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Dear Gary:

I have completed my review of the Marbled Murrelet Fatality Models for the Proposed Bear River Wind Project, California: Collision Fatality Estimates at Wind Turbines by P.M. Sanzenbacher and B.A. Cooper, which was prepared for Shell Windenergy, Inc. The objectives of my review were to critique: (1) the methods, assumptions, data used, results, and interpretation of the results; and (2) how uncertainty was addressed. In addition, through my comments, I address recurring problems with data collection of Marbled Murrelet activity patterns at proposed wind energy sites.

First of all, I want to say that overall I was impressed with the unique method for creating the fatality probabilities and use of model adjustment factors in modeling fatality estimates. To my knowledge, previous fatality models have not adequately addressed these issues. There are some significant issues with this modeling effort however, primarily related to the methods of sampling and the continued use of extrapolation and assumptions based on non-site-specific studies. See below for specific details.

Comments on the Methods and Assumptions

My comments on the methods are related to two aspects: (1) the methods used for surveying murrelets with radar; and (2) the methods and assumptions associated with modeling fatality rates.

(1) Surveying for Marbled Murrelets with Radar

Overall, the methods used for surveying murrelets in this report are inadequate for assessing the impacts of wind turbines on Marbled Murrelets (*Brachyramphus marmoratus*) at the Bear River Wind Project or any wind project at any location. Surveys were not conducted throughout the breeding season, throughout the year, at night, during variable weather conditions, and enough times per year to be sufficient to accurately, reliably, and precisely gauge the number of possible fatalities/per turbine/year. It appears that the authors followed the general Pacific Seabird Group (PSG) survey protocol for timber sales (Evans-Mack et al. 2003), which is not applicable to wind energy developments. The PSG protocol is designed to determine occupancy of specific sites and not the number of murrelets that could be affected by continuous rotating blades in areas near occupied sites. The USFWS needs to come up with protocols that are adequate for determining the accurate number of birds that pass or could pass through proposed turbine strings throughout the year.

The murrelet nesting season begins in April and extends through September (e.g., Hamer and Nelson 1995), therefore conducting four surveys at each of five stations in June and July is inadequate. Radar surveys should be conducted throughout the nesting period. By starting the surveys in June, birds nesting early in the season (April and May) would be missed during the radar sampling. Both years, 2006 and 2007, appeared to be good ocean years and spring was not excessively cold (www.almanac.com/weather/ history), therefore the likelihood of murrelets nesting early in the season was high. In addition, murrelets visit inland sites at all time of year except during fall molt (Naslund 1993, Nelson 1997). Some fall and winter surveys should be conducted to determine the accurate number of possible fatalities/per turbine. Murrelets also visit their nests and nesting stands at night and up to nine times per day during chick provisioning (Nelson 1997, P. Jones, unpublished data). Although visits are limited at night compared to at dawn, different weather, temperature and other factors may affect murrelet flight patterns and height at night. Surveys should be conducted at night and during the day to get an accurate count of the number of murrelets that pass through the development area each day.

Weather conditions affect the flight patterns and flight height of murrelets (Nelson 1997, SKN unpublished data). Four visits are not adequate to capture the variation in murrelet flight patterns with respect to weather. For example, during fog, which is especially prevalent along the northern California coast in spring and summer, murrelets are known to fly at lower altitudes and thus they may be more likely to encounter the blades of the turbines. All weather conditions should be surveyed and assessed to determine the likelihood of murrelets flying at the heights of the proposed turbines. If radar is not suited for sampling during inclement weather then other survey methods need to be implemented to address this issue.

With declining murrelet populations (McShane et al. 2004, Lynch et al. 2009), the probability of detecting murrelets in inland forests/areas is declining. The methods in the PSG survey protocol (Evans-Mack et al. 2003) have become inadequate for detecting birds in areas of low populations and the number of visits should be increased for surveys in all areas to increase the probability of detection. The PSG Marbled Murrelet Technical Committee is currently working on re-evaluating the probability of detection used in the now outdated protocol (W. Ritchie et al. in progress). Four visits per site per year is not adequate, and was not adequate in 2006 and 2007, to account for the increased variability in murrelet nesting chronology and frequency, and variability in flight patterns/paths to inland sites.

One limitation of using radar is the inability to pick up birds flying in the trees or within the radar shadows. The number of murrelets using the area is therefore underestimated. To address this limitation, a correction factor should be included so that a more accurate number of murrelet targets can be included in the fatality calculations. Data could be collected from simultaneous radar and audio-visual surveys to help determine the adjustment factor. I suggest that this adjustment factor be included with others addressed in the model.

(2) Methods and Assumptions Associated with Modeling Fatality Rates
The most disturbing part of the methods for determining fatality rates was that assumptions and data from other sites were used in developing the models. Only site-specific data should be used to make fatality determinations as each site is different in topography, number of murrelets, locations of radar stations (with respect to topography), type of turbines, and so on. Data on the number of murrelets passing through the project area are easily collected over a two year time frame given appropriate intensive surveys, which should be required at each wind turbine development site.

I understand the difficulty of identifying targets with radar after sunrise (more birds that can be confused with murrelets are active after sunrise). However, I disagree with the statement that "nearly all murrelets fly into nesting stands well before sunrise" (page 4). This is simply not true. The methods in the PSG survey protocol (Evans-Mack et al. 2003) call for surveying birds from 45 minutes before to 75 minutes after official sunrise. Many murrelets are detected after official sunrise flying into and out of inland sites, and murrelets feed their chicks at all times of the day, making multiple trips to and from the ocean (Nelson 1997, McShane et al. 2004). Non-breeders also visit occupied sites at various times during the morning and evening. Instead of multiplying the pre-dawn numbers by 2, it would be better to determine the real rates of murrelet passage within the project area, including dawn, dusk, and the middle of the day.

Why was the mean wind direction for 2005 and 2006 used with murrelet target data from 2006 and 2007? The data should be summarized from the same years in order to accurately assess the turbine exposure area.

Flight altitude data were used from other studies to determine the probabilities of interaction with the turbines. This is inappropriate. Data from sites with different topography, distances to the ocean and rivers, number of murrelets, and so on, is not interchangeable. To assess the effect of these turbines at this site, site-specific altitude data should be collected in all weather conditions throughout the year. Adequate sample sizes from the study area do not exist because an inadequate number of radar surveys were conducted at this site and were not conducted throughout the breeding season, throughout the year, and under a variety of weather conditions. First and foremost at any radar development site, appropriate data sampling should be conducted in order to develop accurate and site-specific fatality models.

Fatality probabilities were created under the assumption that murrelets are well adept at avoiding obstacles given that they nest in forested stands. While I agree that murrelets are adept fliers and can dart through trees on the way to their nesting stands, I disagree that avoidance behavior would be the same with man-made objects versus familiar flight corridor and nesting stand objects. Murrelets have high site fidelity and return to the same stands year after year by the same routes (McShane et al. 2004). They are familiar with their home range and the obstacles within it. A new and moving object constructed within their home range or flight corridor would create an unexpected obstacle. In addition, determining the timing of their flight (at 60 mph) to avoid moving blades would be extremely difficult. Murrelets are known to have been killed by transmission lines and moving vehicles (Nelson 1997, SKN unpublished data), both which have occurred within their home ranges and flight corridors for many decades. I acknowledge that evaluating avoidance behavior is difficult, even with dedicated studies. Yet, based on the knowledge that murrelets are not be able to always avoid man-made objects, the 50% collision hazard value, or some conservative value close to this, should always be included until more information on collision avoidance becomes available.

Comments on Data Used
I have addressed some of the problems with the data used for building the models above. I have no problems with the structure of the models themselves, but I am opposed to using non-site-specific data to populate the models as discussed above. I applaud the authors for working with the USFWS to build in model adjustment factors. However, real site-specific data should always be used in place of adjustment factors using off-site data, old data, or generalized assumptions.

The authors have used old data when assessing the length of chick provisioning and have limited the adjustment factor to July. Data from radio-telemetry demonstrates that murrelets provision chicks for 28-40 days, not just 28 days (Hèbert and Golightly 2006, Nelson et al. 2010). In addition, as mentioned above, the murrelet nesting season lasts from April through September and murrelets could be provisioning chicks in May, June, July, August, or September. Murrelets also provision their chicks up to nine times per day. Thus, the number of evening and mid-day flights is likely greater than the 28% used in this modeling effort. This adjustment factor needs to be revised, however, site-specific data from every month during the breeding season should be used instead of an adjustment factor.

The assumption that April has lower detections than May-June is not accurate. Based on April surveys in Oregon (SKN unpublished data) and April survey training, there can be an equal number of detections in April, especially late April, compared to May and June. The adjustment factor for flights outside the peak breeding season should be modified with these data in mind, however, site-specific data from every month during the breeding season should be used instead of an adjustment factor.

Comments on Results and Interpretation of Results
Based on the models used, the authors presented the results and discussion clearly and thoroughly. The authors point out some of the limitations with the modeling and suggest collecting data on movement rates and weather conditions to better determine fatality rates. They also state that species-specific, weather-specific and site specific avoidance data be collected to accurately estimate fatality. In addition, they discuss additional factors, both positive and negative, that could influence their fatality calculations. Generally they were forthcoming about most of the limitations of the models they created, which was refreshing.

Comments on How Uncertainty was Addressed
Uncertainty was addressed by using data from other studies, non-site-specific data, and speculation based on old, recent, other species, and other site data. While the authors

used the best available information in most cases, and provided thoughtful discussion about the limitations or assumptions that would have an effect on the model, the small sampling window for collecting on-site data, high level of speculation, and extensive use of non-site-specific data, makes the model and its use questionable in determining the impacts of this wind turbine array on murrelets in the Bear River area.

Conclusions

I like the unique approach used to model the effects of wind turbines on Marbled Murrelets in this report. I have no objections to the model structure and the thought process used for creating the fatality rate, as indicated in Figure 3. However, I am mystified at the widespread use of off-site data, speculation, and assumptions to populate the model. Data should be collected to provide species-specific, site-specific, weather-specific, topography-specific, etc. information to use in the modeling effort. A minimal amount of time was spent in the field to collect the data used in the model and there appeared to be no effort expended to attempt to address the many unknowns about murrelets and wind turbine interactions. Instead, a lot of effort was expended to create adjustment factors and discussion of other factors that could have been addressed in the model, when Shell Windenergy should have paid for the appropriate, thorough surveys to be conducted in the first place. Is this setting a precedent for how modeling efforts associated with wind energy will be conducted? Will everyone continue to use speculation and assumptions to create models? I recommend that before additional surveys are conducted at proposed radar instillation facilities, appropriate protocols be developed to provide accurate, site-specific data at each location. Once protocols are developed they should be used at all sites, but adapted based on new information when appropriate. In addition, studies should be conducted at existing facilities to determine if decreased fatalities would occur if temporary operational shutdowns were implemented based on time of day or over the breeding season.

Given the status of murrelets (USFWS 1992) and known population declines (McShane et al. 2004, Falxa et al. 2010), better direction should be provided to wind energy developers as to the requirements for assessing the impact of development in the range of the Marbled Murrelet. We can not afford to lose any birds, especially breeding adults, as populations are already stressed by a variety of anthropogenic factors including habitat loss, predation, disturbance, and lack of high quality prey (USFWS 1997, McShane et al. 2004, Lynch et al. 2009). Adding possible fatalities by wind turbines, especially given the extensive pressure to develop this industry quickly and across the range of the murrelet, could jeopardize the chances for survival and recovery of this unique species. I can not stress enough the importance of conducting appropriate surveys and research on a site-specific basis at all proposed wind energy development facilities in order to develop accurate and precise models of collision fatality.

Thank you for the opportunity to comment. Please let me know if you have any questions.

Sincerely, S. Kim Nelson

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