U.S. Fish & Wildlife Service

Land-based Wind Energy Voluntary Operational Avoidance Guidance for the Tricolored Bat: Frequently Asked Questions (FAQs) Supplement

1. How did the U.S. Fish and Wildlife Service (Service; USFWS) develop its position that incidental take (of tricolored bats; TCB) would not be "reasonably certain to occur," if the measures in the guidance are implemented?

When the land-based wind energy avoidance guidance for TCB (avoidance guidance) is implemented, the Service anticipates that incidental take[1] of TCB would not be reasonably certain to occur[2], because the guidance requires operational measures during time periods when TCB could be at risk of collision with turbines. Question 4 below, explains the rationale for the specific operating regimes included in the guidance. In addition to these operational measures, the guidance requires at least 1 year of standardized postconstruction mortality monitoring[3] and additional monitoring at specified intervals to verify that these measures are effective, and continue to be effective, at a local level. The Service is currently developing a monitoring framework for wind projects with a low risk of taking listed bat species. We intend to use the new framework in place of these monitoring requirements when completed[4]. For projects with and without a Federal Nexus, also see Questions 8, 9, and 10 for guidance specific to sections 7 and 10 of the Endangered Species Act (ESA).

This guidance was developed to be generally applicable, but risk may vary across the range. Companies that operate differently from this guidance are not automatically considered to be at risk of taking tricolored bats. Wind projects can also use their own project-specific information

[1] The ESA defines as: to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct (16 U.S. C. 1542 (b)).
[2] The reasonable certainty standard is explained in 80 FR 26832 and Section 3.1 of the Service's Habitat Conservation Planning and Incidental Take Permit Processing Handbook.
[3] Additional intensive post-construction fatality monitoring may be required if the site implements smart curtailment for avoidance. Further guidance is currently being developed by the Service and this guidance will be modified once those recommendations are available.
[4] Under the new framework, a project operating under the TCB Wind Avoidance Guidance would be considered to have high certainty of low risk and would have a monitoring requirement of 1 year.

and data to determine risk to tricolored bats. We recommend coordinating with the local Field Office. Ultimately, it is the company's decision whether to pursue a take permit (see Question 9).

2. Why is the Service requiring different blanket curtailment wind speeds for TCB compared to northern long-eared bats (NLEB)?

A total of 1,215 TCB carcasses have been reported at 39 percent of unique projects[5] (90 out of 233) in the range of the species (Table 1 and 2; USFWS 2023). This is much higher than the number of reported NLEB carcasses (i.e., 35 NLEB carcasses at 7 percent of unique projects within the range of NLEB (USFWS 2023)) and suggests that TCB are more susceptible to wind mortality. The relatively large number of TCB mortalities also provides more data to evaluate different seasonal impacts of wind fatalities on TCB, see Questions 3 and 4.

Table 1. TCB mortalities by state and the number of projects within each state that have reported mortality. Data includes mortalities pre- and post-establishment of white-nose syndrome (WNS).

State	# Projects with Documented TCB Mortality	TCB Mortalities
Iowa	20	66
Illinois	8	33
Indiana	6	12
Maryland	2	60
Minnesota	4	16
Missouri	4	30
North Carolina	1	1
New Hampshire	1	1
New York	8	12
Ohio	3	6
Oklahoma	4	24
Pennsylvania	17	499
Tennessee	1	70
Texas	2	2
West Virginia	7	385
Wisconsin	2	3
Total	**90**	**1215**

[5] A unique project is a specific wind facility, which may have multiple years of monitoring reports submitted and incorporated into the USFWS database (USFWS 2023); however, it is still considered one project.

Table 2. TCB mortalities by state and the number of projects within each state that have reported mortality. Data only includes projects and mortalities that have occurred post-WNS.

State	# Projects with Documented TCB Mortality Post-WNS only	TCB Mortalities Post-WNS only
Iowa	18	61
Illinois	5	29
Indiana	6	9
Maryland	3	55
Minnesota	2	8
Missouri	4	30
North Carolina	1	1
New Hampshire	1	1
New York	8	12
Ohio	3	6
Oklahoma	2	17
Pennsylvania	15	387
Tennessee	0	0
Texas	0	0
West Virginia	6	116
Wisconsin	2	3
Total	**75**	**735**

3. What rationale was used to develop the proposed blanket curtailment[6] wind speeds seasonality for TCB compared to NLEB?

The most standardized datasets we have showing the relative impact of wind turbines throughout the year on TCB comes from the Appalachian and Midwest Regions (figure 1, 2). Prior to the local emergence of white-nose syndrome (WNS), when no turbines were curtailing, the greatest proportion of TCB wind mortalities were found during the fall migration period, mainly August and September, with fewer mortalities occurring during the summer and the lowest number of active season mortalities occurring during the spring (figure 1). This seasonal fatality pattern is true for total bats as well. We also have sufficient data to consider the seasonal pattern at projects that were curtailing at 11.2 miles per hour (mph, 5.0 meters per second (m/s) post-WNS [figure 2]). The same pattern is evident for these projects though total numbers were reduced. The

[6] Turbine “curtailment” is one strategy for reducing bat fatalities at wind turbines. Curtailment is when turbine operations are altered, that is, blades are “feathered”, during periods of high risk for bats. “Feathered” blades are rotated to reduce the blade angle to the wind, such that the turbine blades cease spinning or rotate very minimally [<1 rpm], thus eliminating or greatly reducing risk of bat fatalities until the designated operating conditions are met.

multiple blanket curtailment speeds in the guidance reflect the changing risk of TCB mortality throughout the year (figure 2). This contrasts with the fatality data available for NLEB. With only 35 NLEB fatalities, we concluded that there is likely an increased risk of fatality during the fall relative to the rest of the year. The blanket curtailment speeds recommended in the NLEB Guidance reflect this (i.e., feathering turbines below 11.2 mph (5.0 m/s) during fall migration and manufacturer's cut-in speed[7] during the remainder of the bat active season).

For specific justification for the TCB guidance as it pertains to specific curtailment strategies, see Question 4.

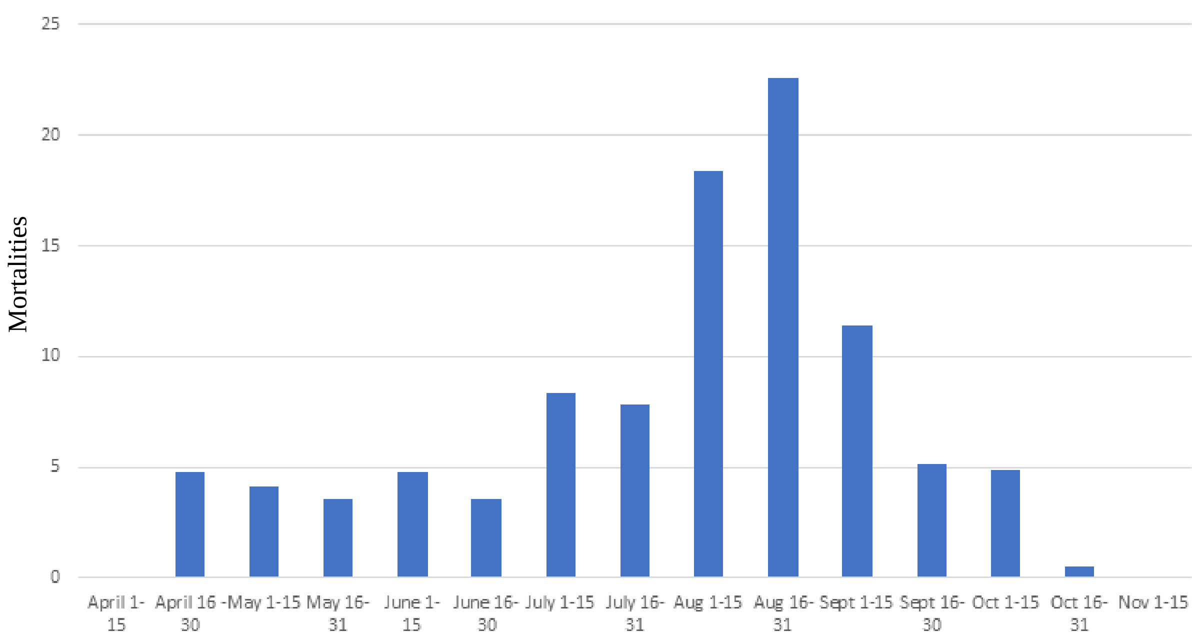

Figure 1. Percent of TCB mortalities (n = 273) pre-WNS with no curtailment or feathering, across the active season from post-construction mortality studies in Pennsylvania and Maryland. These projects had required mortality monitoring from April 1 to November 15.

[7] Cut-in speed is the wind speed at which the turbine blades begin to spin and generate electricity.

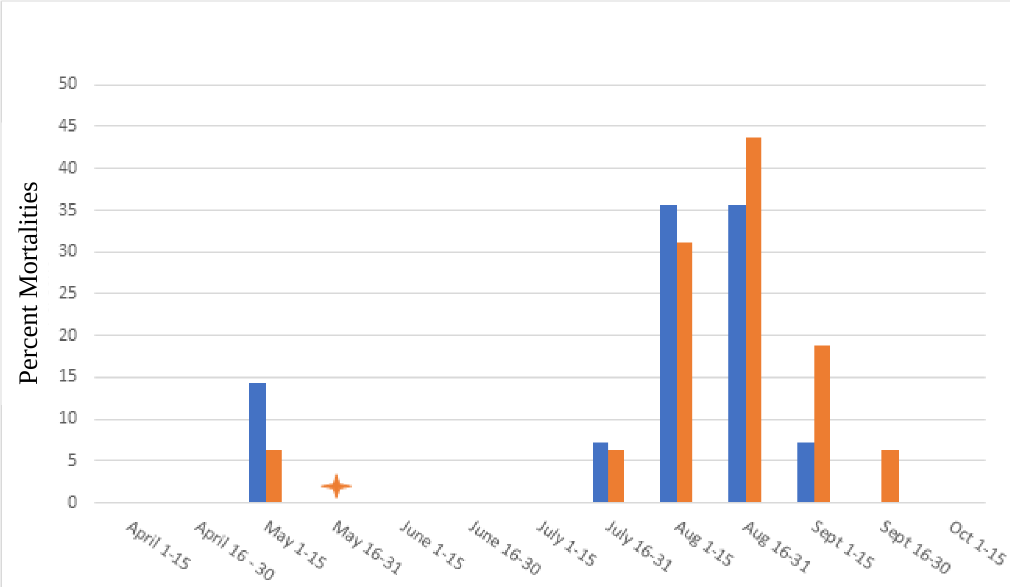

Figure 2. Percent of post-WNS TCB mortalities by date at sites feathering turbine blades below 11.2 mph (5.0 m/s). The Appalachian mortalities (illustrated in blue) are from wind projects operating at 11.2 mph (5.0 m/s) from July 1 to October 31 and thus the May mortalities occured at turbines with no curtailment. The Midwest projects (illustrated in orange) had curtailment strategies based on risk to Indiana bats and terms outlined in project-specific Incidental Take Permits and associated Habitat Conservation Plans. The May fatalities in the Midwest generally occurred at facilities with no curtailment at that time but two mortalities occurred while operating at 11.2 mph (5.0 m/s). This indicates there are some projects that might have higher risk in the spring and some individual project assessment of risk will be needed. The orange star depicts a single mortality at a wind project without full active season mortality data due to changes in turbine operations.

4. What rationale was used to develop the blanket curtailment speeds for projects with risk to TCB?

To develop the blanket curtailment speeds, the Service analyzed mortality and acoustic data at various curtailment speeds across the range of TCB and across the seasons. The pre-WNS seasonal risk is displayed in Figure 1 where there is no curtailment occurring and bat behavior is determining the mortality risk across the seasons. The August and September peak in bat mortality is very consistent across species and locations and occurs when bats are migrating from summer to winter habitat. These long migrations likely put more bats in the air for longer distances and increase the chance for encounters with turbines. Figure 2 illustrates the effects of 5.0 m/s curtailment during this time period and after the population has been reduced by WNS, which is most similar to what is happening on the landscape today. We know curtailment is an effective way of reducing bat fatalities (Whitby et al 2021, entire) and we have scaled the level of curtailment to the level of risk at different times of year. The precise reductions in mortality that may occur with each increasing level of curtailment are not exact and the risk to bats may be different in different locations (Adams et al. 2021,p.16). But the best available data suggests that curtailment at 5.0 m/s is expected to reduce the total bat mortality by 62% (Whitby et al. 2021,p.22), so curtailment at 5.0 m/s when risk is low should reduce risk to where take of TCB is not likely. When risk is high, such as late July, August, and September, higher levels of curtailment are needed to avoid the likelihood of take.

Table 3. Maximum cut-in speeds in meters per second (m/s) at projects where TCB mortality has been documented as of February 2024, including both pre- and post-WNS data. Only 2 mortalities were pre-WNS in this table (and occurred at or below 5 m/s). Reports vary by project location (e.g., USFWS Region), post-construction mortality monitoring protocol (i.e., search interval, plot size, etc.), location of the TCB carcass (e.g., if a carcass was found between two turbines operating using different cut-in speeds), and turbine curtailment operations, especially at locations implementing an ABIC smart curtailment approach (e.g., a single turbine operating at different cut-in speeds throughout a given night).

CUT-IN SPEED (m/s)	TCB MORTALITIES	Number of annual reports within range of TCB that used this as the MAXIMUM cut-in speed
3.0	42	46
3.5	15	14
4.0	13	24
4.5	1	5
4.8	0	2
4.0 or 5.0	6	2
4.5 or 5.5	1	1
5.0	47	102
5.0 or 5.5	7	1
5.5	0	5
6.0	0	8
6.5	0	2
6.9	5	59
7.0[1]	0	3
7.5[2]	0	3
8.0[3]	1	5
Smart curtailment[4]	7	2

[1] There are three projects currently operating at this cut-in speed (i.e., feathering blades below 7.0 m/s) for at least a portion of the year. One project in our database operated at 7.0 m/s (USFWS 2023). This project only operated this way for 11 nights in June before the project voluntarily ceased all nighttime operations due to take of listed species.
[2] There are four wind projects that operated using this cut-in speed for at least a portion of the year (USFWS 2023)
[3] Three wind projects operated in this manner in the TCB range for at least a portion of the year. Two facilities were operating under Technical Assistance Letters designed for endangered gray bats (*Myotis grisescens*) from either

March 3, 2021 to August 30, 2021, or April 8, 2021 to September 6, 2021, until both projects began operating under an ESA section 10(a)(1)(A) incidental take permit.
[4]Turbine operation varied by time of night and month of the year, ranging from no feathering/cut-in speeds at all to feathering below 6.9 m/s. It was unclear at what cut-in speed tricolored bats were killed at in these studies.

11.2 mph (5.0 m/s) Curtailment Rationale during Spring and Late Fall

The Service has limited detailed data throughout the TCB range; however, we know that TCB have been killed at wind sites throughout the range and at times outside of the fall migratory period.

Mortality risk is generally low April 1 through July 14, with some exceptions in May. In most cases, mortalities in May have occurred when there was no curtailment, thus adding curtailment below 5.0 m/s should reduce that risk. In MO, two mortalities have occurred in May while curtailing at 5.0 m/s and suggests there may be some areas where risk is higher, and specific project information will be needed to determine the appropriate curtailment strategy. Late fall also has low risk of mortality and curtailment below 5.0 m/s should be sufficient to reduce take to not likely.

13.4 mph (6.0 m/s) Curtailment Rationale during late July

TCB appear to be at greatest risk of wind fatalities from late summer through early fall. Regional data shows a peak in TCB fatalities starting at the end of July and lasting through September (see figures 1 and 2, above). Likewise, an analysis of acoustic data found that exposure (i.e., acoustic calls detected at the nacelle) tended to peak in late summer (July 15 – 31) and early fall (August – September) across all sites included in this analysis (Stantec 2024). Fatalities in July alone account for approximately 4.6 percent of TCB fatalities in Pennsylvania and the Service's Midwest Region at facilities operating under a variety of cut-in speeds, including no curtailment (USFWS 2023).

We are aware of two late-July TCB fatalities at sites operating at 11.2 mph (5.0 m/s). These fatalities are evidence that wind turbines pose a risk to TCB while operating at 5.0m/s cut-in speeds during late July. In conjunction with the above data showing increased TCB fatalities at, and increased exposure to, wind turbines during late summer through early fall, these fatalities informed the minimum cut-in speed of 13.4 mph (6.0 m/s) from July 15 to 31 required in the guidance.

We chose a 13.4 mph (6.0 m/s) curtailment speed versus a 12.3 mph (5.5 m/s) curtailment speed based on a meta-analysis that showed a 75 percent reduction in all-bat fatality at 13.4 mph (6.0 m/s) compared to a 69 percent reduction at 12.3 mph (5.5 m/s) (Whitby et al. 2021). We chose this more protective curtailment speed (i.e., 13.4 mph (6.0 m/s)) based on the seasonal trend of increased mortalities at the end of July as reflected in the Service's mortality data (figures 1 and 2; USFWS 2023).

15.4 mph (6.9 m/s) Curtailment Rationale

The Service's rationale for feathering turbines below 15.4 mph (6.9 m/s) in August and September is based on several forms of data. First, August and September have the highest rates of TCB fatality, whether using cut-in speeds or not, and whether considering pre- or post-WNS data (figures 1 and 2). This time period reflects the fall migration of bats from summer to winter habitat when bats (adults and juveniles) are in the air, flying long-distances, and likely have higher encounters with wind turbines. Second, the Service has data from 59 reports, including 31 unique projects in 8 states, that used a cut-in speed of 6.9 m/s for some portion of the fall period. In this dataset, only five TCB mortalities have been conclusively documented from 59 projects with turbines curtailing below 6.9 m/s (Table 3) and 3 of these fatalities occurred pre-WNS when take was more likely. Further, based on a meta-analysis of acoustic calls compiled by Stantec (2024), only approximately 10 percent of all TCB acoustic calls at nacelle height occur during wind speeds at or above 7.0 m/s, indicating greatly reduced TCB activity, and thus risk of mortality, during winds speeds at or above 7.0 m/s (figure 3). Based on our best available data, the Service believes that take of TCB is not reasonably certain if turbines are feathered below 15.4 mph (6.9 m/s) in August and September.

As described above, there are a few rare instances where TCB mortality has been detected at 6.9 m/s cut-in speeds. Three of these five mortalities occurred pre-WNS in the Appalachian Mountains, and two occurred post-WNS in the Midwest. Some projects were close to a small TCB hibernaculum, while other sites were not located in proximity to any hibernacula. Some sites provided summer habitat while others did not. Thus, it is difficult to discern what, if anything, made these sites a higher risk to TCB at 6.9 m/s. We have limited data, 12 reports from 7 projects, operating between 7.0 and 8.0 m/s cut-in speeds during fall, and 1 TCB mortality was documented in these data. This TCB mortality occurred while feathering below 8.0 m/s in the active season (April 1 – October 31) under a TAL designed for endangered gray bats (*Myotis grisescens*) at a Missouri project located approximately 10 mi from a small TCB hibernacula. This mortality event occurred in early September. This project also documented TCB mortalities throughout the active season (i.e., not just in August and September) while operating turbines to be feathered below either 3 m/s or 5 m/s under an ESA section 10(a)(1)(A) permit. Further, this project collected acoustic data at the nacelle and turbine mid-tower (20 m high) with associated wind speed and temperature data collected at the nacelle. The project found that TCB activity declined by over 50 percent above 8 m/s but persisted up to approximately 12 m/s (Stantec 2023). Thus, at this facility, there was greater TCB acoustic activity at higher wind speeds than observed in Stantec's meta-analysis (Stantec 2024), although these data were included in the meta-analysis. Given all the above data, we believe that the risk of TCB mortality at 6.9 m/s and above is rare, and not reasonably certain to occur at most wind projects.

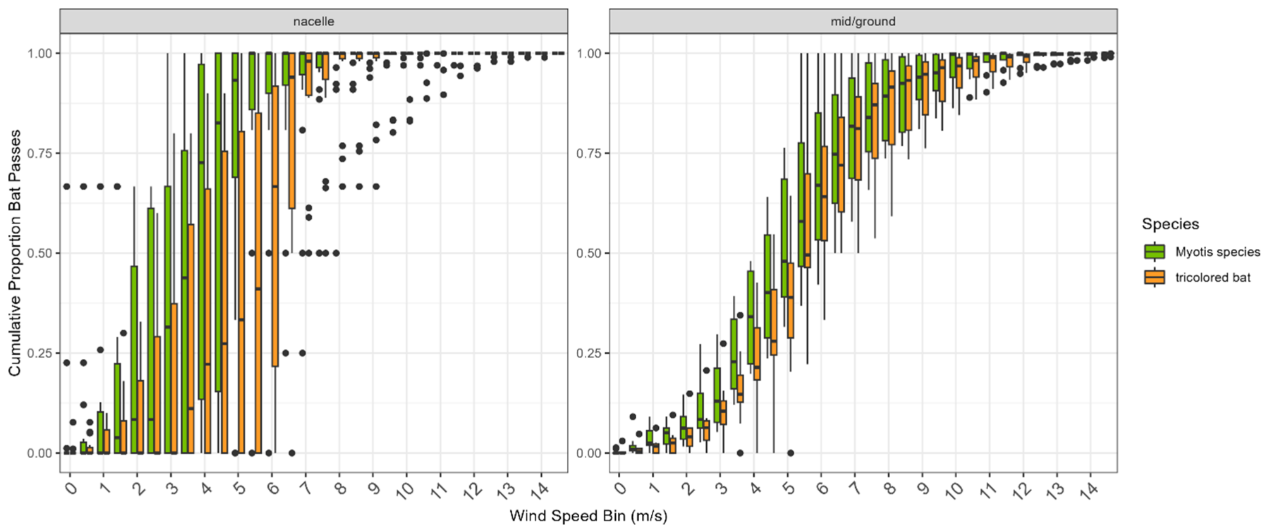

Figure 3. The total proportion of TCB calls at nacelle height at or above 7.0 m/s is roughly 10 percent of total calls. (from Stantec 2024, pg. 18)

5. Why does the TCB guidance recommend curtailment at 5.0 m/s from November 16 – March 14 in the year-round active zones?

In the southern portion of the range, TCB are not in full hibernation but rather forage and roost in culverts, bridges, tree cavities and foliage. They may be in torpor and inactive for days at a time during cold weather. This level of activity is viewed as having more risk than full hibernation behavior that occurs in northern areas, but not as high a risk as occurs in August and September when bats are migrating to winter habitat. The curtailment at 5.0 m/s should reduce the risk of fatalities while we collect more information on what actual fatality numbers occur. If projects within the year-round active zone have site-specific acoustic and/or mortality data covering this period, please provide this information to your local Field Office

6. What does this guidance mean for projects with a Federal Nexus[8]?

Section 7 of the ESA requires Federal agencies to consult with the Service to ensure that actions they fund, authorize, permit, or otherwise carry out will not jeopardize the continued existence of any listed species. Although this guidance specifies a way for wind projects to operate in such a way that "take" of TCB is not likely to occur, in some cases, the action (50 CFR 402.02) may still cause adverse effects to TCB and/or other listed species (e.g., via habitat removal or impacts to designated critical habitat), necessitating formal consultation between the action agency and the Service. However, incorporating this guidance into the agency's action is typically expected to reduce the risk of take and reach a "*may affect, not likely to adversely affect*" determination for TCB. Risk may vary across the range, and it may be possible to reach a "*may affect, not likely to*

[8] Projects with a Federal Nexus include those funded, authorized, and/or carried out by a Federal government agency.

adversely affect" determination based on project-specific information and/or data. If a project cannot implement this guidance, the project should initiate consultation with the Service.

7. What does this guidance mean for projects with existing HCPs and ESA section 10(a)(1)(B) Incidental Take Permits that have TCB as a covered species?

Projects with existing Incidental Take Permits (ITP) and associated Habitat Conservation Plans (HCPs) for TCB under ESA section 10(a)(1)(B) should continue to implement their ITP and do not need to implement this guidance, as their project already has coverage for incidental take. In addition to take authorization, ITPs provide regulatory assurances (Habitat Conservation Plan Assurances "No Surprises" Rule, FR 8859 8859-5573 1998); the Service will not impose additional requirements or restrictions as long as the permittee is properly implementing the HCP. If an unforeseen circumstance occurs, unless the permittee consents, the Service will not require additional commitments (e.g., additional land, water, or financial compensation) or restrictions on the use of land, water, or other natural resources beyond the agreed-upon levels in the HCP. The Service will honor these assurances as long as a permittee is implementing their ITP and HCP in good faith and their permitted activities do not jeopardize the species.

However, if a permittee would like to amend their existing permit to remove TCB or adjust their conservation strategy in light of this guidance, they may reach out to the local Ecological Services Field Office to discuss further, and if appropriate, begin the amendment process. Additional information on HCPs can be found here: habitat-conservation-planning-handbook-entire.pdf (fws.gov).

8. What does this guidance mean for projects with existing ESA section 10(a)(1)(B) permits, that do not have TCBs as a covered species?

For projects with existing section ESA section 10(a)(1)(B) permits that do not have TCBs as a covered species and are within the range of TCB, we recommend that permittees contact their local Service Field Office to determine how to address the potential take of TCB.

9. Do I need an ESA section 10(a)(1)(B) Incidental Take Permit for TCB?

The guidance offers a way for wind projects to site and operate in a manner in which the Service anticipates that take of TCB is not reasonably certain to occur, based on the Service's examination of the best available information (see Question 1). However, we recognize that not all wind projects will be able to follow this guidance. Wind projects can also use their own project-specific information and data to determine risk to tricolored bats. Wind project proponents who conclude on their own that their project will result in take regardless of the Service's technical guidance, or projects that are not in alignment with the guidance and pose unavoidable risk to TCB (or other federally listed species) are advised to apply for an ITP.

However, seeking an ITP is voluntary, and the HCP process is applicant-driven. Additional information on HCPs can be found here: habitat-conservation-planning-handbook-entire.pdf (fws.gov).

10. Does the TCB guidance apply to other bat species?

Currently, our records do not suggest that this approach could be applied widely across the range of other listed bat species or those proposed to be listed. However, some projects that choose to operate in accordance with the TCB guidance may preclude reasonable certainty of taking other listed bat species. For example, project(s) may preclude reasonable certainty of taking NLEB, as the TCB guidance is more protective than the NLEB Wind Avoidance Guidance. For projects with migration risk for Indiana bats, wind avoidance guidelines vary in cut-in speeds and time of year across the species range, and therefore the TCB guidance may not be equally protective. Field Offices may consider adding listed bat species to the TAL based on project-specific data and occurrence records. Contact information for local Field Offices is available online at U.S. Fish and Wildlife Service Ecological Services Field Office in your area. Any approval to use the TCB guidance for other listed bat species would need to be approved by the respective Service Regional Office to ensure consistency.

11. Why is post-construction mortality monitoring required, if the Service has determined that take is not likely to occur?

The effectiveness of the TCB guidance at individual wind projects is validated through 1 year of standardized, site-specific post-construction mortality monitoring and at defined intervals thereafter. This monitoring is important to confirm whether implemented operational commitments were as effective as anticipated and to detect if TCB mortality occurs when no take was anticipated (i.e., a Type II error). Long-term monitoring at specified intervals will continue to validate the effectiveness of the guidance in light of variables that may change over time (e.g., landscape cover changes, TCB population changes). The monitoring required for consistency with the TCB guidance is in alignment with the Service's Land-based Wind Energy Guidelines (USFWS 2012). Although the Service anticipates that incidental take of TCB is not reasonably certain to occur (Question 1), monitoring is required for the Service to validate expectations and reaffirm determinations through the TAL.

12. What are the cost-benefit considerations for implementing blanket versus smart curtailment?

To date, few studies have reported on estimated power or revenue losses associated with curtailment or on cost-benefit analyses for implementing smart curtailment compared to blanket curtailment strategies. A 2007 study in Alberta, Canada estimated a total revenue loss of 3,000 to 4,000 Canadian dollars from curtailing 15 turbines below a raised cut-in speed of 12.3 mph (5.5

m/s) (relative to a manufacturer's cut-in speed of 4.0 m/s) for a month (Baerwald et al. 2009)[9]. At a Pennsylvania project, Arnett et al. (2011) tested the effectiveness of raising turbine cut-in speeds from a manufacturer's cut-in of 3.5 m/s to treatment cut-in speeds of 5.0 and 6.5 m/s. Following the study, they estimated that if the 11.2 mph (5.0 m/s) curtailment strategy had been applied to all 23 project turbines, it would have resulted in 3-percent lost power output during the 75-day study period, but only 0.3 percent of the total annual power output. If the 6.5 m/s curtailment strategy had been implemented across all turbines, the estimated power lost was 11 percent for the study period and 1 percent of total annual output. The researchers noted that in addition to decreased revenue from power loss, the wind company also incurred minor costs associated with implementing the curtailment treatments.

A 2015 study at a Wisconsin wind project estimated that a real-time acoustic activated system known as Turbine Integrated Mortality Reduction (TIMR), decreased power generation and estimated annual revenue by less than or equal to 3.2 percent for treatment versus control turbines (operating at a manufacturer's cut-in speed of 3.5 m/s). Additionally, it was estimated that the TIMR system reduced curtailment time by 48 percent relative to a standard blanket curtailment regime (Hayes et al. 2019). Rabie et al. (2022) subsequently reevaluated costs and benefits of implementing the TIMR smart curtailment system relative to blanket curtailment during the same study and estimated that over the study period, TIMR turbines were curtailed during 39.4 percent of nighttime hours compared to 31.0 percent of nighttime hours for blanket curtailed turbines. Additionally, Rabie et al. estimated that revenue losses were approximately 280 percent greater for TIMR compared to blanket curtailment turbines. However, the cost disparity between smart and blanket curtailment was largely attributable to the difference in cut-in speeds (4.5 m/s for blanket turbines compared to 8 m/s for TIMR turbines). Additionally, the researchers noted that the project site has a relatively low average wind speed, which likely influenced their analysis.

In Germany, Behr et al. (2017) used bat acoustic activity along with wind speed, temperature, precipitation, time of night, and time of year to develop smart curtailment algorithms that reduced energy losses while achieving targeted bat fatality reductions across 35 wind projects. They calculated losses in power production as a percentage of mean annual production for different thresholds of bats killed per year and turbine and found that operational mitigation based solely on wind speed was more expensive than activity-informed smart curtailment: for two dead bats per year and turbine, the mean loss in power production was 1.4 percent of annual revenue for the activity-informed curtailment and 1.8 percent of annual revenue for curtailment based on wind speed alone.

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[9] Note that curtailment in this study was implemented 24 hours per day, as opposed to nightly and/or above a temperature threshold predictive of bat activity.

Finally, a study simulating the effects of blanket and smart curtailment approaches on wind energy production at six wind projects in Alberta, Canada found that while both blanket and smart curtailment resulted in relatively low annual energy production (AEP) loss across all facilities and treatments, ranging from 0.23- to 1.73-percent power loss for blanket curtailment and from 0.00 to 0.87 percent for smart curtailment, smart curtailment reduced AEP losses incurred by blanket curtailment by 50 to 100 percent. However, as noted by the researchers, these simulations did not account for costs associated with implementing and maintaining a smart curtailment system, which could be restrictive for some facilities (Hayes et al. 2023).

13. Why do the smart curtailment approaches (Options 2 and 3) for the TCB wind guidance and associated technical assistance letter require the placement of acoustic detectors on turbine nacelles or within the rotor swept zone (RSZ)?

Research has demonstrated that bat acoustic activity recorded at nacelle height or within the rotor swept zone (RSZ) during turbine operation (e.g., exposed bat activity) has a higher correlation with carcass-based fatality estimates than mid-tower acoustic activity (Korner-Nievergelt et al. 2013, Peterson 2020, Peterson et al. 2021, Stantec 2023). While more bat activity occurs at lower elevations, and these data may help develop ABIC models, field validation studies of real-time acoustic-activated systems are currently only available for systems with nacelle-mounted detectors (Weller 2007, Peterson et al. 2021, Consumers Energy Company 2022, Barre et al. 2023, Stantec 2023). ABIC detectors can be mounted at the nacelle, mid-tower, and on the ground; however, the goal is to understand exposed bat passes (i.e., bat passes within the RSZ) to model a curtailment strategy to minimize risk to targeted species or all bats. Placement options within the RSZ are often limited to the nacelle, especially for taller turbine models, but other placements within the RSZ (e.g., on the tower) may be an option depending on turbine model(s).

A recent meta-analysis by Stantec (2024) found pronounced and consistent differences in bat acoustic activity recorded at mid-tower vs. nacelle-height detectors, suggesting that more turbine-related interactions and impacts are occurring in the lower part of the RSZ and highlighting the potential importance of understanding the vertical distribution of bats when evaluating potential risk. However, in this analysis, there were mid-tower detectors place below the RSZ due to the turbine model.

Height above the ground is known to influence wind characteristics such as horizontal wind speed (speed shear) and wind direction (veer) (Wagner et al. 2011), which affect both curtailment and bat behavior. For example, wind speed increases with height (Rehman et al. 2013), and site-specific daily and seasonal variation in wind shear is an important consideration for optimizing wind turbine hub height and power generation (Rehman et al. 2013, 2015). At a wind project in southwestern Alberta, more migratory bats were recorded at acoustic detectors placed on turbine towers (30 m) than at ground-level (3 m) or on nacelles (67 m), although the difference was not statistically significant. However, more hoary bats (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*) were detected at 30 m than at ground level (3 m) or nacelle height (Baerwald et al. 2011). At two Missouri wind projects, acoustic detectors were placed on turbine nacelles and mid-towers (Stantec 2023). Acoustic exposure (i.e., bat calls detected on the nacelle) was strongly correlated with bat mortalities at the weekly level, and although monitoring focused on nacelle-mounted detectors, mid-tower detectors provided a useful supplement and recorded substantially more activity for certain rare species, supporting previous unpublished results from other wind projects (Stantec, unpublished data) and pre-construction surveys.

Therefore, although we require that detectors be placed on a minimum number of turbine nacelles (or other placement within the RSZ) for each smart curtailment approach, additional placement of tower and/or ground detectors may provide valuable supplemental data for further informing fatality risk and refining smart curtailment strategies.

14. Why does the real-time smart curtailment approach for the TCB wind guidance (Option 2) and the activity-based informed curtailment (ABIC) smart curtailment approach (Option 3) targeting all bat calls require detectors to be placed on at least 10 percent of turbines?

A limited number of studies at facilities implementing real-time acoustic-activated smart curtailment systems have suggested that acoustic detectors placed on roughly 10% of turbines are effective at characterizing all-bat activity across a wind project.

At a proposed 45-turbine wind development site in California, acoustic detectors were affixed to four meteorological towers at 2, 22, and 52 meters above ground, and generalized mixed models were used to calculate the precision of bat activity estimates that could be achieved with more or fewer towers (Weller 2007). The best-fitting model was used to demonstrate that four towers produced relatively precise estimates of bat activity at each height during the study period, and only small improvements in precision (≤3% as measured using coefficient of variation), would be achieved by using more than four towers. In fact, the study concluded that similarly precise estimates for bat activity at the site (within 6%) could have been achieved using only three towers. Field validation studies of the EchoSense (DARC, Natural Power) acoustic-activated curtailment system have demonstrated five detectors to be sufficient for characterizing bat exposure across turbines for both 36-turbine and 69-turbine facilities (C. Sutter, unpublished data, as cited in Consumers Energy Company 2022; see also https://www.naturalpower.com/mediaLibrary/other/english/4371.pdf).

The average detector-to-turbine ratio from these studies is roughly 10 percent; therefore, unless informed by USFWS-approved site-specific research or until additional data suggests a more appropriate ratio, we require that detectors be placed on at least 10 percent of turbines implementing real-time smart curtailment. This minimum is also considered appropriate for

ABIC approaches targeting all bat calls, as they are likely to achieve a sufficient sample size of calls to design an effective ABIC strategy from detectors on 10% of turbines in Year 1.

15. Why does the activity-based informed curtailment (ABIC) smart curtailment approach for the TCB wind guidance require detectors to be placed on 15 percent of turbines if targeting only TCB or ≥40kHz calls?

Limited field validation studies demonstrating the number of detectors needed to adequately sample bat activity (including calls of any species) at facilities implementing real-time acoustic-activated smart curtailment systems have suggested that acoustic detectors placed on roughly 10% of turbines are effective at characterizing bat activity across a wind project (see Question 154 above). Therefore, unless informed by USFWS-approved site-specific research or until additional data suggests a more appropriate ratio, we require that detectors be placed on at least 10 percent of turbines implementing real-time smart curtailment or implementing an ABIC approach that targets all bat calls (see Question 14 above).

Currently, no research has reported on the proportion of detectors needed to adequately sample bat activity at facilities collecting data to inform ABIC. However, a recent meta-analysis of bat acoustic data from turbine-mounted detectors across 23 wind projects recommends considering monitoring goals when determining an appropriate number and placement of detectors (Stantec 2024). Monitoring programs measuring rates of acoustic exposure or assessing spatial variation in risk may require a greater number of detectors to account for substantial variation among turbines and detectors and/or achieve adequate spatial coverage than those focused solely on evaluating curtailment effectiveness. Stantec et al. (2023) also urge caution when interpreting species-specific patterns of activity, noting that metrics of activity based on all species may be most representative of risk. An ABIC approach targeting a subset of all bat calls requires an adequate number of species- or frequency-specific call files to model the ABIC strategy for a project; therefore, the number of turbines collecting ABIC data should reflect the expected number of targeted calls and understanding of the minimum number needed to design an effective strategy.

We assume that species-specific calls and calls with a minimum frequency of 40 kHz will be recorded less frequently than all bat calls, in part because higher frequency sounds attenuate more quickly and therefore have a more limited detection range. A meta-analysis of 49 paired pre- and post-construction studies across the US and Canada reported that although bat activity recorded at ground, raised, and nacelle-mounted microphones was not predictive of overall fatality rates measured during the same time period, low-frequency bat activity was significantly higher than high-frequency activity at all three microphone heights (Solick et al. 2020). Thus, we are requiring that facilities implementing ABIC (Option 2) and targeting only TCB or ≥40 kHz calls install acoustic detectors on at least 15 percent of project turbines at nacelle height or within the RSZ to allow the project to collect sufficient acoustic data to generate an effective avoidance

ABIC approach that can be implemented in Year 2. For example, two 69-turbine facilities in Missouri chose to place acoustic detectors on 15 turbine nacelles (~21 percent) when designing an ABIC strategy targeting ≥40 kHz calls. Other projects have added supplemental acoustic detectors on the turbine tower (20 m) and ground (3 m) to increase the target-specific sample size. Mid-tower and ground detectors have been shown to follow the same seasonal and temporal activity patterns as nacelle-mounted detectors but record substantially more bat passes (Stantec 2024). However, based on the turbine model specifications (i.e., hub height, blade length, etc.) the mid-tower detectors may not be monitored within the RSZ (i.e., risk area) and therefore would be monitoring general activity but not exposure risk.

16. Why does the real-time smart curtailment approach for the TCB wind guidance and associated technical assistance letter require that all bat calls be used as a surrogate for TCB calls?

Despite the development and widespread use of qualitative methods and automated programs to classify bat echolocation calls to species, there is considerable overlap and variation in call structure among species, making it difficult to distinguish many species acoustically (Barclay 1999) and resulting in low agreement between auto-identification software (Lemen et al. 2015, Nocera et al. 2019). However, the Service works with the Virginia Cooperative Fish and Wildlife Research Unit and U.S. Geological Survey to perform rigorous testing of automated acoustic bat identification programs as part of the Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines (USFWS 2023, 2019).

The potential for automated classification to misidentify TCB calls during real-time smart curtailment creates risk of turbine operation when TCB are present and vulnerable to collisions. TCBs typically produce echolocation calls in the range of 40 kilohertz (kHz) (Broders et al. 2001), which is higher than the typical sonar patterns of several other species with overlapping geographic ranges, including hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris notivagans*), evening bat (*Nycticeius humeralis*), big brown bat (*Eptesicus fuscus*), and Mexican free-tailed bat (*Tadarida brasiliensis*) (Murray et al. 2001, Corcoran 2007, Kinzie 2018). Atmospheric attenuation, or the absorption of sound energy by the air, increases with frequency, or pitch (Murray et al. 2001, Kinzie 2018, AWWI 2018). Therefore, depending on the size of a turbine’s rotor-swept zone (RSZ) and the amplitude, or volume, of the sonar pulses, high-frequency calls may not be detected by nacelle-mounted detectors until bats have entered the RSZ. On the other hand, species with lower echolocation ranges and/or more conspicuous calls are more likely to trigger turbines to curtail before bats are at risk of collision. Fill et al. (2023) used acoustic grids to investigate spatial and temporal overlap of eight bat species in an agriculture-dominated landscape in Nebraska. Despite evidence of fine-scale partitioning behavior, there was significant overlap in two-dimensional space and considerable temporal overlap among all species.

Given the uncertainties associated with the detectability of TCB calls at nacelle-mounted detectors and overlap in activity patterns among sympatric bat species, we are requiring that real-time smart curtailment use all bat calls as a surrogate for TCB activity until additional data are gathered to verify the reliability of high-pass frequency filters and/or automated identification of TCB to screen acoustic activity in real time.

17. Why does the activity-based informed curtailment (ABIC) approach for the TCB wind guidance and associated technical assistance letter allow acoustic data to be filtered by frequency range or species?

As noted in Question 16, overlap and variation in acoustic call structure among species and low agreement among auto-identification programs present challenges to quickly and reliably detecting TCB at nacelle-mounted detectors during turbine operations. However, compared to other protected bat species (e.g., those of the genus Myotis), TCB produce more acoustically distinct search call patterns (MacDonald et al. 1994). More importantly, because ABIC systems will use data collected over an entire season of monitoring to inform periods of risk to TCB, occasional misidentification of TCB calls is not expected to distort overall trends in activity as they relate to season, wind speed, weather, and other potential ABIC variables.

Peterson (2021) found that species composition varied among months, wind speed, and temperature at two wind projects in West Virginia. Generally, bat activity occurred at lower wind speeds (less than 11.2 mph (5.0 m/s)) and temperatures above 50°F (10°C), except in September when activity increased below 50°F (Peterson 2021). By allowing projects to design an ABIC approach specific to TCB, we are allowing companies to design a curtailment strategy that is equally protective as Option 1 (i.e., blanket curtailment) while not requiring 100-percent avoidance for other non-listed bat species. “Equally protective as” means that turbines should be feathered during all periods when TCB bat calls were detected, at minimum, under the conditions [season, temperature, wind speed, etc.] specified in Option 1. We expect that the proposed ABIC approach will minimize impacts to other bat species, but we are not holding wind projects to a higher standard than that required for a blanket curtailment approach (see Option 1 in the TCB wind guidance).

18. How does this guidance apply to distributed wind projects of single turbines?

The wind energy guidance for tricolored bat is not specifically tailored for small, distributed wind projects involving single turbines. These projects typically pose lower risk to listed bat species due to their singular nature and smaller rotor-swept zone. Distributed wind energy projects are usually subject to Section 7 consultation with the lead federal agency. Consultations for such projects may be conducted either individually or programmatically through the lead federal agency. During the consultation process, the Service acknowledges and considers logistical constraints.

19. Is a Technical Assistance Letter (TAL) required? What flexibility exists for projects to propose different conservation measures specific to the circumstances of their project and still receive a TAL?

The decision to pursue a Technical Assistance Letter (TAL) under the wind guidance is voluntary. As discussed in Question 9, wind projects have the option to utilize their own project-specific information and data to assess the risk to tricolored bats. In addition, certain projects may opt to manage endangered species risk by implementing their own conservation measures tailored to the unique context of their project.

While adherence to the conditions outlined in the wind guidance is voluntary, following these conditions as written is typically the most efficient route to obtain a TAL from the Service. However, variations in conditions based on project-specific circumstances may still be deemed appropriate for receiving similar technical assistance. It's important to note that proposed variations in project operations might require additional data review by the Field Office and coordination with the Regional Office to ensure consistency. Additionally, the issuance of a TAL by the Service is also voluntary, and the assessment of proposed variations in conditions may be balanced with other priorities within the consultation workload of the Field Office.

20. Where can I learn more about the TCB?

Information on the TCB is available online at https://www.fws.gov/species/tricolored-bat-perimyotis-subflavus or from a U.S. Fish and Wildlife Service Ecological Services Field Office in your area.

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