Acoustic Environment and Soundscape Resource Summary
Golden Gate National Recreation Area

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
Natural Sounds & Night Skies Division

The acoustic environment is a resource with intrinsic value. It is important as a natural resource, a cultural resource, or both. As a critical component of wilderness character, the acoustic environment plays an important role in wildlife communication, behavior, and other ecological processes. Results from multiple surveys of the American public indicate that hearing the sounds of nature is an important reason for visiting national parks. Therefore, the value of acoustic environments and soundscapes is related to an array of park resources and has broad implications for park management. The quality of the acoustic environment is relevant in nearly every unit in the NPS System. When developing the foundation document, park staff should consider the acoustic environment as a resource with inherent value. The topics in Attachment 1 discuss the importance of the soundscape and the acoustic environment in relation to park resources and values.

At **Golden Gate NRA**, acoustic resources protection and noise reduction are related to the following park priorities:

- enhancing visitor experience and recreational opportunities
- conducting a wide variety of interpretive and educational programs
- dynamic cultural and historic settings throughout the park
- preserving quality wildlife habitat

Potential Threats

- Noise from park facilities and operations
- Noise from commercial tours of the park (land, water, air based)
- Noise from nearby development, transportation, watercraft and aircraft
- Noise from visitors such as visitor vehicles, music, shouting, electronics

Potential Opportunities

- Reduce noise from park operations (e.g. time activities to preserve quiet times, purchase quieter equipment)
- Outreach to visitors about reducing noise from sources such as electronics and idling vehicles
- Communicate with visitors about benefits of noise reduction to park experience and wildlife health
- Collaborate with partners and neighbors to manage noise sources that could affect park resources
- Consider quiet pavement alternatives for park roads and other driving surfaces

Existing data/planning:

- Baseline acoustic conditions from sampling in 2007/2008
- Predicted acoustic conditions based on continental acoustic model

Future data/planning:

- Re-measure acoustic conditions to describe trend
- Use acoustic measurements and monitoring to address a specific noise source
- Develop acoustic goals, indicators and standards in an acoustic resources plan or related park plans or strategies

NPS policy guidance:

Management Policies 2006: 4.9 Soundscape Management, 5.3.1.7 Cultural Soundscape Management, 8.2.2 Recreational Activities; 8.2.3 Use of Motorized Equipment, 8.4 Overflights and Aviation Uses

Director's Order 47: Preservation of the Acoustic Environment and Noise Management

Quality of the Resource at Golden Gate NRA

Parameters useful for assessing a park's acoustic environment include an understanding of a) *natural* conditions without the influence of human-caused sounds, b) *existing* acoustic conditions including both natural and human-caused sounds, and c) the *impact* of human-caused sound sources in relation to natural conditions. The *impact* demonstrates the influence of human activities to the acoustic environment.

The Natural Sounds and Night Skies Division (NSNSD) estimates these acoustic conditions using predictions from a geospatial sound model. For the model, sound pressure levels for the continental United States were predicted using actual acoustical measurements combined with a multitude of explanatory variables such as location, climate, landcover, hydrology, wind speed, and proximity to noise sources (roads, railroads, and airports). The model predicts daytime sound levels during midsummer. The maps are generated using 270 meter resolution - meaning that each square of color on the map represents 270 square meters. It should be noted that while the model excels at predicting acoustic conditions over large landscapes, it may not reflect recent localized changes such as new access roads or development. The park-specific maps are a subset of the national model and show predicted sound pressure levels for the park unit. An inset map is included in each park-specific map to provide a better sense of context, and major roads and highways are labeled for reference. Figures 1 shows the *impact* between natural and existing acoustic conditions. This provides a condition assessment of the conditions because it tells us how much the area is influenced by human-caused sounds. Figure 2 shows the *natural* sound pressure levels which are the sound levels NPS works to preserve in most cases. Figure 3 shows *existing* sound pressure levels for the park unit which demonstrates the current conditions with all sound sources.

To determine impact, NSNSD examines the difference between the natural ambient sounds levels (without the influence of human-made sound) and the existing sound levels (including human-caused sound) as predicted by the model (Figure 1). The mean *impact* is predicted to be 5.73 decibels (dBA) (ranging from 0 decibels (dBA) in the least impacted areas to 20.22 decibels (dBA) in the most impacted areas.) That is, the average existing sound level (with the influence of human-caused sounds) is predicted to be 5.73 dBA above natural conditions.

A one decibel change is not readily perceivable by the human ear, but any addition to this difference could begin to impact listening ability. An increase of 5.73 dBA would reduce the listening area for wildlife and visitors by 73 %. For example, if a predator can hear a potential prey animal in an area of 100 square feet in a setting with natural ambient sounds, that animal's ability to hear would be reduced to 27 square feet if the sound levels were increased by 5.73 dBA. A similar reduction would occur for visitors, reducing their ability to hear natural sounds or interpretive programs.

In addition, NSNSD examines whether existing sound levels exceed certain decibel (dBA) values that relate to human health and speech. At 35 dBA, human and wildlife sleep can be interrupted (Haralabidis, et. al., 2008). The World Health Organization's recommends that noise levels inside bedrooms remain below 45 dBA (Berglund, et. al., 1999). At 52 dBA, a listener wouldn't clearly hear another person speaking in a raised voice at 10 meters (Environmental Protection Agency, 1974). At 60 dBA, normal voice communications can be interrupted at 1 meter. Visitors in the park would likely be conducting such conversations.

The mean existing sound level across Golden Gate NRA is estimated to be 39.6 dBA (decibels). At this sound level, campers would begin to be interrupted during sleep but personal and interpretive speech could be heard by a listener. Since 39.6 dBA is the mean, there may be periods when noise exceeds the listening thresholds described above. The mean existing sound levels at the park are lower than the sound levels in nearby developed areas (Figure 3 a/b). This demonstrates that sounds intrinsic to the park are a resource important to protect in the park environment and may be a refuge for both nearby humans and wildlife.

In addition to this national model, baseline acoustic inventory was conducted for Golden Gate NRA in 2007/2008. This research provides a more comprehensive description of the acoustic environment by characterizing existing sound levels, estimating natural ambient sound levels, and identifying audible sound sources during winter and summer seasons. Results show that there is a high amount of variability throughout the park in terms of the amount and amplitude of human-caused sound present in each sampling area. There is also high variability in the amount and types of natural sounds that are audible in each sampling areas. The methods, data and results of this monitoring effort are provided in an Acoustic Monitoring Report, included as Attachment 2.

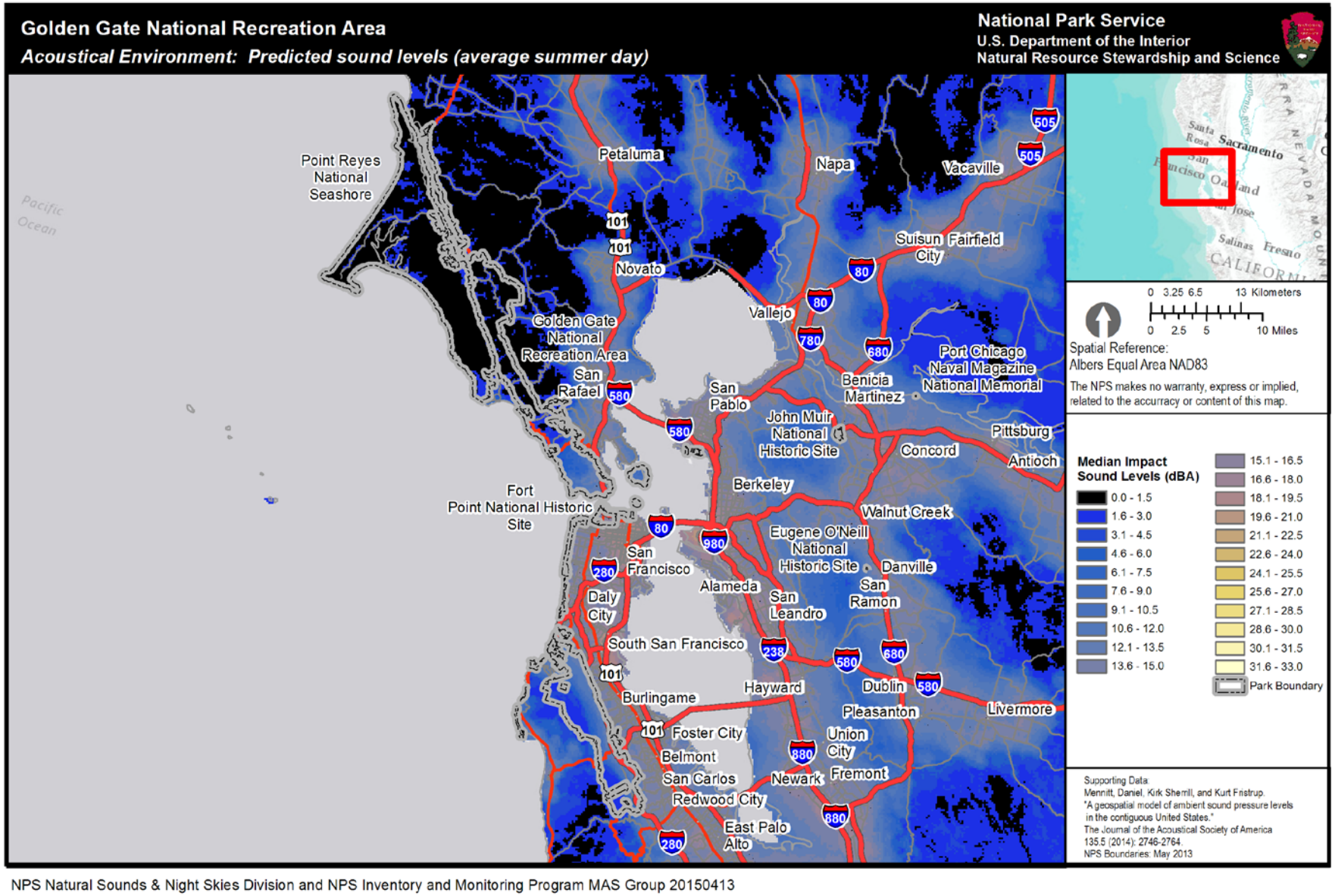

Figure 1. *Median sound level* ***impact*** *map for Golden Gate NRA*. This park-specific acoustic impact map as generated by version 3.0 of the geospatial model. The color scale indicates how much human-caused noise raises the existing sound pressure levels in a given location (measured in A-weighted decibels, or dBA), with 270 meter resolution. Black and dark blue colors indicate low impacts while yellow or white colors indicate greater impacts. Note that due to the national scale of the model inputs, this graphic may not reflect recent localized changes such as new access roads or development. (note: although the color ramps are similar, each figure has different legend values)

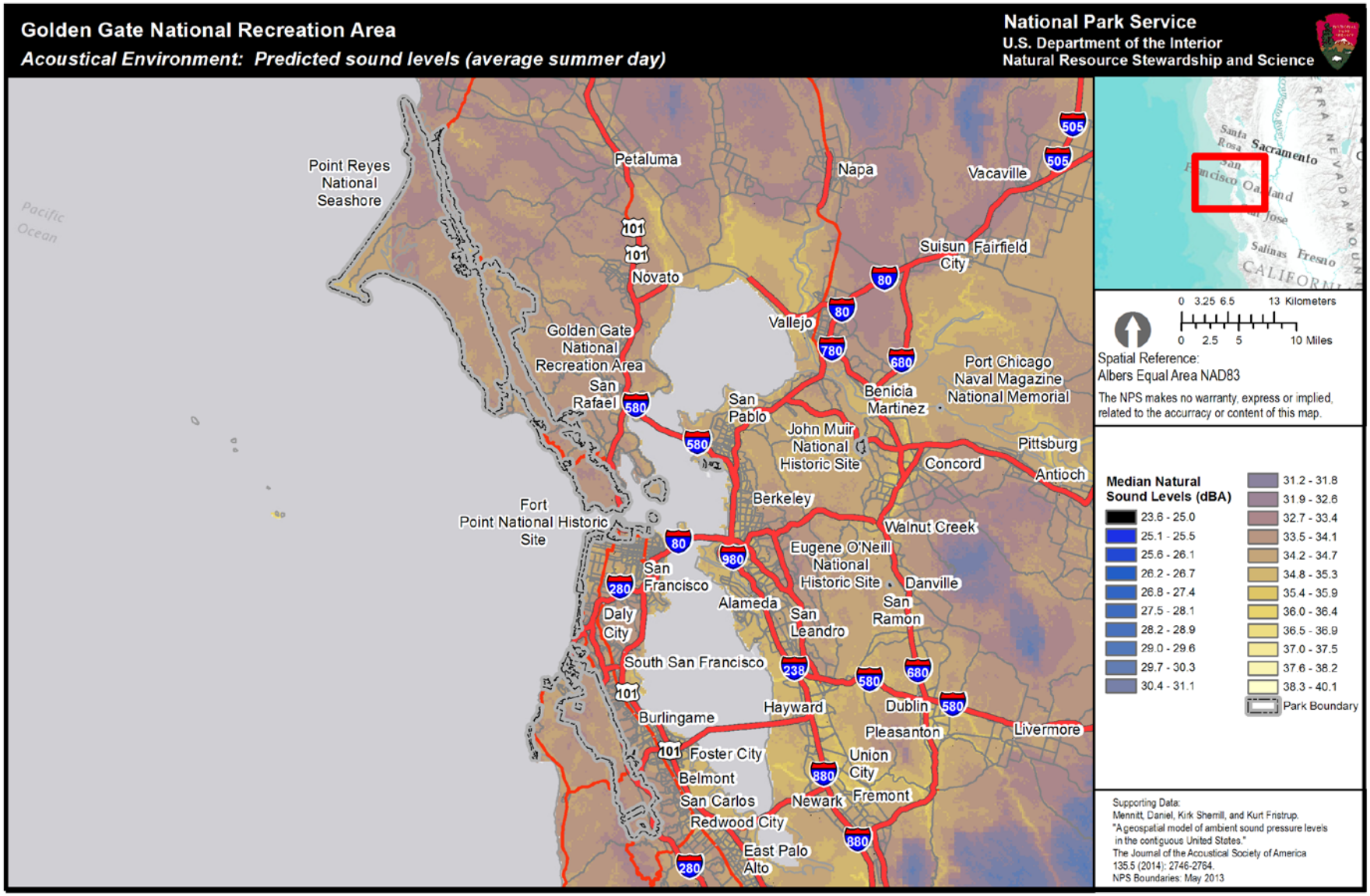

Figure 2. *Median **natural** sound pressure levels for Golden Gate NRA.* This park-specific natural sound level map is generated by version 3.0 of the geospatial model. The color scale indicates the decibel level that is predicted in the park based only on natural sound sources. Sound level is measured in A-weighted decibels, or dBA, with 270 meter resolution. Black and dark blue colors indicate low decibel impact levels while yellow or white colors indicate higher decibel impact levels. Note that due to the national scale of the model inputs, this graphic may not reflect recent localized changes (such as new access roads or development). (note: although the color ramps are similar, each figure has different legend values)

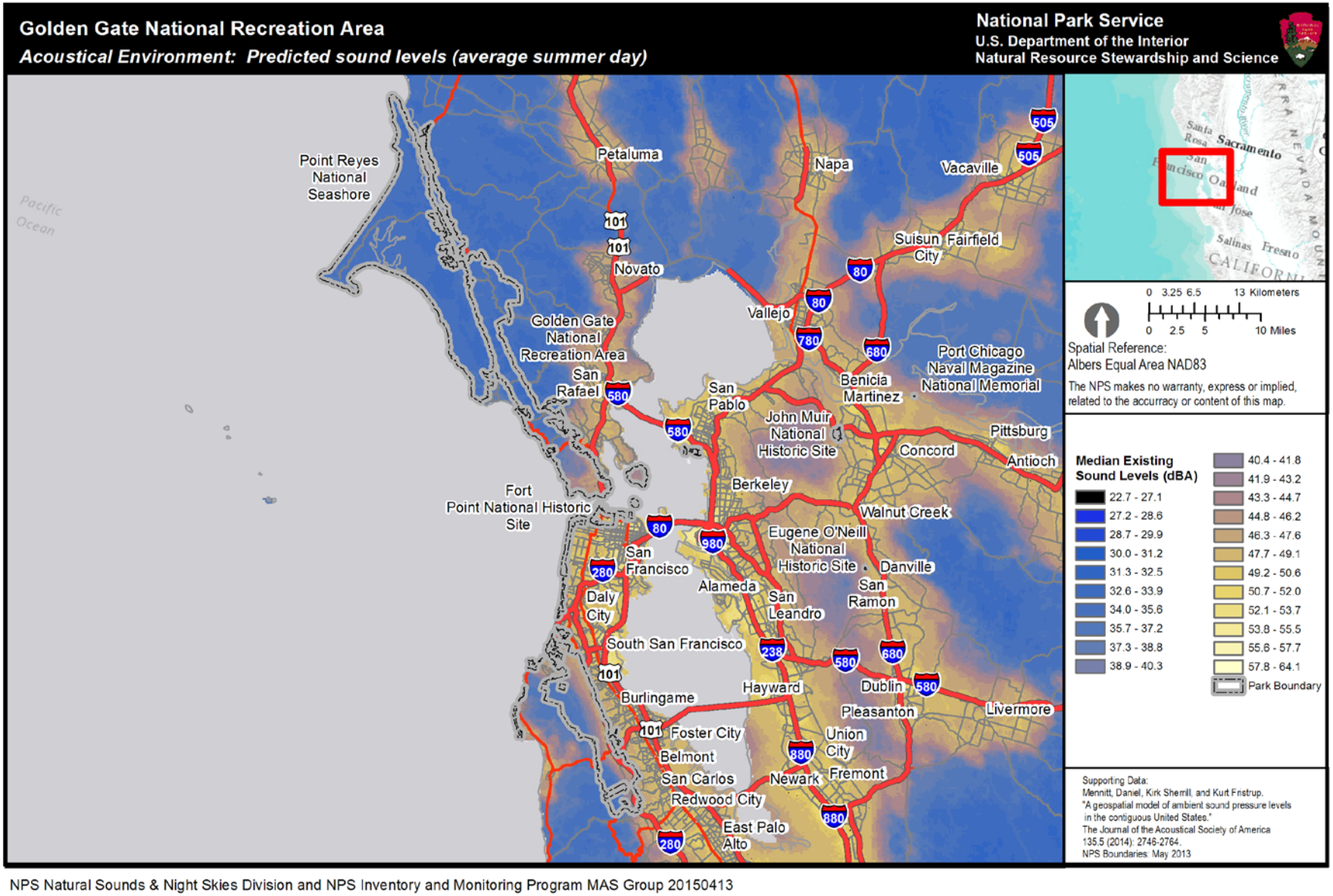

Figure 3. *Median **existing** sound pressure levels for Golden Gate NRA.* This park-specific existing sound level map is generated by version 3.0 of the geospatial model. The color scale indicates the decibel level that is predicted in the park based only on both human-caused and natural sound sources. Sound level is measured in A-weighted decibels, or dBA, with 270 meter resolution. Black and dark blue colors indicate low existing decibel levels while yellow or white colors indicate higher existing decibel levels. Sound levels in national parks can vary greatly, depending on location, topography, vegetation, biological activity, weather conditions and other factors. For example, the din of a typical suburban area fluctuates between 50 and 60 decibels (dBA), while the crater of Haleakala National Park is intensely quiet, with levels around 10 dBA. Note that due to the national scale of the model inputs, this graphic may not reflect recent localized changes (such as new access roads or development). (note: although the color ramps are similar, each figure has different legend values)