Report to Congress

Real-Time Aircraft Sound Monitoring
Final Report

November 30, 2021

Department of the Navy
2000 Navy Pentagon
Washington, DC 20350

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EXECUTIVE SUMMARY

In compliance with the Fiscal Year 2020 National Defense Authorization Act (NDAA), the United States Department of the Navy (Navy) measured sound levels of jet aircraft at Naval Air Station (NAS) Whidbey Island and NAS Lemoore over the past year and compared the resulting measured data with modeled noise data. In accordance with Department of Defense (DoD) policy, the Navy assesses military noise using DoD-approved noise models for impact assessments and long-term land use planning. Measuring of military sound is implemented only when modeling is not feasible. In this case, Congress directed the Navy to measure aircraft sound by conducting real-time sound monitoring and to report the results of such monitoring, along with a comparison of the monitoring results with noise contours from prior studies that used DoD-approved noise modeling.

The Navy collected real-time aircraft sound level and operational data during four discrete seven-day monitoring periods in 2020 and 2021. The data collected each period included: (1) acoustic recordings by sound level meters deployed at sites around each airfield to capture sound levels during a range of flight operations across a range of seasonal weather conditions; and (2) operations data, including logs of air traffic controllers and the monitoring teams, to document the flight activity scheduled and observed during each monitoring period. The operations data collected included items such as aircraft type, number/type of flight operations, and flight track and runway usage.

The Navy solicited input from local leaders, state and federal representatives, and interested federal agencies during the planning stage of this study in mid-2020. Stakeholder input received through two virtual meetings and multiple in-person engagements was a key component of the sound level meter site selection process.

For each airfield, the Navy compared the collected sound data against two modeling efforts: (1) modeling done specifically for this study using the collected flight operations data; and (2) modeling completed as part of previous impact assessments at the two Navy installations. This analysis allowed the Navy to assess whether model predictions were consistent with the actual sound level data collected by the meters given the same variables.

For the monitoring site at the remote training area near NAS Whidbey Island (near the Olympic Military Operations Area) in the Olympic National Park, a different approach was taken because of the sporadic nature of the training events in that area and because the training flights in that area do not perform regular patterns within the airspace. For this site, acoustic data were collected continuously over the course of an entire year.

Overall, the Navy determined that the DoD-approved noise models operate as intended and provide an accurate prediction of noise exposure levels from aircraft operations for use in impact assessments and long-term land use planning.

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ANSI/ASA	American National Standards Institute-Acoustical Society of America
ATC	Air Traffic Control
CNEL	Community Noise Equivalent Level
COVID-19	coronavirus disease 2019
dB	decibels
dBA	A-weighted decibels
DNL	Day-Night Average Sound Level
DoD	Department of Defense
EIS	Environmental Impact Statement
FCLP	Field Carrier Landing Practice
FY	Fiscal Year
$\mathbf{L_{Aeq}}$	Equivalent Continuous Sound Level
$\mathbf{L_{Amax}}$	Maximum Sound Level
$\mathbf{L_{dnmr}}$	Onset Rate-Adjusted Monthly Day-Night Average Sound Level
MOA	Military Operations Area
MRNMAP	Military Operations Area Range NOISEMAP
MTR	Military Training Routes
NAS	Naval Air Station
Navy	United States Department of the Navy
NDAA	National Defense Authorization Act
OLF	Outlying Landing Field
SEL	Sound Exposure Level
SUA	special use airspace

1. INTRODUCTION

In compliance with Section 325 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020, the United States Department of the Navy (Navy) submits this report on real-time aircraft sound monitoring. The NDAA for FY 2020 directed the Secretary of the Navy to submit a report to the congressional defense committees no later than December 1, 2020, on the results of real-time sound monitoring at two Navy installations on the West Coast. Due to late finalization of the NDAA and the outbreak of coronavirus disease 2019 (COVID-19) and associated travel restrictions, the FY21 NDAA deferred the submittal requirement until December 1, 2021.

The report summarizes the findings of the sound monitoring study; provides an explanation of the analysis; reports the results of real-time sound monitoring; and compares the results to modeled noise contours. In addition to the congressionally required information in this report, Navy will provide the raw data collected during the sound monitoring effort to the public in a follow-on technical report.

1.1 FISCAL YEAR 2020 NATIONAL DEFENSE AUTHORIATION ACT

Section 325 of the NDAA for FY 2020, entitled "Real-Time Sound-Monitoring at Navy Installations where Tactical Fighter Aircraft Operate," states the following:

> ***(a) MONITORING***—The Secretary of the Navy *shall conduct real-time sound-monitoring at no fewer than two Navy installations and their associated outlying landing fields on the west coast of the United States where Navy combat coded F/A-18, E/A-18G, or F-35 aircraft are based and operate and noise contours have been developed through noise modeling. Sound monitoring under such study shall be conducted—*
>
> *(1) during times of high, medium, and low activity over the course of a 12-month period; and*
>
> *(2) along and in the vicinity of flight paths used to approach and depart the selected installations and their outlying landing fields.*
>
> ***(b) PLAN FOR ADDITIONAL MONITORING****—Not later than 90 days after the date of the enactment of this Act, the Secretary of the Navy shall submit to the congressional defense committees a plan for real-time sound monitoring described in subsection (a) in the vicinity of training areas predominantly overflown by tactical fighter aircraft from the selected installations and outlying landing fields, including training areas that consist of real property administered by the Federal Government (including Department of Defense, Department of Interior, and Department of Agriculture), State and local governments, and privately owned land with the permission of the owner.*
>
> ***(c) REPORT REQUIRED****—Not later than December 1, 2020, the Secretary of the Navy shall submit to the congressional defense committees a report on the monitoring required under subsection (a). Such report shall include—*
>
> *(1) the results of such monitoring;*
>
> *(2) a comparison of such monitoring and the noise contours previously developed with the analysis and modeling methods previously used;*

(3) an overview of any changes to the analysis and modeling process that have been made or are being considered as a result of the findings of such monitoring; and

(4) any other matters that the Secretary determines appropriate.

(d) PUBLIC AVAILABILITY OF MONITORING RESULTS*—The Secretary shall make the results of the monitoring required under subsection (a) publicly available on a website of the Department of Defense.*

1.2 SOUND MONITORING APPROACH

In accordance with Department of Defense (DoD) policy outlined in DoD Instruction 4715.13, the Navy assesses military noise-related issues associated with testing and training operations using the latest, DoD-approved noise models. Per DoD policy, measuring of military noise is implemented only when modeling is not feasible. Noise modeling allows the Navy to cost-effectively consider alternative operational scenarios and develop noise contours to assist with impact assessments and long-term land use planning.

In conducting the monitoring for this study, the Navy relied on guidance outlined in the American National Standards Institute-Acoustical Society of America (ANSI/ASA) S12.9-1992/Part 2: *Quantities and Procedures for Description and Measurement of Environmental Sound, Part 2, Measurement of Long-term, Wide Area Sound* (ANSI/ASA, 2018). Consistent with the ANSI/ASA procedures, the Navy conducted real-time sound monitoring of aircraft flight operations at Naval Air Station (NAS) Whidbey Island and NAS Lemoore to allow a comparative analysis of actual measured sound levels with sound levels predicted by noise models. The analysis involved collecting sound measurements at specific locations and then comparing those measurements to previous noise results and contours as well as to noise modeling conducted as a part of this effort. The Navy collected data during periods of high, medium, and low flight activity during four discrete monitoring periods over a 12-month period. The monitoring team measured sound at selected monitoring sites along and in the vicinity of tactical fighter aircraft approach and arrival flight paths, and near training areas overflown by tactical jet aircraft. The Navy solicited input from local leaders, state and federal representatives, and interested federal agencies during the planning stage of this study in mid-2020. Stakeholder input received through two virtual meetings and multiple in-person engagements was a key component of the sound level meter site selection process.

The Navy used the data collected during this study to assess the accuracy of the noise-modeling process. For the airfields, the Navy compared the collected data against two modeling efforts: (1) modeling done specifically for this study using the observed flight operations data; and (2) modeling completed as part of previous impact assessments at the two Navy installations. For the first comparison, the operational data collected during the monitoring periods were entered into a DoD-approved noise model, and the results were compared with what was measured during the monitoring periods. The first comparison is a better evaluation of the modeling process than using the previously modeled data as it eliminates operational variations that may have changed since previous modeling efforts were completed, such as sortie rates, runway and flight track utilizations, and time of day. The second comparison compared the real-time measured data with previously modeled data. This comparison of the real-time measured data with the previously modeled results allowed the Navy to determine if previously modeled results for each installation accurately predicted noise levels during periods of operational activity. The previously modeled data were provided in the *Environmental Impact Statement (EIS) for EA-18G "Growler" Airfield Operations* (Navy, 2018) for NAS Whidbey Island and the *F-35C West Coast Homebasing EIS* (Navy, 2014) for NAS Lemoore.

For the monitoring site at the remote training area near NAS Whidbey Island (near the Olympic Military Operations Area) in the Olympic National Park, a different approach was taken because of the sporadic nature of the training events in that area and because the training flights in that area do not perform regular patterns within the airspace. For this monitoring site, acoustic data were collected for 365 days (October 20, 2020, through October 20, 2021). The measured sound levels when the adjacent Olympic Military Operations Area (MOA) was active were compared to the measured sound levels when the Olympic MOA was inactive to assess the military aircraft noise contribution to overall sound levels. The cumulative aircraft noise exposures at the MOA monitoring location were below average sound levels from other sources, most of which were natural, so the Navy was unable to do a direct comparison of measured and modeled aircraft noise exposure levels. This finding is consistent with the analysis contained in the *Northwest Training and Testing Supplemental EIS/Overseas Supplemental EIS* (Navy, 2020).

1.3 DOD-APPROVED NOISE-MODELING TOOLS

DoD analyzes aircraft noise exposure that affects communities near military airfields using the NOISEMAP program. NOISEMAP is a suite of computer programs developed by the United States Air Force, which serves as the lead DoD agency for fixed-wing aircraft noise modeling. NOISEMAP predicts noise exposure based on aircraft flights and maintenance activities during an average annual day. NOISEMAP draws from a library of actual aircraft noise measurements obtained in a controlled environment and then incorporates the site-specific operations data (i.e., types of aircraft, number of operations, flight tracks, altitude, speed of aircraft, engine power settings, and engine maintenance run-ups), environmental data (i.e., average humidity and temperature), and surface hardness and terrain that contribute to the noise environment.

The MOA Range NOISEMAP (MRNMAP) tool is part of the NOISEMAP suite of computer programs. It calculates noise levels for Restricted Areas, MOAs, Military Training Routes (MTRs), and Ranges. MRNMAP uses two primary methods to calculate the noise exposure: area and track operations. Area operations are operations that do not have well-defined tracks but occur within a defined area, such as air combat tactics within a MOA. Track operations are operations that have a well-defined flight track, such as MTRs and aerial refueling tracks.

Both NOISEMAP and MRNMAP require accurate descriptions of the operations being modeled. The number of operations used by the NOISEMAP model is based on the average annual day, per DoD Instruction 4715.13. The average annual day represents the average number of daily airfield operations that would occur during a 24-hour period based on 365 flying days per year; the average annual day is calculated by dividing the total annual airfield operations by 365. The number of operations used by the MRNMAP model is based on the average number of operations per year. The timespan of one year is used to account for the sporadic nature of the training events away from airfields.

Atmospheric conditions, such as wind and temperature, can cause large variations in real-time received sound from day to day. Airfield noise modeling, including NOISEMAP and MRNMAP, considers long-term averages of the acoustical environment. Thus, NOISEMAP calculations assume more favorable conditions for the propagation of sound and, in so doing, these calculations tend to the higher range of potential received sound levels (Cole, 1975). For example, even though

NOISEMAP does not include the effect of wind explicitly, it assumes for purposes of prediction that sound travels downwind, which is the most favorable condition for sound levels to be higher at a receiver location. For this reason, the model is expected to over-predict sound levels.

NOISEMAP and MRNMAP noise models currently used by DoD to assess noise exposure from military flight operations are based on scientific principles and measured noise data. The underlying algorithms (calculation procedures and methods) that predict noise propagation are based on theory and empirically-derived relationships. NOISEMAP and MRNMAP models have improved with time as computer power has increased and as our understanding of physical acoustics has improved. The usefulness of these noise models lies in the flexibility they give an analyst to assess the noise levels in various scenarios over a large area of interest (e.g., airfields and their surrounding communities and training areas). A model allows comparison of the advantages and disadvantages of a defined set of operations, along with many alternatives, in order to determine what scenario best minimizes the noise impacts on the environment while still meeting the Navy's training goals.

1.4 SOUND METRICS

The following provides a basic description of the sound metrics used in this analysis.

Frequency Weighting

Most sounds contain a mixture of many frequencies simultaneously. The human ear varies in its sensitivity to sounds of different frequencies. Experts have developed weighting curves to correspond to the sensitivity and perception of different frequencies of sound. A-weighting is the most common adjustment for human perception to environmental sounds, as it emulates the frequency sensitivities of the human ear. In accordance with DoD policy and with federal standards (Federal Interagency Committee on Noise, 1992) adopted by DoD, the Federal Aviation Administration, and other federal agencies, the Navy's aircraft noise analysis uses the A-weighting adjustment. Sound is usually represented on a scale with a unit called the decibel (dB). The threshold of human hearing is approximately 0 dB, normal speech is about 60 dB, and the threshold of discomfort or pain is around 120 dB. For outdoor sound events, a sound level change of 3 dB is the just noticeable difference threshold. Also, a 10 dB difference in sound level is perceived by most listeners as twice as loud or half as loud.

Acoustic Metrics Used for Aircraft Sound

The metrics discussed in this report are defined below and cover both cumulative and single aircraft events. The Navy used the Day-Night Average Sound Level (DNL) and Community Noise Equivalent Level (CNEL) metrics to compare noise contours. DNL and CNEL are used as the primary comparative metrics in this study because they provide a complete picture of the overall noise environment and are the federal standard (Federal Interagency Committee on Noise, 1992) used to produce aircraft noise exposure contours in impact assessments and other land use planning documents. The Navy also used the Sound Exposure Level (SEL) to compare the sound levels of individual events.

Day-Night Average Sound Level (DNL). DNL is a cumulative metric that accounts for all noise events, such as aircraft operations, in a representative 24-hour period (Figure 1.1). It also contains a nighttime noise adjustment to account for humans' increased sensitivity to noise at night; DNL applies a 10 A-weighted decibels (dBA) adjustment (penalty) to noise events that occur during the nighttime period, defined as 10:00 p.m. to 7:00 a.m.

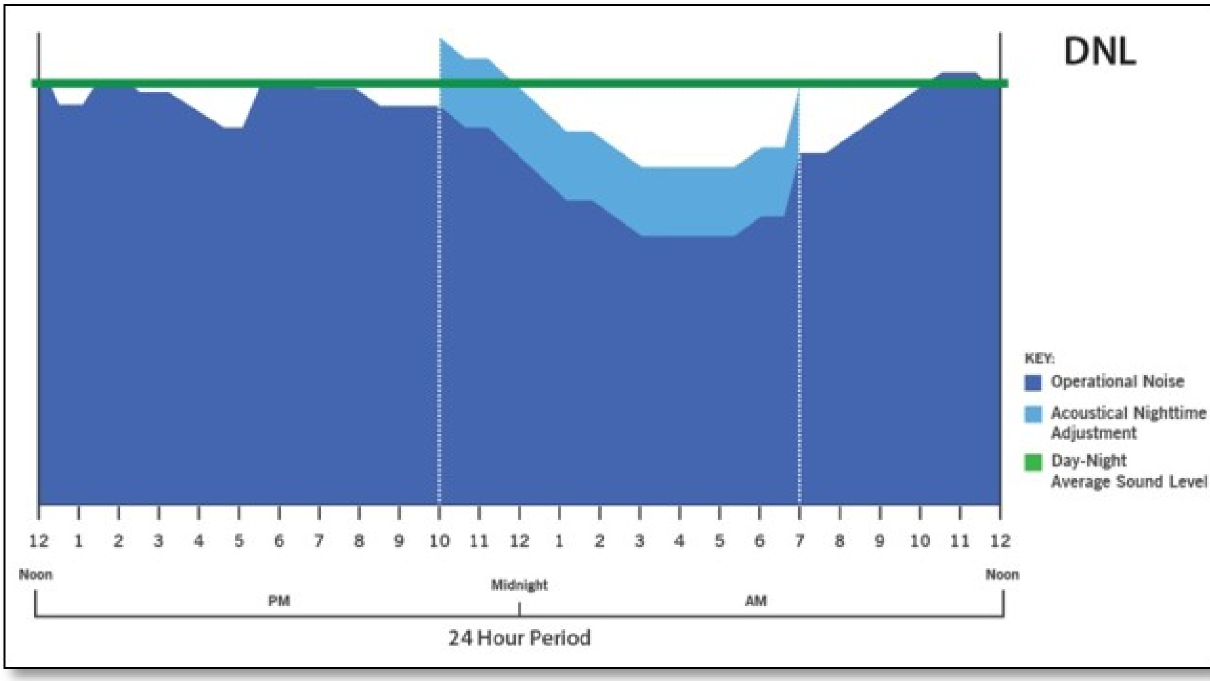

Figure 1.1 Representation of Day-Night Average Sound Level

Community Noise Equivalent Level (CNEL). CNEL is a variation of DNL. CNEL is only used in California, so it only applies to NAS Lemoore in this study. In addition to the 10 dBA adjustment for DNL, it also includes a 5 dBA adjustment for events occurring during the evening period of 7:00 p.m. to 10:00 p.m.

For airports and military airfields, DNL and CNEL represent the average sound level for an average annual day. These metrics help assess the effect of aircraft noise on nearby communities.

Maximum Sound Level (L_{Amax}). Aircraft sounds are generally transient with a defined duration. Aircraft sounds increase in level as the aircraft approaches, reach a maximum level when the aircraft flies overhead, and then decrease as the aircraft departs. L_{Amax} represents the maximum sound level that a person would hear on the ground as an aircraft flies over.

Sound Exposure Level (SEL). SEL includes all the noise levels produced as part of the aircraft overflight, together with how long it lasts. SEL does not directly represent the sound level heard at any given time during a flyover event but rather is a measure of noise representing the entire flyover event. As a result, SEL provides a more accurate measure of aircraft flyover noise exposure than L_{Amax} alone. Additionally, SEL is the basic metric used to calculate DNL. For a typical aircraft flyover event, the SEL will be greater than the L_{Amax}, since SEL is compressed into one second.

Equivalent Continuous Sound Level (L_{Aeq}). The L_{Aeq} averages the acoustic energy over a specific period of time and represents the continuous sound level over that period that generates the same acoustic energy exposure. The period can be any length of time, but it usually is a meaningful block of time, such as a 24-hour period ($L_{Aeq,24hr}$), an 8-hour period ($L_{Aeq,8hr}$) for the office, or a 1-hour period ($L_{Aeq,1hr}$) for a lecture.

Onset Rate-Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}). The L_{dnmr} metric is used to assess noise under or near special use airspace (SUA) and other areas where military aircraft conduct much of their training (e.g., low-level training routes, MOAs, and restricted airspace). The

United States Air Force developed a modified version of DNL for assessing noise in flight routes, which makes adjustments for the sudden increase in (or onset of) noise and the sporadic nature of the sounds. The "m" in L_{dnmr} defines the intermittent nature of the aircraft noise from SUA and is averaged over the busiest month. The "r" accounts for the added annoyance from the "surprise factor" of the rapid-onset rates. This metric is a model-based metric; it is not measured by sound level meters. Additionally, the rapid-onset adjustment is minimal for flight altitudes above 2,000 feet, lateral offset greater than 2,000 feet, or airspeeds below 450 knots.

1.5 KEY TERMS USED IN THIS STUDY

- ***real-time acoustic data*** – acoustic data collected by the sound level meters during the monitoring periods
- ***real-time flight operations data*** – flight operations data collected from local Air Traffic Control (ATC) logs and separate visual field observations by the monitoring team
- ***real-time measured data*** – real-time acoustic data merged with real-time operations data
- ***real-time modeled results*** – the NOISEMAP modeling results based on input from the real-time flight operations data collected as a part of this study
- ***previously modeled results*** – the NOISEMAP modeling results from prior impact assessment efforts

2. SITE SELECTION PROCESS

2.1 SELECTION OF NAVY INSTALLATIONS

The Navy selected NAS Whidbey Island, including Outlying Landing Field (OLF) Coupeville, and NAS Lemoore for the monitoring effort. Both installations lie on the West Coast of the United States and host Navy combat-coded F/A-18, E/A-18G, or F-35 aircraft. These installations both have noise contours developed using standard DoD-approved noise-modeling tools, including NOISEMAP and MRNMAP.

The Navy selected NAS Whidbey Island due to public interest in the noise landscape in that area and because of its varying topography, which influences aircraft noise propagation. The Navy selected NAS Lemoore as a second location due to its high level of flight activity, flat topography, and surrounding land uses that offer minimal variability and are conducive to consistent outdoor acoustic measurements.

2.2 SELECTION OF SOUND MONITORING LOCATIONS

The Navy used a spatial stratification analysis to determine suitable monitoring locations around the airfields at both installations. This analysis involved selecting sites to ensure sound measurements would capture a range of typical flight operations including aircraft arrivals, departures, patterns (e.g., Field Carrier Landing Practice [FCLP]), and inter-facility flights. Selection of monitoring locations also took into consideration primary flight paths to offshore training areas and modeled flight tracks or overflight areas. In addition to spatial distribution, the sites also needed to provide a range of SELs.

The Navy also solicited input from local leaders, stakeholders, state and federal representatives, and interested federal agencies. Due to the outbreak of COVID-19, the Navy relied on virtual outreach methods to communicate with stakeholders. Between May and June 2020, the Navy hosted several virtual meetings with local leaders, external stakeholders, government representatives, and other federal agencies to gather input regarding potential monitoring locations. Based on this outreach, the Navy incorporated a total of eight monitoring sites (seven near NAS Whidbey Island and one near NAS Lemoore) suggested by local leaders and/or stakeholders that also met the technical requirements for the study.

The Navy conducted the final site selection for the sound meters systematically to ensure each site met all technical requirements. The monitoring team conducted site visits in August 2020 and October 2020 for NAS Whidbey Island and NAS Lemoore, respectively, to confirm the viability of each potential site. To ensure accurate data collection, the Navy, to the greatest extent possible, selected sites having minimal external sound sources (e.g., cars, trains, commercial aircraft, or construction noise), where the target source (military aircraft) was the dominant source of sound. Locations also had to be easily accessible, safe, and secure to deploy the sound level meter equipment. The Navy obtained access agreements to deploy sound level meters on properties not under DoD jurisdiction.

NAS Whidbey Island

The Navy identified 11 sound level meter monitoring sites adjacent to NAS Whidbey Island (Ault Field and OLF Coupeville), seven of which were suggested by local stakeholders. In addition, the Navy placed a sound level meter within the Olympic National Park near the Olympic MOA training airspace used by NAS Whidbey Island, based on an evaluation of sites suggested by the National Park Service. At Olympic National Park, the Navy used a semi-permanent[1] sound level meter due to the sporadic nature of flight activity in this area and the remote location of the site. The Navy also used semi-permanent sound level meters at the Port Townsend (Site ID: 33_SG - *Port Townsend City Hall*) and Lopez Island (Site ID: 5B_SG - *Lopez Island*) locations due to the difficulty in accessing both sites during the monitoring periods. The monitoring sites are depicted in Figures 2.1 and 2.2.

NAS Lemoore

The Navy identified 10 sound level meter monitoring sites on and adjacent to NAS Lemoore (Reeves Field). NAS Lemoore stakeholders suggested one monitoring site, which the Navy included as one of the 10 locations. Figure 2.3 depicts the monitoring locations for NAS Lemoore.

3. MONITORING PERIODS

The monitoring team collected real-time aircraft sound and operations data over four seven-day discrete monitoring periods in accordance with the ANSI/ASA standard. A seven-day monitoring period typically represents high (Tuesday through Thursday), medium (Monday and Friday), and low (Saturday and Sunday) flight activity. To capture data during different conditions, the Navy planned to have one monitoring period during each season (winter, spring, summer, and fall) at each airfield location.

[1] The Navy initiated a 365-day monitoring period for the monitoring site within Olympic National Park. See Sections 5.2 and 6.3 for more information. The meter was considered semi-permanent because it was installed at the beginning of the first monitoring period and remained in place for a year. It was the same type of meter deployed at the other sites.

Figure 2.1 Location of Sound Level Meters near NAS Whidbey Island

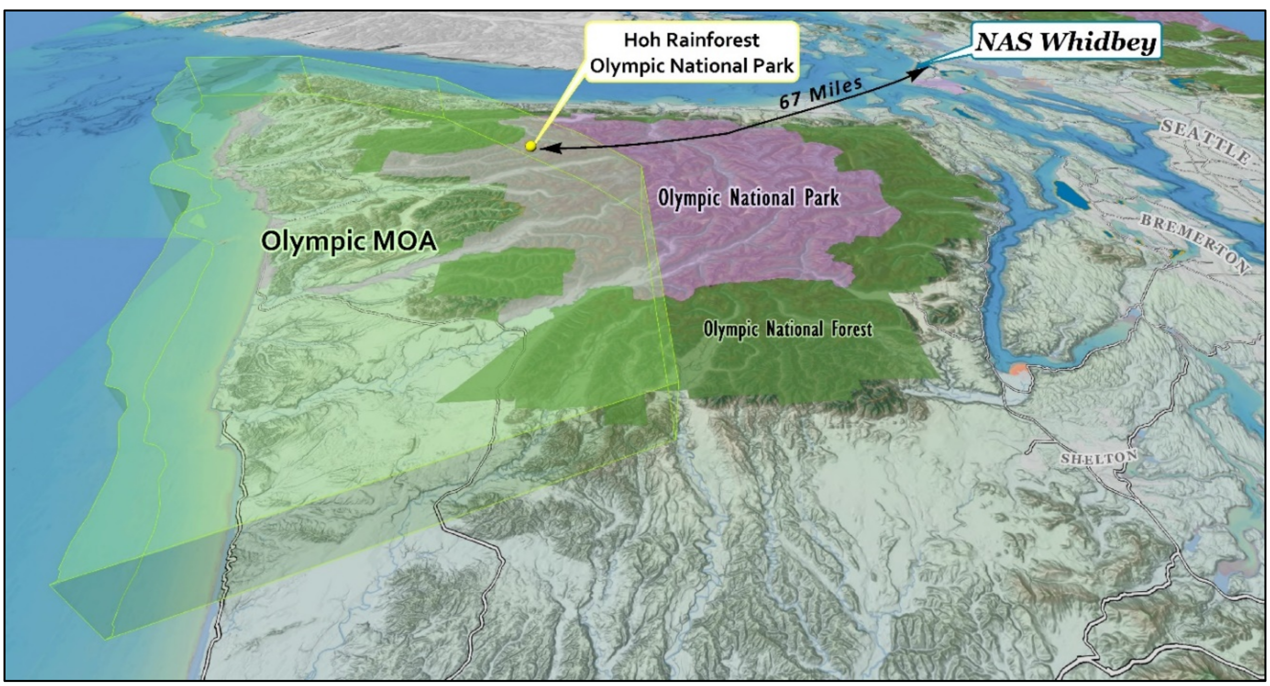

Figure 2.2 Location of Sound Level Meter at the Olympic National Park

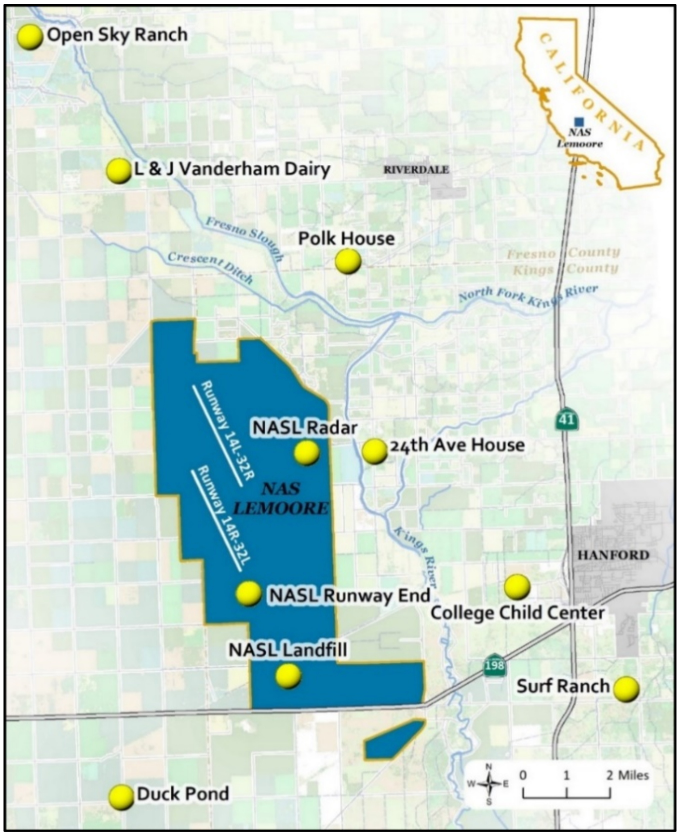

Figure 2.3 Location of Sound Level Meters near NAS Lemoore

Table 3.1 identifies each monitoring period and provides a description of the flight activity and weather conditions. The monitoring periods took place during a range of weather conditions. The Navy planned the monitoring periods to coincide with flight activity at each installation. Since the Navy uses OLF Coupeville intermittently, monitoring periods for NAS Whidbey Island were scheduled when the OLF was in use. When OLF Coupeville is used, the most common aircraft activity is FCLPs, which simulate landing on an aircraft carrier.

As noted in Section 1.2, the Navy initiated a 365-day monitoring period (October 20, 2020, through October 20, 2021) for the monitoring site within Olympic National Park due to the sporadic nature of aircraft activity in that area; the longer monitoring period allowed the Navy to monitor more flights.

Table 3.1 Monitoring Periods

Monitoring Period	Overall Flight Activity[1]	Weather Conditions
NAS Whidbey Island		
December 13–19, 2020	High (127% of average)	42 to 52 °F 0.55" of precipitation (windy and overcast)
March 28–April 3, 2021	Medium (70% of average)	34 to 56 °F 0.15" of precipitation
June 6–12, 2021	High (128% of average)	43 to 75 °F 0.08" of precipitation
August 8–14, 2021	Medium (78% of average)	55 to 79 °F 0.06" of precipitation
NAS Lemoore		
January 24–30, 2021	Low (53% of average)	28 to 60 °F 1.03" of precipitation (rainy)
April 11–17, 2021	Medium (68% of average)	39 to 84 °F 0.0" of precipitation
May 16–22, 2021	Medium (93% of average)	42 to 88 °F 0.0" of precipitation
August 22–28, 2021	High (187% of average)	58 to 103 °F 0.0" of precipitation (smoky)

Key: °F = degrees Fahrenheit; " = inches; NAS = Naval Air Station
[1] Overall flight activity averages are the sum of all real-time flight operations divided by four.

4. DATA COLLECTION

The data collection process yielded over 14,000 total hours of real-time acoustic data covering over 15,000 total flight operations over the course of the four monitoring periods at the two airfields. In addition, the sound level meter within Olympic National Park collected data for 365 days.

4.1 REAL-TIME ACOUSTIC DATA COLLECTION

The Navy collected acoustic data at the airfields and the Olympic MOA using sound level meters following the ANSI/ASA technical guidelines. The Navy supplemented the acoustic data at the airfields with direct field observations to help identify non-aircraft sound sources near the sound level meters.

The monitoring team placed Larson Davis 831C Class I sound level meters at the same monitoring locations in each seven-day monitoring period for the two airfields. This type of meter was also used for the 365-day monitoring at the Olympic MOA. These meters are calibrated data recorders capable of high-fidelity sound capture over extended periods and adhere to a range of industry standards (ANSI/ASA, 2014). They are not audio recorders and do not record everything audible at the site as would a personal recording device. They are sound level recorders, designed to respond to sound in the same way as a human ear and give reproducible measurements of sound pressure levels. Each station setup (example shown in Figure 4.1) consisted of a sound level meter and wind monitor with the instrumentation protected in a lockable weather-tight case. All meters were set to record data every one second, which allowed the meters to capture all sound sources in their vicinity. The data collected by the sound level meters are referred to in this report as the ***real-time acoustic data***.

Figure 4.1 Sound Level Monitoring Station Deployed at NAS Whidbey Island (Site 8B_SG - *Dog Park*)

The monitoring team also conducted observations near the sound level meters to help identify non-aircraft sound sources picked up by the meters. The monitoring team scheduled observation locations at or near specific meters based on expected runway use and flight operational tempo for each day. The monitoring team noted all audible sound sources it observed at each observation site in a table, an example of which is shown in Figure 4.2.

Location 27A_SG: Water Treatment Plant
Recorder XXXXXXXXXXXXXX
Date 8-Aug-21
Ctrl + Shift + T: Hot Key in for current time in seconds

Start Time	End Time	Stamp	Aircraft	Sound Source	Description	NOTE:
10:20:36 AM					Arrival at the site. Ambient: 1. birds 2. nearby traffic 3. wind through the trees	
10:23:42 AM	10:24:33 AM		GA Propeller		GA Prop overflight (directly over the site)	
10:25:56 AM	10:26:08 AM			Nearby Traffic	car driving by the site on the main road	
10:29:47 AM	10:30:03 AM			Nearby Traffic	car driving by the site on the main road	
10:30:37 AM	10:30:42 AM			Nearby Traffic	car driving by the site on the main road	
10:33:07 AM	10:34:37 AM		GA Propeller		GA Prop overflight (directly over the site)	
10:36:48 AM	10:37:00 AM			Nearby Traffic	car driving by the site on the main road	
10:38:18 AM	10:38:35 AM			Nearby Traffic	three cars driving by the site	
10:41:22 AM	10:41:38 AM			Nearby Traffic	loud pickup truck driving by the site	
10:42:31 AM	10:42:50 AM			Nearby Traffic	car pulled into the gravel parking at the site then turned around	
10:44:35 AM	10:47:02 AM		GA Propeller		GA Prop nearby (offset)	
10:48:16 AM	10:49:48 AM		GA Propeller		GA Prop nearby (offset)	
10:50:07 AM	10:50:21 AM			Nearby Traffic	three cars driving by the site	
10:50:59 AM	10:51:05 AM			Nearby Traffic	car driving by the site on the main road	
10:51:56 AM	10:52:05 AM			Nearby Traffic	FedEx truck driving by the site	
	10:52:26 AM				End of Observations	

Figure 4.2 Example Acoustic Observation Log

Table 4.1 provides overall summaries of the acoustic data collected during the monitoring effort for the airfields. For NAS Whidbey Island, 11 meters were deployed for each monitoring period,[2] which resulted in up to 1,848 (7 days*24 hours*11 meters) hours of recorded acoustic data each period. For NAS Lemoore, 10 meters were deployed for each monitoring period, which resulted in up to 1,680 (7 days*24 hours*10 meters) hours of recorded acoustic data each period. A brief data omission occurred during the first monitoring period at two specific sites due to cold weather, which drained the batteries of the sound level meters faster than anticipated. The data omission at NAS Whidbey Island occurred at one site for approximately 15 hours, while the data omission at NAS Lemoore occurred at one site for approximately 14 hours. These hours occurred during periods of low flight activity and represent less than 1 percent of the collected hours of acoustic data.

Table 4.1 Summary of Hours of Acoustic Data Measurements

Monitoring Period	NAS Whidbey Island Total Hours	NAS Lemoore Total Hours
1	1,833	1,664
2	1,848	1,680
3	1,848	1,680
4	1,848	1,680
Total	**7,377**	**6,704**

Key: NAS = Naval Air Station

4.2 REAL-TIME FLIGHT OPERATIONS DATA COLLECTION

The real-time flight operations data collection relied on two data sources: local ATC logs and separate visual field observations by the monitoring team. The local ATC personnel documented operations data from the ATC towers at both airfields. The monitoring team supplemented the tower data with data it gathered independently near each airfield tower and OLF Coupeville. This data included observable flight details such as runway use, aircraft type, and operation type. The observed flight operations data collected during each monitoring period are referred to in this report as the ***real-time flight operations data***.

For each monitoring period, the monitoring team consulted with ATC and operations personnel for the planned daily flight schedule. This preplanning assisted in the scheduling of observers from the monitoring team for flight and acoustic observations.

For OLF Coupeville, FCLP operations are the primary contributors to the DNL at the five monitoring locations around the OLF. Thus, the measurement periods for this study coincided with planned FCLP activity at the OLF, which resulted in higher FCLP flight activity in the real-time flight operations data compared to the previously modeled flight operations data, which are based on an average annual day.

Tables 4.2 and 4.3 provide overall summaries of the flight operations data collected during the monitoring effort for NAS Whidbey Island and NAS Lemoore, respectively. For these summaries, one flight operation is counted whenever an aircraft touches or leaves a runway surface. Thus, an arrival and a departure each count as one flight operation, whereas a closed pattern, such as an FCLP, counts as two flight operations for each circuit.

[2] This does not include the sound level meter within Olympic National Park, which recorded data over the course of a year.

Table 4.2 Summary of Real-Time Flight Operations Recorded at NAS Whidbey Island

Monitoring Period	Total Number of Operations[1]		Total Number of FCLP Operations	
	Ault	Coupeville	Ault	Coupeville
December 13–19, 2020	1,038	1,224	306	1,112
March 28–April 3, 2021	879	462	0	422
June 6–12, 2021	1,752	766	172	694
August 8–14, 2021	868	590	104	534
Totals	**4,537**	**3,042**	**582**	**2,762**

Key: FCLP = Field Carrier Landing Practice; NAS = Naval Air Station

[1] Total number of operations includes arrivals, departures, pattern operations, including FCLP operations, and inter-facility operations, as these are explained in this section. A single FCLP counts as two operations, one landing and one takeoff.

Table 4.3 Summary of Real-Time Flight Operations Recorded at NAS Lemoore

Monitoring Period	Total Number of Operations[1]	Total Number of FCLP Practice Operations
January 24–30, 2021	1,251	238
April 11–17, 2021	1,815	254
May 16–22, 2021	2,125	446
August 22–28, 2021	2,802	1,320
Totals	**7,993**	**2,258**

Key: FCLP = Field Carrier Landing Practice; NAS = Naval Air Station

[1] Total number of operations includes arrivals, departures, and pattern operations, including FCLP operations.

For the Olympic MOA, NAS Whidbey Island ATC provided operations data collected for military activity, which included aircraft squadron type and estimated entry and exit times, to distinguish between times when the MOA was active and inactive. The data collection involved post-processing flight data of aircraft entering and exiting the MOA. This process was non-standard, involving manpower-intensive data collection, and provided a conservative number of sorties flying in the MOA. A summary of this data is provided in Table 4.4. The data collection to support this sound monitoring study differed from the data source used in the *Northwest Training and Testing Supplemental EIS/Overseas Supplemental EIS* (Navy, 2020) to allow for identification of MOA entry and exit times.

Table 4.4 Summary of Operations for the Olympic MOA

Month	Acoustic Day Events (7:00 a.m. to 10:00 p.m.)	Acoustic Night Events (10:00 p.m. to 7:00 a.m.)	Total Sorties[1]
October 2020	135	12	142
November 2020	269	5	269
December 2020	248	0	248
January 2021	253	0	253
February 2021	344	2	344
March 2021	321	0	321
April 2021	235	15	235
May 2021	274	0	274
June 2021	313	44	315
July 2021	277	9	277
August 2021	318	11	320
September 2021	241	6	241
October 2021	216	10	218

Key: MOA = Military Operations Area

[1] The total sorties may be less than the sum of acoustic day and acoustic night events if some of the sorties entered before 10:00 p.m. and exited afterward.

5. DATA ANALYSIS

The data analysis process included identifying aircraft sound events, calculating sound metrics, and comparing the measured data to modeled results. Figure 5.1 provides an overview of the process.

5.1 IDENTIFYING AIRCRAFT NOISE EVENTS AND CALCULATING SOUND METRICS

The actual military aircraft noise events must be identified within the real-time measured acoustic data for the airfields to facilitate a comparison to the noise models. Identifying aircraft noise is a two-step process: (1) identify noise events and (2) align real-time flight operations data to noise events.

A noise event is a period in the real-time acoustic data that exceeds (i.e., rises above) the background sound level by at least 10 dBA for at least six seconds. The real-time acoustic data were scanned for these noise events and each identified event was catalogued. SEL values were then calculated for each event.

The real-time flight operations data were used to identify which noise events were due to an aircraft. The modeled trajectory of each aircraft helped to determine the time when the aircraft would be closest to the monitoring site and at its loudest. Noise events near the time the aircraft was closest to the monitoring site were designated as aircraft noise events.

The Navy developed an event database that catalogued all noise events, the sound metrics for each event, and the operation associated with that event. The merged data are referred to in this report as the ***real-time measured data***. The database facilitated comparison of the monitored data captured during the monitoring session to modeled data.

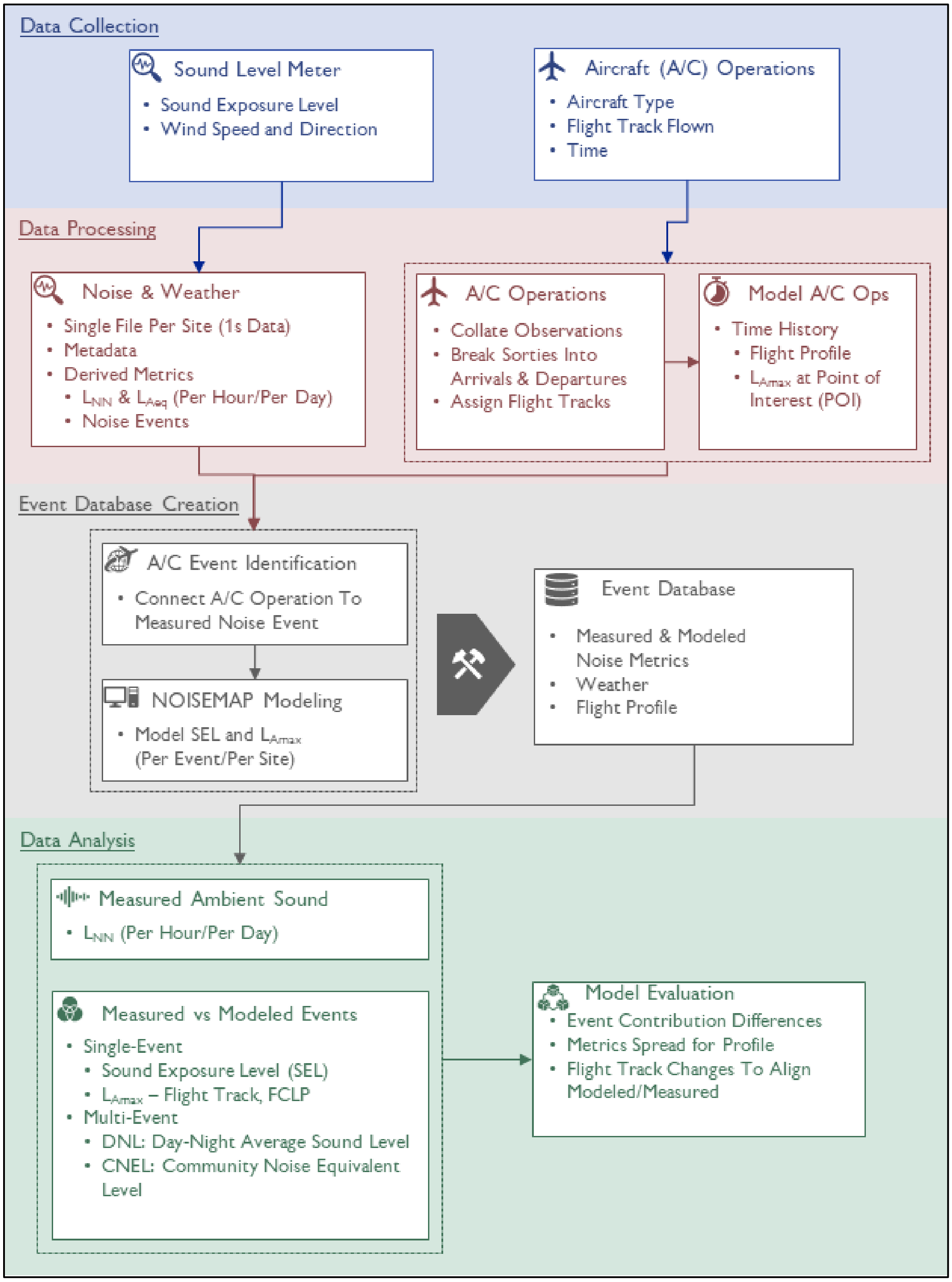

Figure 5.1 Data Analysis Process Diagram

The acoustic analysis process was different for the acoustic data collected at the monitoring site near the Olympic MOA, which involved a yearlong data collection period. The entry and exit times were used to identify times when the MOA was active with military aircraft. During these active periods, the monitor had the potential to receive military aircraft noise events, but these events were not guaranteed to occur during these active periods. Thus, the process involved calculating DNL values during periods when the Olympic MOA was active (potential for receiving military aircraft noise events) and calculating $L_{Aeq,24hr}$ sound levels during periods when the MOA was inactive (mostly receiving natural sounds or sounds of non-military aircraft flyovers). The 10 dBA acoustic night (10:00 p.m. to 7:00 a.m.) adjustment is not applied to other sounds. This process did not include direct identification of unique aircraft noise events as was done for the other monitoring locations because of the sporadic nature of the training events and because the training flights in that area do not perform regular patterns within the airspace. The flights are transient and at higher altitudes. Part of this process removed mechanical noise events (e.g., trash truck pickups from a nearby dumpster) from both active and inactive time periods. Additionally, even though the modeling involved the L_{dnmr} metric, the onset-rate adjustment is negligible at this site because of the relatively high flight altitudes (the floor of the MOA is 6,000 feet above mean sea level). When the onset-rate adjustment is negligible, L_{dnmr} and DNL are the same. Thus, the process involved calculating DNL values during periods when the Olympic MOA was active and calculating $L_{Aeq,24hr}$ sound levels during periods when the MOA was inactive. The resulting monthly DNL and $L_{Aeq,24hr}$ sound levels were compared to assess aircraft noise exposure contribution to the overall sound levels.

5.2 COMPARING MEASURED DATA TO MODELED RESULTS

To assess the accuracy of the DoD aircraft noise-modeling tool, NOISEMAP, the Navy input real-time operations data from the monitoring periods into the NOISEMAP model. The results of this modeling are referred to in this report as the ***real-time modeled results***. The real-time measured data were compared to the real-time modeled results to test the accuracy of the NOISEMAP model based on the same flight activity. This basis provides an accurate comparison of the modeling process by eliminating variations due to sortie rates, runway and flight track utilizations, and time of day.

To determine if previously modeled noise contours from prior impact assessments at NAS Whidbey Island and NAS Lemoore accurately predicted noise levels, the Navy compared the modeling results from prior studies to the real-time measured data (see Section 1.2). The data from prior modeling are referred to in this report as the ***previously modeled results***. The comparison of the real-time measured data with the previously modeled results allowed the Navy to determine if previously modeled results for each installation accurately predicted noise levels during periods of operational activity.

For the Olympic MOA, the Navy ran the MRNMAP model to compare the real-time operations data and the previous results from the *Northwest Training and Testing Supplemental EIS/Overseas Supplemental EIS* (Navy, 2020). Aircraft noise levels at the MOA were below the noise model threshold, so the Navy was unable to do a direct comparison of real-time measured to real-time modeled aircraft sound levels.

6. RESULTS

The Navy compared the real-time modeled results and the previously modeled results to the real-time measured data for the airfields at both installations and determined that the noise model operates as intended and provides an accurate prediction of sound levels from aircraft operations.

Due to the noise propagation assumption built into NOISEMAP, the model predicts the higher end of expected received sound level (Cole, 1975). In addition, during this study other operational factors contributed to over-prediction. The observed differences are within the Navy's expectations. This is discussed in more detail in the sections below.

The Navy compared sound levels at the Olympic MOA when the area was active and inactive to assess the aircraft noise contribution to overall sound levels. This comparison indicates that the aircraft sound levels do not contribute significantly to the overall sound levels at the Hoh Rainforest Visitor Center location, which is consistent with the analysis contained in the *Northwest Training and Testing Supplemental EIS/Overseas Supplemental EIS* (Navy, 2020).

The detailed comparative results are provided in Section 6.1 for NAS Whidbey Island, Section 6.2 for NAS Lemoore, and Section 6.3 for the Olympic MOA.

6.1 COMPARISON BETWEEN REAL-TIME MEASURED DATA AND MODELED RESULTS AT NAS WHIDBEY ISLAND

Figure 6.1 shows a comparison of the measured data and modeled results for both the real-time and previously modeled scenarios at NAS Whidbey Island. The comparison indicates that the model operates as intended and provides an accurate prediction of sound levels from aircraft operations. The figure shows that the real-time measured DNL is usually less than the real-time modeled and previously modeled DNL from NOISEMAP. The largest differences between measured and modeled data occurred at sites not directly overflown by Navy aircraft. The Navy expected this finding based on the model's conservative prediction assumptions (Cole, 1975). Other differences between measured and modeled data were due to variation in ground cover, sortie rates, and a lower number of flights during acoustic night.

Tables 6.1 and 6.2 provide the DNL values associated with Figure 6.1. Table 6.1 is based on the comparison between real-time modeled results and the real-time measured data, and Table 6.2 shows a comparison of the previously modeled results and the real-time measured data. For both tables, a positive difference in DNL indicates NOISEMAP predicted higher DNL values, while a negative difference in DNL indicates NOISEMAP predicted lower DNL values.

The average difference in DNL for the comparison of the real-time modeled results and real-time measured data is +3.2 dBA, with only Site 25B_T (*Private Residence*) showing a negative difference in DNL of -2.0 dBA. The largest difference of +7.8 dBA occurred at Site 20B_SG (*Perry House*), which is inside the FCLP turn for landing on Runway 32 at OLF Coupeville.

The average difference in DNL for the comparison of previously modeled results and real-time measured data is +5.5 dBA, with Site 24A_B (*NPS Reuble Farm*) showing a negative difference in DNL of -4.2 dBA. The largest difference of +12.5 dBA occurred at Site 9B_SG (*NASWI Gate*), which is behind the departures on Runway 14 at Ault Field. The over-prediction arises from: (1) the lower overall sortie rate in the measured data compared to what was previously modeled and (2) fewer operations during acoustic night. The home basing of the EA-18G is still in progress, and not all of the fleet squadrons have been established at NAS Whidbey Island. Overall, the measured EA-18G sorties were about 40 percent less than previously modeled, with 73 percent less acoustic nighttime operations. In addition, the land between Runway 14 at Ault Field and Site 9B_SG (*NASWI Gate*) is primarily forest, and NOISEMAP does not account for the additional sound attenuation provided by vegetation.

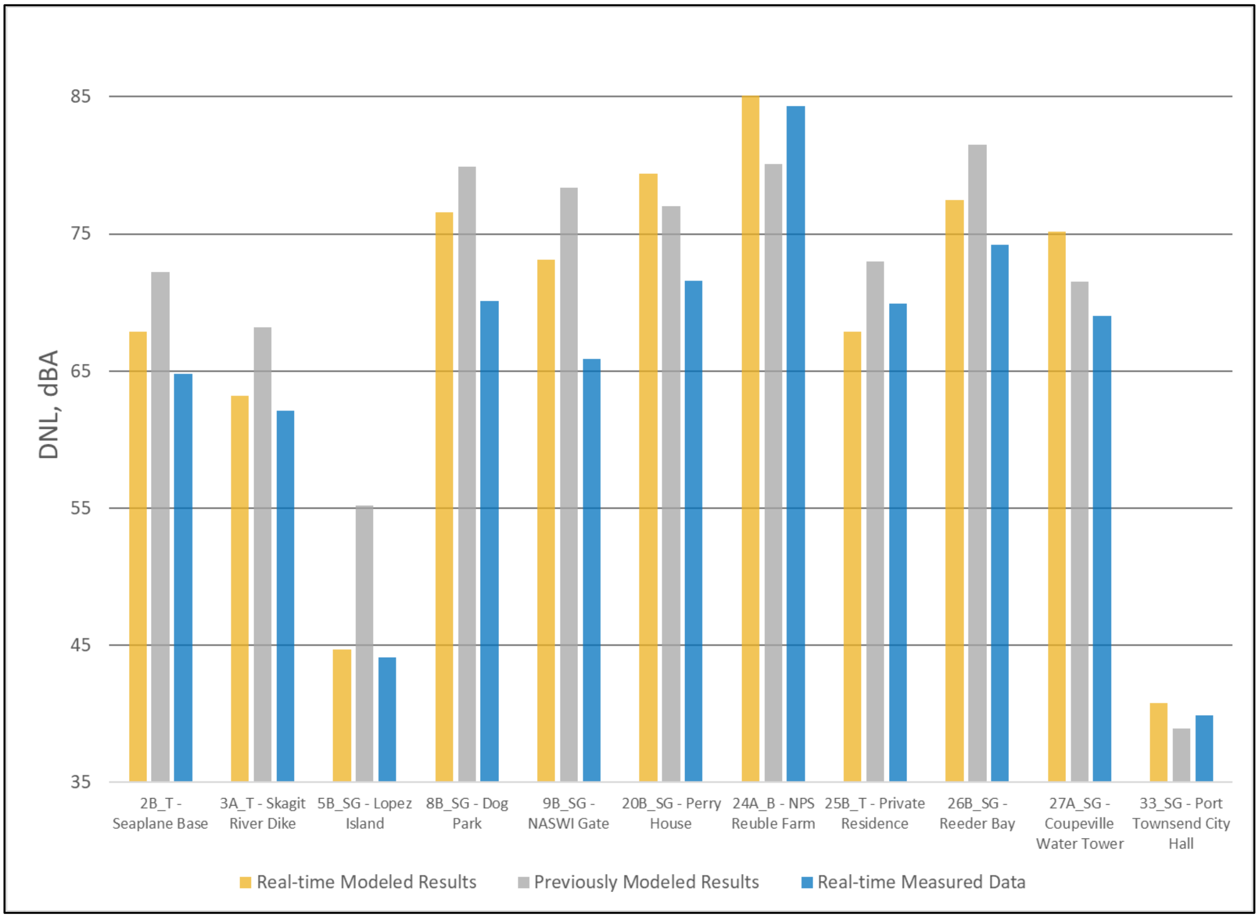

Figure 6.1 DNL Comparison between the Modeled Results and Measured Data for NAS Whidbey Island

Table 6.1 Comparisons between the Real-Time Measured and Real-Time Modeled DNL for Monitoring Periods 1 through 4 at NAS Whidbey Island

Site Name	Real-Time Modeled DNL	Real-Time Measured Aircraft DNL	Difference between Modeled versus Measured DNL
2B_T - Seaplane Base	67.9	64.8	3.1
3A_T - Skagit River Dike	63.2	62.1	1.1
5B_SG - Lopez Island	44.7	44.1	0.6
8B_SG - Dog Park	76.6	70.1	6.5
9B_SG - NASWI Gate	73.1	65.9	7.2
20B_SG - Perry House	79.4	71.6	7.8
24A_B - NPS Reuble Farm	85.1	84.3	0.8
25B_T - Private Residence	67.9	69.9	-2.0
26B_SG - Reeder Bay	77.5	74.2	3.3
27A_SG - Coupeville Water Tower	75.2	69.0	6.2
33_SG - Port Townsend City Hall[1]	40.8	39.9	0.9

Key: DNL = Day-Night Average Sound Level; NAS = Naval Air Station

Note: Shading in the table matches the color scheme in the legend of Figure 6.1.

[1] While the Port Townsend City Hall meter location is away from the airfield, it is located near an arrival and departure flight track.

Table 6.2 Comparisons between the Real-Time Measured and Previously Modeled DNL for Monitoring Periods 1 through 4 at NAS Whidbey Island

Site Name	Previously Modeled DNL[1]	Real-Time Measured Aircraft DNL	Difference between Modeled versus Measured DNL
2B_T - Seaplane Base	72.2	64.8	7.4
3A_T - Skagit River Dike	68.2	62.1	6.1
5B_SG - Lopez Island	55.2	44.1	11.1
8B_SG - Dog Park	79.9	70.1	9.8
9B_SG - NASWI Gate	78.4	65.9	12.5
20B_SG - Perry House	77.0	71.6	5.4
24A_B - NPS Reuble Farm	80.1	84.3	-4.2
25B_T - Private Residence	73.0	69.9	3.1
26B_SG - Reeder Bay	81.5	74.2	7.3
27A_SG - Coupeville Water Tower	71.5	69.0	2.5
33_SG - Port Townsend City Hall[2]	38.9	39.9	-1.0

Key: DNL = Day-Night Average Sound Level; NAS = Naval Air Station

Note: Shading in the table matches the color scheme in the legend of Figure 6.1.

[1] Source: Navy, 2018

[2] While the Port Townsend City Hall meter location is away from the airfield, it is located near an arrival and departure flight track.

Although the monitoring periods had lower sortie rates and fewer acoustic night operations, other factors explain the under-prediction at Site 24A_B (NPS Reuble Farm). Site 24A_B is the only monitoring site directly overflown when FCLPs use OLF Runway 32. The other four sites around the OLF (Site 20B_SG, Site 25B_T, Site 26B_SG, and Site 27A_SG) are not directly overflown when FCLPs use Runway 32. Additionally, the number of FCLP operations for the real-time modeled results was 74 percent higher than previously modeled. FCLP operations are the primary contributors to the DNL at the five monitoring locations around the OLF. Thus, the measurement periods for this study coincided with planned FCLP activity at the OLF, which resulted in higher FCLP flight activity in the real-time flight operations data compared to the previously modeled flight operations data, which is based on an average annual day.

The effect of this variation resulted in higher real-time measured DNL for Site 24A_B (*NPS Reuble Farm*) than the previously modeled DNL.

The results at Site 24A_B (*NPS Reuble Farm*) were also affected by variations in FCLP flight tracks. The observed FCLP flight tracks varied from previously modeled results. The previously modeled results used a distribution among narrow, center, and wide tracks to represent the typical variability in the track over the ground. The center track was modeled at 50 percent of the FCLPs with the narrow and wide tracks at 25 percent each. However, during the monitoring periods, the pilots used narrow tracks more often than was previously predicted, and those flights represented about 80 percent of the observed FCLP operations. While flight tracks are represented as single or multiple lines within the model as a prediction of where aircraft might fly, aircraft, in actuality, can be left or right of the flight tracks in the model due to aircraft performance, pilot technique, number of aircraft in the pattern, fuel load, ATC instruction, other air traffic, noise-abatement procedures, and weather conditions. The effect of this variation resulted in higher DNL values under the narrow flight track and lower values under the center and wide tracks compared to previously modeled results.

In addition to DNL comparisons, the Navy also used SEL values to compare the sound levels of individual events. Figure 6.2 provides examples of SEL comparisons at Ault Field, and additional SEL comparisons will be provided in the follow-on technical report. The plot on the left in Figure 6.2 shows the comparison for arrival operations at Site 9B_SG (*NASWI Gate*). In this example, the modeled values tend to be higher than the measured values. The plot on the right in Figure 6.2 shows the comparison for departures at Site 2B_T (*Seaplane Base*). Again the result is consistent. The agreement is closer between measured and modeled values for Runway 14 departures at Site 2B_T (*Seaplane Base*) since this site is directly overflown by these operations. The outliers shown in both plots demonstrate the large variability observed in individual events due to various environmental and operational factors. The measurement methodology, including multiple monitoring periods covering different environmental and operational conditions, was designed to capture this variability and minimize its effects. All events, including the outliers, are included in the calculation of the real-time measured DNL.

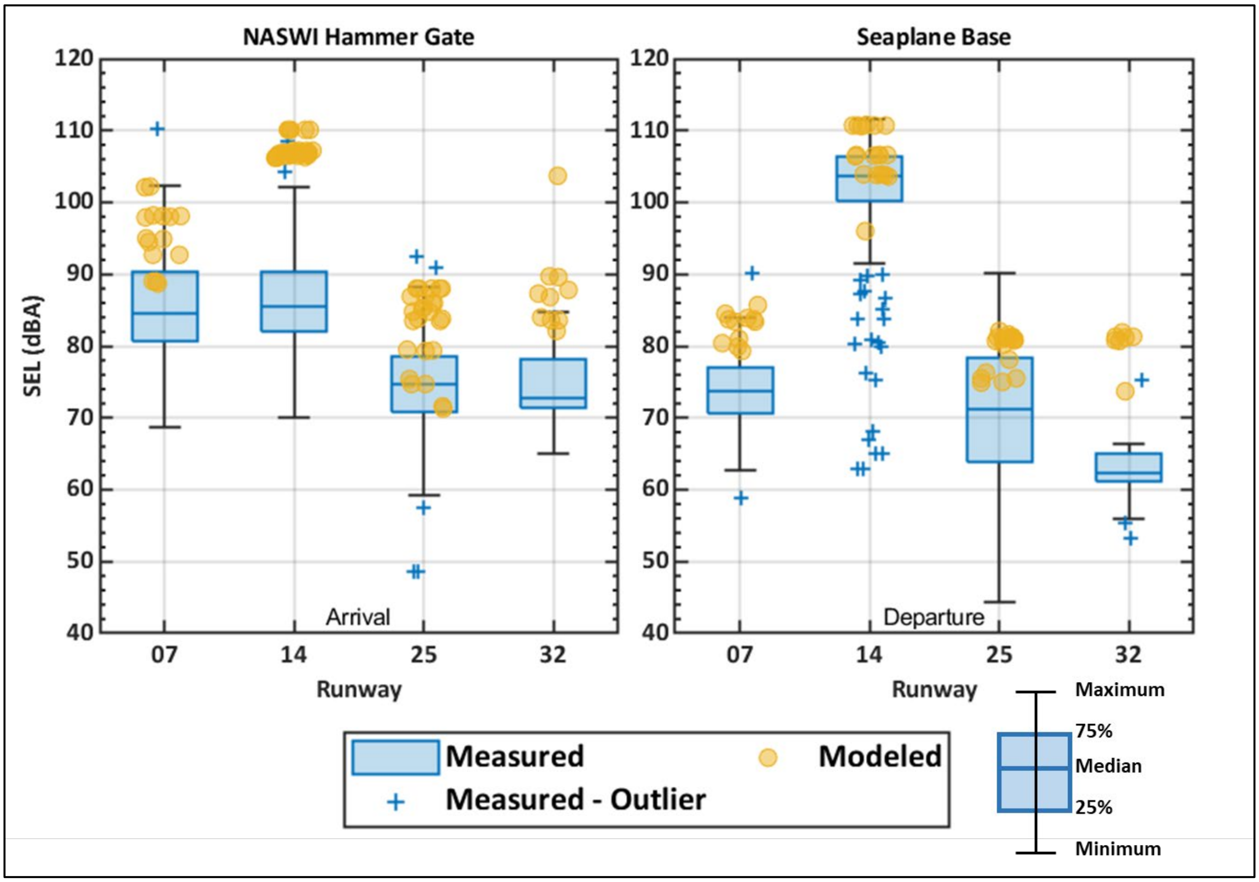

Figure 6.2 Example Comparisons between Measured and Modeled SEL Values at Two Monitoring Locations near Ault Field

6.2 COMPARISON BETWEEN REAL-TIME MEASURED DATA AND MODELED RESULTS AT NAS LEMOORE

Figure 6.3 shows a comparison of the measured and modeled data for both the real-time and previously modeled scenarios at NAS Lemoore. The comparison indicates that the model operates as intended and provides an accurate prediction of sound levels from aircraft operations. The figure shows that the real-time measured CNEL is usually less than the real-time modeled and previously modeled CNEL from NOISEMAP. The largest differences between measured and modeled data occurred at sites not directly overflown by Navy aircraft. The Navy expected this finding based on the model's conservative prediction assumptions (Cole, 1975).

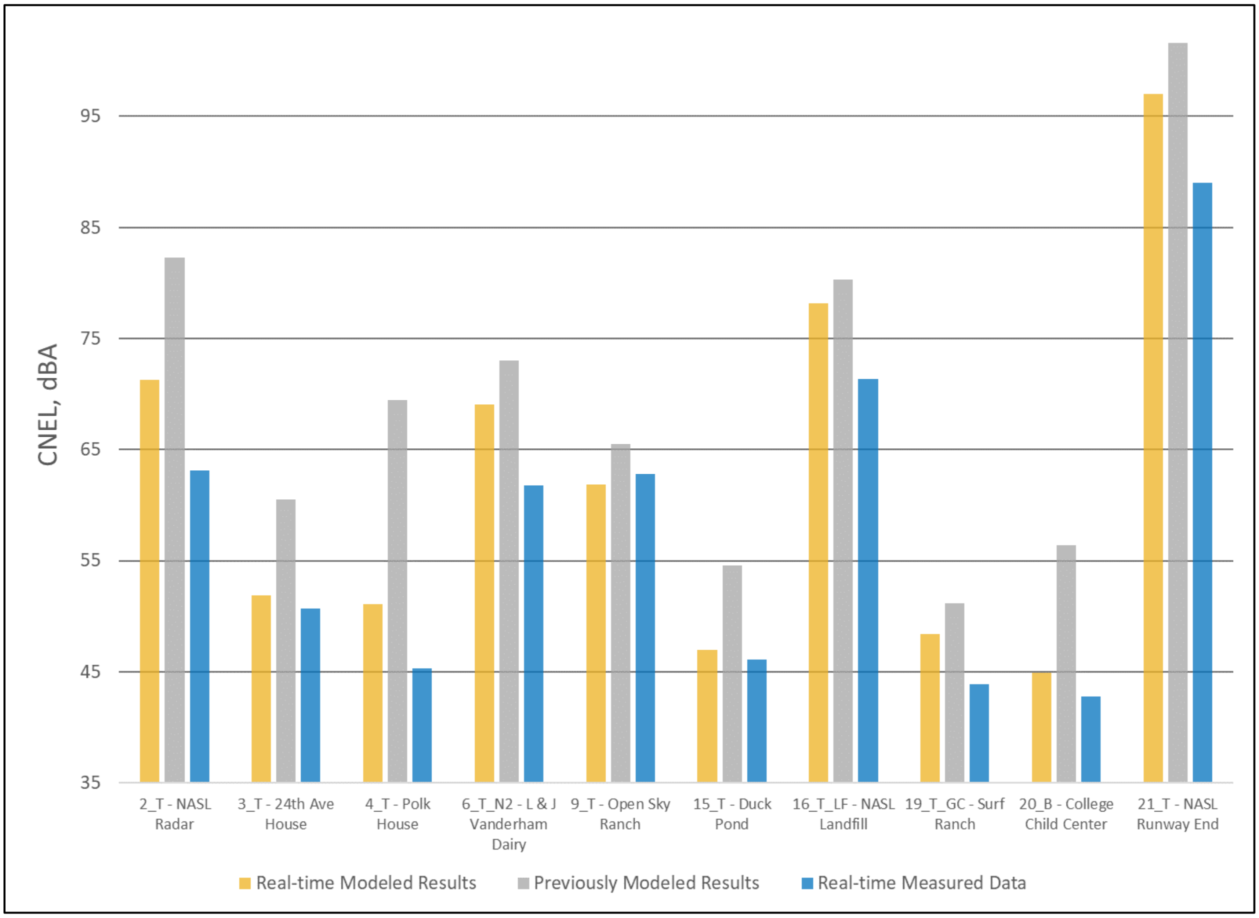

Figure 6.3 CNEL Comparisons between Modeled and Measured Data for NAS Lemoore

Tables 6.3 and 6.4 provide the CNEL values associated with Figure 6.3. Table 6.3 is based on the comparison between the real-time measured data and real-time modeled results, and Table 6.4 shows a comparison of the real-time measured data and previously modeled results. For both tables, a positive difference in CNEL indicates NOISEMAP predicted higher CNEL values, while a negative difference in CNEL indicates NOISEMAP predicted lower CNEL values.

Table 6.3 Comparisons between the Real-Time Measured Data and Real-Time Modeled CNEL for Monitoring Periods 1 through 4 at NAS Lemoore

Site Name	Real-Time Modeled CNEL	Real-Time Measured Aircraft CNEL	Difference between Modeled versus Measured CNEL
2_T - NASL Radar	71.3	63.1	8.2
3_T - 24th Ave House	51.9	50.7	1.2
4_T - Polk House	51.1	45.3	5.8
6_T_N2 - L & J Vanderham Dairy	69.1	61.8	7.3
9_T - Open Sky Ranch	61.9	62.8	-0.9

15_T - Duck Pond	47.0	46.1	0.9
16_T_LF - NASL Landfill	78.2	71.4	6.8
19_T_GC - Surf Ranch	48.4	43.9	4.5
20_B - College Child Center	44.9	42.8	2.1
21_T - NASL Runway End	97.0	89.0	8.0

Key: CNEL = Community Noise Equivalent Level; NAS = Naval Air Station

Note: Shading in the table matches the color scheme in the legend of Figure 6.3.

Table 6.4 Comparisons between the Real-Time Measured Data and Previously Modeled CNEL for Monitoring Periods 1 through 4 at NAS Lemoore

Site Name	Previously Modeled CNEL[1]	Real-Time Measured Aircraft CNEL	Difference between Modeled versus Measured CNEL
2_T - NASL Radar	82.3	63.1	19.2
3_T - 24th Ave House	60.5	50.7	9.8
4_T - Polk House	69.5	45.3	24.2
6_T_N2 - L & J Vanderham Dairy	73.0	61.8	11.2
9_T - Open Sky Ranch	65.5	62.8	2.7
15_T - Duck Pond	54.6	46.1	8.5
16_T_LF - NASL Landfill	80.3	71.4	8.9
19_T_GC - Surf Ranch	51.2	43.9	7.3
20_B - College Child Center	56.4	42.8	13.6
21_T - NASL Runway End	101.6	89.0	12.6

Key: CNEL = Community Noise Equivalent Level; NAS = Naval Air Station

Note: Shading in the table matches the color scheme in the legend of Figure 6.3.

[1] Source: Navy, 2014

The average difference in CNEL for the comparison of the real-time modeled data and real-time measured results is +4.4 dBA, with only Site 9_T (*Open Sky Ranch*) showing a negative difference in CNEL of -0.9 dBA. The largest difference of +8.2 dBA occurred at Site 2_T (*NASL Radar*), which is inside the FCLP turn-to-final for Runway 32R at Reeves Field.

The average difference in CNEL for the comparison of previously modeled data and real-time measured data is +11.8 dBA, with no sites showing a negative difference in CNEL. The largest difference of +24.2 dBA occurred at Site 4_T (*Polk House*), which is laterally offset from most flight tracks at Reeves Field. The over-prediction arises from: (1) the lower overall sortie rate in the measured data compared to what was previously modeled and (2) fewer operations during acoustic night. The monitored F-18E/F sortie rate was 20 percent less than the previously modeled sortie rate. The monitored F-35C sortie rate was 83 percent less due to delays in home basing the F-35C squadrons at NAS Lemoore. Also, both the F-18E/F and F-35C operations occurred more often during acoustic daytime and less during acoustic evening and night than previously modeled.

With regard to sound levels of individual events, Figure 6.4 provides examples of SEL comparisons at NAS Lemoore. The plot on the left in Figure 6.4 shows the comparison for arrival operations at Site 2_T (*NASL Radar*), which indicates that modeled values are higher than measured values. The plot on the right in Figure 6.4 shows the comparison for departures at Site 9_T (*Open Sky Ranch*); in this case the modeled values are higher as well but closer to the measured values because the site is directly overflown by departures from Runways 32L and 32R. The outliers shown in the plot on the right demonstrate the large variability observed in individual events due to various environmental and operational factors. The measurement methodology, including multiple monitoring periods covering different environmental and operational conditions, was designed to capture this variability and minimize its effects. All events, including the outliers, are included in the calculation of the real-time measured CNEL.

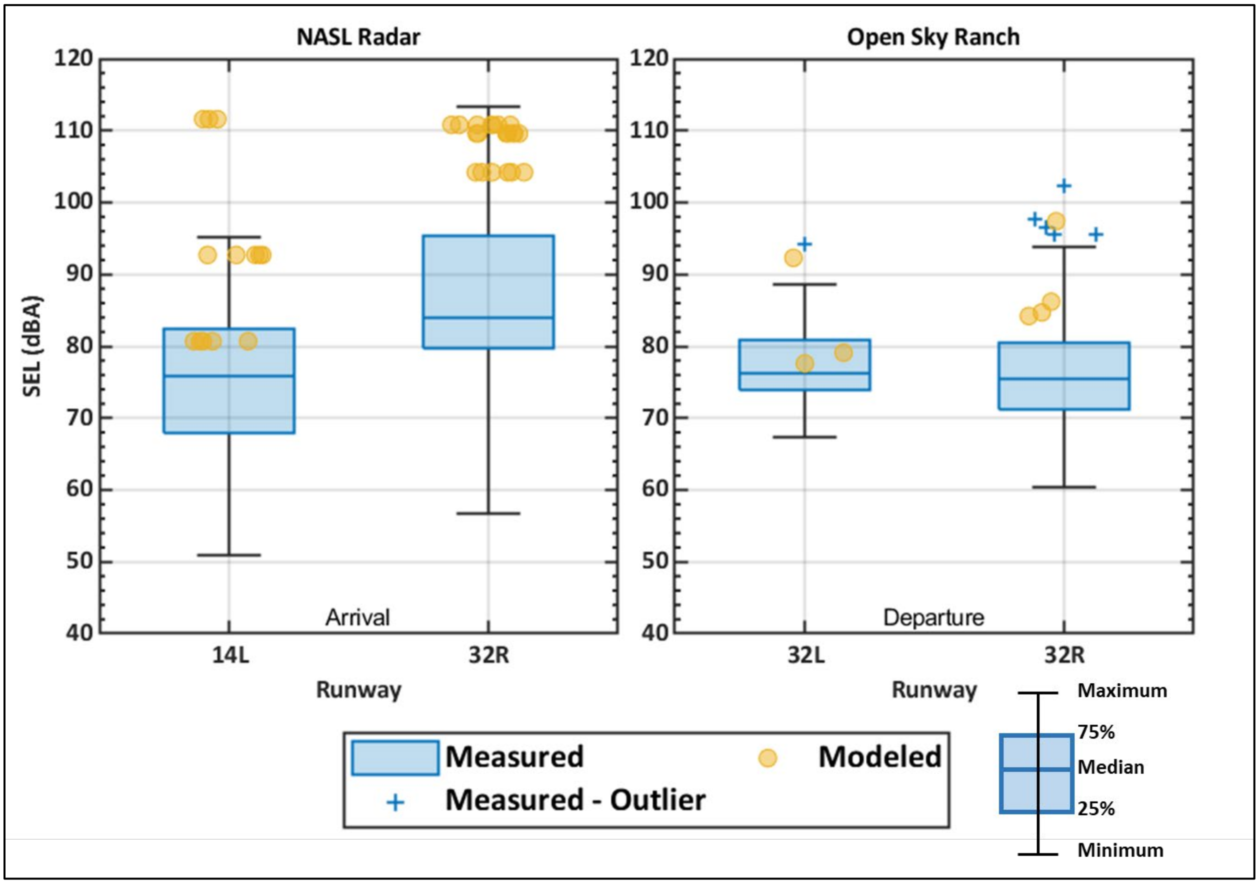

Figure 6.4 Example Comparisons between Measured and Modeled SEL Values at Two Monitoring Location near NAS Lemoore

6.3 COMPARISON BETWEEN ACTIVE AND INACTIVE USE OF THE OLYMPIC MILITARY OPERATIONS AREA

The acoustic data collected at the monitoring site near the Olympic MOA (Hoh River Visitor Center area) involved a yearlong data collection period. The process involved measuring sound levels when the Olympic MOA was active and inactive. When the MOA was active, the monitoring site had the potential to receive noise from military aircraft; however, the site was not guaranteed to receive aircraft noise due to the sporadic nature of the training events and because the training flights in that area do not perform regular patterns within the airspace. Thus, the analysis only considers sound exposure levels between active and inactive periods to assess the potential aircraft noise contribution to the overall sound levels. The aircraft noise exposures at the MOA monitoring site were below average sound levels from other sources, most of which were natural, so the Navy was unable to do a direct comparison of measured and modeled aircraft sound exposure levels.

Instead, the comparison involves average sound exposure levels during periods when the MOA was active and inactive. It does not indicate when aircraft were audible at the site. Audibility of a sound source is a different acoustic measure that is not included in this analysis.

Figure 6.5 shows the comparison of the measured monthly DNL sound levels when the MOA was active (had the potential to receive military aircraft noise) to the measured $L_{Aeq,24hr}$ when the MOA was inactive (mostly received natural sounds or sounds of non-military aircraft flyovers). This approach is described in Section 5.1. The results of this comparison highlight the low sound exposure levels measured at this site. The average sound exposure levels for both active and inactive time periods, for most months, are between 35 and 45 dBA. Only one month (April 2021) had average exposure levels above 45 dBA when the MOA was active. Three months (March, July, and August) had average exposure levels below 35 dBA when the MOA was active.

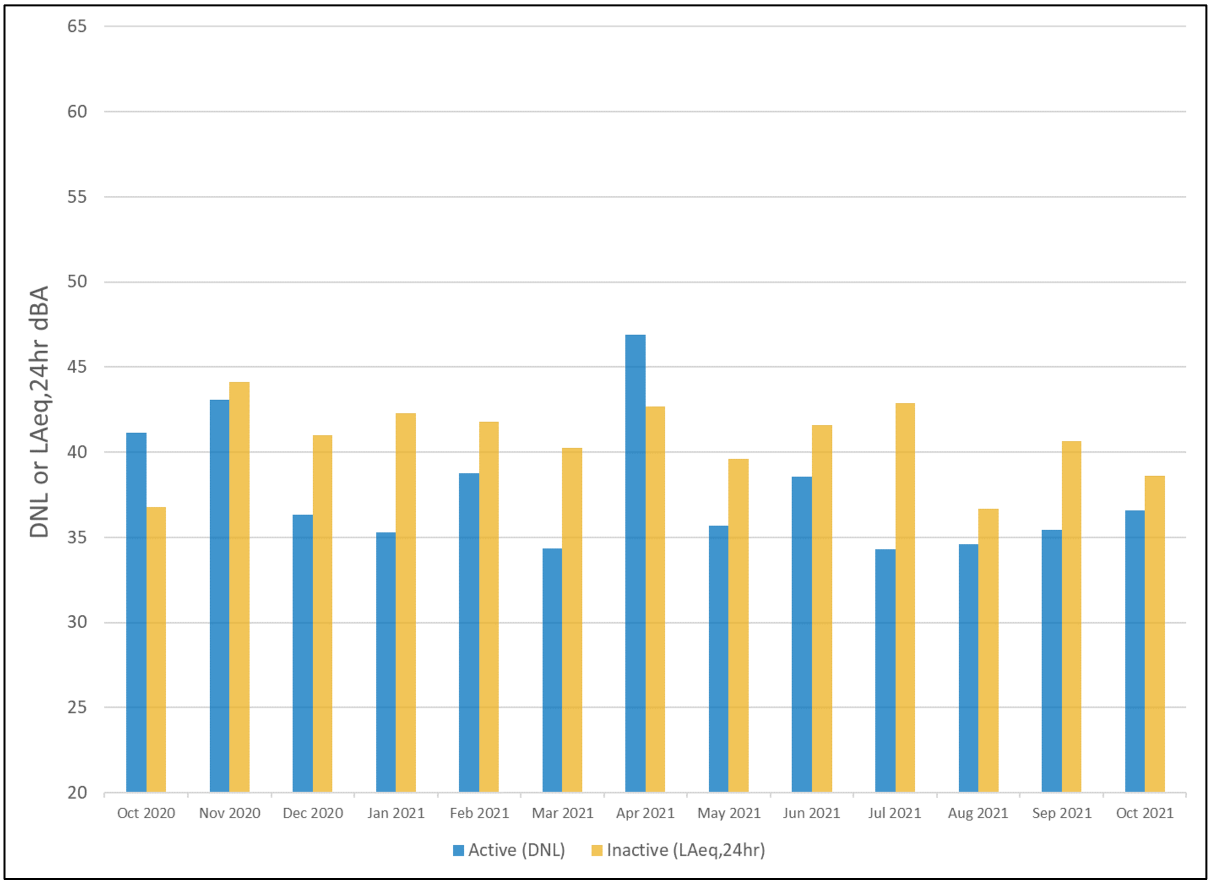

Figure 6.5 Average Measured Sound Exposure Levels at Hoh Rain Forest Visitor Center Area

Levels for Active Periods are DNL and Levels for Inactive Periods are $L_{Aeq,24hr}$.
(Note both October values are for partial months.)

Table 6.5 provides the average sound exposure level values associated with Figure 6.5 along with the difference between the average sound exposure levels for when the MOA was active and inactive. A positive difference indicates that average sound exposure level when the MOA was active was greater than when the MOA was inactive. Natural sounds (e.g., wind in trees and wildlife) contribute to the overall sound level at this location.

Table 6.5 Comparisons between Average Sound Exposure Levels at the Active and Inactive Time Periods at the Hoh Rain Forest Visitor Area Site

Month	Active Periods DNL	Inactive Periods $L_{Aeq,24hr}$	Difference between Active DNL versus Inactive $L_{Aeq,24hr}$
October 2020*	41.2	36.8	4.4
November 2020	43.1	44.1	-1.1
December 2020	36.3	41.0	-4.6
January 2021	35.3	42.3	-7.0
February 2021	38.8	41.8	-3.0
March 2021	34.4	40.2	-5.9
April 2021	46.9	42.7	4.2
May 2021	35.7	39.6	-3.9
June 2021	38.6	41.6	-3.1
July 2021	34.3	42.9	-8.6
August 2021	34.6	36.7	-2.1
September 2021	35.4	40.7	-5.2
October 2021*	36.6	38.6	-2.0

Key: DNL = Day-Night Average Sound Level; $L_{Aeq,24hr}$ = 24-hour equivalent continuous sound level
Note: Shading in the table matches the color scheme in the legend of Figure 6.5.
* Indicates partial month of data. Data were collected from October 20, 2020, through October 20, 2021.

The average difference between active and inactive levels was -2.9 dBA, which indicates that the average sound exposure levels for the active periods were mostly lower. Only two active periods, October 2020 (partial) and April 2021, were higher. Moreover, the month with the highest sortie rate, February 2021, still had average sound exposure levels lower than the inactive periods. This comparison indicates that the aircraft sound exposure levels do not contribute significantly to the overall sound exposure levels at the Hoh Rainforest Visitor Center location.

This observation may seem counterintuitive; however, it is important to reiterate that the monitoring site only had the **potential** to receive military aircraft noise when the MOA was active. The sporadic nature of training in the MOA resulted in periods of time when the MOA was active but the monitoring site only measured other sounds.

The data collected is consistent with the previously modeled results of less than 35 dBA L_{dnmr} for the Hoh Visitor Center area, based on the MRNMAP modeled results from the *Northwest Training and Testing Supplemental EIS/Overseas Supplemental EIS* (Navy, 2020). The resulting aircraft sound levels are not a significant contributor to the sound levels at the meter location.

7. PUBLIC AVAILABILITY OF MONITORING RESULTS

This report was prepared to meet the requirements of Section 325 of the FY 2020 NDAA. The report provides a summary of methods and results of real-time sound monitoring at NAS Whidbey Island, Washington and NAS Lemoore, California. A follow-on technical report (which is expected by early 2022) will include detailed information collected during this study and will also be made publicly available. The technical report will include information on how to access the raw data collected during this study.

8. CONCLUSION

Overall, the Navy determined that the DoD-approved noise models operate as intended and provide an accurate prediction of noise exposure levels from aircraft operations for use in impact assessments and long-term land use planning.

There are two main variables that contribute to accurate noise modeling: a functioning model and accurate input data. The results of this study indicate that the DoD-approved noise models work as intended. Additionally, the noise levels of modeled aircraft (a key input to the model) are accurate as they were obtained by actually measuring sound generated by the aircraft in various parameters under controlled conditions. The largest variable in any aircraft noise-modeling effort is the expected operational flight parameter data. These data include runway and flight track utilization, altitudes at various points in the flight track, and engine power settings among other parameters. Although the results of this study indicate that DoD-approved aircraft noise models work as intended, the Navy will continue to refine operational data collection procedures to enhance model accuracy and reliability.

9. REFERENCES

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