U.S. Fish & Wildlife Service

Land-based Wind Energy Voluntary 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. For projects with and without a Federal Nexus, also see questions 9, 10, and 11 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 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.

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[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.

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

A total of 1,208 TCB carcasses have been reported at 37 percent of unique projects[4] (86 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	19	63
Illinois	8	33
Indiana	5	11
Maryland	2	55
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	1	1
West Virginia	7	385
Wisconsin	1	1
Total	**86**	**1208**

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.

[4] 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.

State	# Projects with Documented TCB Mortality Post-WNS only	TCB Mortalities Post-WNS only
Iowa	17	58
Illinois	5	29
Indiana	5	8
Maryland	2	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	1	1
Total	**72**	**729**

3. What rationale was used to develop the proposed blanket curtailment[5] 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 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

[5] 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.

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[6] 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.

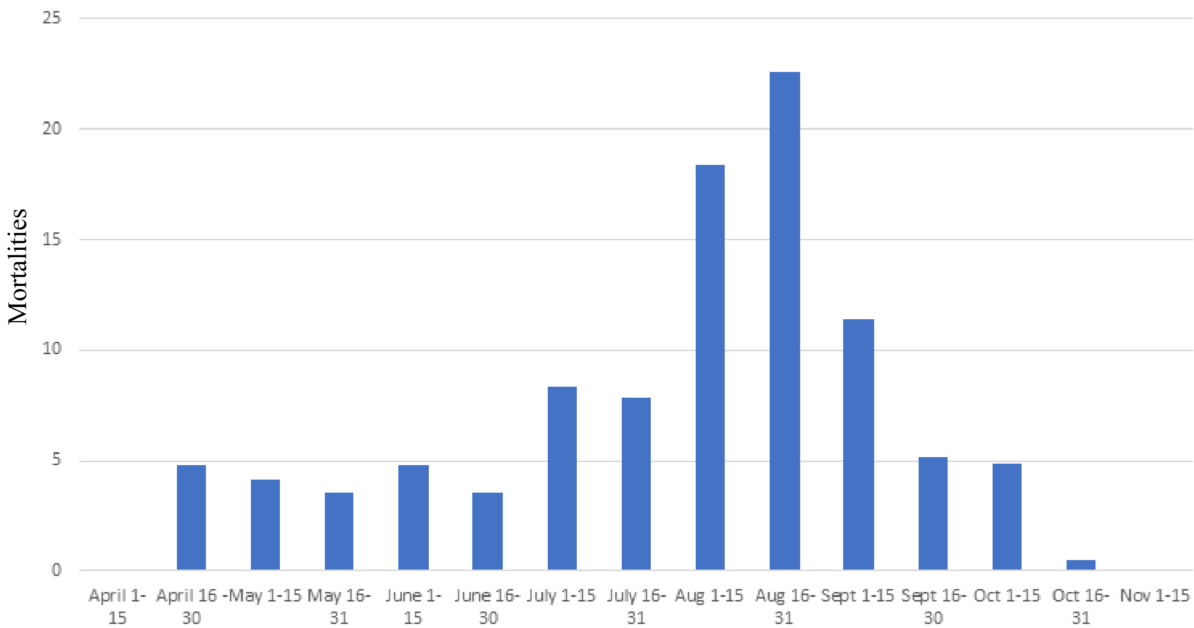

Figure 1. Percent of TCB mortalities (n = 273) pre-WNS and prior to WNS declines (no curtailment or feathering) by date from post-construction mortality studies in Pennsylvania and Maryland. These projects had required mortality monitoring from April 1 to November 15.

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

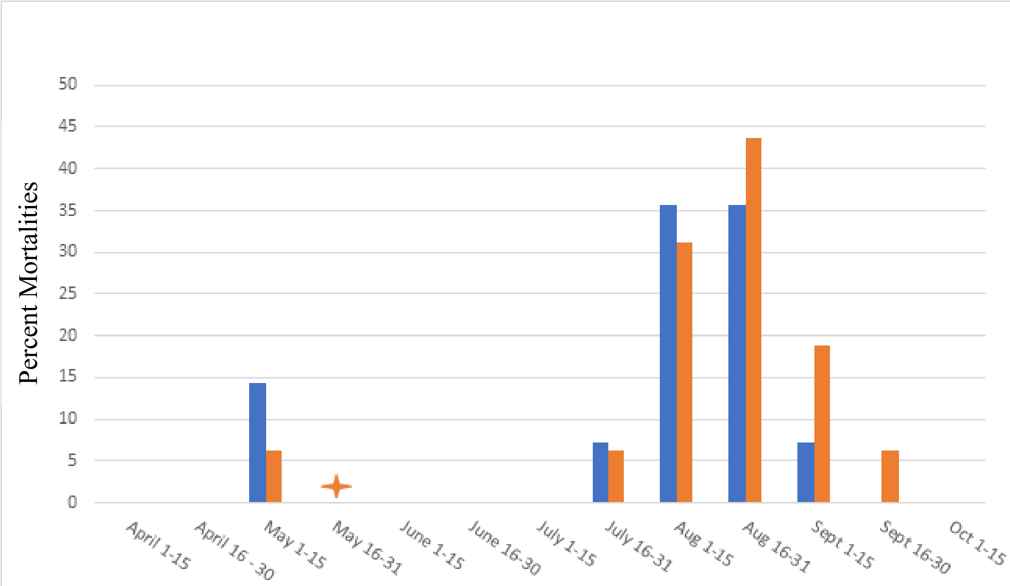

Figure 2. Percent of post-WNS TCB mortalities by date at sites feathering turbine blades below 11.2 mph (5.0 m/s). The Appalachian mortalities (illustrated in blue) are from wind projects operating at 11.2 mph (5.0 m/s) from July 1 to October 31. The Midwest projects (illustrated in orange) operated at 11.2 mph (5.0 m/s) 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 occurred at facilities with summer risk to TCB (i.e., positive summer surveys). 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. Of the 1,208 TCB mortalities that have been reported to the Service both pre- and post-WNS (table 1), 970 occurred when no operational curtailment was implemented and 238 occurred at sites where operational curtailment was implemented[7].

Table 3. Cut-in speeds in meters per second (m/s) at which 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 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-

[7] Implementation, or lack thereof, was not reported for three mortalities in the dataset and hence the discrepancy in the sum of the two previous numbers.

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	37	44
3.5	15	13
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	46	92
5.0 or 5.5	7	1
5.5	0	4
6.0	0	4
6.5	0	2
6.9	5	57
7.0[1]	0	3
7.5[2]	0	4
8.0[3]	1	5
Optimized smart curtailment[4]	4	1

[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] Four 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 5.5 m/s.

11.2 mph (5.0 m/s) Curtailment Rationale

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. We analyzed available data and determined that take is not reasonably certain to occur since we have no documented mortalities under a blanket curtailment speed of 11.2 mph (5.0 m/s) throughout the active season for hibernating populations except from May 1 to 31, July 15 to 31, August 1 to September 30. For year-round active zones see question 5 for curtailment options from November 16 to March 14.

12.3 mph (5.5 m/s) Curtailment Rationale

We based our recommendation on TCB fatalities that occurred in Pennsylvania, Maryland, and throughout the Service's Midwest Region (Region 3), which showed approximately 5.2 percent of TCB fatalities occurred in May and June at facilities operating at various cut-in speeds, including no curtailment[8] (Figure 2, USFWS 2023). Specifically, we recommend higher cut-in speeds in May based on four mortalities at 11.2 mph (5.0 m/s) in Missouri. The two mortalities that occurred in early May was likely associated with spring migration, as the project was near a small TCB hibernaculum (i.e., within 10 miles [mi]; 16 kilometers [km])). Therefore, we recommend a curtailment speed of 12.3 mph (5.5 m/s) for the beginning of May (May 1 – May 14) for all wind projects with risk to TCB. The other two mortalities in May occurred in late May. One occurred at a project site that was approximately 65 mi from the closest hibernaculum and has known summer risk for TCB (documented summer presence). The other occurred approximately 10 miles from a small TCB hibernacula, and this project also has known summer risk to TCB. Therefore, we chose to increase the blanket curtailment wind speeds for projects with known summer risk (i.e., positive presence/ absence (P/A) survey for TCB[9] or within 2.7 mi of known TCB summer occurrence records) from May 15 to May 31.

The Service is not aware of any post-WNS TCB mortalities at or above 11.2 mph (5.0 m/s) in June or early July (June 1 – July 14; figure 2) at projects with known summer risk to TCB. Therefore, we chose to reduce cut-in speeds at 11.2 mph (5.0 m/s) during this period. If projects would like to reduce the amount of curtailment modifications on a project site, 11.2 mph (5.5 m/s) can be used from May 15th to July 14th for projects with summer risk. If a project does not have summer risk (i.e., negative P/A survey and no known summer occurrences within 2.7 miles of the project), they can operate at the manufacturer's cut-in speed and must feather blades below manufacturer's cut-in speed from May 15 to July 14.

13.4 mph (6.0 m/s) Curtailment Rationale from July 15 to 31

Approximately 4.6 percent of TCB fatalities in Pennsylvania and the Service's Midwest Region occurred in July at facilities operating under a variety of cut-in speeds, including no curtailment[10] (USFWS 2023). We require a minimum cut-in speed of 13.4 mph (6.0 m/s) from July 15 to 31 based on a single TCB fatality at a site operating at 11.2 mph (5.0 m/s), which is 0.08 percent of all TCB fatalities reported to the Service (USFWS 2023). This bat was found at a site in Pennsylvania during the endemic phase of WNS (USFWS 2021, pg. 34). We increased the curtailment requirement during this time to 13.4 mph (6.0 m/s) based on this fatality in

[8] Projects operating with no curtailment are freewheeling or floating below manufacturer's cut-in speeds (i.e., they are not feathered below any wind speed to reduce the rotations per minute (RPM) below 1).
[9] Surveys should follow the most recent Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines | FWS.gov.
[10] Projects operating with no curtailment are freewheeling or floating below manufacturer's cut-in speeds (i.e., they are not feathered at any wind speed to reduce the rotation per minute (RPM) below 1).

conjunction with regional data that shows a peak in TCB fatality starting at the end of July and lasting through September (see figures 1 and 2, above). 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). An analysis of acoustic exposure further supports the Service's mortality data (figures 1 and 2) and approach by finding 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).

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). Second, the Service has data from 57 reports including 28 unique projects in 7 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 documented. 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.

We note, however, that in rare instances TCB mortality has been detected at 6.9 m/s cut-in speeds. These five mortalities occurred at four unique projects with variable land cover and habitat, ranging from heavily agricultural, flat land to predominantly forested Appalachian Mountains. 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 spring and fall 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 was 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.

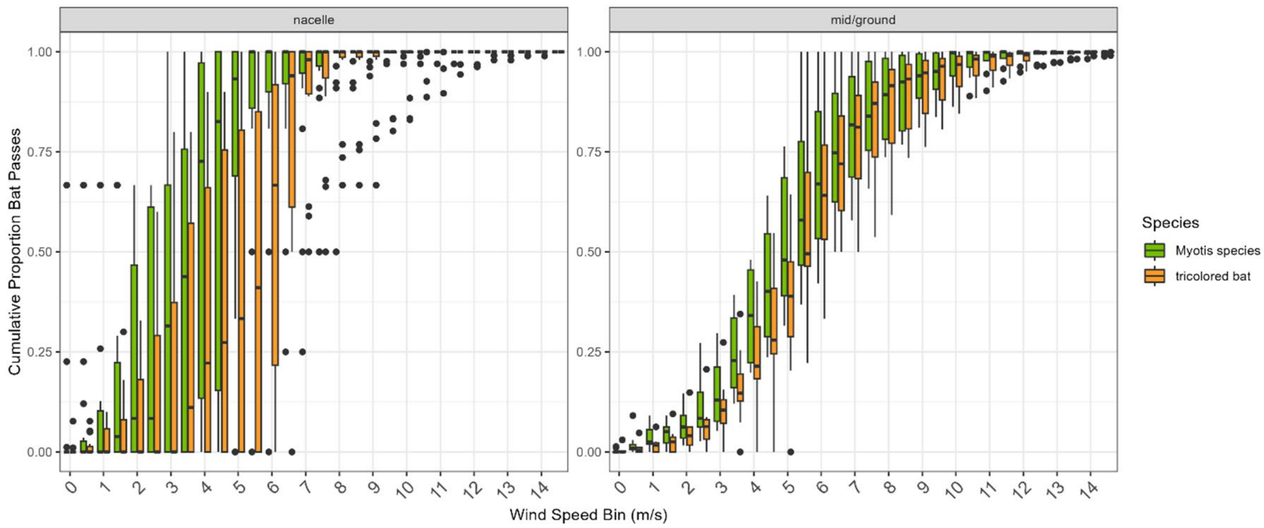

Figure 3. The total proportion of TCB calls at nacelle height at or above 7.0 m/s is roughly 10 percent of total calls. (from Stantec 2024, pg. 18)

5. Why does the TCB guidance recommend the most protective curtailment (i.e., 15.4 mph (6.9 m/s)) from November 16 – March 14 in the year-round active zones?

The Service has limited data collected outside the Indiana bat and NLEB range. Therefore, our blanket curtailment guidance for areas within the year-round TCB range is more protective from November 16 to March 14 (i.e., requiring 15.4 mph (6.9 m/s) cut-in speeds when temperatures are above 40°F) for two reasons: (1) the Service lacks acoustic and mortality data to understand impacts during these months in areas with year-round activity, and (2) the Service chose to be more protective of these year-round active populations as they are likely not as impacted by WNS and therefore may be critical to recovering the species. The Service is erring on the side of the species to protect these populations until we collect additional data to refine the blanket curtailment approaches from November 16 to March 14 in locations with year-round activity of TCB. 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 and batwindguidance@fws.gov.

The Service will incorporate new information as it becomes available and modify our TCB wind guidance to better reflect seasonal risk to TCB during this period. Examples of data that can be submitted are post-construction mortality monitoring data with the dates of any TCB found at a wind project, acoustic data identified to TCB or TCB/ cave myotis (in areas where both species overlap). The Service also asks for information on the duration and intensity of monitoring efforts (e.g., weekly carcass searches from January 1 to December 31). If projects would like to combine data with other projects in the same county or portion of the state (e.g. Southern Texas) that is acceptable as long as the data on how monitoring is consistent across projects or called out (e.g., project A, project B, etc.).

6. Why is the Service guidance requiring different curtailment wind speeds for wind projects with summer risk to TCB compared to NLEB?

The TCB avoidance blanket curtailment wind speeds (Option 1) within the TCB wind guidance is based on the relative magnitude of TCB mortality data available compared to the limited NLEB mortality data reported (i.e., 1,208 TCB vs 35 NLEB mortalities). However, the updated NLEB Wind Avoidance Guidance has incorporated curtailment options for projects that have summer risk to NLEB. Additionally, data demonstrate that TCB mortalities are still occurring post-WNS, just at much lower numbers than historically. Additionally, we have documented TCB mortalities at 5 m/s during the summer risk period (figure 2) and we do not have any documented mortalities at 5 m/s for NLEB during the summer risk period. The Service has a TCB mortality dataset from wind projects with summer risk on which we based our avoidance recommendations (USFWS 2024). These data are primarily from the Service's Regions 3 and 5. However, we do have limited additional data from other Regions throughout the TCB range (see tables 1 and 2).

Summer risk for TCB is challenging to fully assess, as surveys designed for Indiana bat and/or NLEB bats have not consistently targeted areas where TCB are likely to be captured or detected. However, limited available acoustic data either collected by ground-based (3 m) or meteorological (MET) tower detectors (typically mounted at 55 m per the Land-Based Wind Energy Guidelines https://www.fws.gov/media/land-based-wind-energy-guidelines) at numerous projects in USFWS Region 3 have yielded low numbers of TCB call files in summer even when no TCB were captured during summer surveys. Suitable TCB summer habitat consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may include some adjacent and interspersed nonforested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields, and pastures (USFWS 2021). Compared to NLEB, that seem to be closely tied to mature forests for both foraging and roosting activities (Caceres and Pybus 1997, White et al. 2017). NLEB generally forage above the understory, 1 to 3 m (3 to 10 ft) above the ground, but under the canopy (Nagorsen and Brigham 1993) on forested hillsides and ridges, rather than along riparian areas (LaVal et al. 1977, Brack and Whitaker 2001). This suggests that TCB may be more prevalent on the landscape and likely to encounter wind turbines in summer compared to NLEB, and that more wind projects may have summer TCB risk compared to NLEB. Given the possibility that a large proportion of facilities may have TCB summer risk, excluding these projects from using this guidance would limit its usefulness. Therefore, we chose to use the best available data to develop cut-in speeds that are protective of TCB in the summer as well as other active periods. See question 4 for more details.

7. What does this guidance mean for projects with a Federal Nexus[11]?

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 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.

8. 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).

9. 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.

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

10. 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).

11. 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 the TCB guidance is not as equally protective since it requires curtailment at 6.9 m/s only during August and September, not for the entire fall migration period. 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.

12. 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.

13. 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)[12]. 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.

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[12] 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.

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 algorithm-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 algorithm-informed curtailment and 1.8 percent of annual revenue for curtailment based on wind speed alone. 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).

14. Why do the smart curtailment approaches (Options 2 and 3) for the TCB wind guidance and associated technical assistance letter require 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.

15. Why does the real-time smart curtailment approach for the TCB wind guidance and associated technical assistance letter require detectors to be placed on at least 10 percent of turbines?

Research at a 45-turbine wind project in California demonstrated that four detectors were needed to adequately sample bat activity (Weller 2007). Additionally, 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 (Consumers Energy Company 2022). The average detector-to-turbine ratio from these three studies is 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.

16. Why does the algorithm-based informed curtailment (ABIC) smart curtailment approach for the TCB wind guidance and associated technical assistance letter require detectors to be placed on 15 percent of turbines?

Among three field validation studies demonstrating the number of detectors needed to adequately sample bat activity at facilities implementing real-time acoustic-activated smart curtailment systems, the average detector to turbine ratio was 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 (see question 15). 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. Any ABIC approach requires an adequate number of species-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 TCB calls and understanding of the minimum number of call files needed to design an effective strategy. Because we assume that some detectors will malfunction during data collection, we are requiring that facilities implementing ABIC (Option 2) 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 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. Other projects have added supplemental acoustic detectors on the turbine tower (20 m) and ground (3 m) to increase the species-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.

17. 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 cooperates 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.

18. Why does the algorithm-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 17, 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 nonlisted 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).

19. Where can I learn more about the TCB and the final rule to list it as endangered?

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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