# Grand Canyon National Park Baseline Noise Analysis

## Introduction

The U.S Department of Transportation's John A. Volpe National Transportation Systems Center, Environmental Measurement and Modeling Division (Volpe Center) has been assisting the NPS and FAA with the noise analysis that was conducted to support the agencies in their efforts to address the overflights issues at Grand Canyon National Park (GCNP). In preparation for the Grand Canyon Working Group meeting, scheduled for March 20 through 22, 2006, this document presents updated results since the January/February meeting of the computer modeling for the current aircraft noise conditions (i.e., baseline conditions) and the extent of achievement of substantial restoration of natural quiet at GCNP on the peak day used (August 8, 2005, the day of the highest number of air tour and air tour related operations). The FAA's Integrated Noise Model (INM) Version 6.2 was utilized for all analyses.

It should be emphasized that this information is preliminary and still under review. It is not at this point in time a final noise analysis. Moreover, the FAA and the NPS have not determined how this information should be interpreted or what its implications are with respect to future work of the stakeholder group through both the Alternative Dispute Resolution and NEPA processes.

Note To Working Group Members: There are several technical terms included in this report. These terms were all explained during the technical presentation at the last meeting and included in the glossary of terms you were provided. You might want to use that as a reference tool as you consider the information below.

## Audibility

The data presented below uses a metric known as "time audible" or "$T_{Aud}$". Time audible or "audibility" is one of the ways NPS measures or characterizes the acoustic environment in National Park units. Characterization of ambient sound conditions and the determination of acoustic ambient baseline conditions are necessary in order to provide a basis against which noise related impacts can be analyzed. Many different measurements are needed to adequately describe the acoustical environment in National Park units. Individual sounds vary in duration, loudness, and frequency. Moreover, the latter two factors often change during the course of the sound (modulation). The chorus of sounds present in the acoustic environment is often composed of a variety of sound sources, and an adequate quantitative description could require hundreds of measurements. While comprehensive quantification of the acoustic environment in units of the National Park system is desirable, it is not often practicable. Therefore, there are many contexts in which a simplified approach is needed and therefore, the agencies are using the audibility metric.

Audibility refers to the capacity of a human or animal to detect the presence of a sound. This ability is affected by the amplitude and structure of the sound (its frequency content and temporal pattern). A given sound will differ in audibility across different animals, because the auditory system of each species is different. Species will differ in their absolute sensitivity (noise-free hearing thresholds), and also in their ability to hear a sound that might be masked by the presence of other sounds. However, human hearing capabilities provide a good foundation:

humans have been very well studied, human hearing capabilities are reasonable proxies for many vertebrate species, and visitor experiences is an important component of park management plans.

## Ambient Noise Level Data

Two ambient sound level maps were provided by the NPS and used to calculate the time aircraft are audible (TAUD): Natural Ambient determined from data measured during daytime hours (7 am to 7 pm); and Natural Ambient determined from data measured during nighttime hours (7 pm to 7 am).[*] The ambient maps, along with the two-zone methodology used in previous studies[†] to account for areas where either detectability or noticeability,[‡] were used to develop the final ambient maps used in the INM. Specifically, for the detectability areas, the data in the NPS ambient maps were used directly in computing audibility; for the noticeability areas, a 10 dB noticeability factor was added to all ambients within the noticeability zones (see Figure 1).

## Noise Modeling

The data presented was run using INM 6.2. This is the model that was recommended by the Federal Interagency Committee on Aviation Noise (FICAN) as the best practice modeling methodology currently available for evaluating aircraft noise in national parks, and agreed to by NPS and FAA after extensive studies comparing the models currently available and upgrades to the previous version of INM. It should be noted however, that as with all models, INM 6.2 is not 100% accurate; FICAN reported the following qualifications regarding the modeling of audibility:

> "Assessing accuracy was extremely difficult due to the complexity of the audibility metric. FICAN agreed that no model will ever be able to predict with absolute certainty the audibility of any particular aircraft event at any specific location. The problem lies in predicting with certainty all three key elements of audibility: ambient sound environment, source noise level, and detectability threshold of the observer (human or animal). Extensive long-term monitoring could substantially reduce uncertainty in the ambient sound levels. Even more extensive long-term measurement programs with detailed aircraft performance and position information may be able to substantially reduce uncertainty in predicted received aircraft sound levels. However, sound propagation over long distances through a complex atmosphere (wind, temperature, turbulence) will always be subject to considerable variability. Furthermore, observer reaction can never be predicted with absolute certainty. Uncertainty often exists to some degree in any type of modeling."[§]

Model uncertainty for this analysis is discussed in more detail below.

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[*] Natural Ambient (as used in this document) is defined as the sound level exceeded 50% of the time determined from the natural sound conditions found in a study area, including all sounds of nature (i.e., wind, streams, wildlife, etc.), and excluding all human and mechanical sounds.

[†] "Special Flight Rules in the Vicinity of Grand Canyon National Park" Federal Aviation Administration (ATA-300), February 2000.

[‡] The Noticeability areas are, generally, Marble Canyon, the South Rim around the Visitor's Center, around Point Imperial, and the West End of GCNP (Sanup region).

[§] "FICAN Findings and Recommendations on Tools for Modeling Aircraft Noise in National Parks," Washington, DC: Federal Interagency Committee on Aviation Noise, February 2005 (http://overflights.faa.gov/).

## Model Scenarios

All analyses were conducted for August 8, 2005, the peak day of operations for commercial air tours and related flights. The GCNP personnel confirmed this day from the information contained in the Air Tour operations spreadsheet (the "operations database") maintained by the FAA.

The Peak Day baseline case includes the following operations as listed in the operations database on the Peak Day:

- Commercial Air Tours are the advertised air tour flights and charter flights offered by the GCNP commercial air tour operators. This is the category of air tour operation to which the allocation caps apply.
- GC West (a.k.a. Hualapai Exempt) refers to the helicopter and fixed-wing flights to the Hualapai Reservation. The helicopter flights originate in Las Vegas and descend to landing pads along the side of the Colorado River. Most fixed-wing flights also originate in Las Vegas but fly to Grand Canyon West airport on the Reservation.
- Transportation, Repositioning, etc. is an aggregate category of all flight operations in support of commercial air tours. Transportation is typically the return leg of the Las Vegas/Tusayan (South Rim) fixed-wing commercial air tour, while repositioning refers to the movement of empty aircraft in support of these trans-Canyon commercial air tour operations.
- Over the Edge (a.k.a "Elevator Flights") is a helicopter descent offering from GC West airport to the Colorado River pads conducted wholly on and within the Hualapai Reservation.
- Bar 10 refers to the helicopter operations conducted between the Bar 10 airstrip and the boat pull out at the base of Whitmore Canyon.

Figure 2 presents the flight tracks for these aircraft types. In addition, the baseline case includes all general aviation ("GA"), military, and civil air transport ("Commercial") overflight activities within a rectangular block of airspace extending 20 nautical miles from the farthest edge of the GCNP boundary in each of the cardinal compass points. These civil and military operations were collected from the FAA's Enhanced Traffic Management System (ETMS) and Performance Data Analysis and Reporting System (PDARS).

It should be noted that since the initial modeling results (presented at the January/February Working Group meeting), the FAA's Air Traffic Organization has reviewed the operations that were initially categorized as GA by the ETMS database. Based on their review, 76 of these GA operations (65 daytime and 11 nighttime) were identified as Part 135 commercial air taxi operations and have been consequently moved to the Commercial category. Updated results are presented in this document to reflect this update. Figures 3 and 4 present a breakdown of the GA and Commercial operations that were modeled by altitude. Figures 5 through 7 present the flight tracks for these aircraft types.

Table 1 presents the list of modeled scenarios and the number of operations associated with each scenario.

**Table 1. List of Modeled Scenarios.**

| Scenario | Aircraft | Number of Operations |
|---|---|---|
| **1** | **All Aircraft (Total Air Tour and Air Tour Related, GA, Military, Commercial – daytime operations 7 am to 7 pm)*** | **2047** |
| **2** | **Total Air Tour and Air Tour Related GA, and Military – daytime operations (7 am to 7 pm)** | **768** |
| **3** | **Total GA, Military, and Commercial – daytime operations (7 am to 7 pm)** | **1412** |
| **4** | **Total GA, Military, and Commercial – nighttime operations (7 pm to 7 am)** | **524** |
| 5 | Commercial Air Tours | 314 |
| 6 | GC West (a.k.a. "Hualapai Exempt") | 118 |
| 7 | Transportation, Repositioning, etc. | 85 |
| 8 | Over the Edge (a.k.a. "Elevator Flights") | 98 |
| 9 | Bar 10 | 20 |
| **10** | **Air Tour and Air Tour Related (scenarios 5 – 9 above)**<br>(Note: All air tours are daytime operations, 7 am to 7 pm) | **635** |
| 11 | GA – daytime operations (7 am to 7 pm)** | 122 |
| 12 | GA – nighttime operations (7 pm to 7 am)** | 13 |
| 13 | Military – daytime operations (7 am to 7 pm) | 11 |
| 14 | Military – nighttime operations (7 pm to 7 am) | 1 |
| 15 | Commercial – daytime operations (7 am to 7 pm)** | 1279 |
| 16 | Commercial – nighttime operations (7 pm to 7 am)** | 510 |

* Note: The "All Aircraft" scenario is a new scenario modeled at the request of the Working Group during the January/February meeting.

** Note: As stated previously, the FAA's Air Traffic Organization has reviewed the operations that were categorized as GA by the ETMS database. Based on their review, 76 operations (65 daytime and 11 nighttime) were identified as Part 135 commercial air taxi operations and have been consequently moved to the Commercial category.

## Time Audible ($T_{Aud}$) Summary

Table 2 and Figures 8 through 18 present the preliminary 25% time audible contour results for each modeled scenario. Note: For the Bar10, GA (daytime and nighttime), and Military (daytime and nighttime) scenarios, aircraft sounds were audible less than 25% of the time. As such, no contours will be presented for these scenarios.

Substantial restoration of natural quiet has been defined by NPS to mean 50% or more of the park will achieve natural quiet (i.e., no aircraft audible) for 75 to 100% of the day. Natural quiet has not been substantially restored within the areas covered by the 25% time audible contour because the criterion of no audible aircraft noise for 75 to 100% of the day has not been achieved. The third column below reports the percentage of the park covered by the 25% time audible contour for each indicated aircraft scenario (% of Park). The fourth column reports the % of natural quiet restored (% Restored). Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account

for noise from all aircraft to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from all aircraft operations is 50% or more.

**Table 2. 25% time audible contour results.**

| Scenario | Aircraft | % of Park | % Restored |
|---|---|---|---|
| **1** | **All Aircraft (Total Air Tour and Air Tour Related, GA, Military, Commercial – daytime operations 7 am to 7 pm)** | **99.3%** | **0.7%** |
| **2** | **Total Air Tour and Air Tour Related, GA, and Military – daytime operations (7 am to 7 pm)** | **85.3%** | **14.7%** |
| **3** | **Total GA, Military, and Commercial – daytime operations (7 am to 7 pm)** | **99.0%** | **1.0%** |
| **4** | **Total GA, Military, and Commercial – nighttime operations (7 pm to 7 am)** | **93.6%** | **6.4%** |
| 5 | Commercial Air Tours | 38.4% | 61.6% |
| 6 | GC West (a.k.a. “Hualapai Exempt”) | 7.3% | 92.7% |
| 7 | Transportation, Repositioning, etc. | 10.3% | 89.7% |
| 8 | Over the Edge (a.k.a. “Elevator Flights”) | 4.6% | 95.4% |
| 9 | Bar 10 | 0.0% | 100% |
| **10** | **Air Tour and Air Tour Related (scenarios 5 – 9 above)**<br>(Note: All air tours are daytime operations, 7 am to 7 pm) | **46.1%** | **53.9%** |
| 11 | GA – daytime operations (7 am to 7 pm) | 0.0% | 100% |
| 12 | GA – nighttime operations (7 pm to 7 am) | 0.0% | 100% |
| 13 | Military – daytime operations (7 am to 7 pm) | 0.0% | 100% |
| 14 | Military – nighttime operations (7 pm to 7 am) | 0.0% | 100% |
| 15 | Commercial – daytime operations (7 am to 7 pm) | 97.6% | 2.4% |
| 16 | Commercial – nighttime operations (7 pm to 7 am) | 90.0% | 10.0% |

A key determination of the above-mentioned FICAN study was that on average, there was no statistical difference between INM 6.2 and the “gold standard” measurement data used for analysis in that study. Further, it was determined that the measured data had associated with it an uncertainty in time audible of 4%. Given that the modeled and measured results were statistically similar, and the measurement uncertainty was 4%, the best one could expect from the model in terms of uncertainty was also 4%, expressed in terms of percent time audible. Since the substantial restoration criteria for Grand Canyon is a function of park area, the 4% uncertainty in percent time audible was translated into an uncertainty in park area. After doing so, it was determined that the model uncertainty for this study was approximately 2% (plus or minus) for the air tour scenarios. That is, the “% Restored” presented for the air tour scenarios is plus or minus 2%. For other aircraft scenarios, the contour area uncertainty was larger, mostly dependent on flight track dispersion over the park. A summary table of model uncertainties for each scenario is presented in Table 3.

## Table 3. 25% time audible contour results with model uncertainty.

| Scenario | Aircraft | % Area Uncertainty |
|---|---|---|
| **1** | **All Aircraft (Total Air Tour and Air Tour Related, GA, Military, Commercial – daytime operations 7 am to 7 pm)** | **-0.1%, +0.7%** |
| **2** | **Total Air Tour and Air Tour Related, GA, and Military – daytime operations (7 am to 7 pm)** | **-2.1%, +2.5%** |
| **3** | **Total GA, Military, and Commercial – daytime operations (7 am to 7 pm)** | **-0.4%, +1.4%** |
| **4** | **Total GA, Military, and Commercial – nighttime operations (7 pm to 7 am)** | **-2.1%, +2.8%** |
| 5 | Commercial Air Tours | -2.5%, +2.2% |
| 6 | GC West (a.k.a. “Hualapai Exempt”) | -0.4%, +0.5% |
| 7 | Transportation, Repositioning, etc. | -2.2%, +2.2% |
| 8 | Over the Edge (a.k.a. “Elevator Flights”) | -2.2%, +2.2% |
| 9 | Bar 10 | 0% |
| **10** | **Air Tour and Air Tour Related (scenarios 5 – 9 above)**<br>(Note: All air tours are daytime operations, 7 am to 7 pm) | **-1.8%, +1.8%** |
| 11 | GA – daytime operations (7 am to 7 pm) | 0% |
| 12 | GA – nighttime operations (7 pm to 7 am) | 0% |
| 13 | Military – daytime operations (7 am to 7 pm) | 0% |
| 14 | Military – nighttime operations (7 pm to 7 am) | 0% |
| 15 | Commercial – daytime operations (7 am to 7 pm) | -1.5%, +1.3% |
| 16 | Commercial – nighttime operations (7 pm to 7 am) | -2.5%, +2.8% |

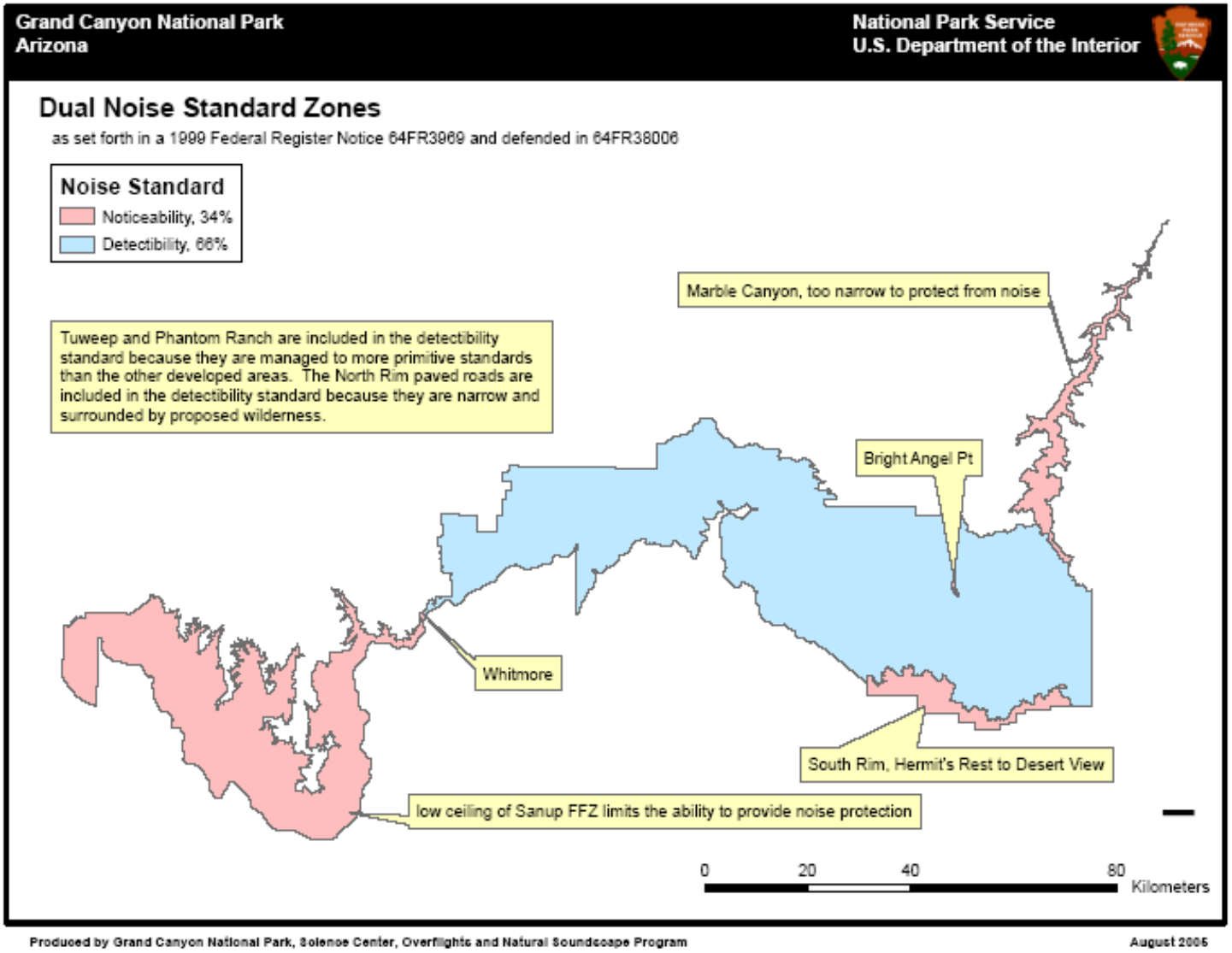


**Figure 1. Grand Canyon National Park Dual Noise-Standard Zones**

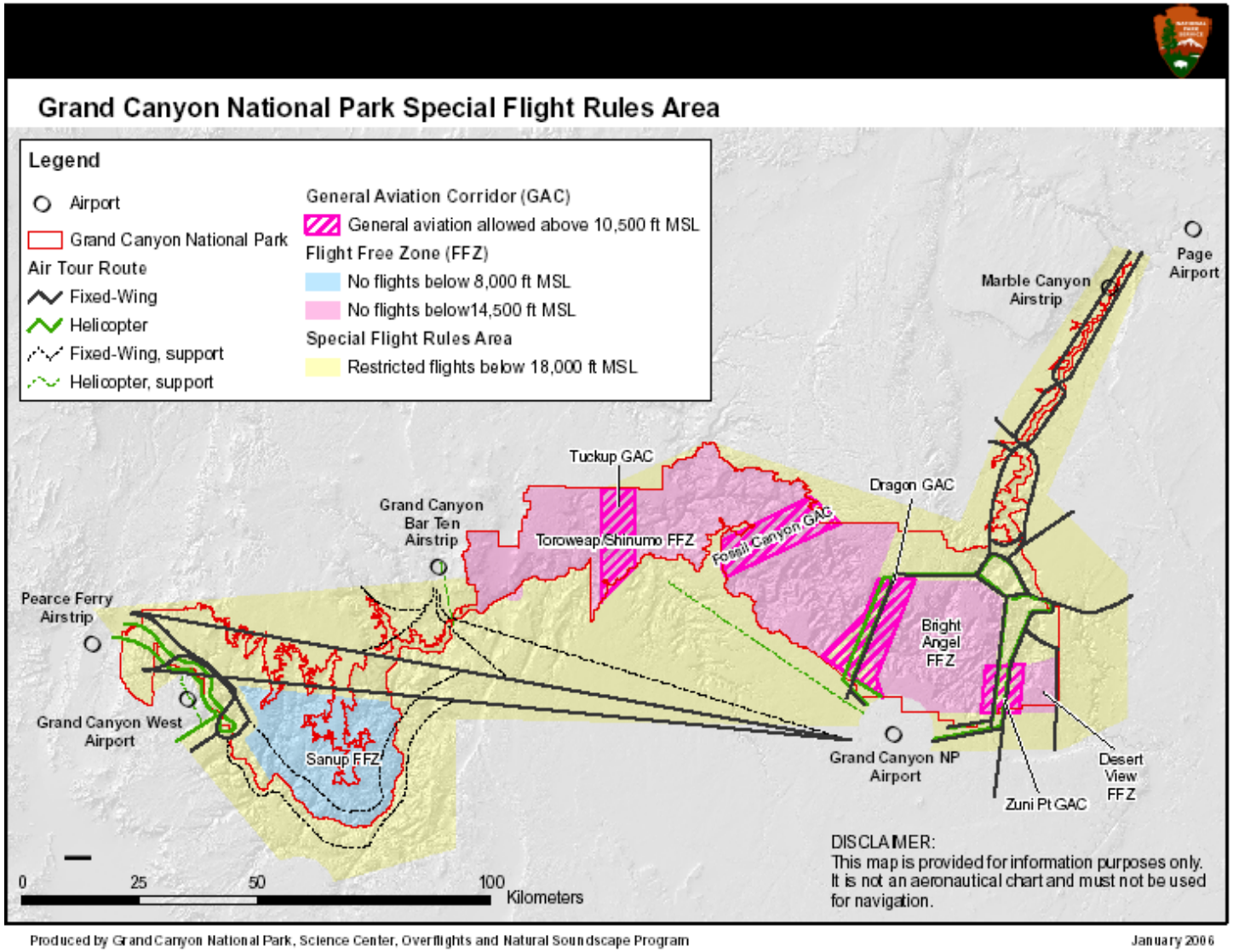


**Figure 2. Grand Canyon National Park Special Flight Rules Area**

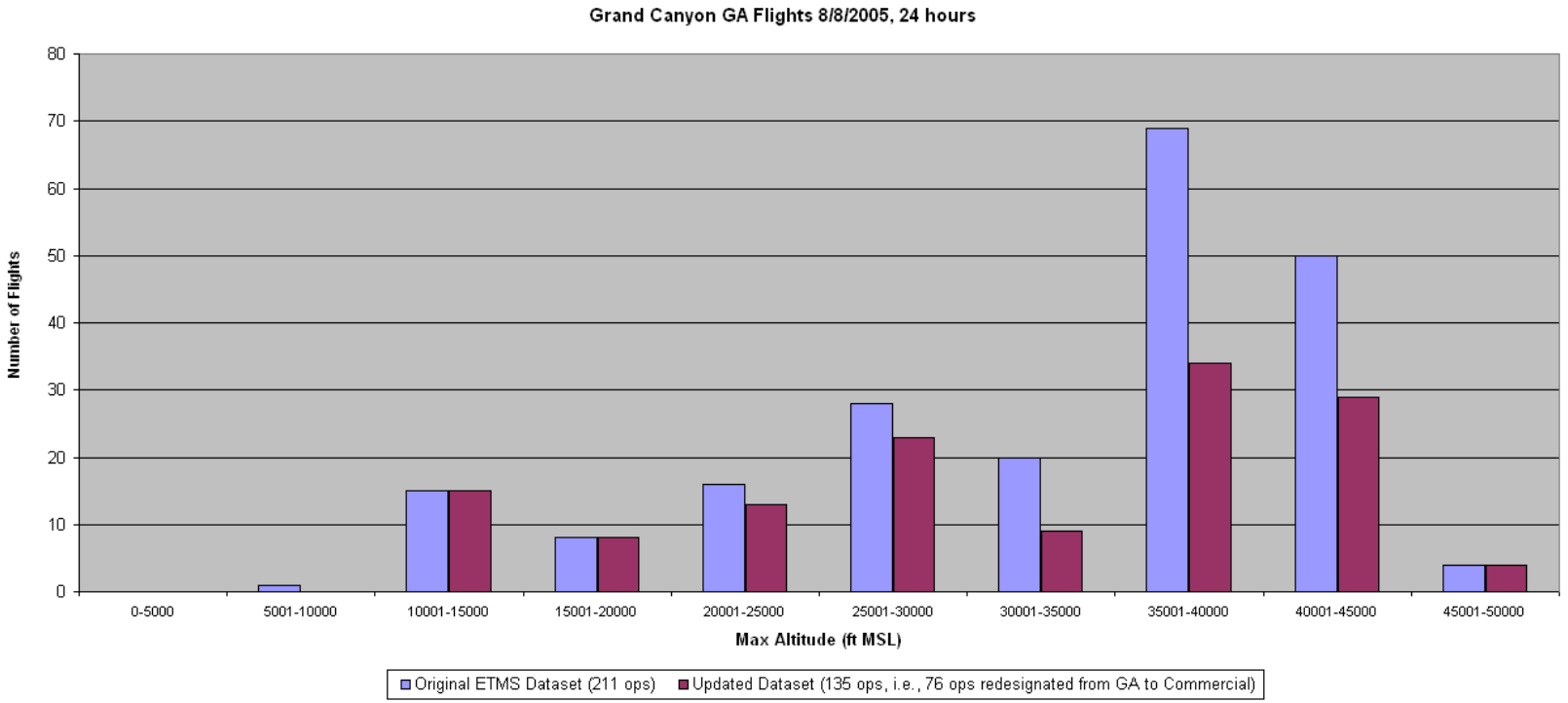


**Figure 3. Distribution of GA operations by altitude before and after 76 GA operations were redesignated as Commercial**

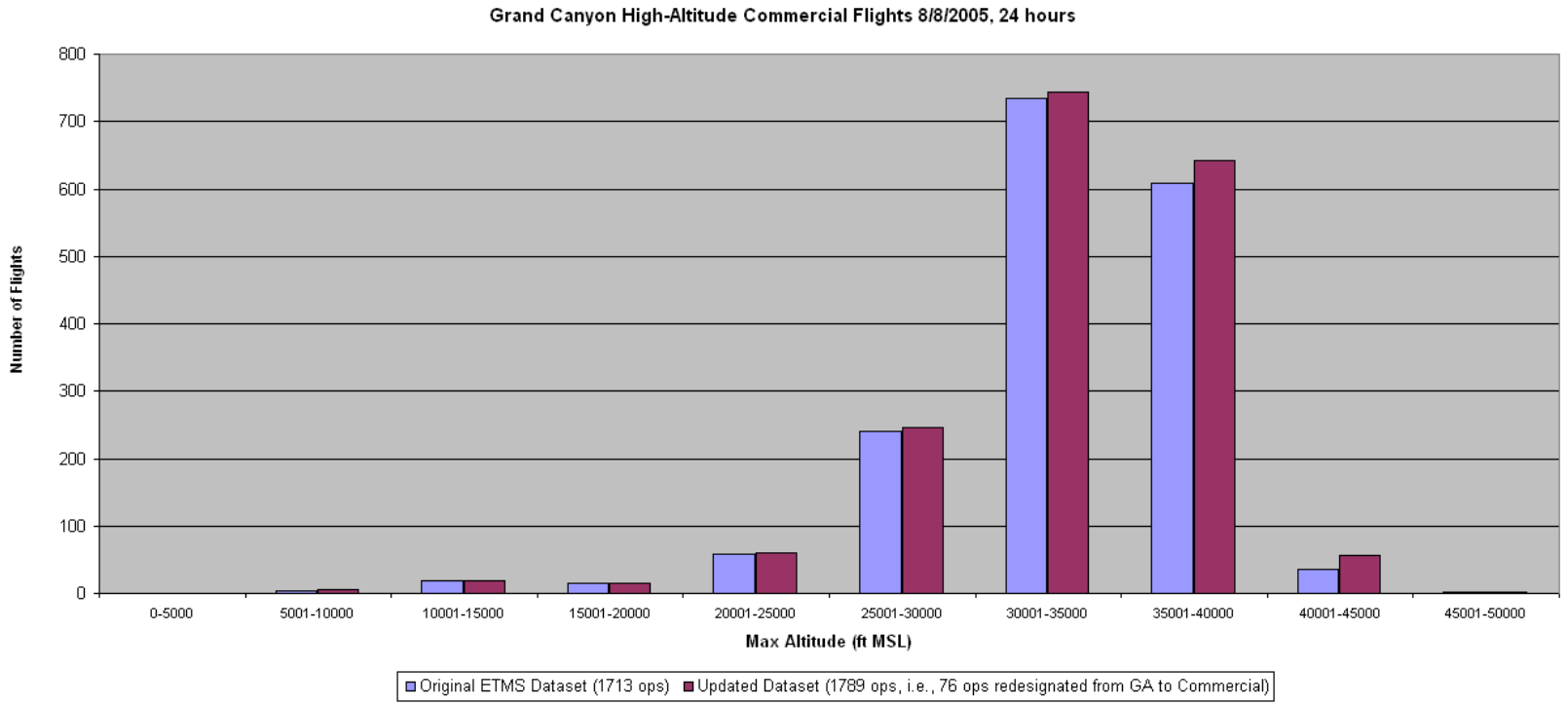


**Figure 4. Distribution of Commercial operations by altitude before and after 76 GA operations were redesignated as Commercial**

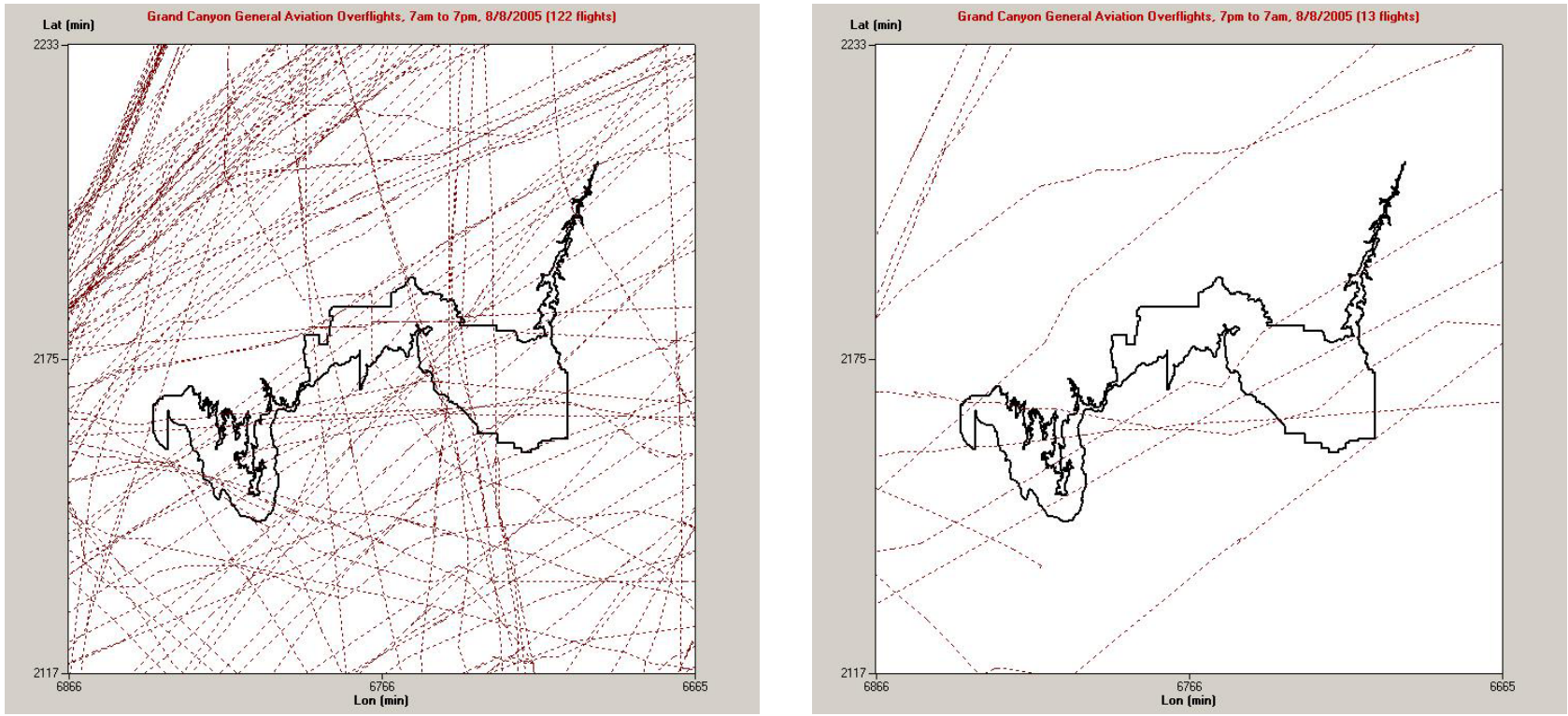


**Figure 5. Flight Tracks for GA Operations: Daytime and Nighttime**

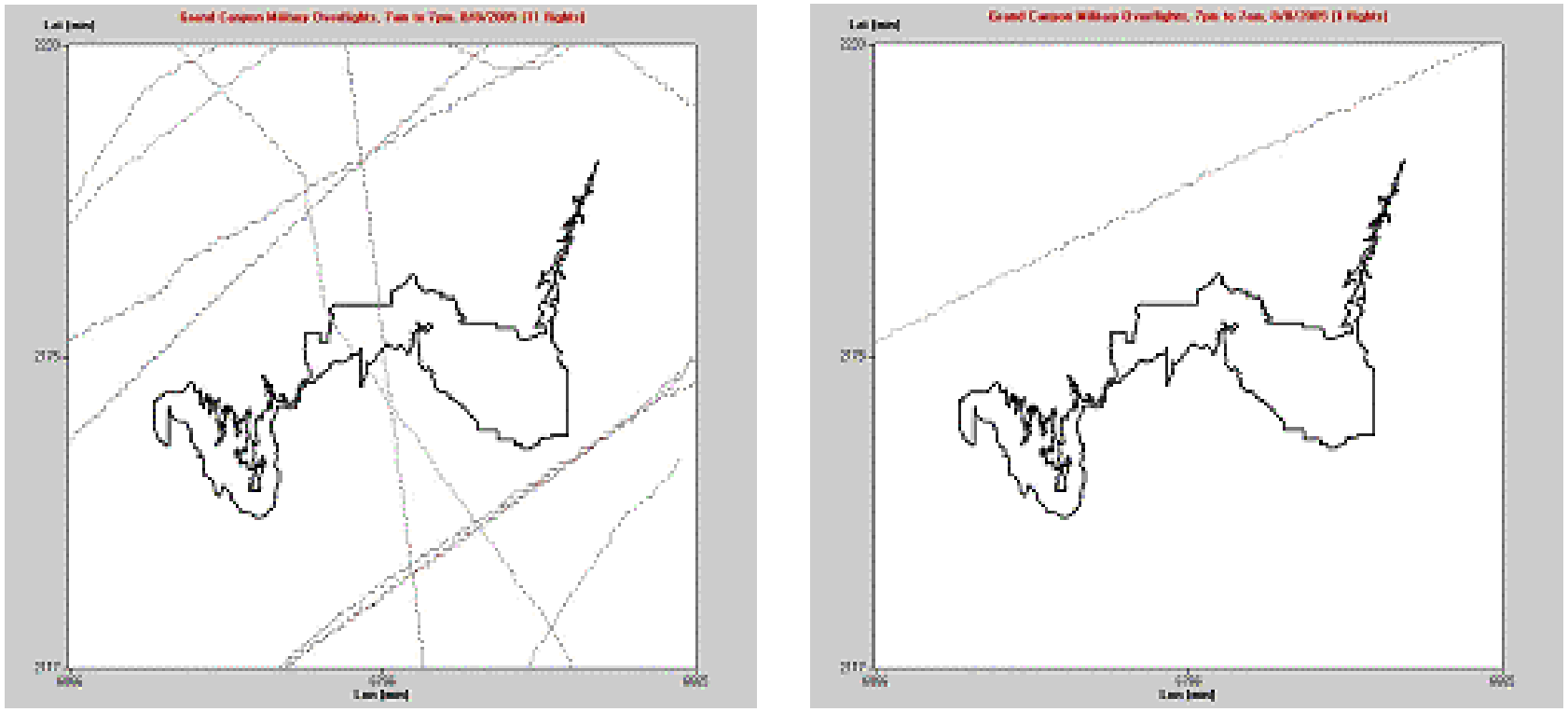

**Figure 6. Flight Tracks for Military Operations: Daytime and Nighttime**

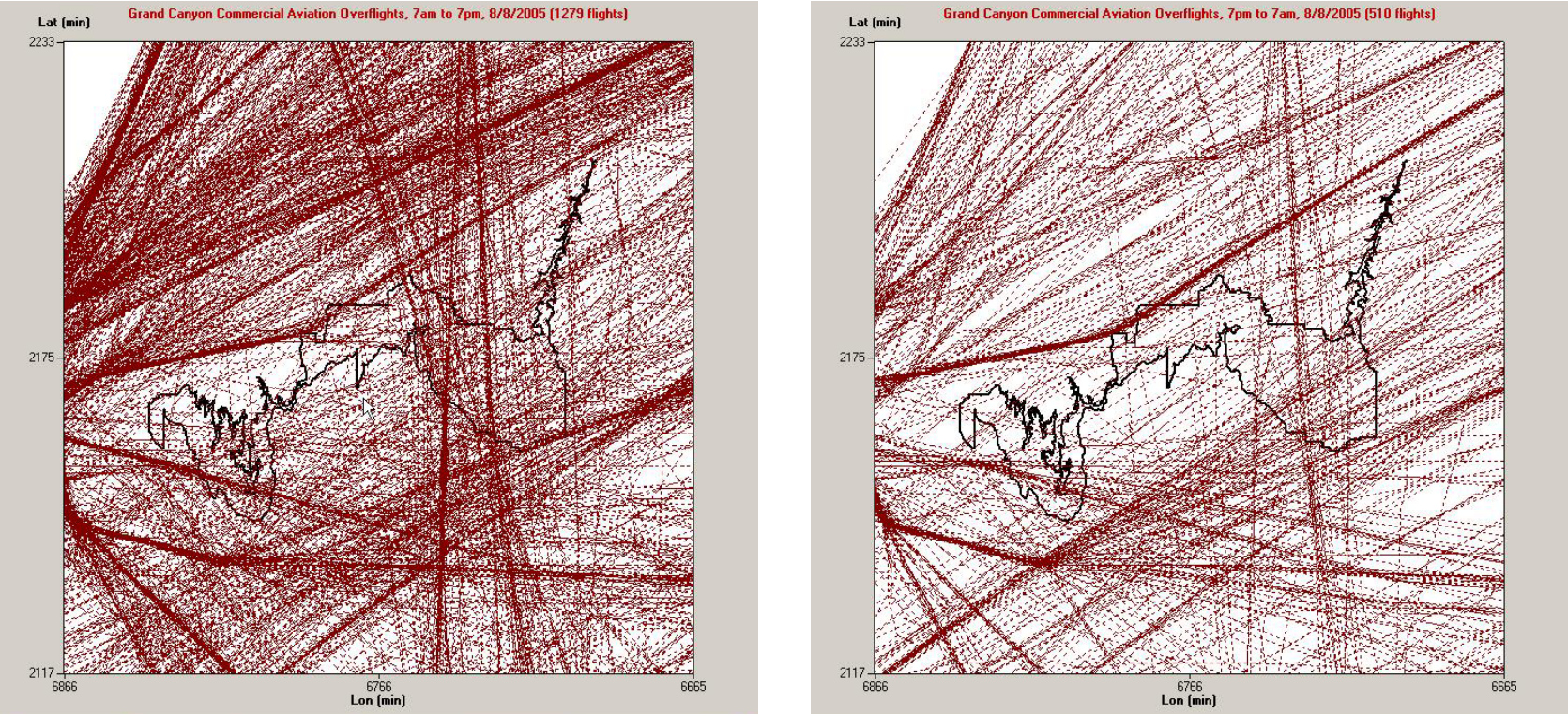


**Figure 7. Flight Tracks for Commercial Operations: Daytime and Nighttime**

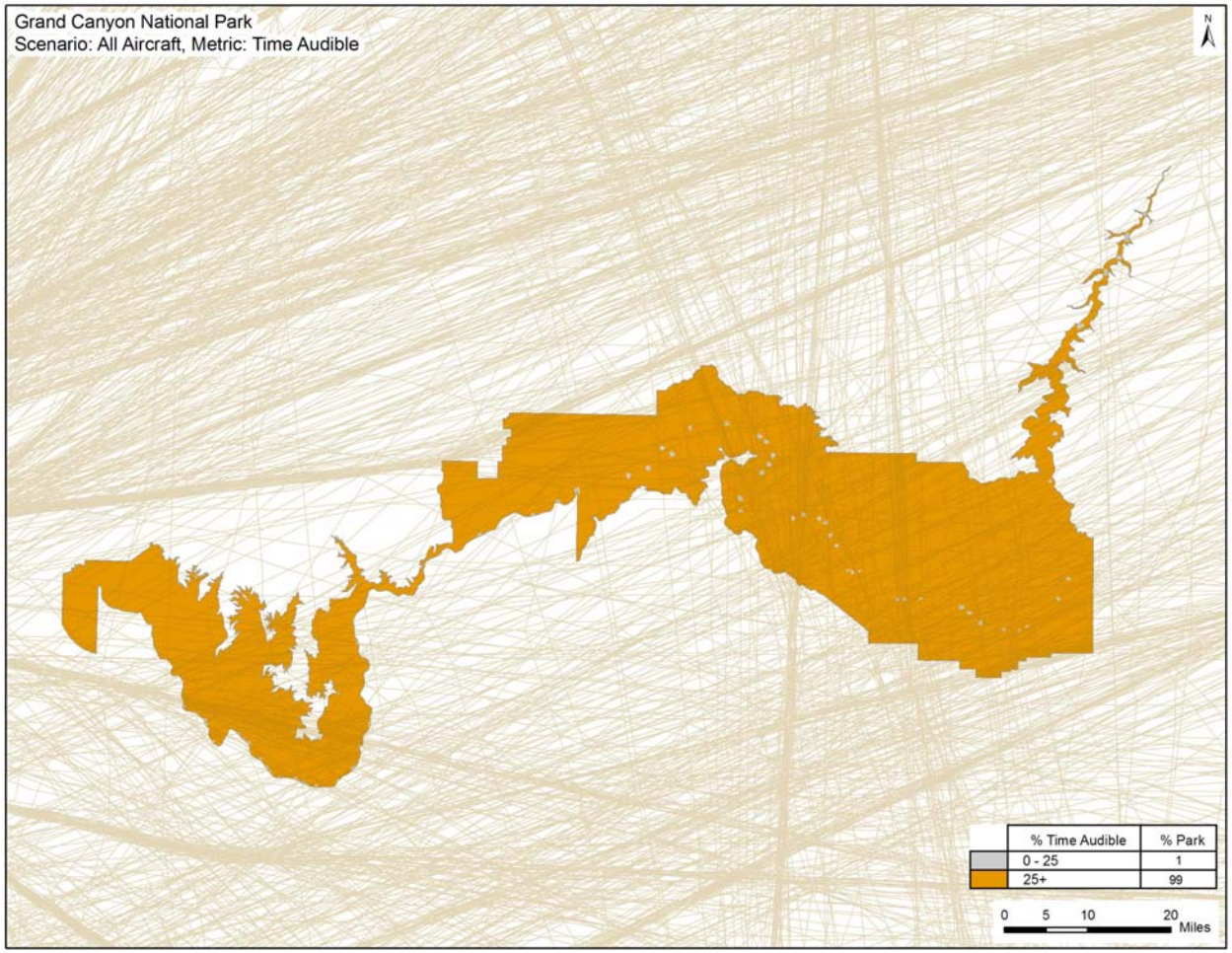


**Figure 8. All Aircraft (Air Tour and Air Tour Related, GA, Military, Commercial) – daytime operations**

**25% $T_{Aud}$ = 99% of Park**

**(1% Restored)**

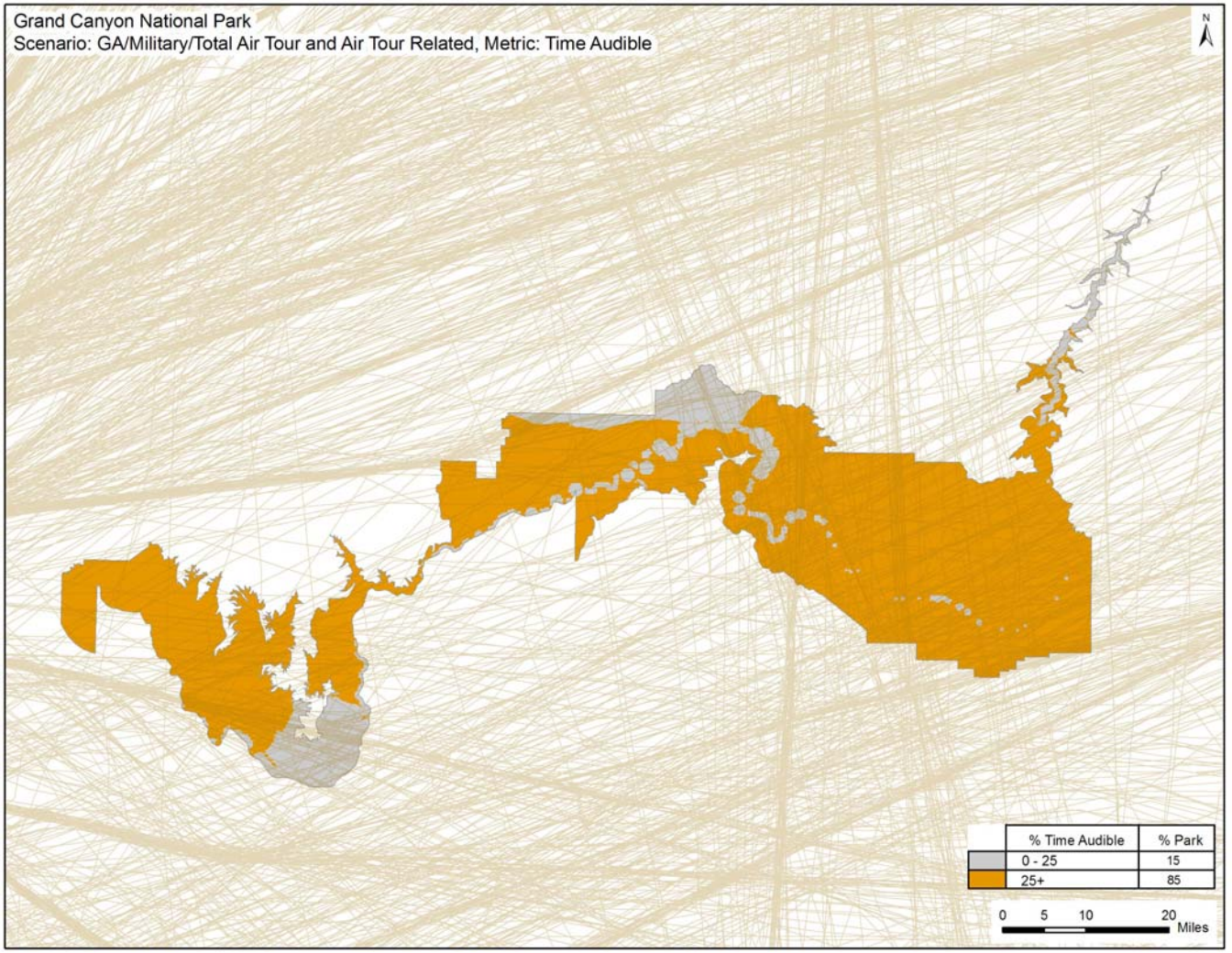


Figure 9. Air Tour and Air Tour Related, GA, and Military – daytime operations

**25% $T_{Aud}$ = 85% of Park (15% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

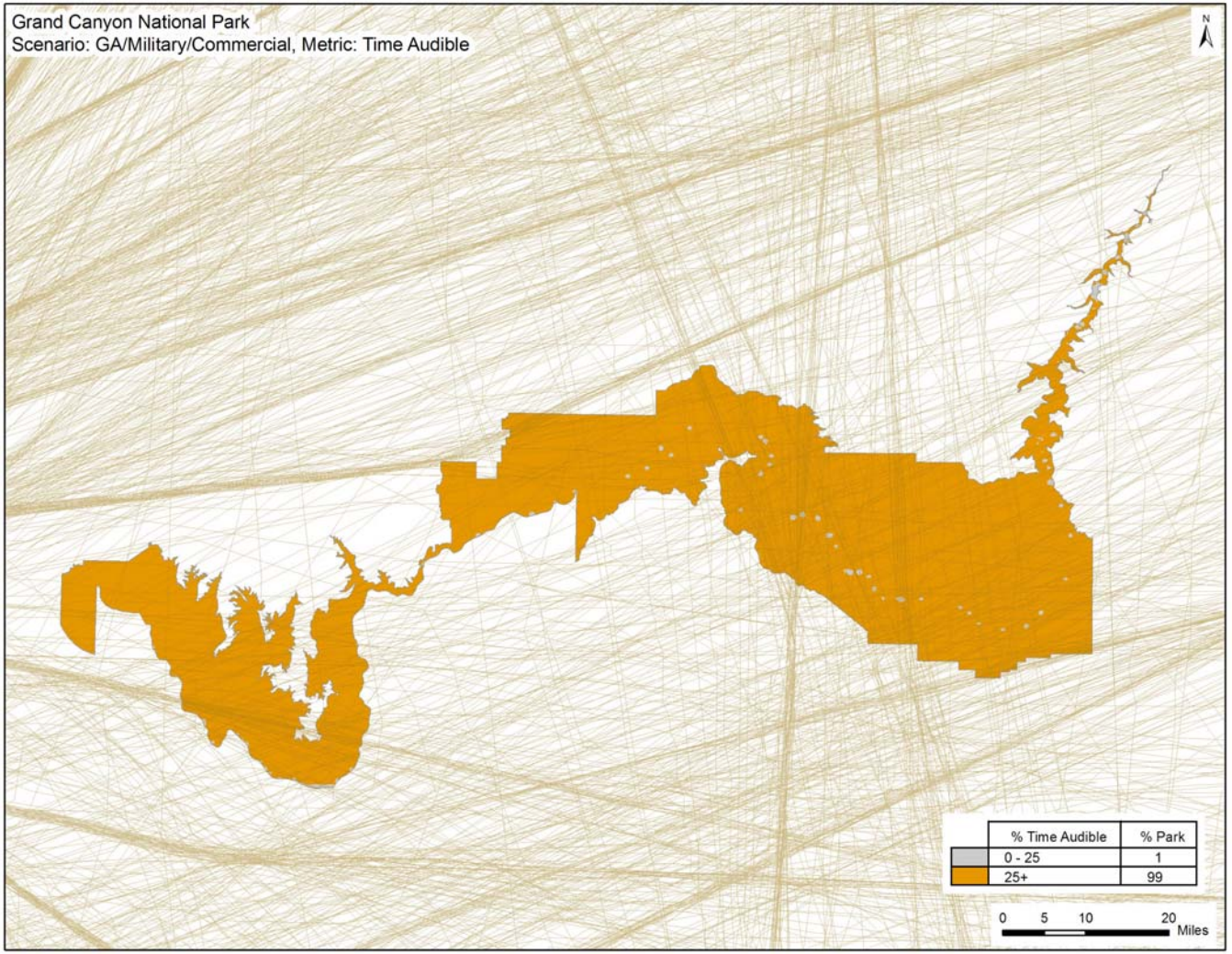


**Figure 10. GA, Military, and Commercial – daytime operations**

**25% $T_{Aud}$ = 99% of Park (1% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

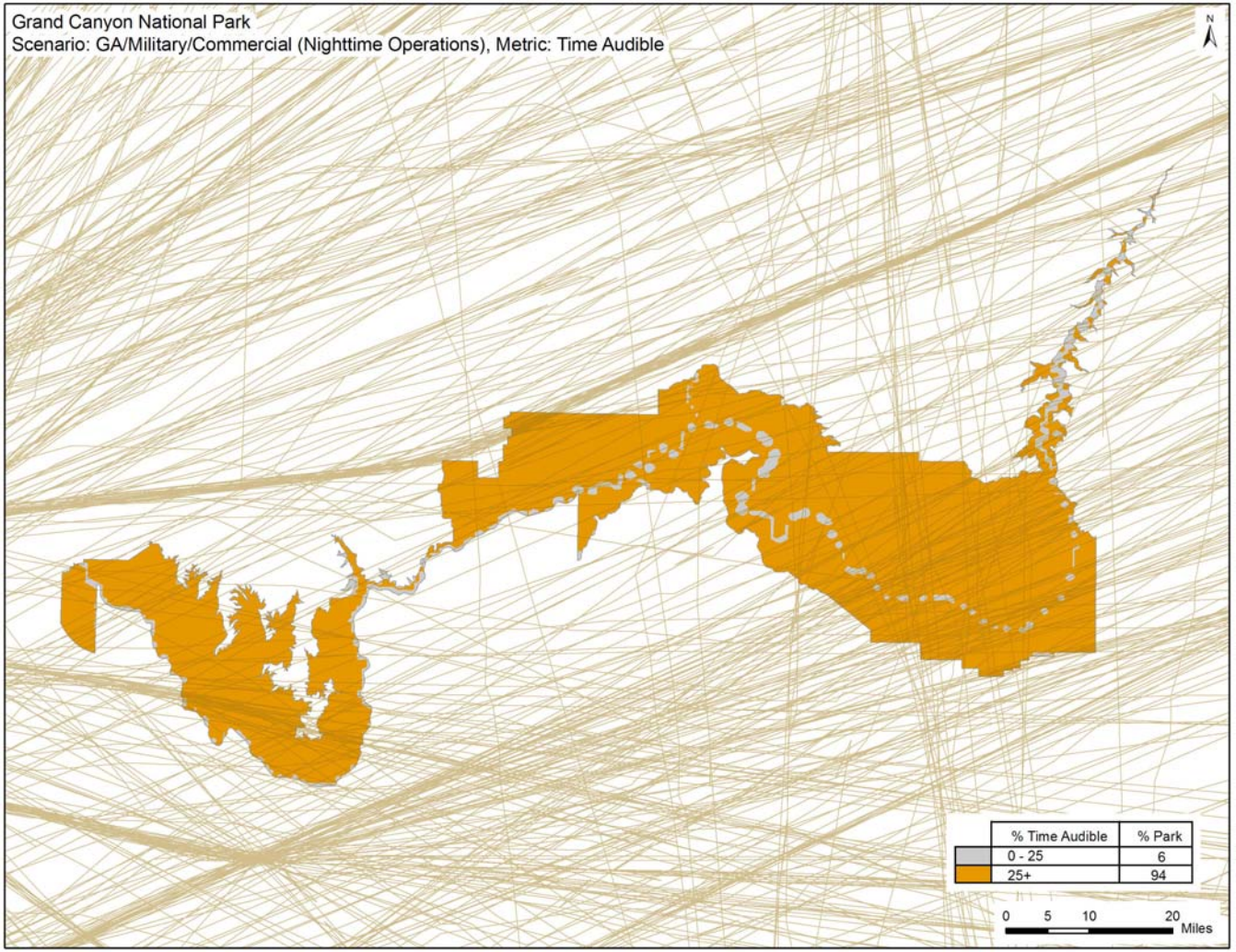


**Figure 11. GA, Military, and Commercial – nighttime operations**

**25% $T_{Aud}$ = 94% of Park (6% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

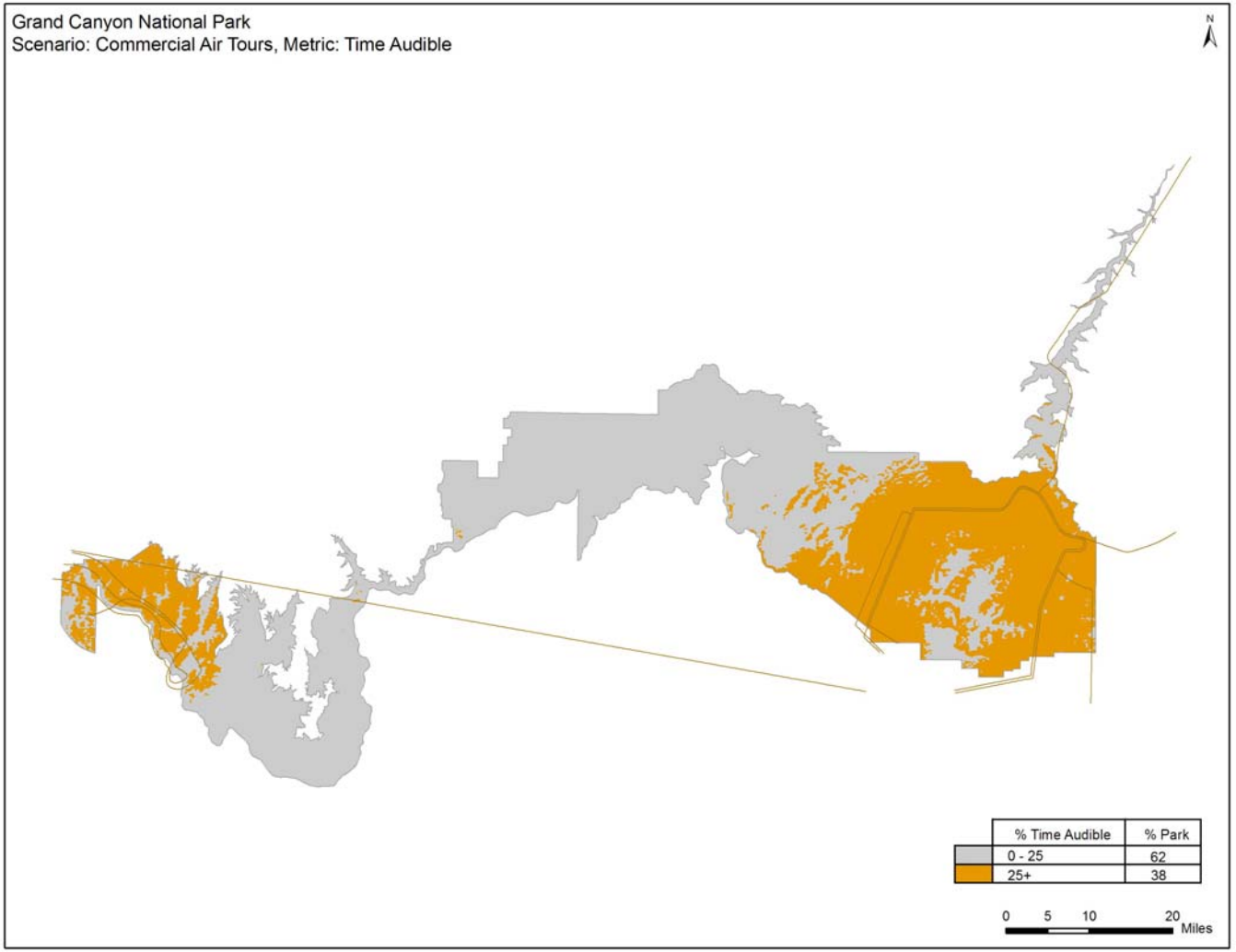


**Figure 12. Commercial Air Tours**

**25% $T_{Aud}$ = 38% of Park (62% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

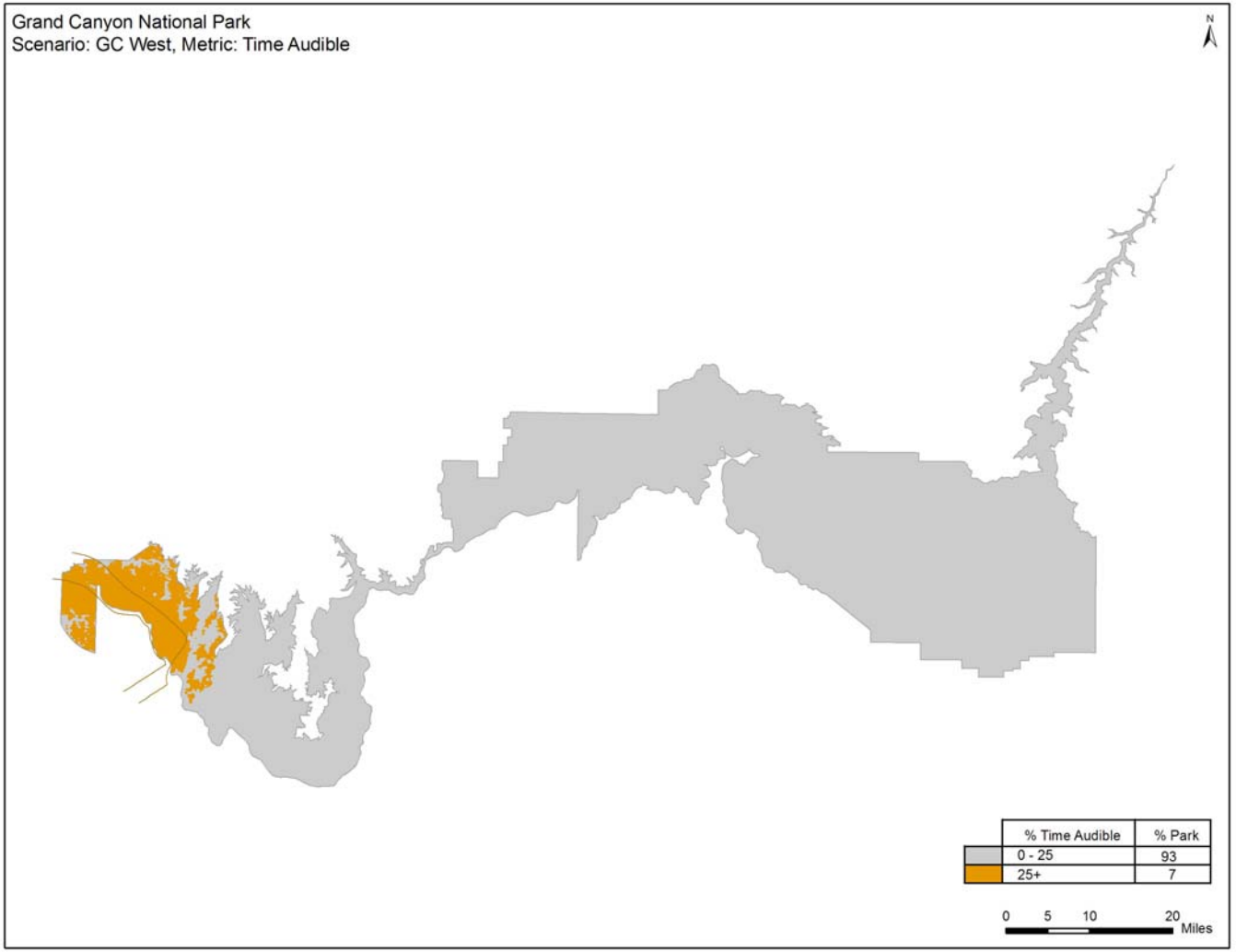


**Figure 13. GC West**

**25% $T_{Aud}$ = 7% of Park (93% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

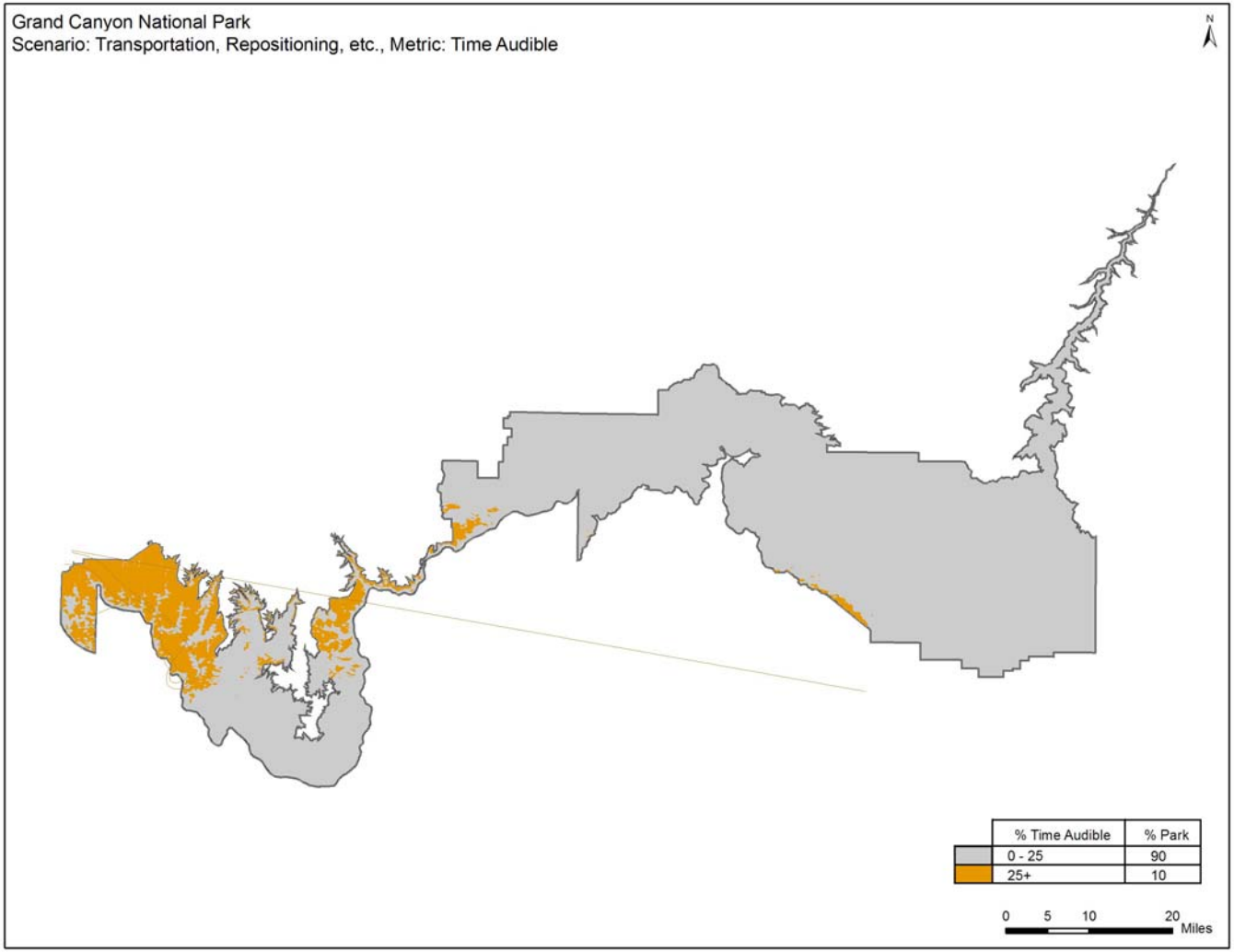


**Figure 14. Transportation, Repositioning, etc**

**25% $T_{Aud}$ = 10% of Park (90% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

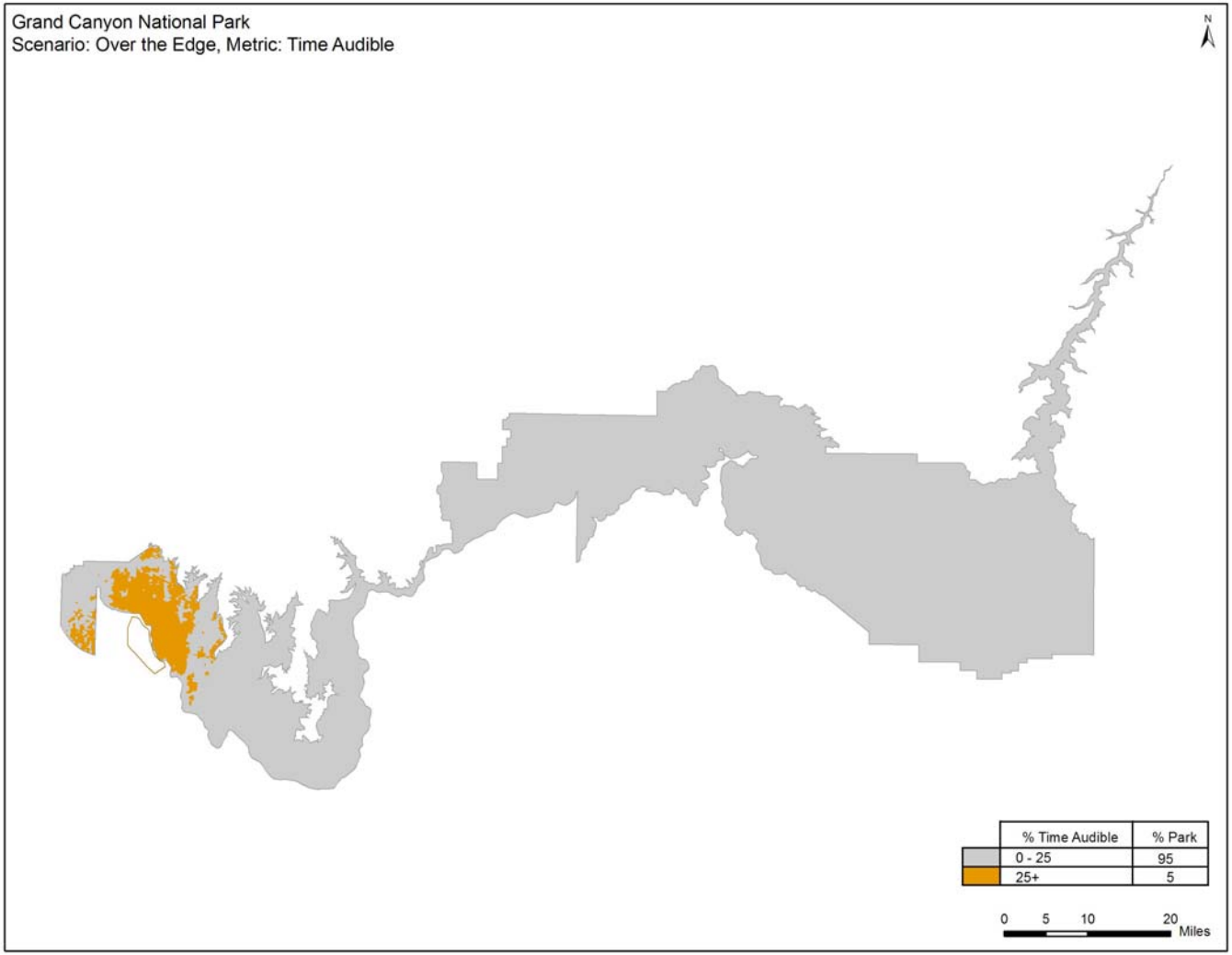


**Figure 15. Over the Edge**

**25% $T_{Aud}$ = 5% of Park (95% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

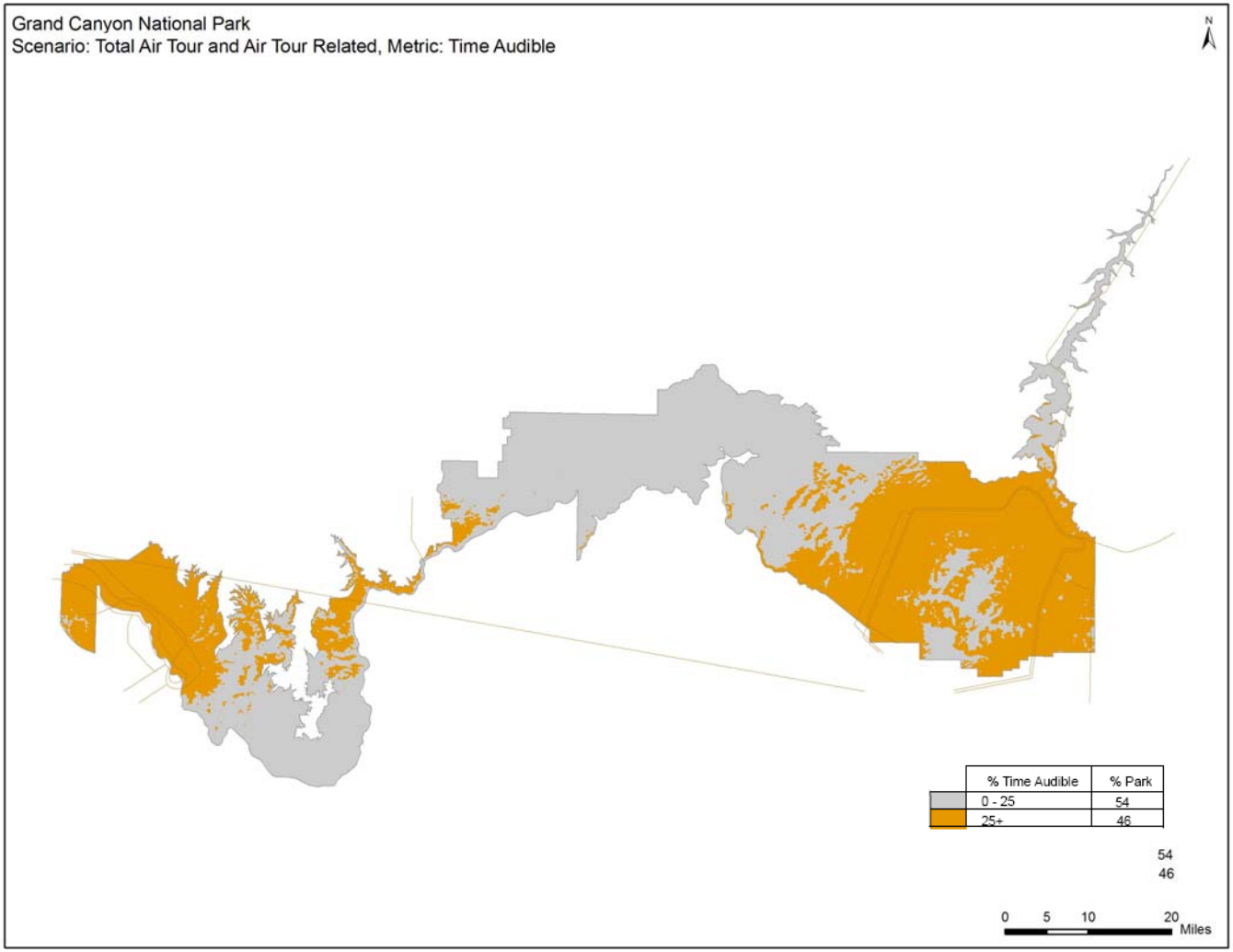


**Figure 16. Total Air Tour and Air Tour Related**

**25% $T_{Aud}$ = 46% of Park (54% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

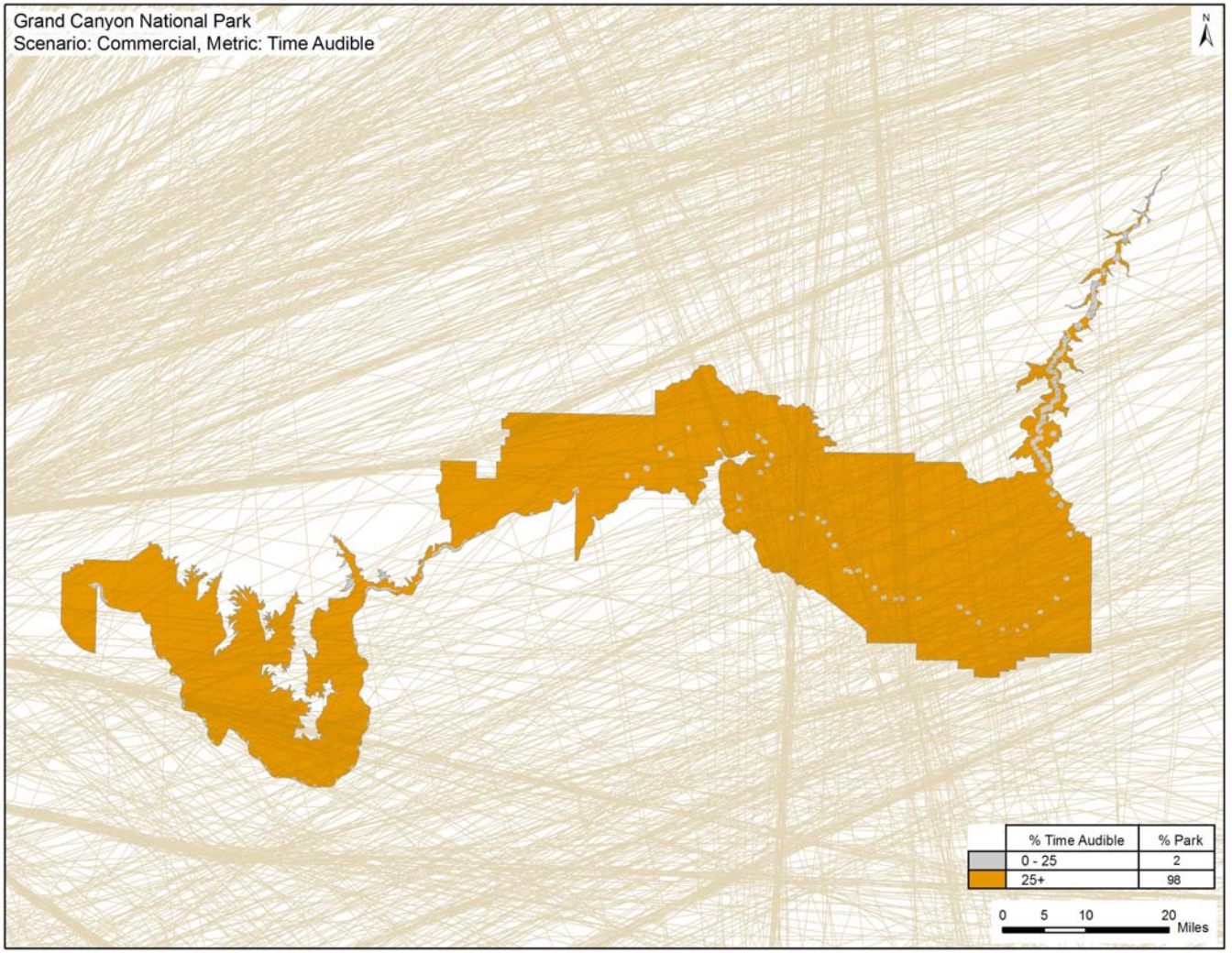


**Figure 17 . Commercial – daytime operations**

**25% $T_{Aud}$ = 98% of Park (2% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.

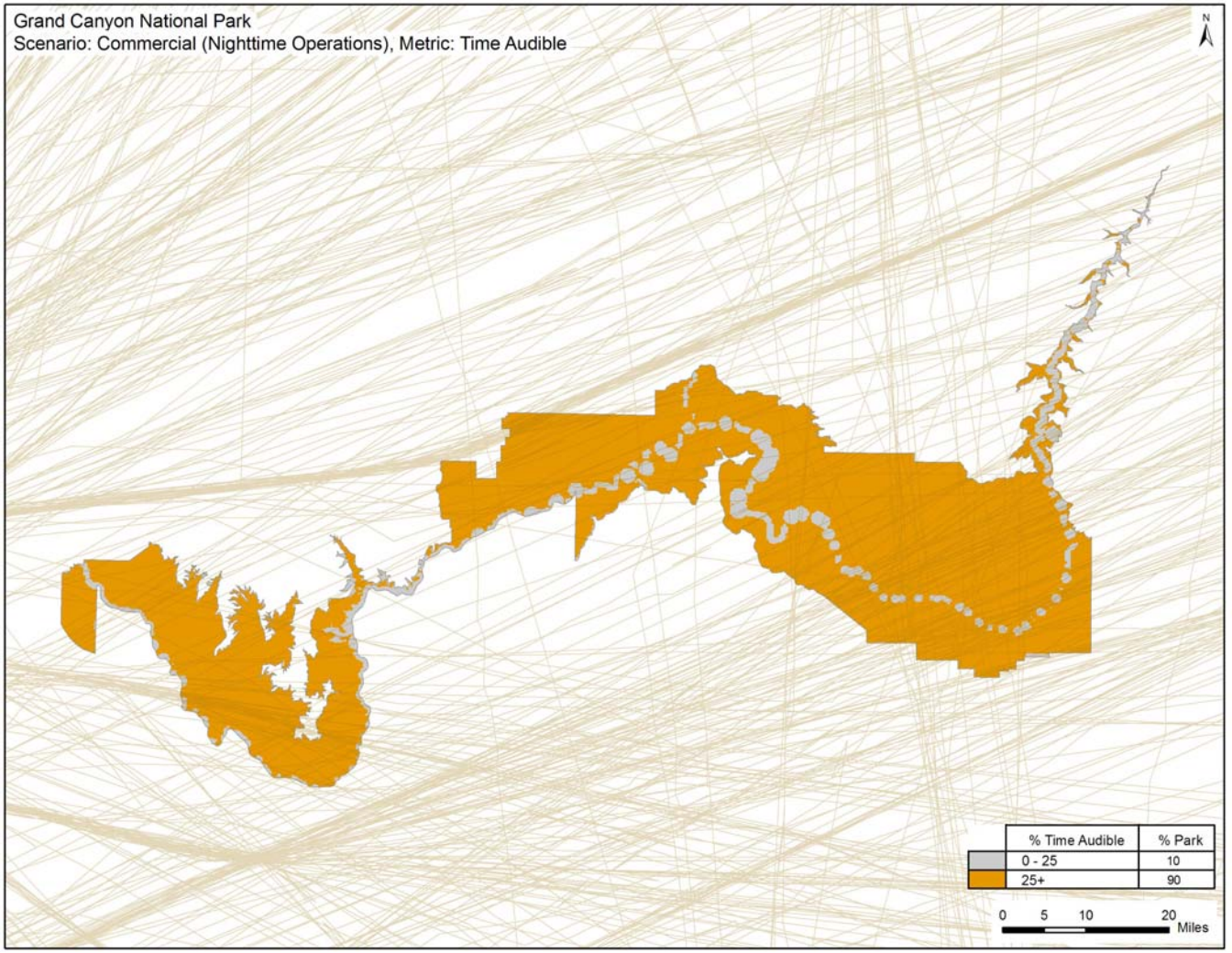


**Figure 18. Commercial – nighttime operations**

**25% $T_{Aud}$ = 90% of Park (10% "Restored")**

Note: Notwithstanding the various scenarios modeled, the 1987 Overflights Act and the subsequent relevant court holdings require that the model account for noise from ***all aircraft*** to determine whether substantial restoration of natural quiet has been achieved. Moreover, NEPA requires that the agencies analyze the impacts of all noise sources cumulatively. Substantial restoration of natural quiet is achieved when the total percentage restored from ***all aircraft*** operations is 50% or more.