce the impacts to the southwestern willow flycatcher to the minor threshold. If nesting areas were closed, it is probable that the impacts could be reduced to minor. Designation of critical habitat by the U. S. Fish and Wildlife Service for the southwestern willow flycatcher in the Lower Gorge has been proposed. Creating one additional campsite by removing tamarisk could have a very localized adverse effect on potential flycatcher habitat if the vegetation manipulation occurred within the designated critical habitat. The Fish and Wildlife Service would be consulted on any proposed actions within the designated critical habitat.

Impacts to bat species would remain at the moderate level for cave-dwelling bats and minor for crevice-roosting species because the number of hikers would probably remain similar to

Alternative 1. Day-trip group sizes would be reduced from 100 to 30, which would reduce the potential for adverse interactions. However, the number of overnight launches could increase drastically from the current average of three per month to one per day.

Mitigation of Effects. As described for Alternative 1, reasonable mitigation actions to consider for reducing or eliminating impacts to threatened, endangered, and sensitive wildlife species include all of those listed for Lower Gorge alternatives under "Terrestrial Wildlife" plus measures such as developing and implementing monitoring programs and closing habitats to visitor use.

Cumulative Effects. The impact rating from all cumulative actions on a regional basis is beneficial, short term, seasonal, and minor, and on a local basis adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 2, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative 2, the impacts to threatened, endangered, and sensitive species would be regional and local, negligible to major, adverse, and short-term and long-term. Alternative 2 would not result in the impairment of threatened, endangered, and sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 2 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 3

Analysis. Components of Alternative 3 likely to affect threatened, endangered, and sensitive wildlife species are discussed under "Terrestrial Wildlife."

Because the amount of day and overnight use would be significant, the potential destruction of habitat or individuals of the relict leopard frog at Surprise Canyon would keep impacts on this species at the major level. Closure of Surprise Canyon would reduce impacts to the minor level, if the closure was strictly enforced.

With a doubling of pontoon boat passengers and associated helicopter flights into the Quartermaster area, American peregrine falcons would probably not reestablish territories for several miles on either side of this high impact area. Therefore, impacts would remain at least at the moderate level and could increase to major depending on the routes taken by helicopters. If the flight area expanded to accommodate the increased number of pontoon boat passengers per day in the high season (which would coincide with peregrine falcon breeding season), areas not currently impacted could see decreased population levels of a magnitude approaching the major impact threshold.

If winter use reaches the maximum allowable of 400 pontoon passengers per day, the constant flushing and harassment of bald eagles would result in at least a moderate adverse impact.

Doubling pontoon passengers and associated helicopter flights per day would double the present chance of condors colliding with aircraft, but the decrease in numbers of HRR day trips would result in a small decrease in the possibility of adverse human interactions from this source of activity. If the level of overnight use reached the maximum allowable level of two launches per day, the chance of adverse interactions would increase dramatically. Condors are drawn to human activity (Snyder and Snyder 2000), and the large increase in the number of humans at the pontoon launch site could attract any condor in the area. With such a large increase in helicopter flights in a small area, a collision is much more likely than at the present level of activity. The loss of even one condor would result in a significant decrease in the free-flying condor population in Arizona, which would meet the criteria for a major adverse impact.

Impacts to Mexican spotted owls would remain negligible, unless increased overnight use allowed hikers to reach their limited potential nesting habitats.

The impacts of recreational use of the river corridor on the southwestern willow flycatcher would be primarily habitat destruction and disruption of nesting by people on shore. Some disturbance could also probably be attributed to the large number of motorized boats passing nesting areas. It is likely that the reduction in day trip numbers and the subsequent reduction in disturbance would be overshadowed by the possible increase in the number of overnight passengers. The impacts to the southwestern willow flycatcher would remain at the moderate threshold. If the nesting areas were closed to visitor use, and the closure was enforced, it is probable that the impacts could be reduced to the minor level. Designation of critical habitat by the U. S. Fish and Wildlife Service for the southwestern willow flycatcher in the Lower Gorge has been proposed. The creation of two additional campsites, requiring tamarisk removal, could have a localized adverse effect on potential flycatcher habitat if the vegetation manipulation occurred within the designated critical habitat. The Fish and Wildlife Service would be consulted on any proposed actions that occur within the designated critical habitat.

Impacts to bats would remain at the level described for Alternative 1.

Mitigation of Effects. As described for Alternative 1, reasonable mitigation actions to consider for reducing or eliminating impacts to threatened, endangered, and sensitive wildlife species include all of those listed for Lower Gorge alternatives under “Terrestrial Wildlife” plus measures such as developing and implementing monitoring programs and closing habitats to visitor use.

Cumulative Effects. The impact rating from all cumulative actions on a regional basis is beneficial, short term, seasonal, and minor, and on a local basis adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 3, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative 3, the impacts to threatened, endangered, and sensitive species would be regional and local, negligible to major, adverse, and short-term and long-term. Alternative 3 would not result in the impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 3 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 4 (NPS Preferred Alternative)

Analysis. Components of Alternative 4 likely to affect threatened, endangered, and sensitive wildlife species are discussed under "Terrestrial Wildlife."

This alternative would reduce river-related helicopter flights compared to Alternative 1 (but flights for passengers not associated with river use would keep numbers of flights and impacts at about the same levels as discussed under cumulative effects for Alternative 1). The changes from Alternative 1 would roughly cancel each other out and would not be substantially different from Alternative 1. Therefore, the analysis and impact ratings for threatened, endangered, and sensitive species under Alternative 4 would be the same as for Alternative 1. Reduced use in the winter could benefit bald eagles to a small degree, but impacts would still meet the minor threshold criteria as in Alternative 1

Designation of critical habitat by the U. S. Fish and Wildlife Service for the southwestern willow flycatcher in the Lower Gorge has been proposed. The creation of three additional campsites, requiring tamarisk removal, could have localized adverse effects on potential flycatcher habitat, if the vegetation manipulation occurred within the designated critical habitat. The Fish and Wildlife Service would be consulted on any proposed actions that occur within the designated critical habitat.

Mitigation of Effects. As described for Alternative 1, reasonable mitigation actions to consider for reducing or eliminating impacts to threatened, endangered, and sensitive wildlife species include all of those listed for Lower Gorge alternatives under "Terrestrial Wildlife" plus measures such as developing and implementing monitoring programs and closing habitats to visitor use.

Cumulative Effects. The impact rating from all cumulative actions on a regional basis is beneficial, short term, seasonal, and minor, and on a local basis adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 4, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative 4, the impacts to threatened, endangered, and sensitive species would be regional and local, negligible to major, adverse, and short-term and long-term. Alternative 4 would not result in the impairment of threatened, endangered, or sensitive species

in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 4 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Alternative 5 (Hualapai Tribe Proposed Action)

Analysis. Components of Alternative 5 likely to affect threatened, endangered, and sensitive wildlife species are discussed under "Terrestrial Wildlife."

Because the amount of day and overnight use would be significant, the potential for destruction of habitat or individuals of the relict leopard frog at Surprise Canyon would keep impacts on this species at the major level. Closure of Surprise Canyon would reduce impacts to the minor level, if the closure was strictly enforced.

If winter pontoon use reached the maximum allowable of 960 passengers per day, the constant flushing and harassment of bald eagles could reach the major impact threshold.

With more than four times the number of daily pontoon passengers and associated helicopter flights into the Quartermaster area, compared to Alternative 1, American peregrine falcons would likely not reestablish territories for several miles on either side of this high impact area. If the flight area expanded for safety reasons to accommodate the higher number of round-trip helicopter flights per day in the high season (which would coincide with the peregrine falcon breeding season), other areas not currently impacted could see decreased population levels of a magnitude reaching the major impact threshold.

A large increase in pontoon boat passengers and associated helicopter flights would vastly increase the present chance of condors colliding with aircraft. If the level of overnight use reached the maximum allowable level of three launches per day, the chance of adverse interactions would increase dramatically. Condors are drawn to human activity (Snyder and Snyder 2000) and the huge increase in the number of humans at the pontoon launch site would attract any condor in this area. Under this scenario, with such a large increase in helicopter flights in a very concentrated area, a collision would be inevitable. The loss of even one condor would result in a significant decrease in the free-flying condor population in Arizona, which would meet the criteria for a major adverse impact.

Impacts to Mexican spotted owls would remain at the negligible level, unless the level of overnight use enabled hikers to reach the very limited potential nesting habitat of this species.

The impacts of recreational use of the river corridor on the southwestern willow flycatcher would be primarily due to habitat destruction and disruption of nesting by people on shore. Some disturbance could also probably be attributed to the large number of motorized boats passing nesting areas. It is likely that the increase in day trip numbers and the consequent increase in disturbance would result in adverse impacts to the southwestern willow flycatcher at a moderate or slightly higher threshold. If the nesting areas were closed, and the closure enforced, it is probable that the impacts could be reduced to the minor level. The creation of three additional campsites, requiring tamarisk removal, could have localized adverse effects on potential

flycatcher habitat, if the vegetation manipulation occurs within critical habitat, which is being considered by the U. S. Fish and Wildlife Service. The Fish and Wildlife Service would be consulted on any proposed actions that occurred within critical habitat.

Impacts to bats would remain at the level described for Alternative 1 for the reasons discussed in that alternative.

Mitigation of Effects. As described for Alternative 1, reasonable mitigation actions to consider for reducing or eliminating impacts to threatened, endangered, and sensitive wildlife species include all of those listed for Lower Gorge alternatives under "Terrestrial Wildlife" plus measures such as developing and implementing monitoring programs and closing habitats to visitor use.

Cumulative Effects. The impact rating from all cumulative actions on a regional basis is beneficial, short term, seasonal, and minor, and on a local basis adverse, short to long term, seasonal to year-round, and minor to major. Cumulatively, the effects of Alternative 5, when combined with these other past, present, and reasonably foreseeable actions, would result in regional to localized, adverse, short- to long-term, seasonal to year-round, minor to major effects on threatened, endangered, and sensitive wildlife species. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.

Conclusion. Under Alternative 5, the impacts to threatened, endangered, and sensitive species would be adverse, regional and local, short and long term, and negligible to major. Alternative 5 would not result in the impairment of threatened, endangered, or sensitive species in Grand Canyon National Park. Cumulative effects would be regional to localized, adverse, short to long term, seasonal to year-round, and minor to major. Alternative 5 would result in a localized, adverse, short- to long-term, seasonal to year-round, moderate contribution to these cumulative effects.