January 12, 2017

Letter from David Luther, Associate Professor in the Department of Biology and Smithsonian-Mason School of Conservation at George Mason University, and Kate Gentry, Research Assistant & Ph.D. Candidate, in Support of the National Parks Conservation Association's Objection to the Forest Service's Draft Decision Pacific Northwest Electronic Warfare Range[1]

Reviewing Officer Olympic National Forest Supervisor Laford,

The Forest Service recently issued a Draft Decision Notice and Finding of No Significant Impact for the Pacific Northwest Electronic Warfare Range (Draft Decision). That document in turn purported to incorporate many prior environmental impact analyses conducted by the Navy. However, in our professional opinion, neither the Forest Service's Draft Decision nor any of Navy's prior environmental impact analyses adequately analyze the acoustic impacts on the Olympic National Forest and Olympic National Park. The fundamental flaw of the assessments of the Forest Service and the Navy is the lack of underlying data. Without this underlying data, the public cannot adequately assess the true acoustical impacts associated with the Navy's electronic warfare training activities on and above the Olympic Peninsula. Additionally, the Forest Service and the Navy used improper methodologies to estimate audibility, and excluded other important analyses.

**Background**

Free from human interference, the natural soundscape is dominated by natural biotic sounds caused by living animals, including the songs of birds and the sounds of insects, and natural abiotic sounds, including wind and waterfalls. The natural soundscape that one hears when outdoors is recognized as a valuable but threatened natural resource, (Dumyahn &

[1] Due to the size of the studies cited throughout this letter and incorporated by reference, they will be provided to the Forest Service on an independent compact disc. However, in addition to a hard copy of this letter provided with that compact disc, NPCA will submit this letter electronically alongside its Objection to the Forest Service's Draft Decision Notice and Finding of No Significant Impact Pacific Northwest Electronic Warfare Range.

Pijanowski 2011), because there are very few acoustic environments that are not polluted by man-made "anthropogenic" sound. (Barber et al. 2011). Anthropogenic sound is considered noise when it disrupts animal behavior or is perceived by humans as annoying, stressful, or damaging to the ears. (Pepper et al. 2003). Anthropogenic noise has both an extensive spatial and temporal impact. (Barber, et al. 2010).

While Olympic National Park has been largely ignored in the noise impact analyses performed by the Forest Service and Navy, the National Park Service (NPS) recognizes the need to preserve natural soundscapes, which "are vital to the protection of wilderness character, fundamental to the historical and cultural context, and critical for park wildlife." (https://www.nps.gov/orgs/1050/index.htm). These natural soundscapes also need to be preserved as they have a pleasing effect for visitors, (Pilcher et al. 2009), and visitors expect to experience the natural soundscape while in national park settings. (Szeremeta & Zannin 2009; Lynch et al. 2011); see also United States Dep't of the Navy, Pacific Northwest Electronic Warfare Range Environmental Assessment (2014 EA) 3.3.2.1.1 (noting that "[r]ecreational users of USFS … lands would also be considered sensitive receptors."). In fact, the majority of national park visitors value the natural soundscape and wellbeing of park wildlife (Anderson & Mulligan 1983); see also Misty D. Nelson National Park Service Natural Sounds and Night Skies Division, Herbert Hoover National Historic Site Acoustic Monitoring Report, at 1 (noting that "[a] 1998 survey of the American public revealed that 72 percent of respondents thought that providing opportunities to experience natural quiet and the sounds of nature was a very important reason for having national parks, while another 23 percent thought that it was somewhat important (Haas & Wakefield 1998). In another survey specific to park visitors, 91 percent of

respondents considered enjoyment of natural quiet and the sounds of nature as compelling reasons for visiting national parks (McDonald et. al 1995)").

However, the Forest Service's Draft Decision represents a significant threat to these natural soundscapes. While the Forest Service and Navy seek to minimize the impact of the Forest Service's decision by focusing on the operation of three mobile emitters and one fixed emitter, a significant source of anthropogenic noise pollution comes from the aircraft overflights of the military aircraft conducting electronic warfare training exercises associated with these mobile and fixed emitters. Rather than having a pleasing effect, noise from military aircraft and other types of vehicles can elicit feelings of annoyance, cause distraction, and diminish park visitor experience. (Szeremeta & Zannin 2009; Mace, Marquit & Bates 2013). In addition, the introduction of noise into the natural soundscape heightens the perception of crowded conditions within the park, further reducing park visitor satisfaction. (Kim & Shelby 2011).

In order to learn whether military aircraft noise disturbs park visitors, park soundscapes must be quantified and qualitatively described. But neither the Forest Service nor the Navy independently quantified or qualitatively described Olympic National Forest or Olympic National Park's soundscape. The Navy did note that the baseline ambient noise level in the Olympic National Forest is 40 dBA[2] for undisturbed forested areas in its 2014 Pacific Northwest

[2] The human ear is able to hear an incredibly wide range of sounds. The decibel scale is "a logarithmic scale where 0 dB represents the threshold of human hearing. The logarithmic scale is a useful way to express the wide range of sound pressure levels over which the auditory system functions." NPS, Olympic National Park 2010 Acoustic Monitoring Report, at 2. However, "[t]he logarithmic dB scale can be difficult to interpret, and the effects of a seemingly small change in [sound pressure levels (SPL) can be greater than anticipated." *Id.* For instance, "[a] long-term increase in the average hourly ambient sound level at any sensitive receptor of five or more dB[,]" which may seem insignificant to a lay person would actually "indicate a substantial degradation in the noise environment." 2014 EA, at 3.3-4. Further, "dBA" stands for "A-Weighted Sound Pressure Level," 2015 EIS, Appendix J, at 1. It is "assessed using a filter that approximates the frequency response of the human ear, adjusting low and high frequencies to

EW Range Environmental Assessment (2014 EA), but it failed to incorporate this finding into any of its subsequent analysis. 2014 EA at 3.3.2.1.2. Neither the Navy nor the Forest Service ever established a baseline noise level for the portions of Olympic National Park underlying the Olympic Military Operating Areas (MOAs).

But, the Federal Interagency Committee on Noise (FICON)—composed of representatives of the Departments of Transportation (Office of the Secretary and the Federal Aviation Administration), Defense, Justice, Veterans Affairs, Housing and Urban Development; the Environmental Protection Agency; and the Council on Environmental Quality—required the measurement of the timing, level, duration, and frequency of the sound exposure from aircraft overflights. Federal Interagency Committee on Noise (FICON), Federal Agency Review of Selected Airport Noise Analysis Issues (1992). Additionally, NPS Director's Order No. 47 (National Park Service 2000) required each park to protect its natural soundscape by following these planning guidelines:

> (1) describe the baseline natural ambient sound environment in qualitative and quantitative terms; (2) identify sound sources and sound levels consistent with park legislation and purposes; (3) identify the level, nature and origin of internal and external noise sources; (4) articulate desired future soundscape conditions; and (5) recommend the approaches or actions that will be taken to achieve those conditions or otherwise mitigate noise impacts.

In 2010, the National Park Service undertook such a study in Olympic National Park, and found that many of the daytime sound levels in Olympic National Park were below 40 dBA. National Park Service, Olympic National Park, Acoustic Monitoring Winter 2010, at 9. The report also considered the "Existing Ambient [Sound] Without All Aircraft," including military aircraft. NPS found this to be "consistent with FAA's historical approach for cumulative impacts analysis." Id. at 6.

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match the sensitivity of the ear. This "A-weighting" filter is used to assess most community noise sources." *Id.* at 5.

Without conducting independent studies to determine the baseline soundscapes in the portions of Olympic National Forest and the Olympic National Park underlying the MOAs or any other impacted, the Navy and the Forest Service's claims that the proposed naval training exercises on and above the Olympic Peninsula will have no significant impact to Olympic National Park, its visitors, or its wildlife lack an adequate foundation on which to stand. In part, their claim is based on the Navy's 2015 Northwest Training and Testing Final Environmental Impact Statement/Overseas Environmental Impact Statement (2015 EIS) that the Forest Service purported to incorporate. See Draft Decision, at 3, 11, 14–17, 24.

Specifically, in the 2015 EIS, the Navy addressed noise impacts associated with the Navy's expanding electronic warfare training activities in its Airspace Noise Analysis for the Olympic MOAs. United States Dep't of the Navy, 2015 EIS, Appendix J, Airspace Noise Analysis for the Olympic Military Operations Areas ("Airspace Noise Analysis") (2015). The stated objective of the Airspace Noise Analysis was to "document changes to the noise environment within the Special Use Airspace (SUA) of the Olympic MOA A, Olympic MOA B, and Warning Areas W-237A and W-237B during the transition from the EA-6B to the EA-18G." Id. at 3. In the analysis, three primary noise metrics are used to describe the changes to the acoustic environment, including Day-Night Average Sound Level (DNL), Maximum Sound Level ($L_{Max}$) and audibility. See id. at 5–7. The Department of Defense (DoD) and the Federal Interagency Committee On Noise (FICON) use DNL to describe the noise environment based on the cumulative flight and engine maintenance activity. Id. at 5. The $L_{Max}$ metric is used to describe noise exposure based on the measure of the highest sound level occurring during an individual aircraft overflight (single event). Id. at 6. Audibility is used to describe the impact of transportation noise on natural quiet and was first integrated into noise analyses after Congress

directed the Department of Interior to investigate aircraft noise within national parks. Id. at 5. Its use is now recommended to estimate the ability of a human to hear a noise within the soundscape. Airspace Noise Analysis, at 5.

**Analysis and Recommendations**

After reviewing the 2015 Airspace Noise Analysis, in our expert opinion, there are several flaws, including: 1) a deficiency in the amount of information provided in regard to data collection and analysis of DNL, 2) improper methodologies used to estimate audibility, and 3) exclusion of important analyses. Because of these flaws, the Airspace Noise Analysis is inadequate and simply lacks the appropriate data to properly assess the effects of the proposed activities. The basis for our conclusion, and our recommendations, are as follows.

**The Navy's Calculation of DNL Lacks Transparency**

The Navy's calculation of DNL, which measures cumulative noise levels, lacks transparency. This metric can be deceiving because a specified DNL level "can be produced by an infinite number of combinations of single events which occur at different times of the day and produce different noise levels." (FICON 1992). Therefore, it is unclear if DNL was calculated based on either the annual average daily operations or an "average busy day," the latter of which is calculated on the basis of the number of "flying days" per year. (FICON 1992). DNL should be calculated based on whatever is most representative of flying conditions and the report should provide the data used to justify their decision. Instead, the Airspace Noise Analysis only states that the calculation was based on the "average annual operation tempo defined in Section 3," Airspace Noise Analysis, at 21, for reference and proposed activities. But there is no clear definition of what the Navy means by " annual operation tempo." Because the Navy has never stated explicitly how it calculated average annual operation tempos, it is impossible to tell if the

DNL is a true representation of the sound energy of noise events in a typical 24-hour period and whether the Navy's conclusion that there will only be a 1 decibel change in DNL between reference and proposed activities is a reliable estimation. Without any means by which to verify the Navy's conclusions, the DNL values cannot be used to interpret the impact of the proposed changes.

Also important to note is how the analysis assumed aircraft events were uniformly distributed throughout the SUA (region to be impacted by the flights), despite the fact that the report stated that overflight within SUA can be highly variable in occurrence and location. DNL is modeled less accurately when it is not known how and where the aircraft flies within the MOA. In addition, aircraft noise predictions below DNL 65 dB can be less accurate and should be interpreted with caution. See, e.g., Department of Transportation, Federal Aviation Administration, Aviation Noise Abatement Policy 2000, 65 Fed. Reg. 43802, 43820 (July 14, 2000).

**Recommendations**

In order to address the shortcomings of the Navy's use and calculation of DNL, we recommend that the DNL be more clearly defined in quantitative and qualitative terms for the average busy day/annual average daily operations between reference activities and proposed activities, as well as the average annual operation tempo on which the Navy bases their DNL analysis. That way, it is not only obvious which noise events the DNL calculations are based on, but how closely events of an average annual operation tempo match with those that occur on a typical day.

Additionally, the report states "in general, the EA-18G is a quieter aircraft than the EA-6B for most activities." Id. at 3 (emphasis added). It is therefore important to clearly and

specifically state how many of the activities on a typical day are ones in which EA-18G is noisier than the EA-6B. Also, it should be confirmed that the naval training activities on and above the Olympic Peninsula are the same as those included in the 2012 Environmental Assessment for the Expeditionary Transition of EA-6B Prowler Squadrons to EA-18G Growler, Appendix C, Noise Report—the cited source for which the quotation above is based. If they are not, a new study should be prepared specifying in which activities the EA-18G is actually quieter than the EA-6B.

Furthermore, a table should be included that compares reference to proposed activities on a typical day, on the least busy day, and on the busiest day. This table should include the number of flights during the day, during the night, and total over 24 hours. The table should also include a breakdown of the proportion of days per year with number of flights falling in the lower and upper 25 percentile, as well as how many days of the year there are no military aircraft flights. Since there are proposed changes in mission types and numbers of flights of other aircraft as well, the number of flights should include all aircrafts and not be limited to EA-18G and EA-6B. Lastly, a description should be provided to explain the changes involved in proposed shift from antisurface warfare to advanced air combat tactics with EA-18G.

**The Navy Failed to Properly Estimate Audibility**

The Navy's analyses of the $L_{Max}$ metric values—used to compare audibility between the EA-6B and EA-18G and to provide total time at $L_{Max}$ per year—are also of little value because the calculation is based on an undefined event, an "average sortie." For instance, the Navy does not specify what type of training is associated with the "average sortie," or how the Navy arrived at its estimation of time spent at $L_{Max}$ per aircraft sortie. Even if defined, the possibility that the reported values could be of much value is eliminated for two main reasons: 1) a sortie cannot be

averaged because the sorties themselves are too variable,[3] and 2) $L_{Max}$ is not the best metric to use to characterize audibility. Although $L_{Max}$ is easy to understand and useful for gaining perspective on the intrusiveness of the noise event, it is not a descriptor for event duration or amount of sound energy. (FICON 1992, at B-10). Thus, it is not the most informative metric to report, since humans respond to noise based "not only of the maximum level, but also of the duration of the event and its variation with respect to time." Id. at B-11. More importantly, the metric is misleading, as it is 5-10 dB lower than the sound exposure level (SEL) value, a metric that does account for event duration and intensity of sound. Id. at B-11–B-12.

In addition, the Navy failed to use the NMSim model to its full potential, a model which otherwise produces results based on "best available science" and meets NEPA's requirements for high quality information. For instance, NMSim is capable of computing time overlap if a detailed flight schedule is made available, which means it is capable of estimating realistic noise events, like the flight of multiple aircrafts during reference and proposed activities. It is important to consider all aircrafts involved in an activity because noise levels are contingent on the type of engine, and the intensity level of noise emanating from aircraft also controls the extent that noise infiltrates an environment. (Aylor 1972; Pepper et al. 2003).

However, even though NMSim is capable of taking terrain, acceleration, and weather into account, the Navy assumed the aircraft was flying straight, without acceleration, and over flat ground. Airspace Noise Analysis, at 23. Such conditions are atypical. Therefore, the Navy's use of the model does not capture how audibility changes across environmental conditions (e.g. temperature, humidity) and the structural composition of a landscape. For instance, topographic

[3] The Navy admits that sorties are inherently greatly variable as "one aircraft sortie could result in the completion of multiple training activities, [while], similarly, one activity could include multiple aircraft sorties." Airspace Noise Analysis, at 7.

structures such as cliffs and canyons, as well as man-made structures with flat surfaces, cause sounds to reverberate and reflect. (Wiley & Richards 1978).

Lastly, the scope of the analysis was too narrow. The Navy only compared the EA-6B to the EA-18G, but made no other comparisons (for example, reference EA-18G to proposed EA-18G). Similarly, it estimated audibility for "Suppress Enemy Air Defenses" mission type, but no other mission types. Airspace Noise Analysis, at 23. The analysis of audibility was also based on only one percentage of engine power for one type of training activity, rather than for each potential engine power used for every airspace training activity scenario. Although the Navy did provide an $L_{Max}$ estimate for several different altitudes, it assumed a single ambient noise level for all locations. However, audibility is also influenced by the ambient noise, or listening environment, which changes with the location. In addition, aircraft noise is perceived as louder as aircraft altitude decreases and elevation of listener location increases.

**Recommendation**

We recommend using the NMSim to calculate more appropriate single event metrics instead of $L_{Max}$, like sound exposure level (SEL), which other than DNL, is the most commonly reported metric by the DoD. (http://www.public.navy.mil/usff/environmental/Pages/noisemodeling.aspx). The NMSim should also be utilized to its full potential, incorporating all data as specified above. We also recommend the noise analysts follow the procedure specified by NPS Natural Sounds and Night Skies Division (NSNSD) to define acoustic zones within the MOA, where audibility will change with the type of vegetation, climate, elevation and topography present. Within each acoustic zone, reliable ambient sound level data can be obtained through 25 days of acoustic monitoring.

**The Navy Omitted Important Analyses**

As mentioned previously, FICON (1992) recommends sound metrics that supplement DNL to enhance the description of noise especially at specific noise sensitive locations. See, e.g., FICON At ES-3. However, several important sound metrics were excluded from the Navy's analysis. For instance, Sound Exposure Level (SEL) is typically used to describe noise exposure based on the combination of the maximum level of a single event with its duration. However, it was not included in the 2015 Airspace Noise Analysis, and the Navy never explains the reason for its exclusion. Additional relevant sound metrics include Time Above (TA) and Number of Events-Above (NA) as well as the integrated metrics SEL and Leq. Furthermore, the Number of Events Above a Threshold Level provides the total number of noise events that exceed a selected noise level threshold during a specified length of time. (Department of Defense Noise Working Group 2009). For this analysis, a point of interest would be identified, a noise level threshold defined, and then the number of events that exceed the threshold for that particular point of interest presented. These metrics and others provide a better description of the noise environment for both decision makers and the public.

However, the Navy has not established criteria or a threshold for the percent time audible on which to base an assessment of the potential impact of noise. Rather the Navy shows only the percent reduction in the lateral distance to the edge of audibility between the EA-6B and the EA-18G, and conclusively states that "if all of the proposed EA-18G activities were audible for all of their time in the Olympic MOAs, they would be audible for approximately 26 percent of the time over the course of a year." Airspace Noise Analysis, at 23–24. In order to establish this threshold, extra steps need to be taken to understand the ways in which military aircraft noise influence and impact visitors' perceptions of the soundscape. (Davies et al., 2013; see also

Iglesias-Merchan et al. 2015). In particular, the level at which noise is acceptable to visitors needs to be determined. The impact of noise on visitor experience is dependent on park location, park-use, and visitor perceptions of appropriate noise sources within the park. (Pijanowski et al. 2011; Davies et al. 2013; Davies, Bruce, Murphy 2014). This is an important step because park visitors come to National Parks with the expectation that they will experience a natural landscape and soundscape, and the degree they feel such expectations are met is indicative of their park experience satisfaction rating. (Merchan CI, et al. 2005; Benfield et al. 2010). However, the 2015 Airspace Noise Analysis never assessed whether Olympic National Park visitor satisfaction rates will change when the proposed military actions are approved. See generally Airspace Noise Analysis.

The Navy also did not conduct studies to determine the noise levels at which threatened and endangered species are harmed or harassed, and alternatively relied on the US Fish and Wildlife Service's opinion of whether the proposed activities in the Navy's Electronic Warfare may jeopardize bull trout (salvelinus confluentus), marbled murrelets (brachyramphus mormoratus), short-tailed albatross (phoebastria albatrus), and northern spotted owls (Strix occidentalis caurina). U.S. Fish and Wildlife Service, Biological Opinion for the Navy's Northwest Training and Testing Activities ("2016 BiOp") (July 21, 2016). Although the FWS acknowledged the association between anthropogenic noise and elevated stress levels, it failed to consider the significant physiological effect that elevated stress levels have to immune response. Instead, it claimed that there was insufficient evidence to show that stress from noise threatens survival or reproductive success, citing Busch & Hayward (2009). 2016 BiOp, at 14. Yet, the text of Busch & Hayward (2009) states that "high CGs can suppress the immune system, growth, and metamorphosis; promote severe protein loss, deposition of fat and atherosclerotic plaques,

and hypertension; disrupt second messenger systems; and cause neuronal cell death," and includes citations for numerous reviews on the matter: Wingfield & Ramenofsky (1997); Wingfield et al., (1998); Sapolsky et al., (2000); McEwen & Wingfield, (2003).

Because noise from military aircraft overflights is not chronic, animals are less likely to acclimate (Shannon et al. 2016), meaning the stress induced by overflights will not diminish with time. The long-term effects of elevated stress from anthropogenic noise, like that from the proposed military activities, can result in immune system depression and the emergence of disease (Padgett and Glaser 2003; Madden 2011). The risks related to stress are increased when species are affected by multiple stressors, (Folt et al. 1999; Darling & Cote 2008), which is the case for all the species of concern in Olympic National Park. For instance, a lowered immune response is a significant threat to the Northern spotted owl, whose existence is also endangered by the barred owl (Strix varia), an invasive species that recently expanded its range into the western half of the United States. (Peterson & Robins 2003). The invasion of the barred owl has disrupted the ecological balance, resulting in an increased parasite load and likelihood of Haemoproteus parasitic infection in the Northern spotted owl. (Lewicki et al. 2015). Haemoproteus parasites can become pathogenic when coupled with additional stressors. (Remple 2004).

FWS decision to not use stress as an indicator of the severity of the potential disturbance effects of noise led FWS to base its Biological Opinion on behavioral responses. While behavioral studies can provide important insight into the effects of anthropogenic noise, the behavioral response is dependent on the sensitivity of the species to noise and the perception of risk. (Shannon et al. 2016). Nevertheless, the failure of the Navy to study acoustical impacts on the species of concern forced the FWS to frequently rely on the behavioral results published on

other animals in other noise conditions. For instance, the inferences made about military impacts on Northern spotted owls are overwhelmingly based on the studies of Johnson & Reynolds (2002), who investigated the effects of military fixed-wing aircraft (F-16 jets) overflights on the behavior of Mexican spotted owls, and the non-peer-reviewed study conducted by the U.S. Air Force (2012) that tested whether exposure to military jet aircraft noise (from F-16 and Tornado jets) affected Mexican spotted owl territory occupancy or reproductive success. Both studies found the Mexican spotted owls did not respond strongly to overflights, but the behavioral responses of the Northern spotted owl may be entirely different from the Mexican Spotted Owl, especially since gene flow is isolated in each subspecies (Barrowclough & Gutierrez 1990; Barrowclough et al. 1999) and noise from activities involving F-16 and Tornado jets differs from the noise emitted by activities that involve Prowlers and Growlers.

**Recommendation**

The NMSim model should be used to compute other noise metrics in addition to DNL, including SEL, LEQ, time above, and time audible. We recommend noise metrics be reported for each activity so that the impacts of EA-18Gs can be directly compared to: 1) activities that do not involve EA-18G; 2) activities that involve EA-6B instead of EA-18G; and 3) reliable ambient sound level data for the different acoustic zones within the MOAs. It is important to be able to compare the average sound energy of natural sounds with the average sound level energy with aircraft overflights added, which can be determined through the acoustic modeling of predicted sound levels. In doing such an analysis, the Navy should also include the average noise free interval, or the period of time between extrinsic sound events. Also, such an analysis would provide a way to assess whether certain activities involving EA-18G are noisier than others so that it can be determined whether some EA-18G activities should not occur.

In addition, values should be calculated for comparison based on other types of proposed changes, including time of day, since there is a penalty for nighttime noise intrusions (U.S. EPA 1974). Specific metrics for the frequency range attributable to military aircraft noise (20-1250 Hz) should also be provided. The truncated range is more appropriate for identifying impacts from anthropogenic noise because most motorized human-caused noise is confined to the lower-frequency range, whereas many natural biotic sounds occur in the higher-frequency range. (Acoustical Society of America 2014).

We recommend diagnostic surveys be conducted to understand park visitor values and expectations of acoustic environment to help determine acceptable levels of military aircraft noise. For example, an in-person formative belief elicitation survey could be used to understand the park visitors' definition and expectation of quality during their park recreation experience; their natural resource values; their satisfaction rating of current park noise; and if/how they foresee their satisfaction ratings changing if noise is increased by more military aircraft exercises.

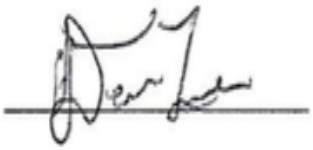
Finally, we recommend the military conduct studies on how the aircraft activities in Olympic MOAs impact threatened and endangered species. In addition to replicating previous tests conducted on other species (like those studies cited in Biological Opinion 2016–but see Francis et al. 2013), the Navy should also examine spatial patterns of stress-indicator hormone levels, like CG, and pathogenic infection, including but not limited to the type of infection and incidence of infection, in relation to military aircraft flyover rates, types of activities, and noise levels. The recent studies that show a reduced foraging efficiency in acoustic predators, including owls, should also be replicated, especially since the issue was not considered in the

2016 BiOp. (Siemers & Schaub 2011; Wale et al. 2013; Voellmy et al. 2014; Bunkley & Barber 2015; Luo et al. 2015; Mason et al. 2016; Senzaki et al. 2016).

**Conclusion**

For the reasons stated above, the Forest Service and Navy's noise impact analyses are fatally flawed. Until proper studies can be done, in part based on the recommendations set forth here, the Forest Service should withhold granting the Navy a special use permit to operate mobile emitters in the Olympic National Forest. Proper studies will help inform decision-makers and the general public and may help reduce acoustic impacts to the Olympic Peninsula's natural soundscape—a treasured and endangered resource.

Sincerely,



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**Bibliography**

FICON 1992 Reference Link: http://www.gsweventcenter.com/GSW_RTC_References%5C1992_0801_FICON.pdf

Acoustical Society of America. 2014. Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas, Melville, NY. ANSI/ASA S3/SC1.100-2014.

Anderson LM, et al. Effects of Sounds on Preferences for Outdoor Settings. Environment and Behavior. 1983 Sep 1;15(5):539-66.

Aylor D. Noise Reduction by Vegetation and Ground. The Journal of the Acoustical Society of America. 1972 Jan 1;51(1B):197-205.

Barber JR, et al. Anthropogenic Noise Exposure in Protected Natural Areas: Estimating the Scale of Ecological Consequences. Landscape ecology. 2011 Nov 1;26(9):1281-95.

Barber JR, Crooks KR, Fristrup KM. The Costs of Chronic Noise Exposure for Terrestrial Organisms. Trends in ecology & evolution. 2010 Mar 31;25(3):180-9.

Barrowclough GF, et al. Phylogeography of Spotted Owl (Strix Occidentalis) Populations Based on Mitochondrial DNA Sequences: Gene Flow, Genetic Structure, and a Novel Biogeographic Pattern. Evolution. 1999 Jun 1:919-31.

Barrowclough GF & Gutiérrez RJ. Genetic Variation and Differentiation in the Spotted Owl (Strix occidentalis). The Auk. 1990 Oct 1:737-44.

Benfield JA, et al. Aesthetic and Affective Effects of Vocal and Traffic Noise on Natural Landscape assessment. Journal of environmental psychology. 2010 Mar 31;30(1):103-11.

Bunkley JP & Barber JR. Noise Reduces Foraging Efficiency in Pallid Bats (Antrozous pallidus). Ethology. 2015 Nov 1;121(11):1116-21.

Busch DS & Hayward LS. Stress in a Conservation Context: a Discussion of Glucocorticoid Actions and How Levels Change with Conservation-Relevant Variables. Biological Conservation. 2009 Dec 31;142(12):2844-53.

Davies WJ, et al. Perception of Soundscapes: An Interdisciplinary Approach. Applied Acoustics. 2013 Feb 28;74(2):224-31.

Darling, E. S. & Côté, I. M.(2008). Quantifying the Evidence for Ecological Synergies. Ecol. Lett. 11, 1278-1286. doi:10.1111/j.1461-0248.2008.01243.x.

Davies WJ, et al. Soundscape Reproduction and Synthesis. Acta Acustica United with Acustica. 2014 Mar 1;100(2):285-92.

Department of Defense Noise Working Group (DNWG) (2009) "Technical Bulletin: Using Supplemental Noise Metrics and Analysis Tools"; available for download at http://www.wyle.com/services/arc.html

Department of Transportation, Federal Aviation Administration, Aviation Noise Abatement Policy 2000, 65 Fed. Reg. 43802, 43820 (Jul 14, 2000).

Dumyahn SL & Pijanowski BC. Soundscape Conservation. Landscape Ecology. 2011 Nov 1;26(9):1327-44.

Ernenwein RL. A Study to Define the Effects of Aircraft Overflights on Parks and Wildlife Areas. Sound and Vibration. 1992;1.

Folt, C. L., et al. (1999). Synergism and Antagonism Among Multiple Stressors. Limnol. Oceanogr. 44, 864-877. doi:10.4319/lo.1999.44.3_part_2.0864

Francis, Clinton D., & Jesse R. Barber. A Framework for Understanding Noise Impacts on Wildlife: an Urgent Conservation Priority. Frontiers in Ecology and the Environment 11.6 (2013): 305-313.

Iglesias-Merchan, et al. Transportation Planning and Quiet Natural Areas Preservation: Aircraft Overflights Noise Assessment in a National Park. Transportation Research Part D: Transport and Environment 41 (2015): 1-12.

Kim SO & Shelby B. Effects of Information on Perceived Crowding and Encounter Norms. Environmental Management. 2011 May 1;47(5):876-84.

Lewicki, K.E., et al., 2015. Effects of Barred Owl (Strix varia) Range Expansion on Haemoproteus Parasite Assemblage Dynamics and Transmission in Barred and Northern Spotted Owls (Strix occidentalis caurina). Biological Invasions, 17(6), pp.1713-1727.

Luo J, et al. How Anthropogenic Noise Affects Foraging. Global Change Biology. 2015 Sep 1;21(9):3278-89.

Lynch E, et al. An Assessment of Noise Audibility and Sound Levels in US National Parks. Landscape ecology. 2011 Nov 1;26(9):1297-309.

Mace BL, et al. Visitor Assessment of the Mandatory Alternative Transportation System at Zion National Park. Environmental Management. 2013 Nov 1;52(5):1271-85.

Madden, Kristin. "Impacts of Anthropogenic Changes on Wildlife Disease." Journal of Wildlife Rehabilitation 31.3 (2011)

Mason, J. Tate, et al. "Anthropogenic Noise Impairs Owl Hunting Behavior." Biological Conservation 199 (2016): 29-32.

Merchan CI, et al. Noise Pollution in National Parks: Soundscape and Economic Valuation. Landscape and Urban Planning. 2014 Mar 31;123:1-9.

National Park Service (2000) Director's Order #47: Soundscape Preservation and Noise Management. Retrieved from http://www.nps.gov/policy/DOrders/DOrder47.html.

Padgett, D., & R. Glaser. 2003. How Stress Influences the Immune Response. Trends in Immunology 24(8): 444–448.

Pepper CB, et al. A Review of the Effects of Aircraft Noise on Wildlife and Humans, Current Control Mechanisms, and the Need for Further Study. Environmental Management. 2003 Oct 1;32(4):418-32.

Peterson AT & Robins CR. Using Ecological-Niche Modeling to Predict Barred Owl Invasions with Implications for Spotted Owl Conservation. Conservation Biology. 2003 Aug 1;17(4):1161-5.

Pilcher EJ, et al. Understanding and Managing Experiential Aspects of Soundscapes at Muir Woods National Monument. Environmental Management. 2009 Mar 1;43(3):425-35.

Pijanowski BC, et al. Soundscape Ecology: the Science of Sound in the Landscape. BioScience. 2011 Mar 1;61(3):203-16.

Remple JD. Intracellular Hematozoa of Raptors: a Review and Update. Journal of Avian Medicine and Surgery. 2004 Jun;18(2):75-88.

Senzaki, Masayuki, et al. "Traffic Noise Reduces Foraging Efficiency in Wild Owls." Scientific reports 6 (2016).

Shannon G et al. A Synthesis of Two Decades of Research Documenting the Effects of Noise on Wildlife. Biological Reviews. 2015 Jun 1.

Siemers BM & Schaub A. Hunting at the Highway: Traffic Noise Reduces Foraging Efficiency in Acoustic Predators. Proceedings of the Royal Society of London B: Biological Sciences. 2011 Jun 7;278(1712):1646-52.

Szeremeta B & Zannin PH. Analysis and Evaluation of Soundscapes in Public Parks through Interviews and Measurement of Noise. Science of the total environment. 2009 Dec 1;407(24):6143-9.

U.S. Air Force. 2012. Biological Assessment in Support of Reinitiation of Consultation for the German Air Force Beddown (USFWS Consultation # 2-22-96-F-334, May 8, 1998) and the Realistic Bombing Training Initiative (USFWS Consultation # 2-22-98-I-124, April 12, 2000) in the Southwest (NM, TX, AZ). 878 pp.

Voellmy IK, et al. Acoustic Noise Reduces Foraging Success in Two Sympatric Fish Species via Different Mechanisms. Animal Behaviour. 2014 Mar 31;89:191-8.

Wale MA, et al. Noise Negatively Affects Foraging and Antipredator Behaviour in Shore Crabs. Animal Behaviour. 2013 Jul 31;86(1):111-8.

Wiley RH & Richards DG. Physical Constraints on Acoustic Communication in the Atmosphere: Implications for the Evolution of Animal Vocalizations. Behavioral Ecology and Sociobiology. 1978 Mar 1;3(1):69-94.