Bat monitoring for the wind farm Jelinak

from June to October 2021

Zagreb, June 2022

Project	**Bat monitoring for the wind farm Jelinak from June to October 2021**
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Contents

1 Introduction

Bat monitoring was implemented in the area of Wind Farm (WF) Jelinak from June to October 2021. The WF is located in the hinterland of Trogir in Split-Dalmatia County (Figure 1-1). It is in operation since 2013.

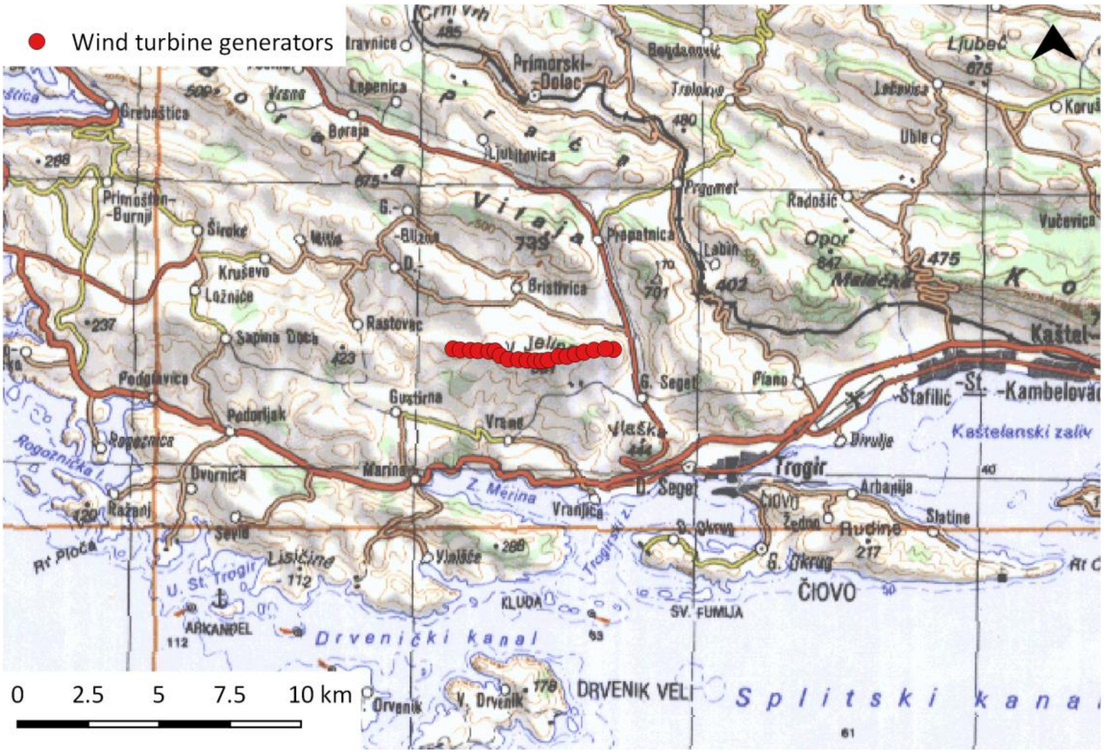


Figure 1-1. Wind farm location

The WF facility is comprised of 20 wind turbine generators (WTG's) positioned along access roads (Figure 1-2). Each wind turbine generator consists of a tower, 80 m high, atop which is a nacelle. Rotor blades are attached to the nacelle and measure 82 m in diameter.

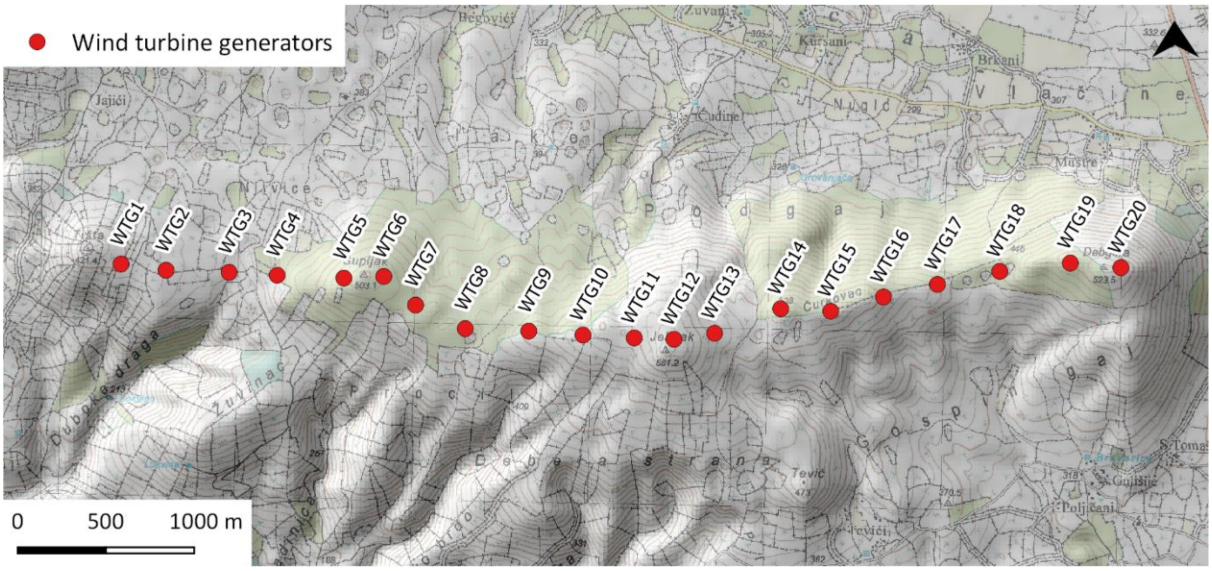


Figure 1-2. WTG's layout

WF Jelinak is located in a hilly area, across the peaks Tišta (421.4 m), Šupljak (503.1 m), Dabgora (523.5 m) and Veliki Jelinak (581.2 m). Dominant habitats in the WF area are eastern Adriatic sub-Mediterranean rocky pastures in succession (Figure 1-3). Other present habitats are thermophilus deciduous downy oak (*Quercus pubescens*) coppice and arable land (orchards).

Figure 1-3. Typical habitat in the WF area

During the monitoring, blade feathering and increased cut-in speed were implemented during pre-determined periods at some of the WTG's (Table 1-1).

Table 1-1. Mitigation measures implemented during this monitoring

PERIOD	WIND TURBINE GENERATORS	BLADE FEATHERING	CUT-IN SPEED	TIMING
1.-15.7.	WTG1, WTG10, WTG13, WTG17, WTG18	yes	5.0 m/s	9 pm-3 am
	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	9 pm-3 am
16.7.-15.8.	WTG1, WTG10, WTG13, WTG17, WTG18	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	from half an hour before sunset until half an hour after sunrise
16.-31.8.	WTG1, WTG10, WTG13, WTG17, WTG18	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	from half an hour before sunset until half an hour after sunrise
1.-30.9.	WTG5, WTG8, WTG12, WTG13, WTG16, WTG20	yes	5.5 m/s	from half an hour before sunset until 3 am

Monitoring was designed in accordance with monitoring reports from previous years of post-construction monitoring at WF Jelinak and Terms of Reference. The monitoring included:

- Monitoring of bat collisions;
- Searcher efficiency and carcass persistence trials;
- Monitoring of bat activity using ultrasound detectors (continuous bat call recording at stationary points and periodic bat call recording on a transect route);
- Data processing and analysis;
- Monthly and final reports.

2 Methodology of monitoring

Methodology and dynamics of the monitoring were in accordance with monitoring reports from previous years of post-construction monitoring at WF Jelinak. Implemented methodology followed EUROBATS guidelines for consideration of bats in wind farm projects (Rodrigues et al. 2014) and additionally adjusted to special demands of this project.

Monitoring of bat collisions was implemented from June to October 2021 at all 20 WTG's. In June and September, searches for bat carcasses were conducted every seven days, always two days in a row (June 11th-25th and September 7th-29th). In July and August, the searches were conducted every day (July 1st-August 31st). In October, carcasses were searched two days in a row in the first week of the month (October 5th-6th) (Table 2-1).

Searcher efficiency and carcass persistence trials were conducted in June 2021, at the beginning of monitoring activities. Trials were set up a day before the first two-day carcasses search (June 10th). Searcher efficiency trial was conducted during the two-day search (June 11th-12th), while carcass persistence trial was conducted for nine consecutive days including the day the test was set up (June 10th-18th). Searcher efficiency trial was repeated with another survey team in August 2021 (August 11th-13th), using the same methodology.

Continuous bat call recording was implemented at two stationary points: WTG1 and WTG18. Bat calls were recorded every night from June 10th until the end of October 2021 (October 31st). Periodic bat call recording along a transect route was carried out in July and August, two times per month for two usually consecutive days (Table 2-1). Transect route was 7 km long and recording lasted for around 2 hours and 32 minutes.

Table 2-1. Monitoring dynamics

		MONITORING OF BAT COLLISIONS		CONTINUOUS BAT CALL RECORDING		PERIODIC BAT CALL RECORDING	
YEAR	MONTH	DATES	NUMBER OF SURVEY DAYS PER MONTH	DATES	NUMBER OF SURVEY NIGHTS PER MONTH	DATES	NUMBER OF SURVEY NIGHTS PER MONTH
2021	June	11.-12.6., 17.-18.6., 24.-25.6.	6	10.-30.6.	21 at WTG1 21 at WTG18	-	-
	July	1.-31.7.	31	1.-31.7.	31 at WTG1 30 at WTG18*	15.-16.7., 29.-30.7.	4
	August	1.-31.8.	31	1.-31.8.	31 at WTG1 31 at WTG18	12.-13.8., 29.-31.8.	4
	September	7.-8.9., 14.-15.9., 21.-22.9., 28.-29.9.	8	1.-30.9.	30 at WTG1 30 at WTG18	-	-
	October	5.-6.10.	2	1.-31.10.	31 at WTG1 31 at WTG18	-	-

*during one night recording was interrupted due to a technical issue

2.1 Continuous bat call recording on stationary location

Continuous bat call recording was implemented to determine bat presence, species composition, abundance, and activity level for all nights in the monitoring period. The recording period started on June 10th and lasted until October 31st.

Monitoring equipment was placed on WTG's previously defined in the project task, one at each end of the wind farm – WTG1 and WTG18 (Figure 2-1), at the same locations as in previous monitoring years.

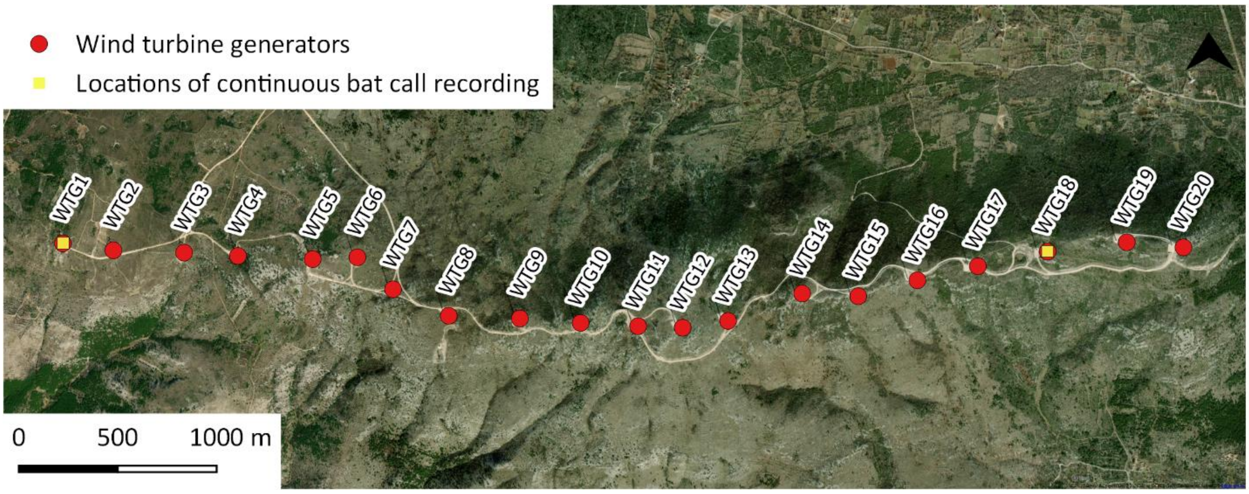


Figure 2-1. Locations of continuous bat call recording (marked yellow)
(Basemap source: Bing Maps)

Bat calls were recorded using ultrasound detectors *Elekon BATLOGGER WE X2* (Figure 2-2), specialized for monitoring at windfarms. Microphones were set at a height of 15 m. They were placed on the skin of the WTG towers, held in place by magnets and adhesive tape. Microphone cables were also secured with tape to prevent strong wind from ripping them off the tower. The recorders were placed inside the towers. Recording started 15 min before sunset and lasted until 15 min after sunrise. All recordings were analysed using *BatExplorer 2*, a specialized ultrasound analysis software with the use of relevant scientific literature (Russo and Jones 2002; Barataud 2020).

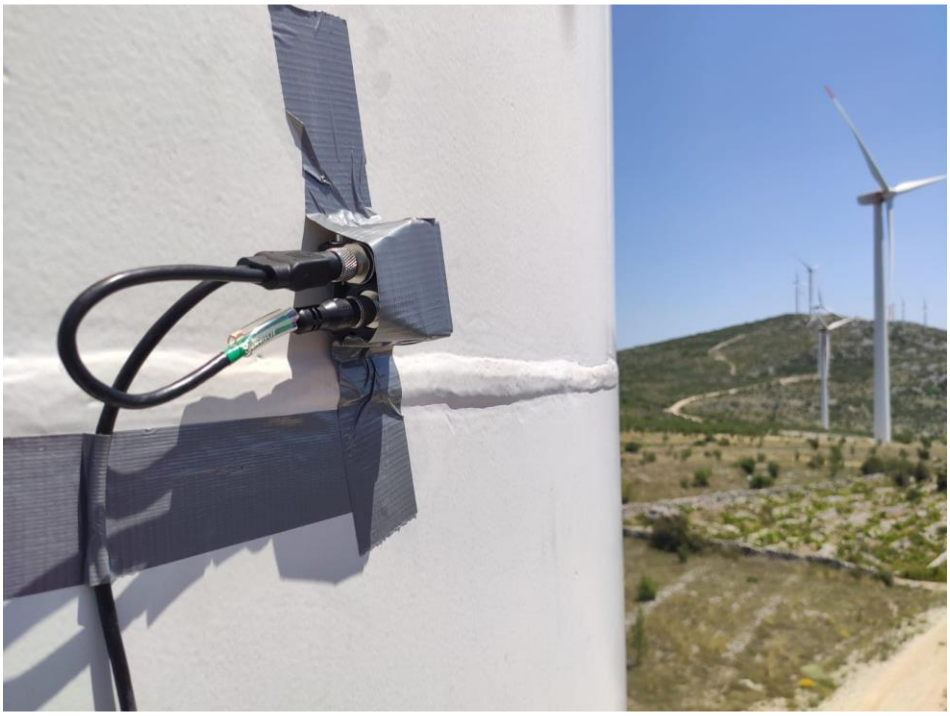


Figure 2-2. Microphone of ultrasound detector Elekon BATLOGGER WE X2 set at WTG1

2.2 Periodic bat call recording on a transect route

Periodic bat call recording (bat detector transect) was used to determine bat presence, species composition, abundance, and activity level in different parts of WF Jelinak. This information also helps in identifying key foraging areas, commuting routes, and behaviour of bats in the wind farm area.

Bat detector surveys were conducted during summer months, when bat activity in the wider wind farm area is highest. Surveys were conducted in July and August, two times per month on two consecutive nights except on August 29th and 31st due to weather conditions. All survey activities were planned and conducted on nights with favourable weather conditions for bats, which means night air temperatures above 10°C, average wind speeds no more than 4 m/s and no precipitation (Appendix I).

The transect route followed access roads between WTG1 and WTG20 and a footpath between WTG4 and WTG5, covering the whole wind farm area (Figure 2-3). The length of the transect was around 7 km. The route was walked at a uniform speed (around 3 km/h) with five-minute-long stationary recording stops at four locations with a total recording duration at the transect route of around 2 hours and 32 minutes.

Locations for stationary recording were selected based on habitat and landscape features important for bats, and approximately equally distributed along the transect route. The first one (SR1) was located near WTG2, near orchards. Location SR2 was at the intersection of access roads near WTG7. Location SR3 was in the centre of the WF, at WTG10. The final location (SR4) was at the intersection of access roads between WTG17 and WTG18.

Walking speed and duration of stationary recording were defined to ensure completion of the survey within three hours after sunset, a time of peak bat activity. Recording started within 30 minutes after sunset, when activities of some of the present bat species start. To reduce survey bias, the direction in which the transect route was walked was changed for the second day of each two-day survey session.

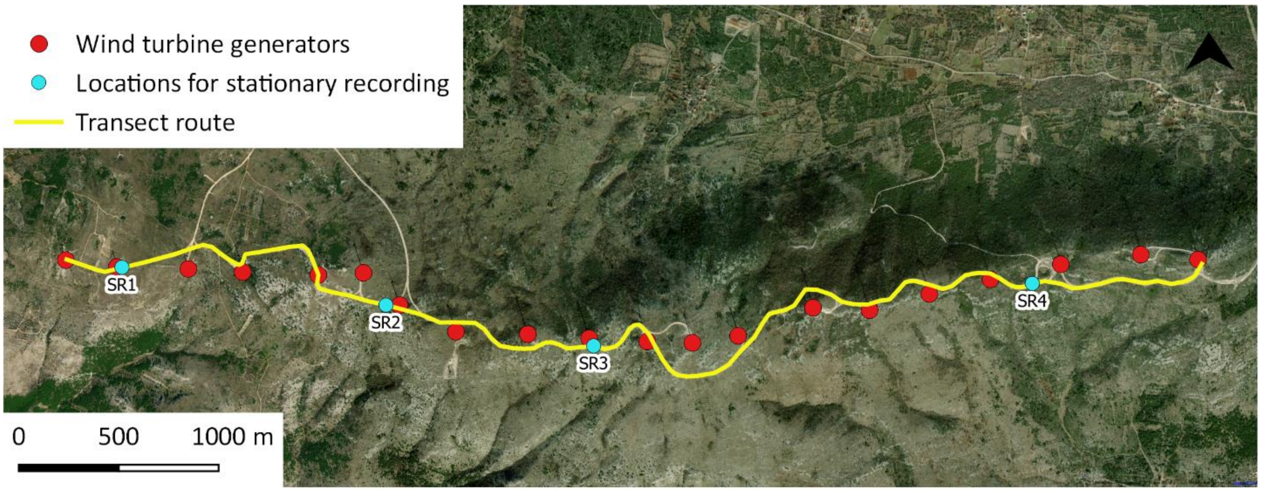


Figure 2-3. Route of linear transect and locations for stationary recording (Basemap source: Bing Maps)

Bat calls were recorded using an ultrasound detector *Elekon BATLOGGER M* which records ultrasound using *time-expansion* (TE) technique (Figure 2-4). Surveyors also played back the bat calls in real time using *heterodyne* (HET) technique which allowed them to "track" the direction of bat flight. All recordings were analysed using *BatExplorer 2*, a specialized ultrasound analysis software, with the use of relevant scientific literature (Russo and Jones 2002; Barataud 2020).

Figure 2-4. Ultrasound detector Elekon BATLOGGER M

During the bat detector survey along transect routes, the walked path was recorded using handheld GPS devices *Garmin GPSmap 62s* and *Garmin GPSmap 64st*. Data regarding start and end times, surveyors present, microclimatic conditions (air temperature, wind speed and humidity), number and location of recorded bat calls was entered into a field form (Appendix II). Microclimatic conditions were measured using *Kestrel 4000 Pocket Weather Tracker* at a height 2 m above ground.

2.3 Monitoring of bat collisions

Bat collisions were monitored by searching for bat carcasses in a radius of 70 m around each WTG. This is the approximate radius in which bats will most likely fall in regard to WTG dimensions, according to Hull and Muir (2010). Carcasses were searched in the same radius in previous monitoring years.

In June and September, searches for bat carcasses were conducted every seven days, always on two consecutive days. In July and August, the searches were conducted every day. In October, carcasses were searched two consecutive days in the first week of the month.

The searches covered all accessible areas of good visibility within 70 m radius around a WTG (Figure 2-5; Appendix IV). Those areas included: **1)** areas of high visibility – easily accessible areas clear of vegetation, i.e., WTG bases (construction plateaus), access roads and accessible slopes (Figure 2-6); and **2)** areas of moderate visibility – accessible areas covered with low vegetation. Inaccessible areas and those of poor visibility, i.e., difficult terrain and areas covered with high vegetation could not be searched.

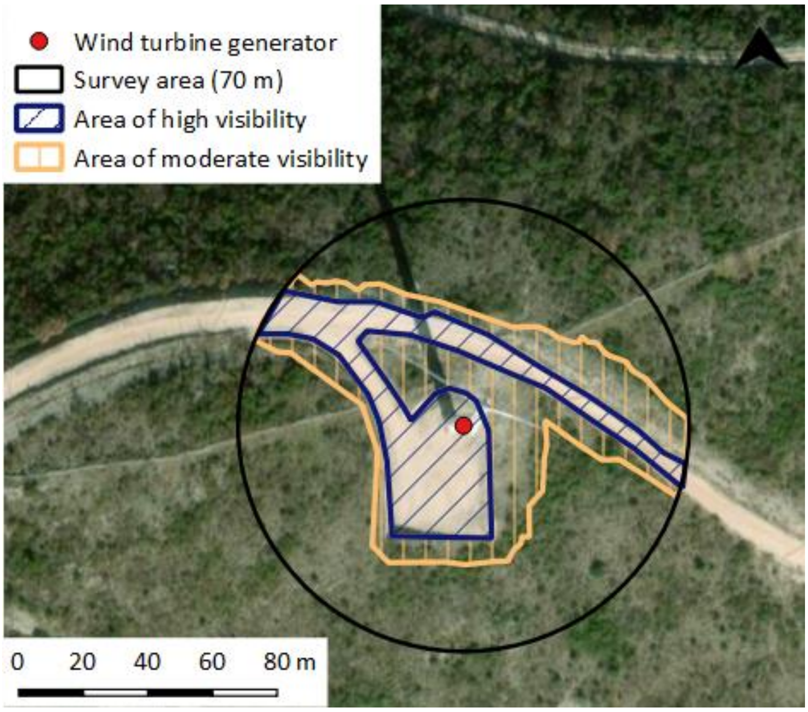


Figure 2-5. Example of survey area for monitoring of bat collisions
(Basemap source: Bing Maps)

Figure 2-6. Example of high (left) and low (right) visibility area

Search started within an hour after sunrise whenever possible, to minimise exposure of carcasses to scavengers. Searchers covered the areas of high visibility by walking across WTG bases and access roads at a slow pace, checking for carcasses for up to 3 meters on both sides of the walking line. In areas of moderate visibility, searchers followed best paths, checking up to 1.5 m on each side. The survey area around each turbine was searched for 15-45 min in total, depending on the searchable area. Each following day, the searchers switched their search areas, so that each one was searching the area different than the day before. This also increased the chance of finding carcasses missed by another searcher.

During each search, a track of walked routes was recorded using handheld GPS devices (*Garmin GPSMap 62s, Garmin GPSMap 64st, Garmin Oregon 650*). Data regarding start and end times, surveyors present in the field, microclimatic conditions and recovered carcasses was entered into a field form (Appendix III). Microclimatic conditions (air temperature, wind speed and relative humidity) were measured using *Kestrel 4000 Pocket Weather Tracker* at a height of 1-2 m above ground.

The discovered carcasses were photographed (Figure 2-7), and their location was recorded using a GPS device. Carcasses were examined and their species, sex, age, state of decay and injuries (if applicable, depending on the state of the carcass) were noted into a field form.

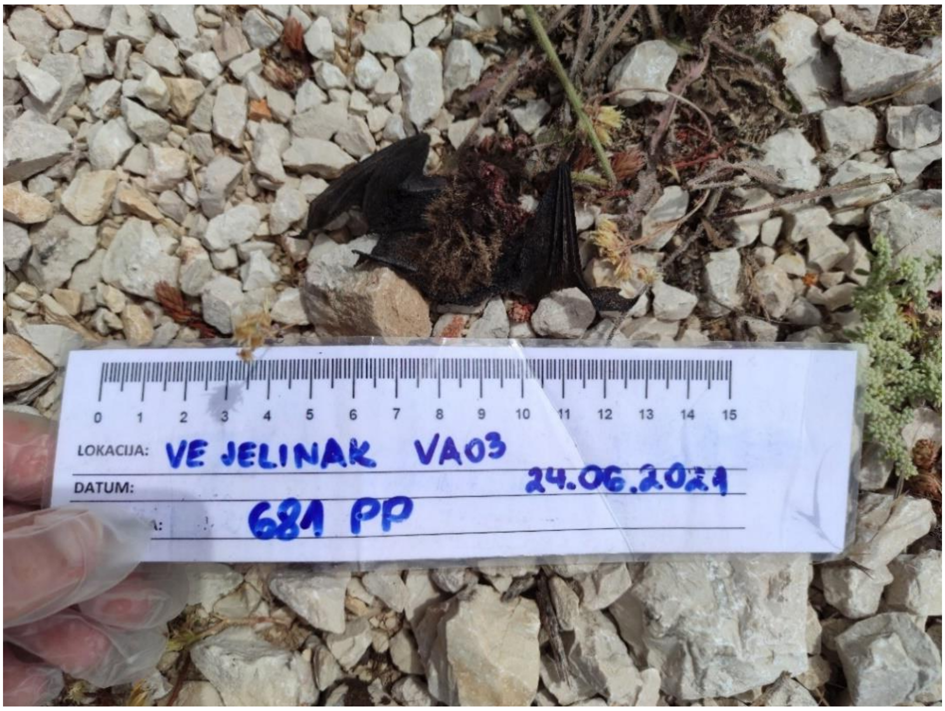


Figure 2-7. Example of bat carcass photo documentation

2.4 Searcher efficiency trials

It is not likely that all bat carcasses will be found by searchers under WTG's, especially in poorer visibility conditions (Korner-Nievergelt et al. 2011, 2013). Searcher efficiency trials were implemented to find out what proportion of bat carcasses is usually found by searchers, and to later refine the estimation of mortality of bats at wind farm Jelinak.

The trial was set a day before the first two-day search for carcasses (June 10th) and was conducted during the two-day search (June 11th-12th). Two teams conducted the trial – one team which set the trial, and another team of two surveyors who searched for carcasses. Twenty-two bat carcasses, previously kept frozen, were placed randomly at WF Jelinak. At each WTG either 0, 1 or 2 carcasses were placed. The number of carcasses at each WTG was determined using a random number generator (set range 0-2). Each carcass position was recorded using a handheld GPS device (*Garmin GPSMap 62s*) to easily determine if scavengers removed any. On June 11th a team of two surveyors were tasked with performing a regular carcass search without prior knowledge as to where, and how many, bat carcasses were placed the previous day. Carcasses they found were removed from the search area. On June 12th, the searcher team performed their second regular carcass search, also continuing to search for remaining placed carcasses. In this second search, the searchers switched for search areas, so that each searcher was searching area different than the day before. This increased the chance of finding carcasses missed by another searcher.

The trial was repeated in the exact same way with another team on August 12th and 13th. Team which set the trial was the same as the first time, while the team of two people who searched for carcasses was different. Thirty carcasses were placed (on August 11th), this time previously kept in alcohol, after which surveyors performed regular carcass searches.

Results of the trials are shown in chapter 3.4.

2.5 Carcass persistence trial

Carcass persistence trial was used to estimate how long bat carcasses persist in the environment before they are removed by other animals such as ants, wasps, birds, or foxes. This is important because searching for bat carcasses was not conducted every day in June and September, so the carcasses could have been removed in between searches before the surveyors could have had a chance of finding them. These results were used to refine the estimation of bat mortality at the wind farm.

The trial was conducted from June 10th until June 18th. A total of 30 fresh mice carcasses were used as bat analogues. They were placed at WF Jelinak on June 10th. At each WTG either 0, 1, 2 or 3 carcasses were placed. The number of carcasses at each WTG was selected using a random number generator (set range 0-3). They were randomly placed inside the 70 m radius search area around the WTG's. Their locations were recorded with a handheld GPS device (*Garmin GPSMap 62s*). Each mouse carcass was marked with masking tape with their unique code, and below (or next to) each one, an identical numbered marker was placed attached to a piece of wire which was stuck into the ground (Figure 2-8). Thus, if the carcass were removed, the marker could still be found to confirm the carcass was indeed not at its location. Also, if a mouse carcass were found at a different location it could easily be matched to its original location. The carcasses were placed in late afternoon and were then checked each morning for eight consecutive days. If a carcass was missing, its corresponding marker was found and removed from site.

Results of the trial are shown in chapter 3.5.

Figure 2-8. Example of a mouse carcass used for carcass persistence trial

3 Monitoring results

3.1 Continuous bat call recording

Bat calls were recorded from June 10th 2021 until October 31st 2021. In total there were 144 nights recorded at both WTG1 and WTG18 (Table 2-1).

At WTG1, a total of 73,180 signals were recorded: 7,452 in June, 24,989 in July, 32,161 in August, 8,296 in September and 282 in October. The term “signal” here refers to a single, distinct recording captured by the bat detector that may contain multiple calls of the same bat. These numbers are similar to those recorded in 2020, with slightly higher number of recordings in June, July, and October 2021, and slightly lower in August and September.

At WTG18, a total of 52,756 signals were recorded: 4,501 in June, 12,418 in July, 25,579 in August, 9,308 in September and 953 in October (Figure 3-1). These numbers are a significant decrease in total activity (~30 %) compared to 2020. Only in October were there more recorded calls in 2021 than in the previous year.

Total bat activity increased from June to August, after which it decreased in September and October. This activity trend reflects bat annual cycle – females give birth in late spring, and by the end of July or August juveniles can actively fly, increasing bat activity in summer months. As temperatures drop through September, so does the activity of bats. The activity trend is comparable to the one observed in 2020, but with lower overall activity, especially apparent in August (Figure 3-2).

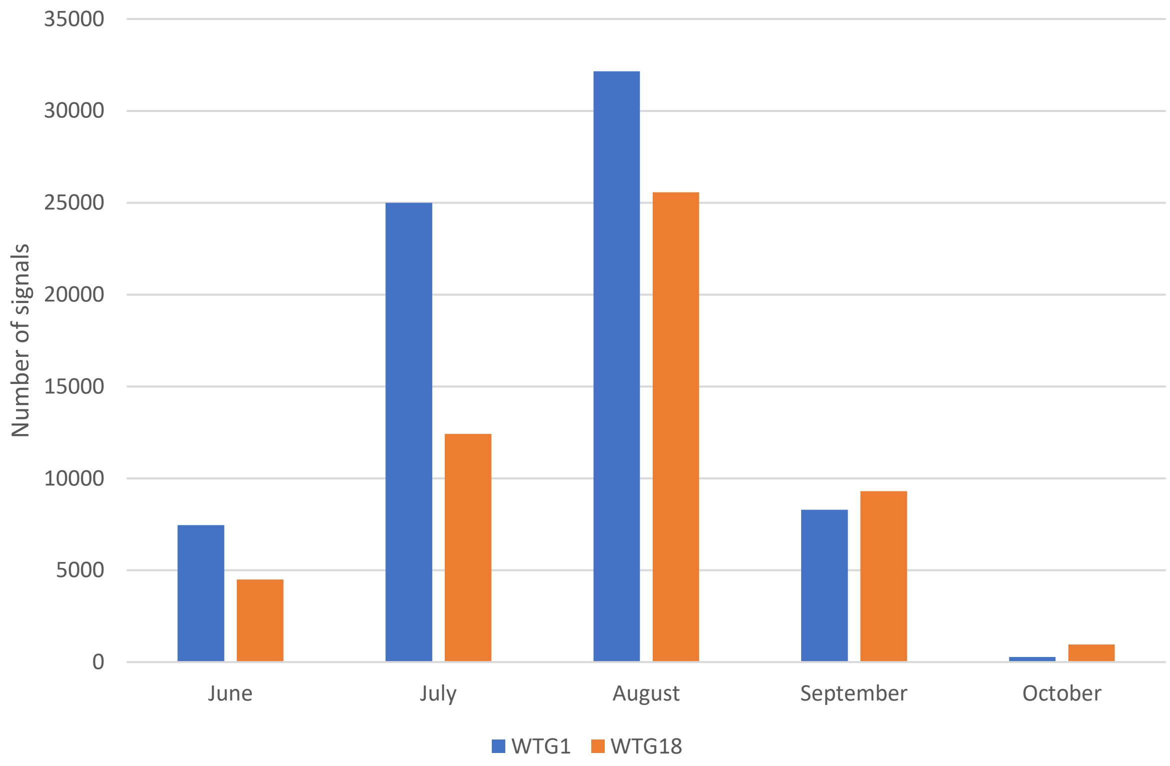


Figure 3-1. Total number of signals per month for both continuous recording devices

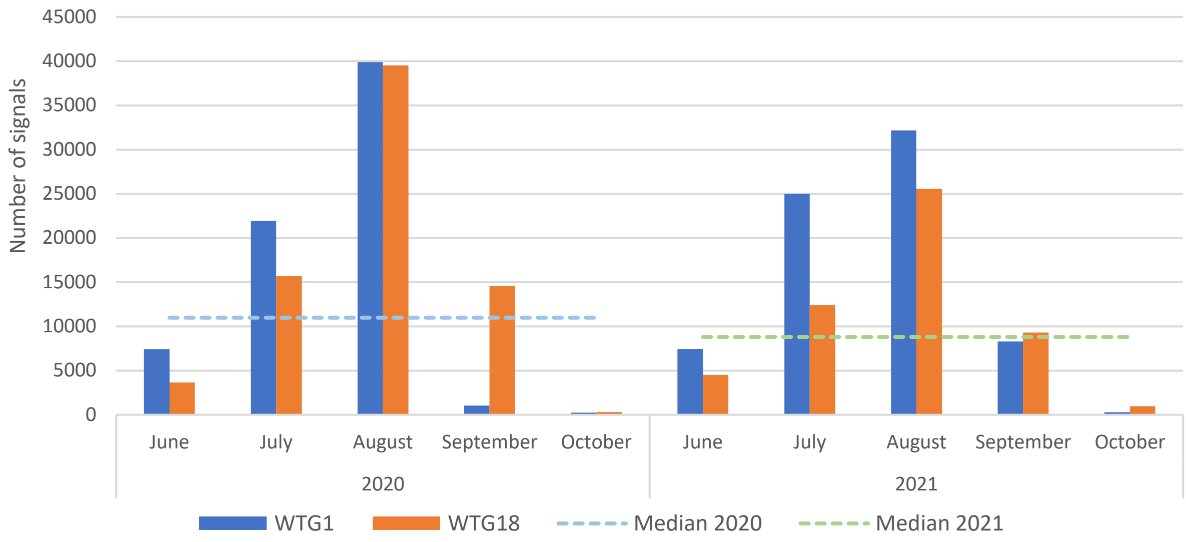


Figure 3-2. Comparison of total recorded bat activity in 2020 and 2021

Signals were identified to genus level, or species level in case of *Eptesicus serotinus, Hypsugo savii*, and *Tadarida teniotis* for which no other species from the same genus occur in the WF Jelinak area. As in previous years, signals belonging to genus *Pipistrellus* were the most common, accounting for 92.59 % of all recorded activity. *T. teniotis* and *H. savii* followed far behind with 2,71 % and 2,30 % of all signals, respectively. All other species/genera accounted for less than 1 % of total signals (Table 3-1). Species composition thus remained nearly identical to what was established during monitoring in 2020.

Table 3-1. Number of signals per species/group

SPECIES/GROUP	NUMBER OF BAT SIGNALS			
	WTG1	WTG18	TOTAL	%
***Pipistrellus* sp.**	68128	48473	116601	92.59%
Tadarida teniotis	1525	1892	3417	2.71%
Hypsugo savii	1897	996	2893	2.30%
***Myotis* sp.**	740	158	898	0.71%
***Nyctalus* sp.**	337	248	585	0.46%
Eptesicus serotinus	178	336	514	0.41%
Pipistrellus kuhlii/Hypsugo savii	173	323	496	0.39%
Nyctalus* sp. */Tadarida teniotis	120	129	249	0.20%
***Eptesicus serotinus/Nyctalus* sp.**	7	156	163	0.13%
Chiroptera	56	2	58	0.05%
***Plecotus* sp.**	15	30	45	0.04%
Pipistrellus* sp.*/Miniopterus schreibersii	1	10	11	0.01%
***Rhinolophus* sp.**	3	3	6	0.01%
TOTAL	**73180**	**52756**	**125936**	

Activity of *Pipistrellus* spp. individuals greatly outnumbered that of any other group on most nights. Their peak of activity was in August (Figure 3-3).

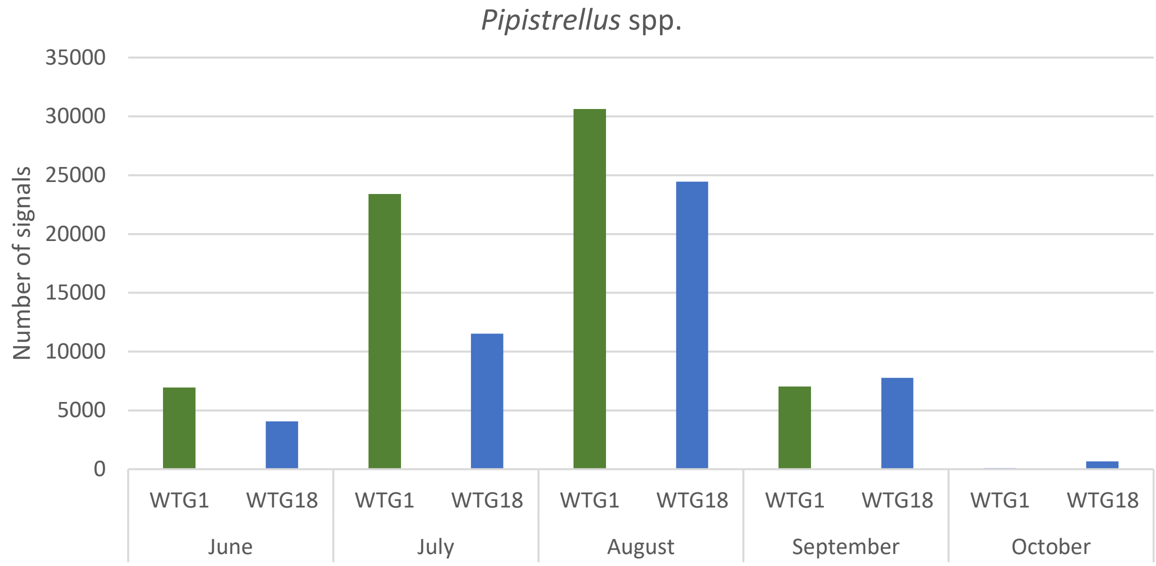


Figure 3-3. Number of signals per month for Pipistrellus spp.

Activity of *Tadarida teniotis* increased steadily from July to September, when it reached its peak, while in October it significantly decreased (Figure 3-4). In 2020 this species had its peak of activity in July, after which the activity decreased.

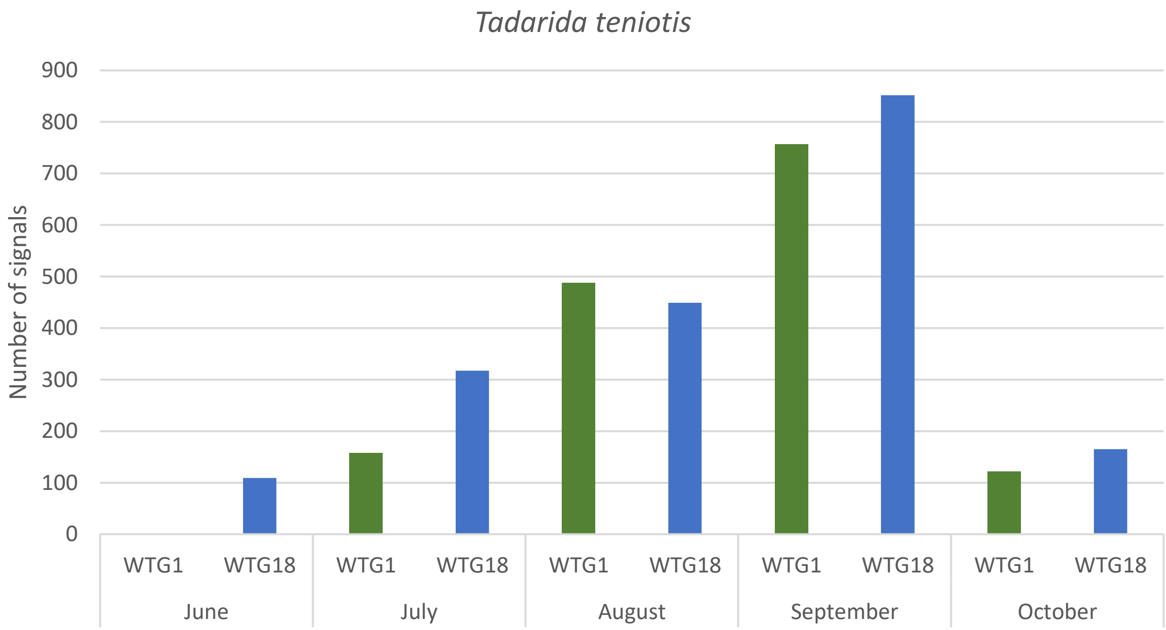


Figure 3-4. Number of signals per month for Tadarida teniotis

Hypsugo savii was more frequently recorded at WTG1, where a peak of its activity was recorded in July. At WTG18, it retained a nearly constant level of activity from June to August. On both locations its activity decreased in September and October (Figure 3-5).

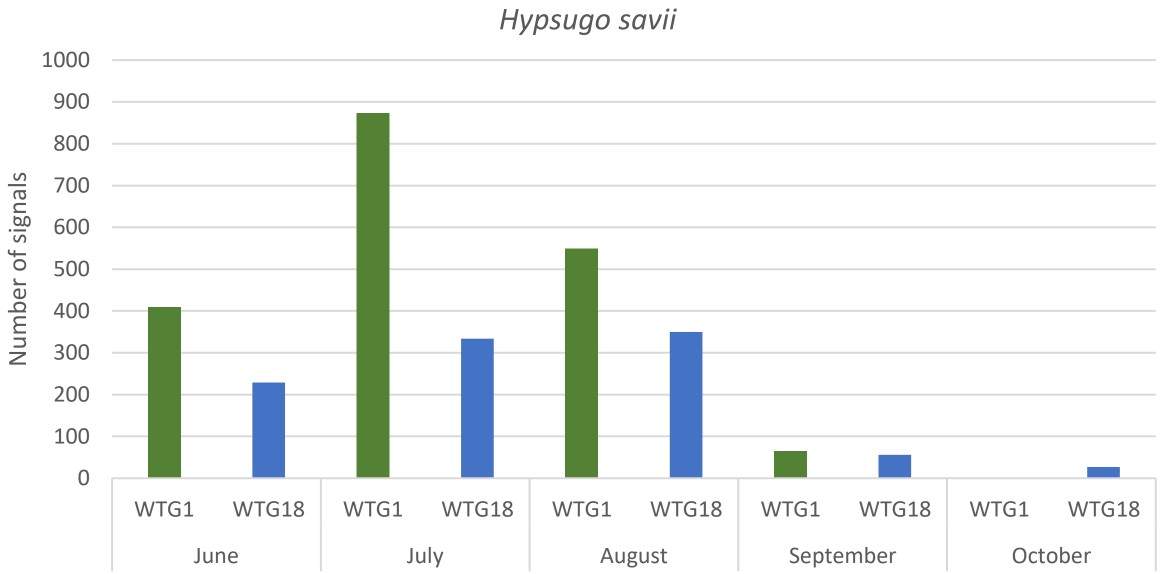


Figure 3-5. Number of signals per month for Hypsugo savii

Genus *Myotis* species, to which accounts only 0,71 %, were also more frequently recorded at WTG1. Peak of their activity was recorded in July and August (Figure 3-6).

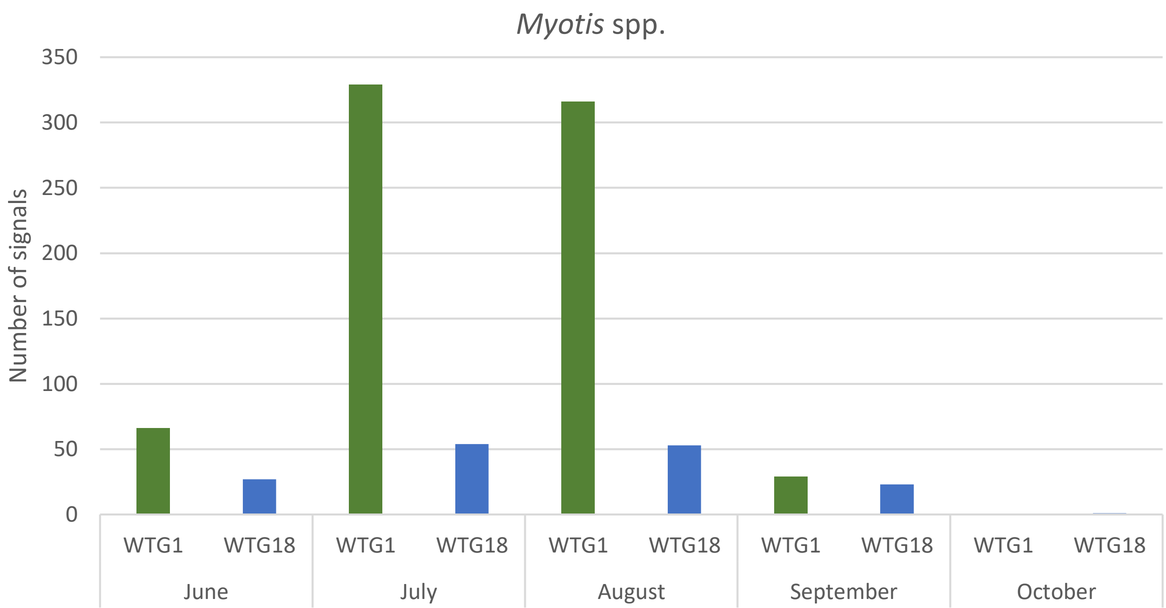


Figure 3-6. Number of signals per month for Myotis spp.

Activity of genus *Nyctalus* was highest in September (Figure 3-7). It showed a higher level of activity at WTG1, except in July and October.

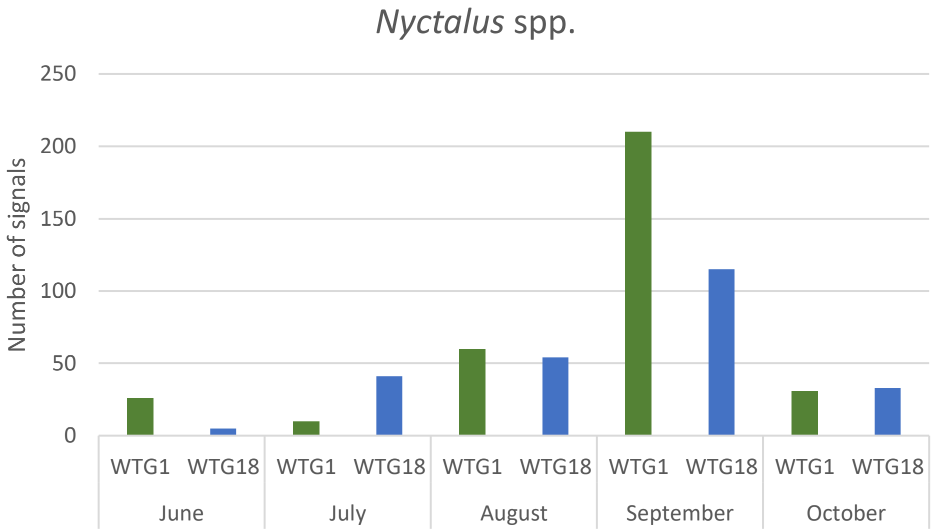


Figure 3-7. Number of signals per month for Nyctalus spp.

Species *Eptesicus serotinus* accounted for 0.41 % of total signals and had a peak of activity in September (Figure 3-8), which was much more pronounced at WTG18.

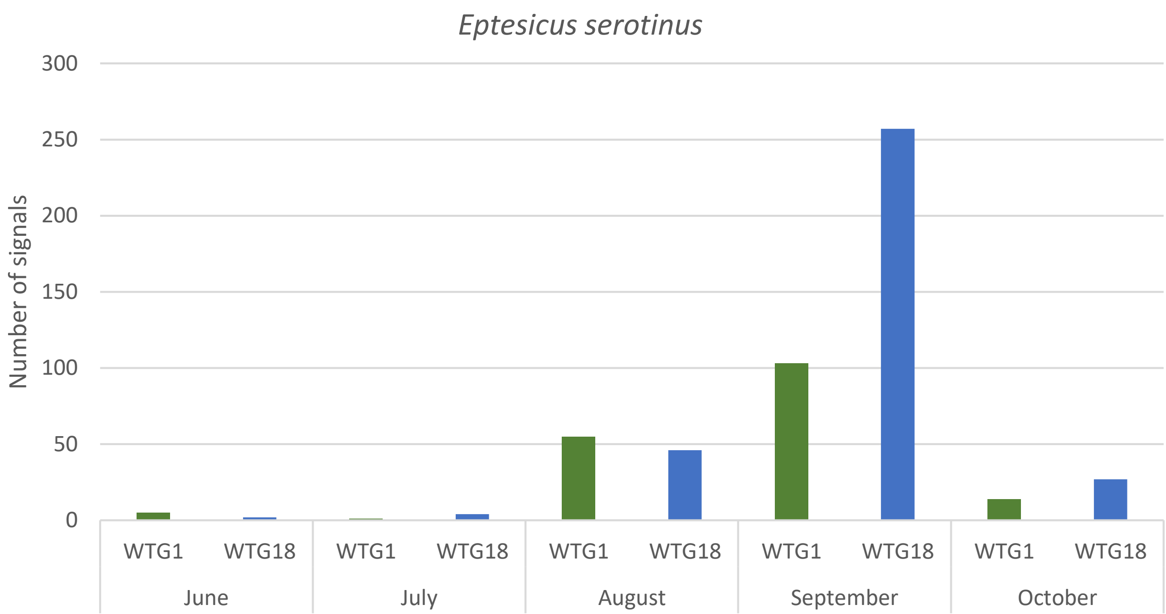


Figure 3-8. Number of signals per month for Eptesicus serotinus

Species of genus *Plecotus* were recorded 45 times in total, more often at WTG18. Peak of their activity was recorded in August and September (Figure 3-9).

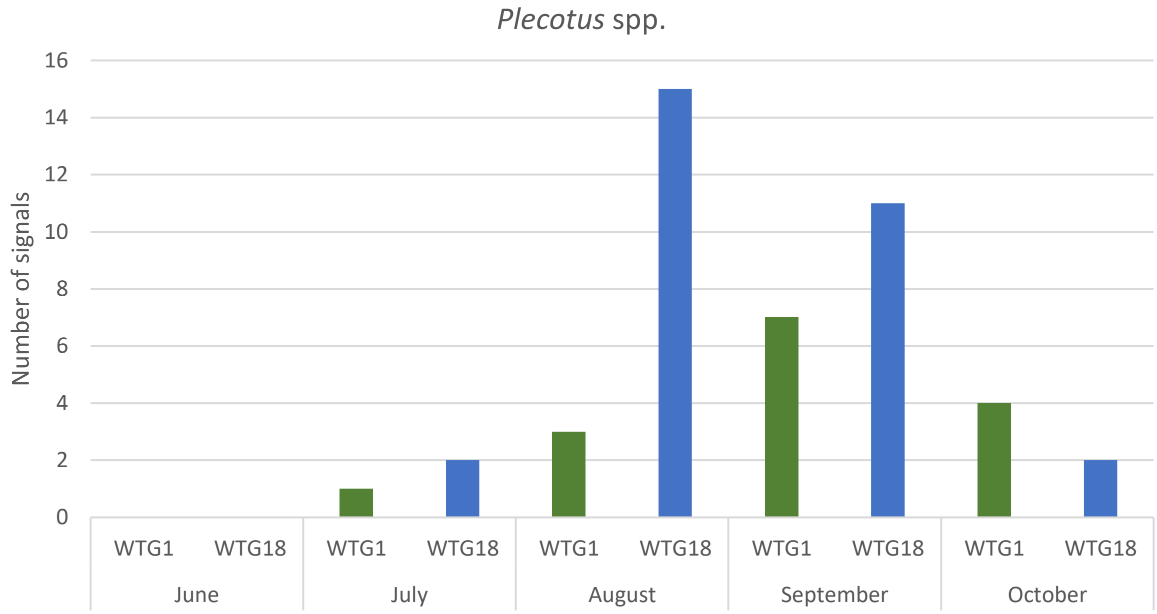


Figure 3-9. Number of signals per month for Plecotus spp.

Signals belonging to *Rhinolophus* species were only recorded six times, twice in June and four times in July. Two of those signals were identified as *R. ferrumequinum* and four as *R. hipposideros*. However, *Rhinolophus* species most often fly closer to vegetation and are not expected to be frequently recorded at the recording height, so activity of those species is probably under sampled. There is not enough data to draw a conclusion on the activity of this genus within the WF Jelinak area.

Activity patterns of individual taxa show minor changes compared to 2020. Most species had similar seasonal activity trends as in 2020, with only *Tadarida teniotis* showing a significant difference. Some species (e.g., *Hypsugo savii*) were more common at one recording location compared to the previous year but overall activity was largely the same. Genus *Myotis* had a higher overall activity in 2020, while genus *Plecotus* had a peak earlier than in 2020.

3.1.1 Bat activity through the night

Bat activity was analysed for evaluation of changes in activity distribution through the night as well. The data is presented in 30-minute intervals for each month of survey and for each recording location.

Due to late sunsets in June, bats were active after 9 PM. Both recording locations had a pronounced peak from 9:30 PM to 10:30 PM, but while at WTG1 activity gradually decreased throughout the night, there was a second activity peak recorded at WTG18 around 3 PM (Figure 3-10).

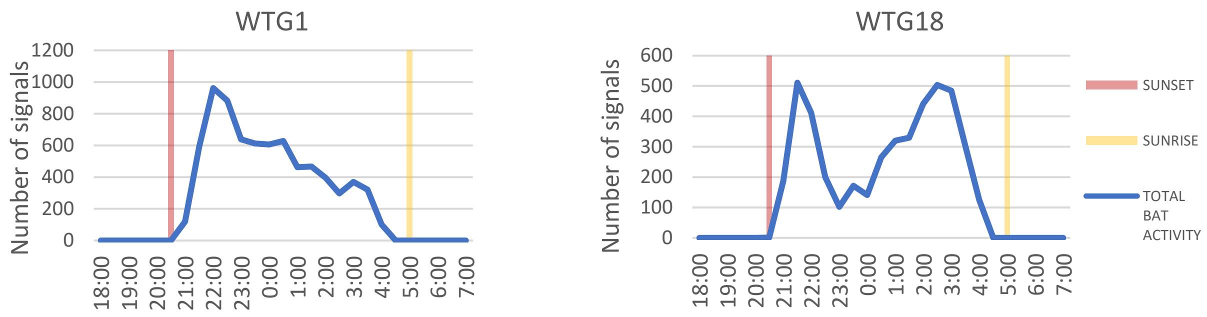


Figure 3-10. Hourly bat activity in June for both recording locations

Activity in July also started around 9 PM and showed pronounced peak activity in the first two hours, with a sharp drop after 11 PM. No bat activity was recorded after 5:30 AM (Figure 3-11).

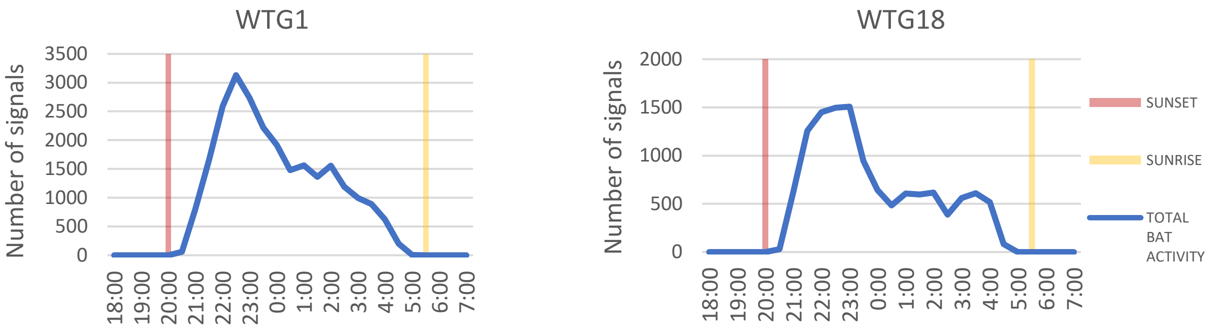


Figure 3-11. Hourly bat activity in July for both recording locations

In August, with shorter days, bat activity started around 8 PM. Activity peak at both locations remained around 10 PM, but the drop of activity after that was more gradual than in July. No signals were recorded after 6 PM (Figure 3-12).

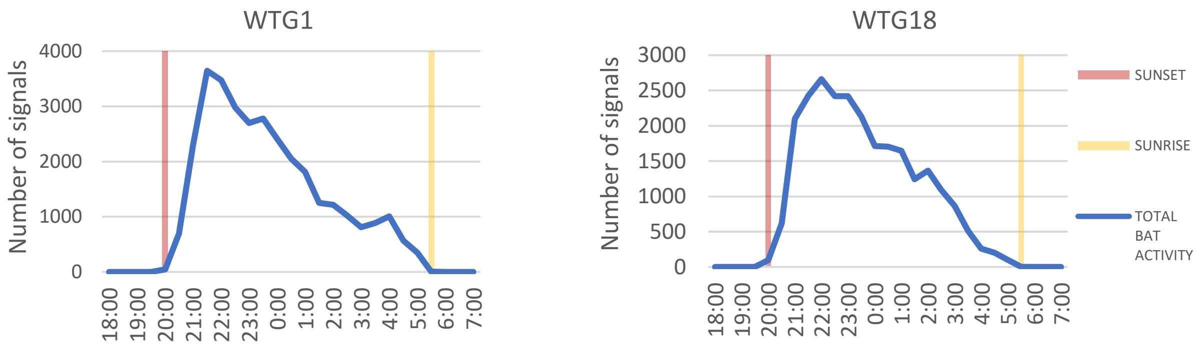


Figure 3-12. Hourly bat activity in August for both recording locations

The period of peak bat activity in September was earlier than in previous months, due to the shortening of days. A pronounced peak of activity was apparent around 9 PM, with a steep drop after. Earliest activity was recorded at 7 PM, and there was no significant activity after 6 PM (Figure 3-13).

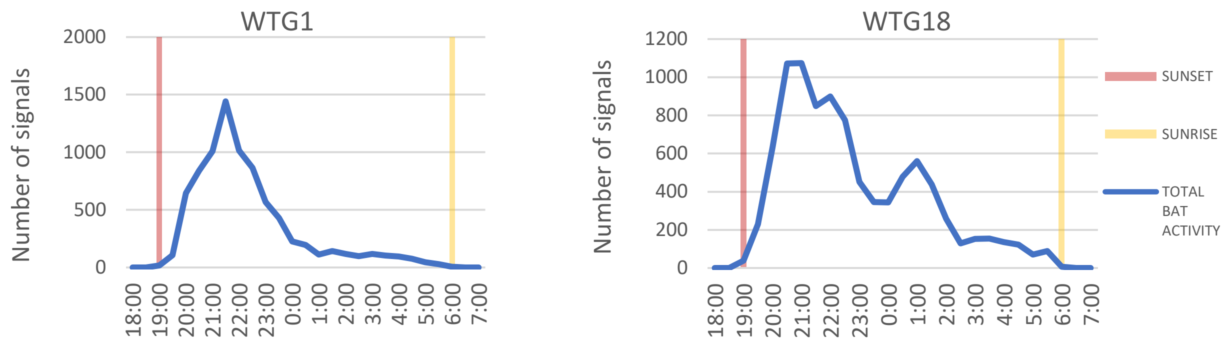


Figure 3-13. Hourly bat activity in September for both recording locations

In October, bat activity started as early as 6 PM and had its peak earlier than in previous months – at WTG1 the peak was around 8 PM and at WTG18 it was somewhat later, around 10 PM. Sharp decrease of activity afterwards is present at both locations, and no bat activity was recorded after 6:30 AM (Figure 3-14). However, due to the low overall activity in October and therefore small data sample, these trends might not be entirely accurate.

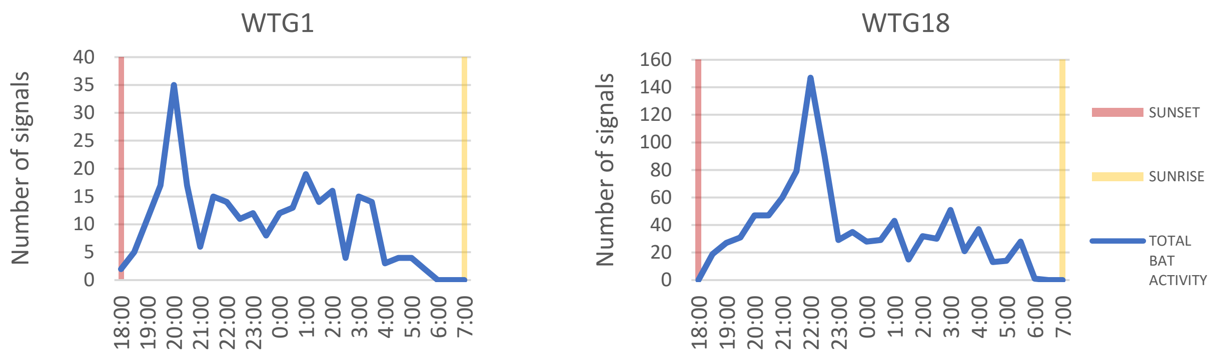
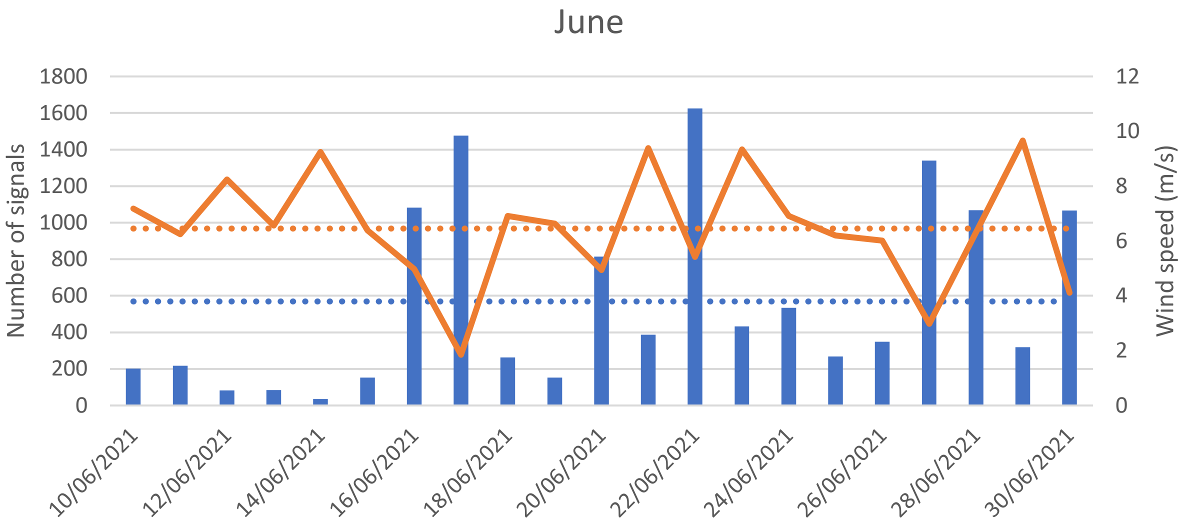


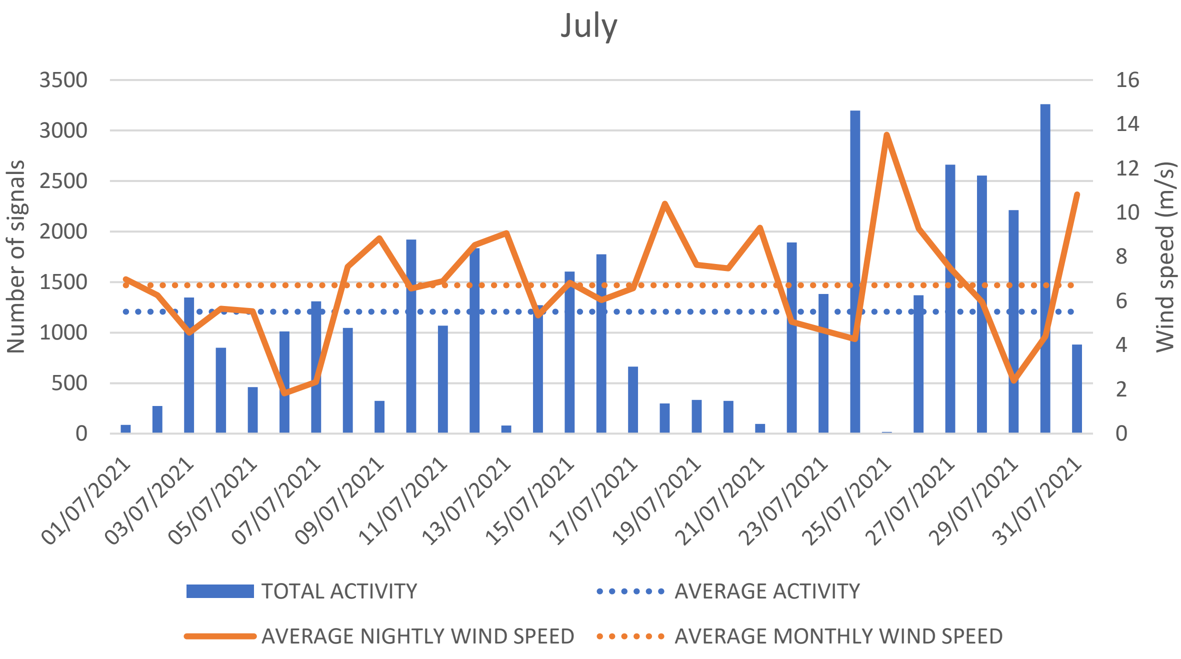
Figure 3-14. Hourly bat activity in October for both recording locations

When comparing results with previous year, bat activity through the night shows very similar patterns. Besides higher overall activity in 2020, only a few differences can be spotted. At WTG1 in August of 2020, there was an elevated level of activity throughout the night, while in August of 2021 there was a decrease after the initial peak. At WTG18, peak of activity in October shifted to later hours in 2021 – from around 21h to around 22h. Despite these differences, in both years the majority of bat activity remained in the first few hours of the night.

3.1.2 Bat activity in relation to wind speed

Data on wind measurements at nacelle height from June to September 2021 was provided by Vjetroelektrana Jelinak Ltd. When plotted against bat activity for each night, it shows there is a clear dependence of bat activity on nightly wind speed. Activity spikes are present at nights of lower average wind speed, while at nights with higher average wind speed activity decreased (Figure 3-15). This trend was apparent in the previous year of monitoring as well and can also be observed for each individual species/genera recorded (Figure 3-16).


June
Number of signals
Wind speed (m/s)
1800
1600
1400
1200
1000
800
600
400
200
0
12
10
8
6
4
2
0
10/06/2021
12/06/2021
14/06/2021
16/06/2021
18/06/2021
20/06/2021
22/06/2021
24/06/2021
26/06/2021
28/06/2021
30/06/2021


July
Number of signals
Wind speed (m/s)
3500
3000
2500
2000
1500
1000
500
0
16
14
12
10
8
6
4
2
0
01/07/2021
03/07/2021
05/07/2021
07/07/2021
09/07/2021
11/07/2021
13/07/2021
15/07/2021
17/07/2021
19/07/2021
21/07/2021
23/07/2021
25/07/2021
27/07/2021
29/07/2021
31/07/2021
TOTAL ACTIVITY
AVERAGE ACTIVITY
AVERAGE NIGHTLY WIND SPEED
AVERAGE MONTHLY WIND SPEED

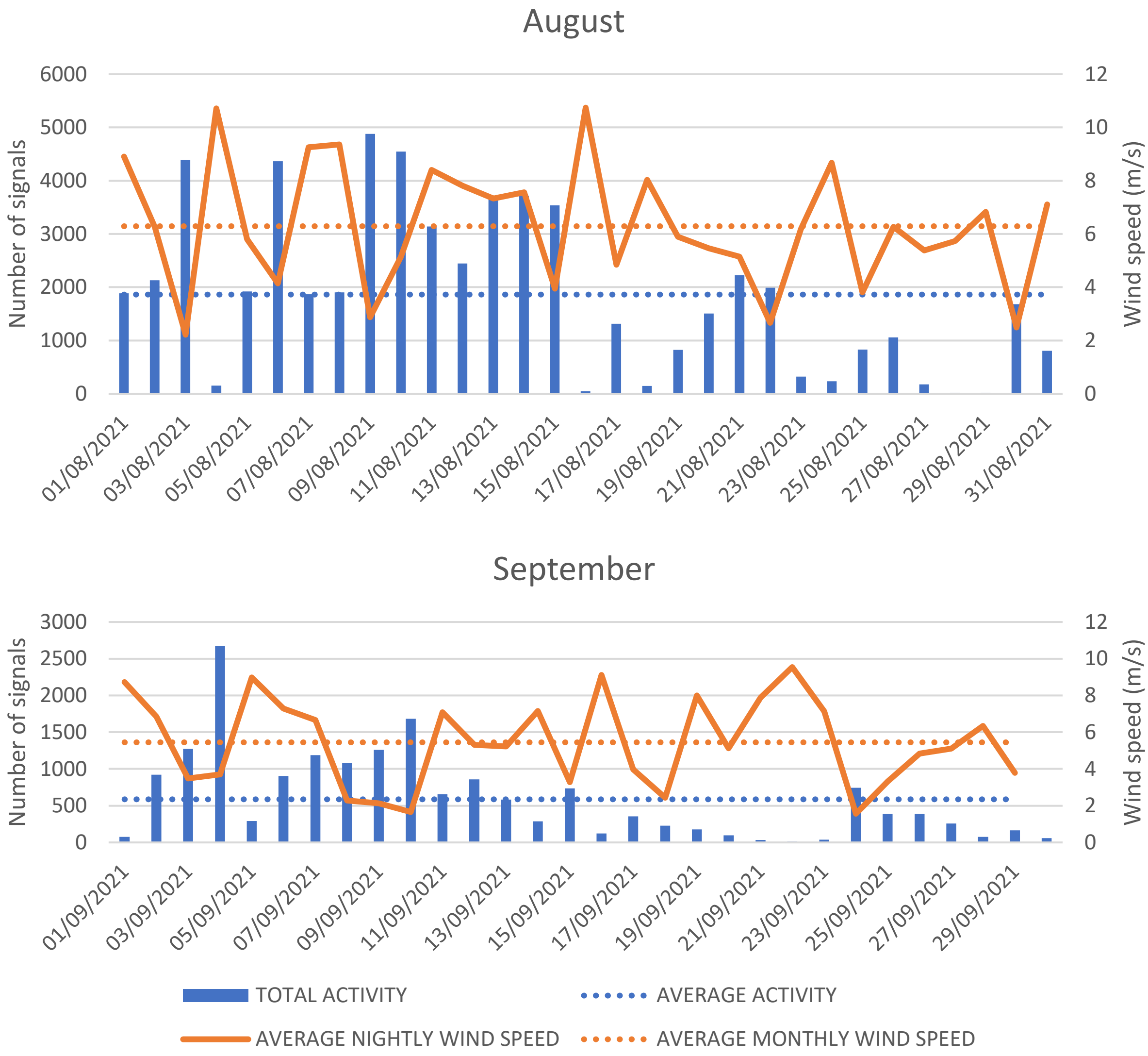
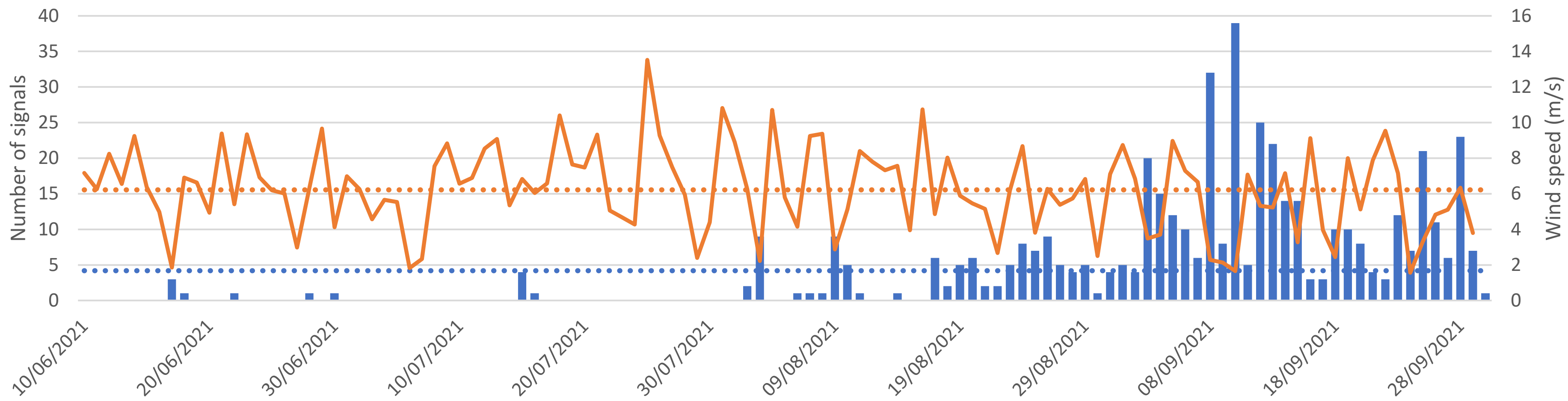
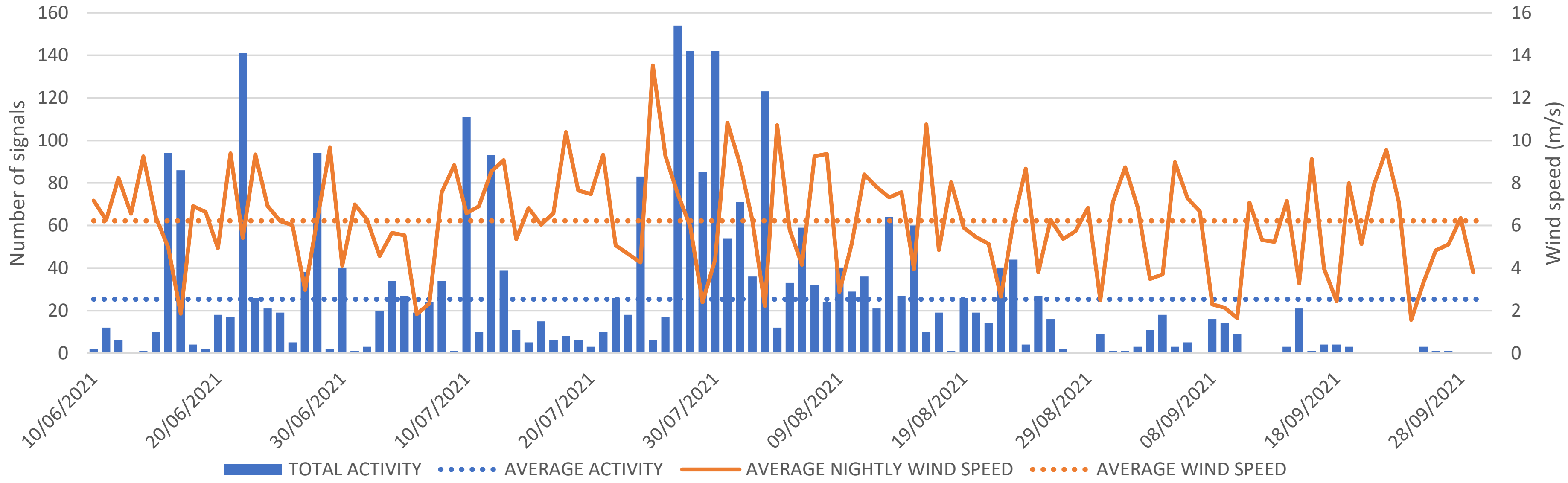


Figure 3-15. Total bat activity per night and average night wind speed for July, August, and September 2021

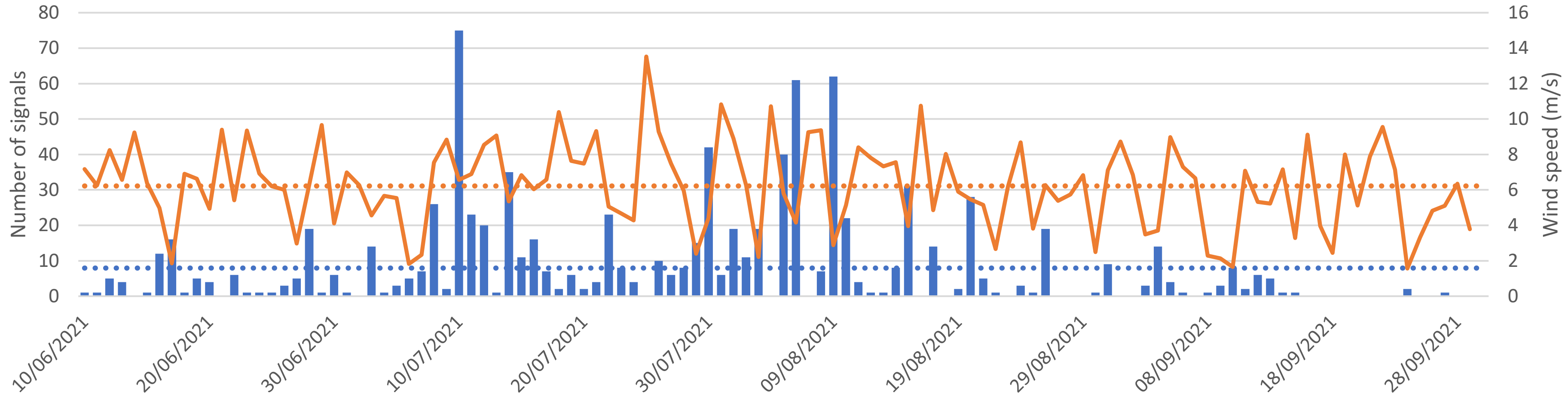
Eptesicus serotinus



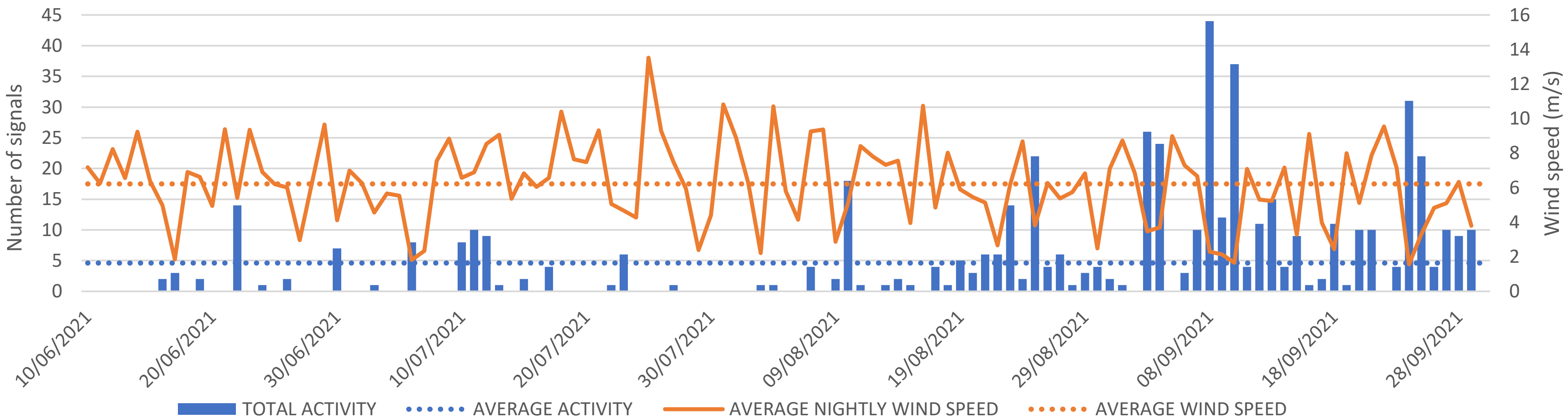
Hypsugo savii



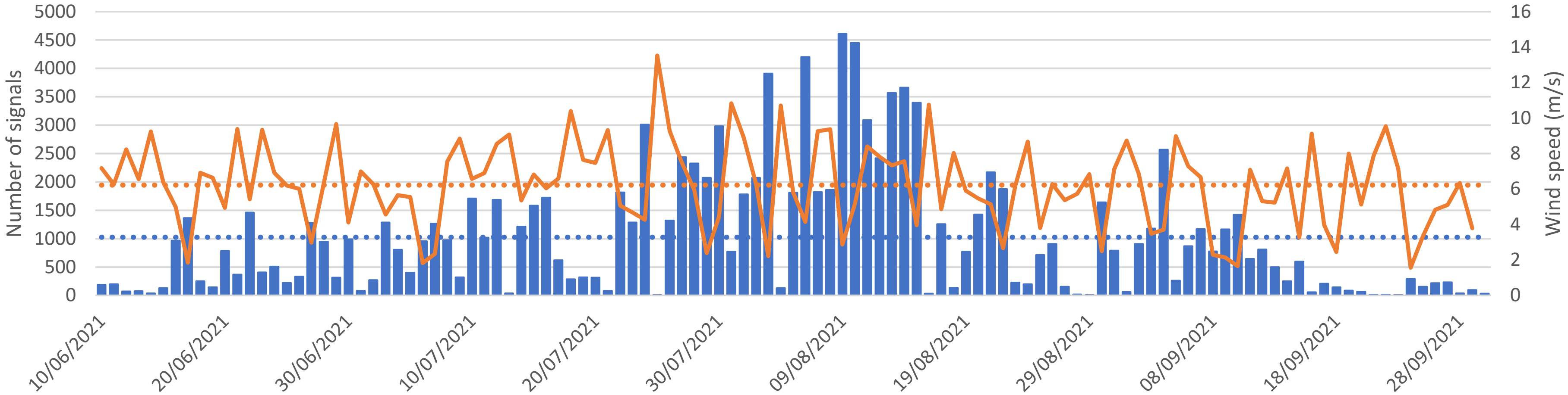
Myotis spp.



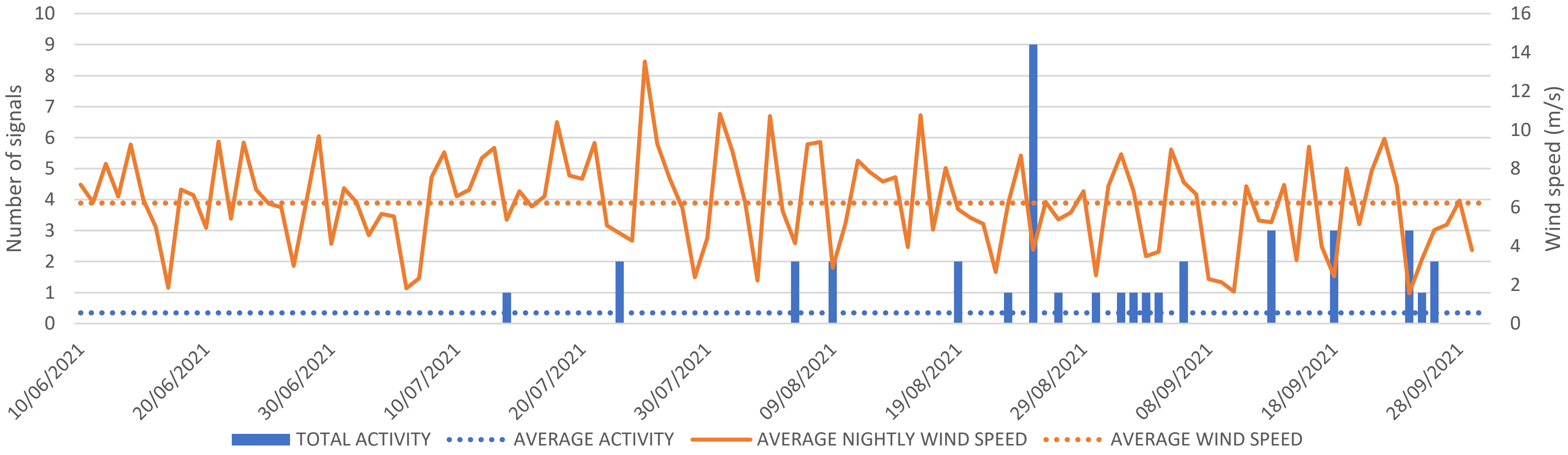
Nyctalus spp.



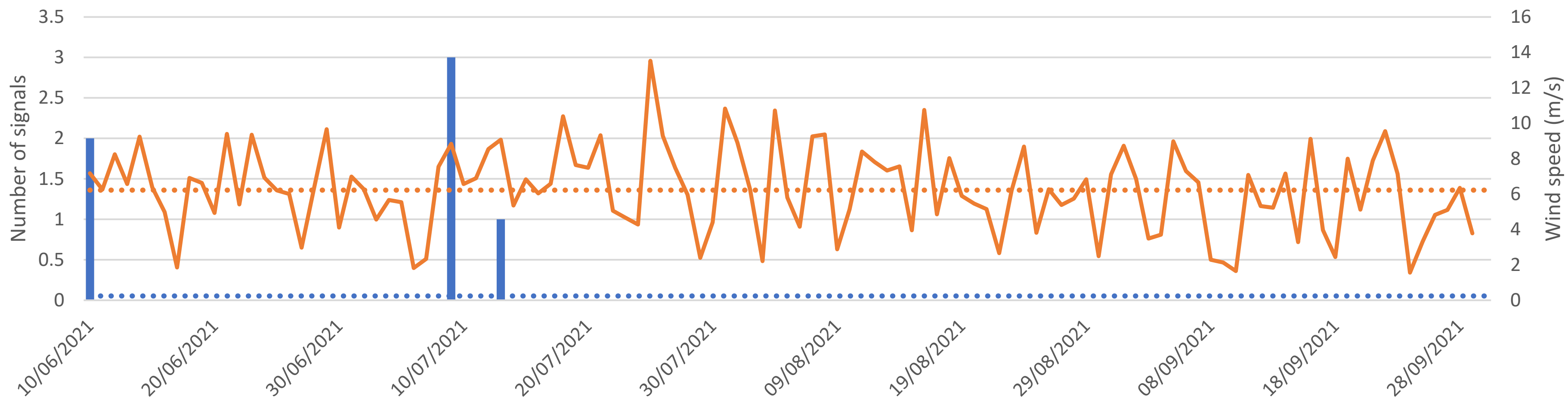
Pipistrellus spp.



Plecotus spp.



Rhinolophus spp.



Tadarida teniotis

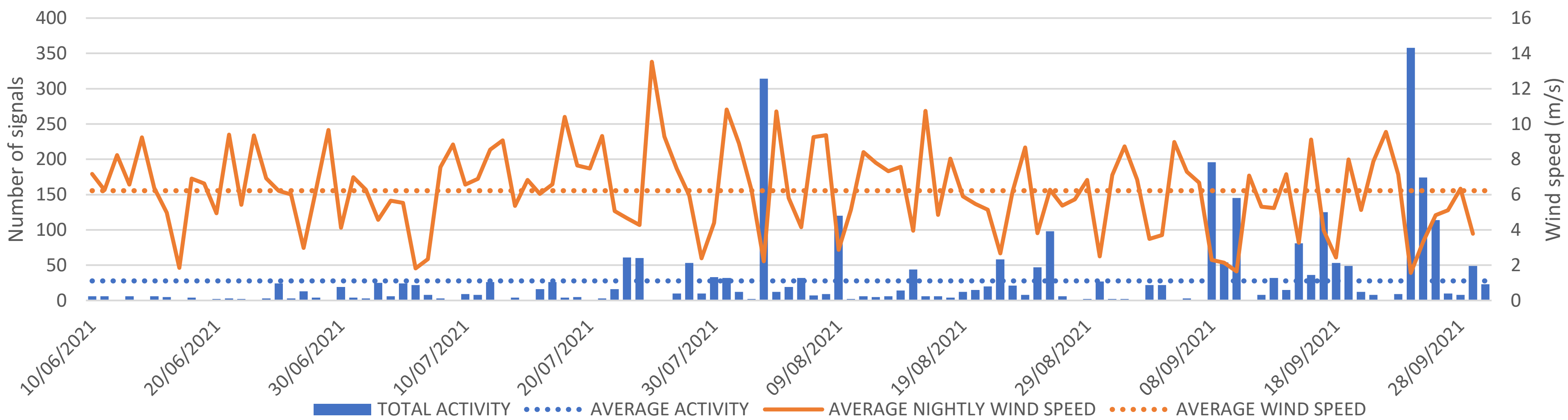


Figure 3-16. Bat activity per species and per night of recording and average night wind speed

In June, July and August, most activity (61.96 %, 55.46 % and 59.24 % respectively) was recorded at wind speeds below 6 m/s, while in September most of the activity (60.09 %) was recorded at wind speeds below 4 m/s. At winds speeds above 7 m/s, which are considered least favourable for bats, only 12.20 % of signals in June and 14.76 % of signals in September were recorded. In July, around a quarter of total signals (24.78 %) were recorded in nights with wind speed above 7 m/s and in August this percentage rose to 34.64 %, more than a third of total signals recorded (Figure 3-15, Figure 3-16). This is a significant increase when compared to 2020 when only 7.12 % of all activity in July was recorded at wind speeds above 7 m/s, and 17.80 % in August.

There were 6 nights with average wind speed over 7 m/s in June, meaning that 87.80 % of all activity accounts to 15 days of survey. In August and July, the number of days with high winds increased to 12, meaning that 75.22 % and 65.36 % of activity was recorded in 19 days, respectively. Foraging conditions were the most favourable in September, when there were 11 days with average wind speeds below 4 m/s. In total 72.49 % of activity was recorded in 20 days that had average wind speeds below 7 m/s.

Average nightly wind speed was higher at WTG1, and it had almost three times more nights with average wind speed above 7 m/s. Despite unfavourable conditions, total bat activity around WTG1 was higher than total bat activity around WTG18 (Figure 3-18). Distribution of bat activity at various wind speeds is also significantly different between these two locations: at WTG1, 39.93 % of bat activity was recorded on nights with average wind speed above 7 m/s, while at WTG18 only 4.10 % of total bat activity was recorded on nights with average wind speed above 7 m/s (Figure 3-17).

Table 3-2. Percentage of total calls for June, July, August, and September at different wind speeds

LOCATI-ON	MONTH	PERCENTAGE OF TOTAL CALLS					NUMBER OF NIGHTS WITH AVERAGE SPEED > 7 m/s
		< 4 m/s	4-5 m/s	5-6 m/s	6-7 m/s	> 7 m/s	
TOTAL	June	23.57%	24.80%	13.59%	24.84%	12.20%	6
	July	12.12%	24.56%	18.78%	19.76%	24.78%	12
	August	29.98%	9.84%	19.42%	6.12%	34.64%	12
	September	60.09%	2.20%	10.20%	12.40%	14.76%	10
WTG1	June	27.08%	40.61%	70.18%	80.94%	19.06%	10
	July	20.46%	30.86%	52.49%	68.03%	31.97%	15
	August	27.38%	36.57%	50.97%	62.08%	37.92%	15
	September	23.39%	54.46%	64.90%	65.25%	34.75%	13
WTG18	June	24.46%	65.12%	91.87%	95.16%	4.84%	5
	July	24.46%	82.49%	68.90%	94.34%	5.66%	6
	August	33.70%	70.81%	88.00%	96.68%	3.32%	5
	September	63.16%	78.72%	92.94%	97.42%	2.58%	4

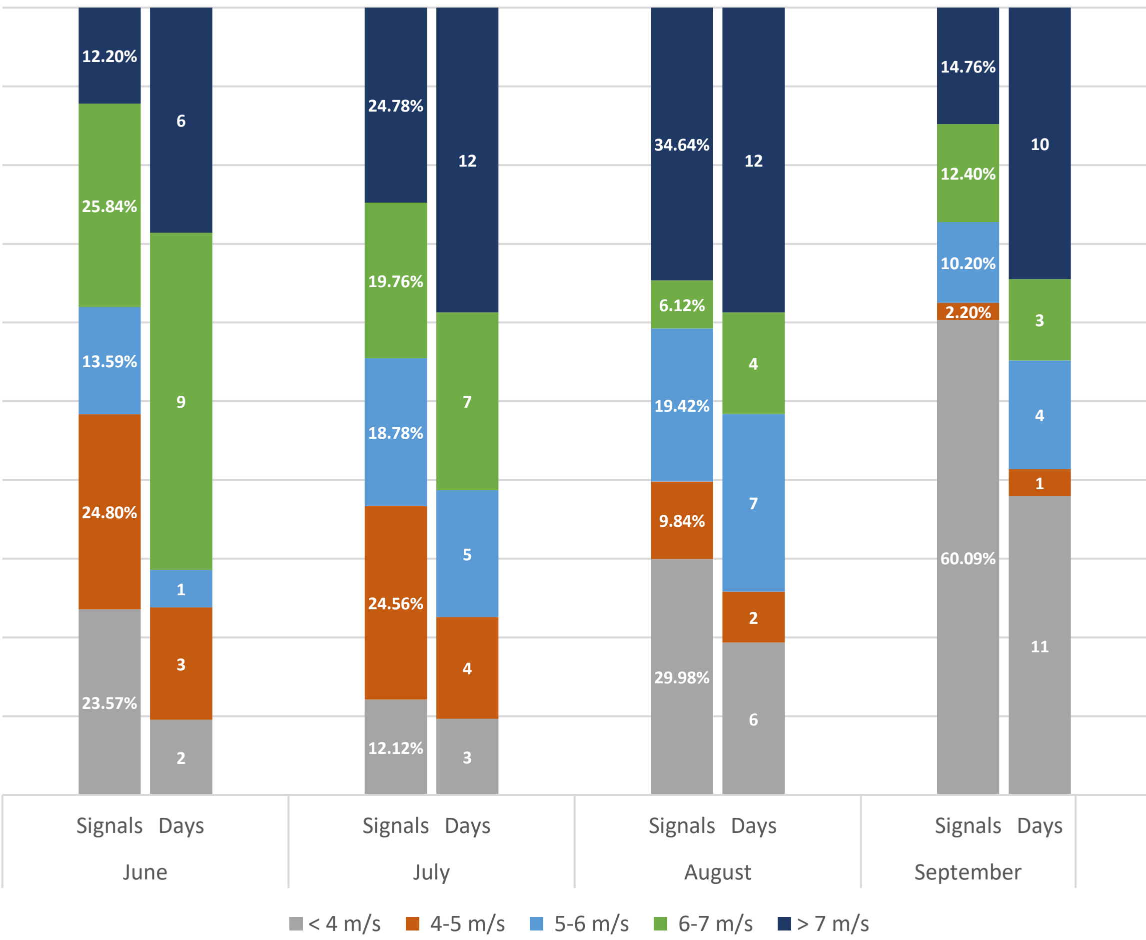


Figure 3-17. Percentage of total calls and number of days for different wind speeds per month

Analysis of the data on bat activity in relation to wind speed shows that in 84.12 % of cases bats were active when wind speed was not optimal (> 3 m/s). Only 8.74 % of nights had optimal foraging wind speed below 3 m/s. This could have forced bats to be active and forage in non-optimal conditions. It should be taken into consideration that wind speed measured at nacelle height is usually significantly higher than it is closer to the ground. Therefore, it is possible that even though wind speed at nacelle height was not optimal, wind speeds near the ground were lower and more favourable for bat activity.

While the number of days per month with the highest wind speeds was largely the same as in 2020, the overall activity on those nights in July and August increased (Figure 3-19). Average wind speed in nights when bat fatalities occurred in 2021 was 5.9 m/s, which is considered non-optimal for bat foraging. This behaviour might be a consequence of a prolonged period of relatively high wind speeds, rarely below 5 m/s on average, through most of July (9th to 23rd; Figure 3-154) that forced bats to forage more often at the end of July and in early August. Incidentally, this was the period when wind speeds rose even more which led to uncharacteristically high activity at high wind speeds, as well as high bat mortality (30 bat carcasses from July 28th to August 4th).

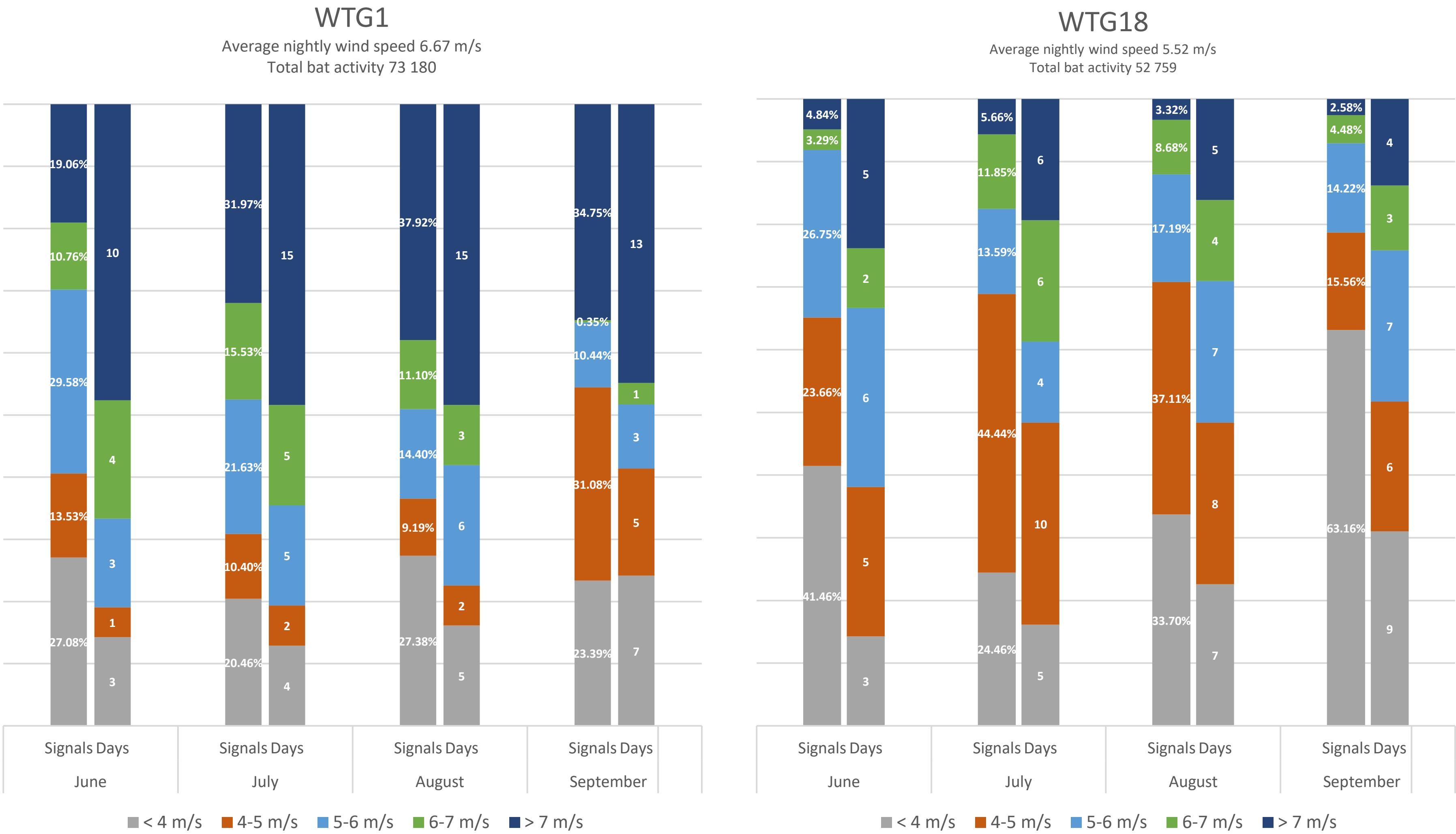


Figure 3-18. Percentage of total calls and number of days for different wind speed per month for each location of recording

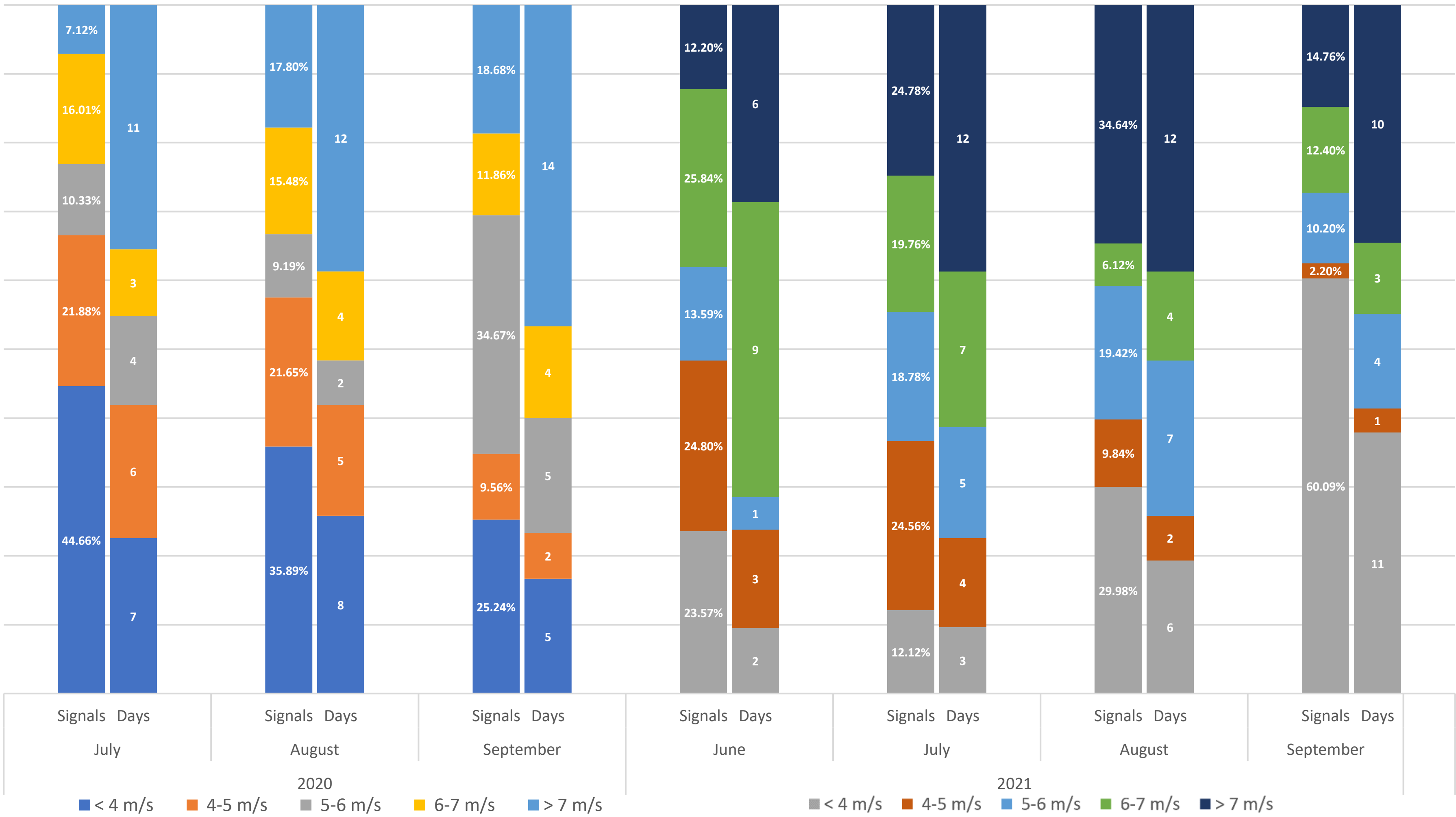


Figure 3-19. Percentage of total calls and number of days for different wind speed - comparison of 2020 and 2021 results

3.1.3 Recordings of bats feeding in WF area

When feeding, bats emit a distinct type of call, a *feeding buzz* (FB), which helps them keep track of prey when approaching it. Sonograms were analysed to identify such calls and determine whether, and how often, bats feed in areas around survey locations. In total, feeding buzz was recorded in 73 out of 144 nights of survey; 54 nights at WTG1 and 48 nights at WTG18 (Figure 3-20).

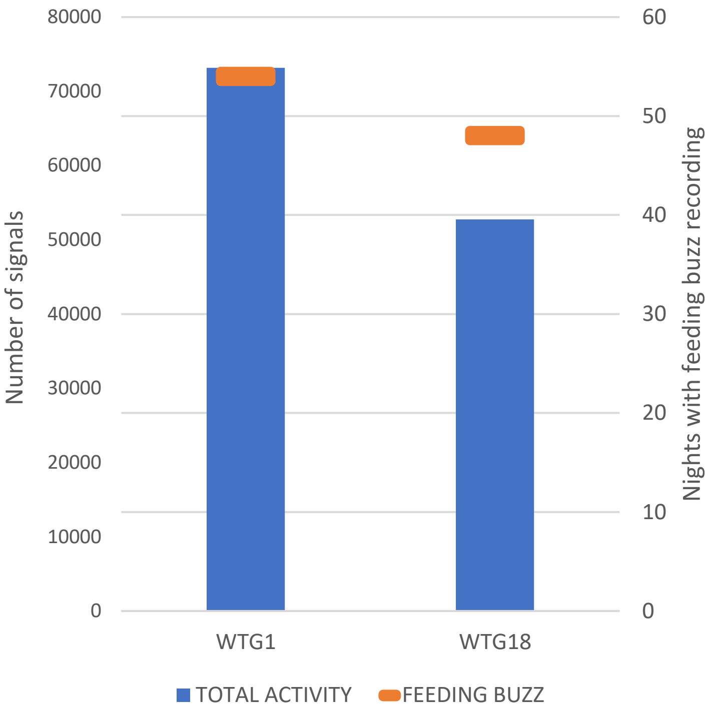


Figure 3-20. Feeding buzz signals compared to overall activity at both locations

At both locations, most of FB signals belonged to species of genus *Pipistrellus* (96.3 % at WTG1 and 85.42 % at WTG18). Feeding buzz of *Eptesicus serotinus*, *Hypsugo savii*, *Myotis* spp., *Tadarida teniotis* and *Eptesicus/Nyctalus* taxa was also recorded.

When compared to overall activity bats were more likely to feed near the WTG18 location compared to the WTG1 recording location. This can indicate that the area around WTG18 is a better foraging habitat for the most common species (*Pipistrellus* spp.), while the area around WTG1 is more often a migration route.

July was the month with the highest number of nights with feeding buzz (23), while there were no recordings of feeding buzz in October (Figure 3-21, Figure 3-22). Despite August having the highest overall activity, the number of nights with FB calls remained lower than in July. A nearly constant overall number of nights with FB calls from June to September indicates that the WF Jelinak area is a foraging habitat for local bat populations, but the foraging behaviour may vary with weather conditions, prey abundance etc. Absence of recorded foraging in October may be due to low recorded activity.

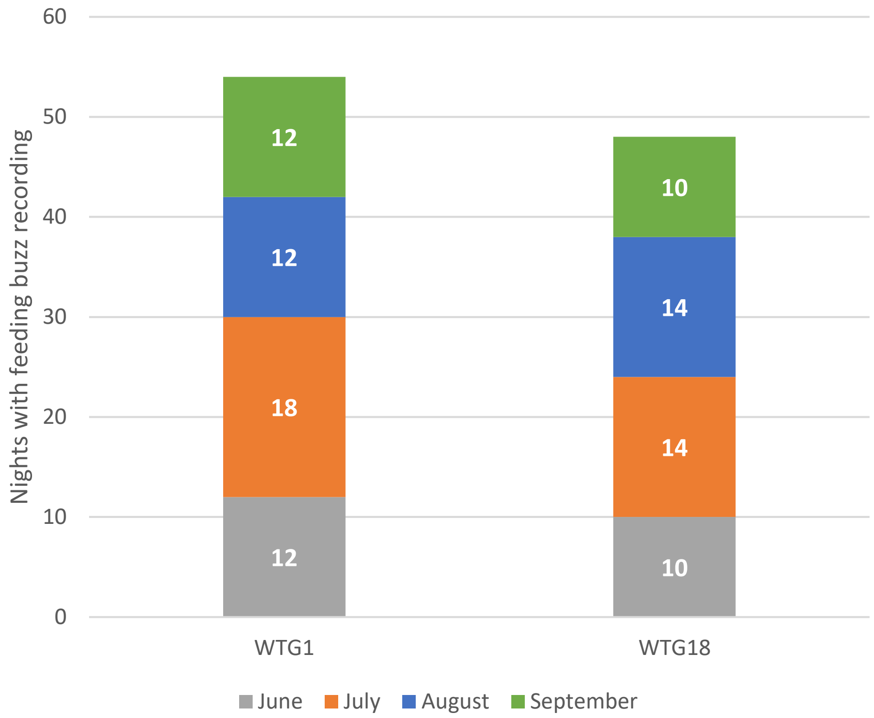


Figure 3-21. Feeding buzz signals per month at each recording location

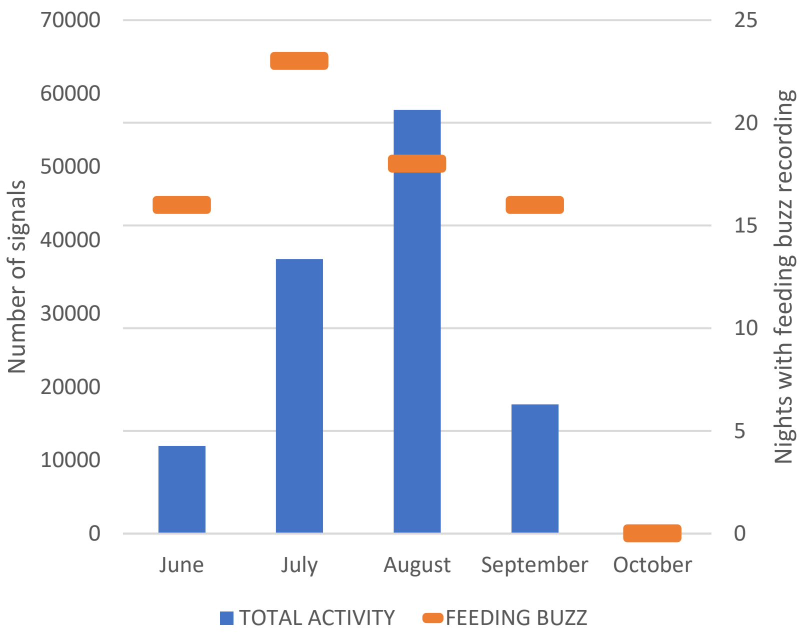


Figure 3-22. Feeding buzz signals compared to bat activity per month

3.2 Periodic bat call recording on a transect route

During eight nights in July and August, 573 signals were recorded in total. Most of the signals (more than 85 %) belonged to *Pipistrellus kuhlii*, *Pipistrellus kuhlii/P. nathusii* and *Pipistrellus kuhlii/Hypsugo savii*, marked as such since some species sometimes could not be distinguished by this method of identification. However, considering dominantly open habitats in the wind farm area, it is more likely that signals marked as *Pipistrellus kuhlii/P. nathusii* belonged to *Pipistrellus kuhlii*, since *Pipistrellus nathusii* prefers deciduous forests, forest edges and riparian areas where it usually follows linear landscape elements (Kyheröinen et al. 2019). With *Hypsugo savii* counted in, more than 93 % of the recorded signals belonged to these species. The rest of the recorded species were *Pipistrellus pipistrellus*, *P. pygmaeus*, *Rhinolophus hipposideros*, *R. euryale* and genus *Myotis* (Figure 3-23, Table 3-3). A proportion of recorded species' activity, *Pipistrellus* spp. being the most abundant, is comparable to activity recorded at stationary points.

During periodic bat call recording on a transect route in July and August, 21 feeding buzz calls were recorded in total. The calls were recorded during four out of eight nights. Most of the calls (more than 80 %) were recorded on July 29th and July 30th, which is proportional to recorded activity. More than 80 % of the calls belonged to *Pipistrellus kuhlii* and *Pipistrellus kuhlii/P. nathusii*. The remaining calls belonged to *Pipistrellus pipistrellus*, *Hypsugo savii* and genus *Myotis,* proportional to total species composition.

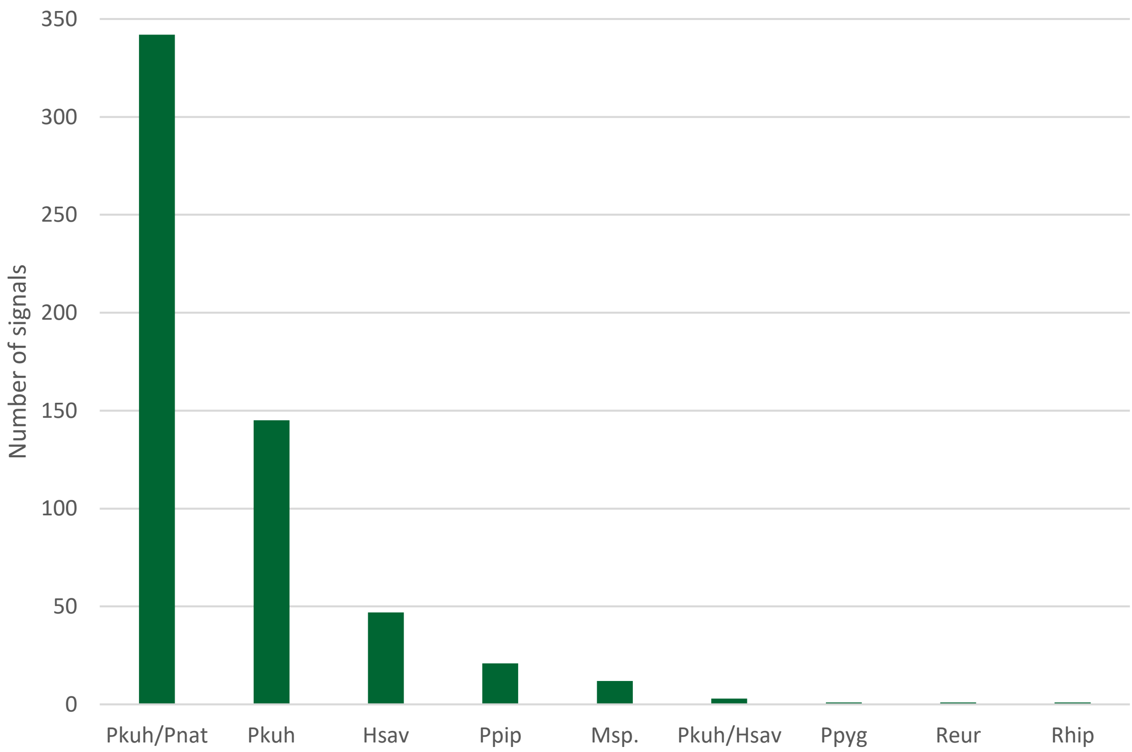


Figure 3-23. Number of calls per species/group recorded during periodic bat call recording on a transect route

(Pkuh = Pipistrellus kuhlii, Pnat = Pipistrellus nathusii, Hsav = Hypsugo savii, Ppip = Pipistrellus pipistrellus, Msp. = Myotis sp., Ppyg = Pipistrellus pygmaeus, Reur = Rhinolophus euryale, Rhip = Rhinolophus hipposideros)

Table 3-3. Number of signals per species/group recorded during periodic sounds recording on a transect route

SPECIES/GROUP	NUMBER OF BAT SIGNALS								TOTAL	PROPORTION
	15.07.2021.	16.07.2021.	29.07.2021.	30.07.2021.	12.08.2021.	13.08.2021.	29.08.2021.	31.08.2021.		
Pipistrellus kuhlii/ Pipistrellus nathusii	27	35	68	103	63	24	1	21	**342**	**59.7 %**
Pipistrellus kuhlii	5	17	37	47	14	17	-	8	**145**	**25.3 %**
Hypsugo savii	4	3	21	9	4	3	-	3	**47**	**8.2 %**
Pipistrellus pipistrellus	6	-	8	4	-	1	2	-	**21**	**3.7 %**
***Myotis* sp.**	-	1	4	1	3	2	-	1	**12**	**2.1 %**
Pipistrellus kuhlii/ Hypsugo savii	-	-	-	-	1	2	-	-	**3**	**0.5 %**
Rhinolophus euryale	-	-	1	-	-	-	-	-	**1**	**0.2 %**
Rhinolophus hipposideros	-	-	-	-	-	1	-	-	**1**	**0.2 %**
Pipistrellus pygmaeus	-	-	-	-	-	-	-	1	**1**	**0.2 %**
UKUPNO	**42**	**56**	**139**	**164**	**85**	**50**	**3**	**34**	**573**	**100.0 %**

To get more accurate quantification of bat activity, an activity index adjusted with detectability coefficient was used.

The **activity index (AI)** was calculated following methodology proposed in Miller 2001. The index uses the time unit of one minute in which bat activity is observed. Therefore, one minute of recording time represents one count of activity of a certain species. The one-minute time unit is short enough to reflect minor changes in bat activity, while reducing some effects that might distort quantification of the actual level of activity. One of the causes of these effects is the difference between calls of different bat species. While some bats, for example *Pipistrellus* spp. and *Myotis* spp., emit a higher number of short calls during a search phase, others, like *Tadarida teniotis*, use fewer but longer pulses. Accordingly, if one individual of each species was foraging during a one-minute period, less calls of the latter would be recorded, though the level of activity was the same. The other effect is caused by the difference between individuals in flight behaviour near a bat detector. Bats can fly in different directions and at different distances from the detector. When an individual briefly ventures outside the detector's range and then returns, it causes an interruption in recording, so it appears as several separate signals. The method described by Miller reduces these effects and allows a more accurate comparison of each species' relative contribution to activity during the survey.

The activity index was calculated by counting the number of one-minute periods in which a certain species was recorded (i.e., deducting repeated signals of the same species during the same minute) (Table 3-4). The activity index reduced the number of signals by more than two thirds for species with the greatest number of signals.

The activity index was additionally adjusted with **detectability coefficient (c_d)**. The detectability coefficient is used because, depending on their ecology, different bat species emit calls of different intensity. Signals emitted with increased intensity have a larger detection range, i.e., species emitting such signals can be detected at greater distances from the bat detector. The detectability coefficient was therefore, derived from the detection range, applying higher values to less detectable and lower values to more detectable species. By multiplying the number of signals or activity index with the coefficient, the level of activity of different species is assessed as if they emitted signals with the same detection probability:

*adjusted activity index = activity index * detectability coefficient*

Detectability coefficients for bats in an open to a semi-open environment as described by Barataud (2020) were used for the adjustment. Barataud classifies *Rhinolophus* and most of *Myotis* species into a group with weak intensity of signal emission, some *Myotis* spp., *Pipistrellus* spp. and *Miniopterus* spp. into a group with medium intensity emission, *Hypsugo savii* into a group with strong intensity of emission and *Tadarida teniotis* into a group with very strong intensity of emission. For signals which could not be identified as one particular species, arithmetic means of activity indices of possible species was taken as activity index value. The proportion of activity of species with strong intensity of emission (*Hypsugo savii*) decreased, while the percentage of species with weak intensity (*Rhinolophus* sp., *Myotis* sp.) increased (Table 3-4).

For the purpose of activity assessment comparable between different time periods, activity index per hour was calculated for all species of each survey conducted. The index per hour is equal to adjusted activity index multiplied by one hour (60 minutes) and divided by duration of a survey (in minutes):

*activity index per hour = adjusted activity index * 60 min / survey duration (min)*

Mean activity index per hour (c_dAI/h) is the arithmetic mean of indices calculated in an observed period. Mean activity index per hour for all surveys reflects the share of total activity expressed by the adjusted activity index (Table 3-4, Figure 3-24).

Table 3-4. Total number of signals, activity index, adjusted activity index and mean activity index per hour for bat species/group recorded during periodic sounds recording on a transect route

SPECIES/GROUP	NUMBER OF SIGNALS	AI*	c_d**	c_dAI	MEAN c_dAI/h
Pipistrellus kuhlii/ Pipistrellus nathusii	**342** (59.7 %)	**186** (51.7 %)	1.00	**186.00** (51.4 %)	**75.02** (51.4 %)
Pipistrellus kuhlii	**145** (25.3 %)	**109** (30.3 %)	1.00	**109.00** (30.1 %)	**43.96** (30.1 %)
Hypsugo savii	**47** (8.2 %)	**34** (9.4 %)	0.63	**21.42** (5.9 %)	**8.56** (5.9 %)
Pipistrellus pipistrellus	**21** (3.7 %)	**13** (3.6 %)	1.00	**13.00** (3.6 %)	**5.24** (3.6 %)
***Myotis* sp.**	**12** (2.1 %)	**12** (3.3 %)	1.81	**21.68** (6.0 %)	**8.76** (6.0 %)
Pipistrellus kuhlii/ Hypsugo savii	**3** (0.5 %)	**3** (0.8 %)	0.82	**2.45** (0.7 %)	**1.04** (0.7 %)
Rhinolophus euryale	**1** (0.2 %)	**1** (0.3 %)	2.50	**2.50** (0.7 %)	**0.96** (0.7 %)
Rhinolophus hipposideros	**1** (0.2 %)	**1** (0.3 %)	5.00	**5.00** (1.4 %)	**2.14** (1.5 %)
Pipistrellus pygmaeus	**1** (0.2 %)	**1** (0.3 %)	1.00	**1.00** (0.3 %)	**0.40** (0.3 %)
UKUPNO	**573**	**360**		**362.05**	**146.09**

*(Source: *according to Miller 2001; **Barataud 2020)*

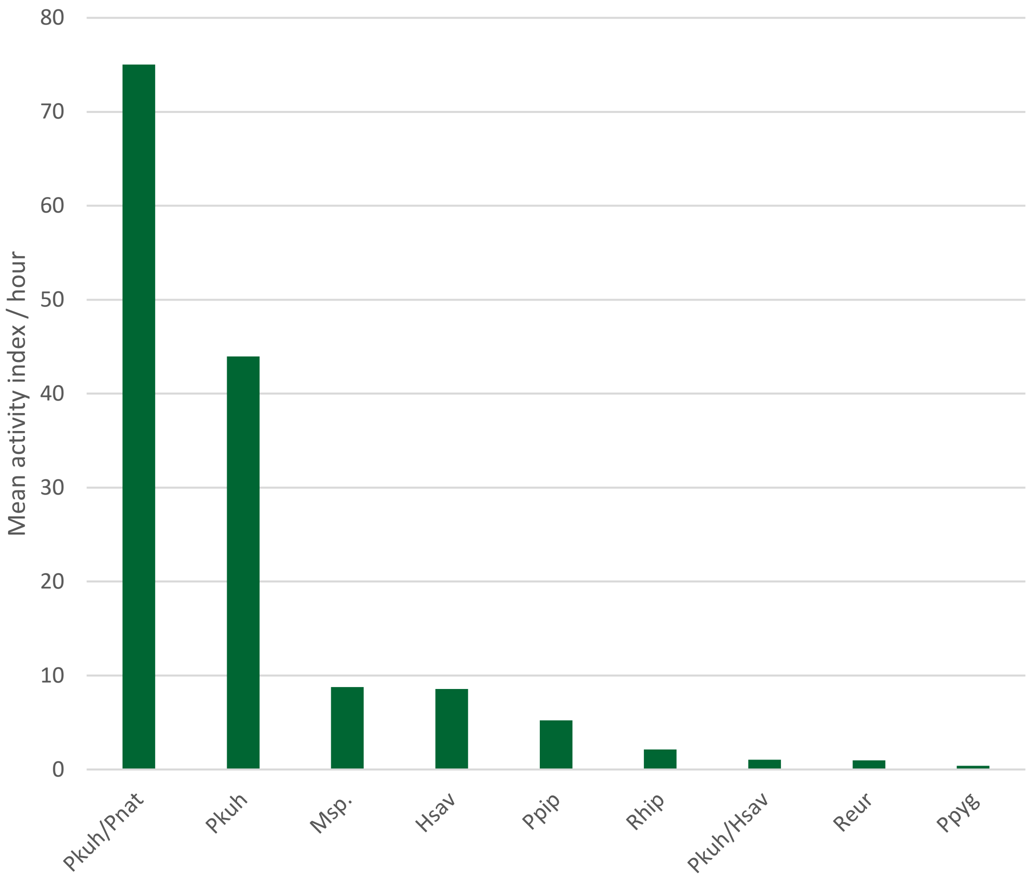


Figure 3-24. Mean activity index per hour for bat species/group recorded during bat call recording on a transect route

(Pkuh = Pipistrellus kuhlii, Pnat = Pipistrellus nathusii, Msp. = Myotis sp. Hsav = Hypsugo savii, Ppip = Pipistrellus pipistrellus, Ppyg = Pipistrellus pygmaeus, Reur = Rhinolophus euryale, Rhip = Rhinolophus hipposideros)

The highest bat activity was recorded east of Veliki Jelinak peak, between WTG10 and WTG11, WTG14 and WTG16, and near WTG7. Activity was also high at the location of stationary recording SR1 at WTG2 (Figure 3-25-Figure 3-27). These sections of the transect had higher activity than the rest of the transect during recording along the same transect route in 2020 as well (Figure 3-28).

The highest feeding activity was recorded between WTG15 and WTG16, between WTG4 and WTG5, and near WTG2, at the location of stationary recording SR1. The highest feeding activity mostly coincides with the overall highest bat activity.

The lowest activity was recorded around the peak Dabgora, in the area of WTG19 and WTG20. Low activity was also regularly recorded near WTG12. That could be because WTG12 and WTG19 are further away from the access road, i.e. from the transect route. It was observed that bat activity was generally higher around WTG's than in the surrounding area, because bats often circle around WTG towers, above the manipulative plateau.

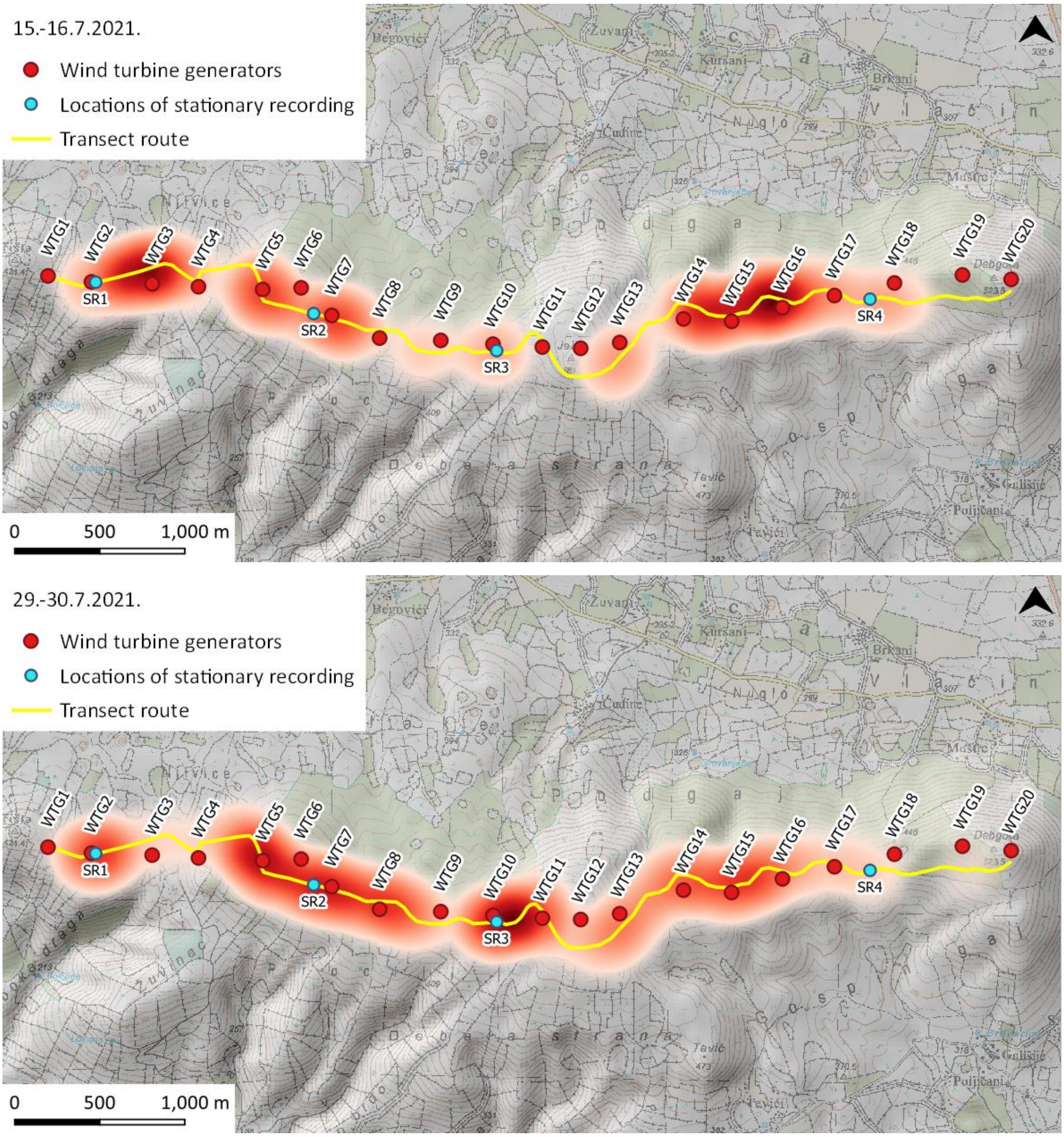


Figure 3-25. Heatmaps of activity index along the transect route in July 2021

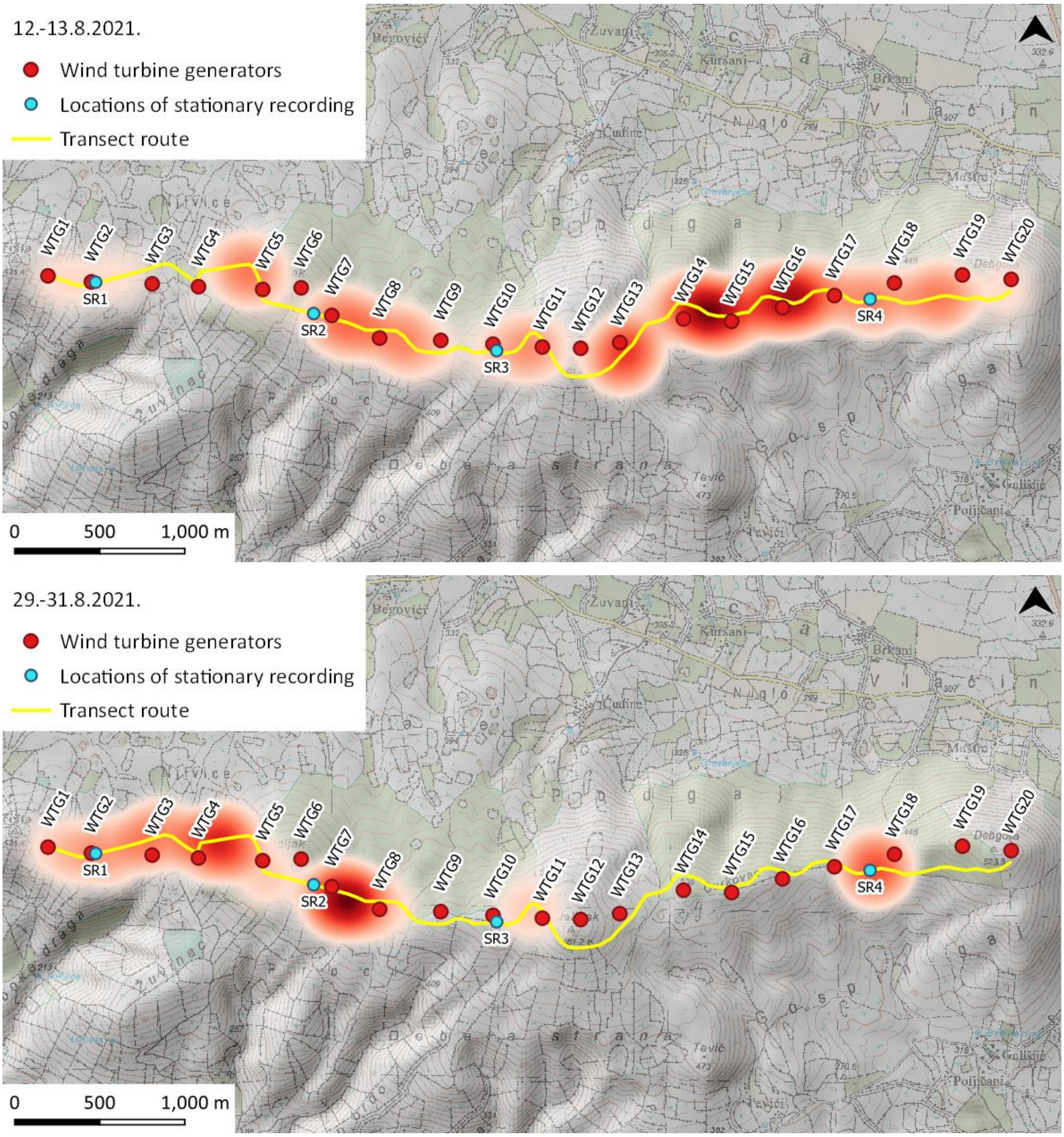


Figure 3-26. Heatmaps of activity index along the transect route in August 2021

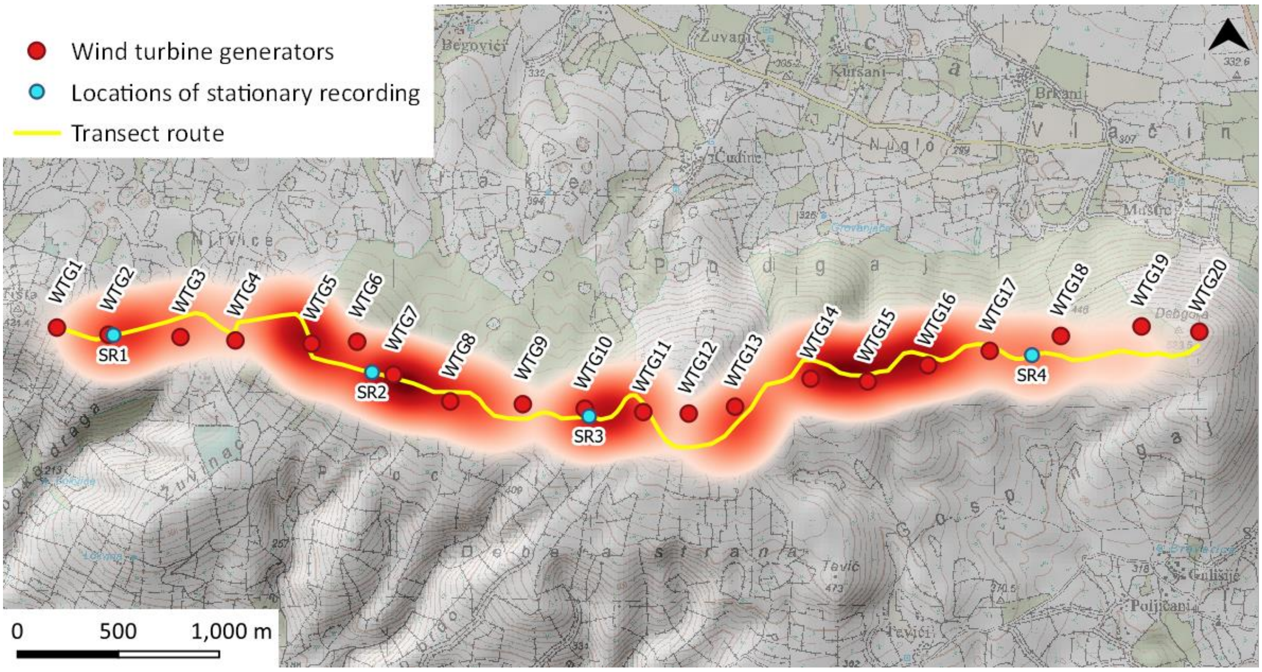


Figure 3-27. Heatmap of total activity index along the transect route in 2021

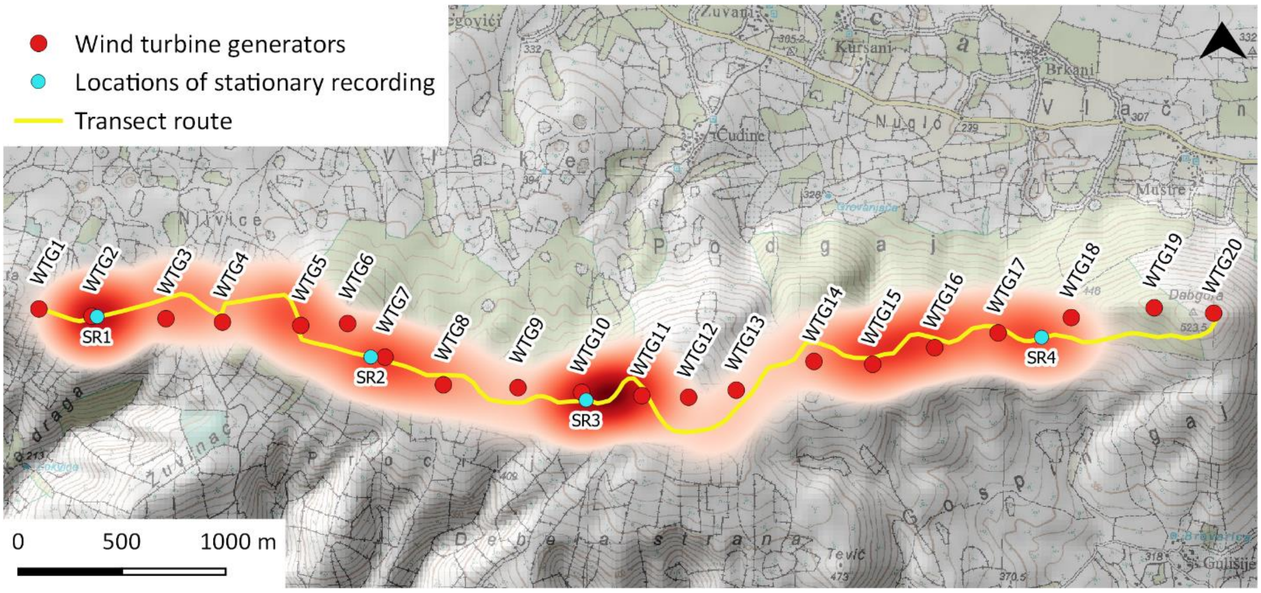


Figure 3-28. Heatmap of total activity index along the transect route in 2020

Wind speed and direction at each WTG from July to September was analysed. At WTG1, WTG2, WTG5, WTG9-WTG12, WTG15, WTG19 and WTG20, which are positioned at the highest altitudes around peaks Pišna, Veliki Jelinak and Dabgora, wind speed was often higher than the average wind speed on all WTG's (Figure 3-29). That is likely why low bat activity was recorded around WTG12, WTG19 and WTG20. Overall distribution of average wind speeds at the WTG’s was similar as in 2020, and the average wind direction was very similar (from the south).

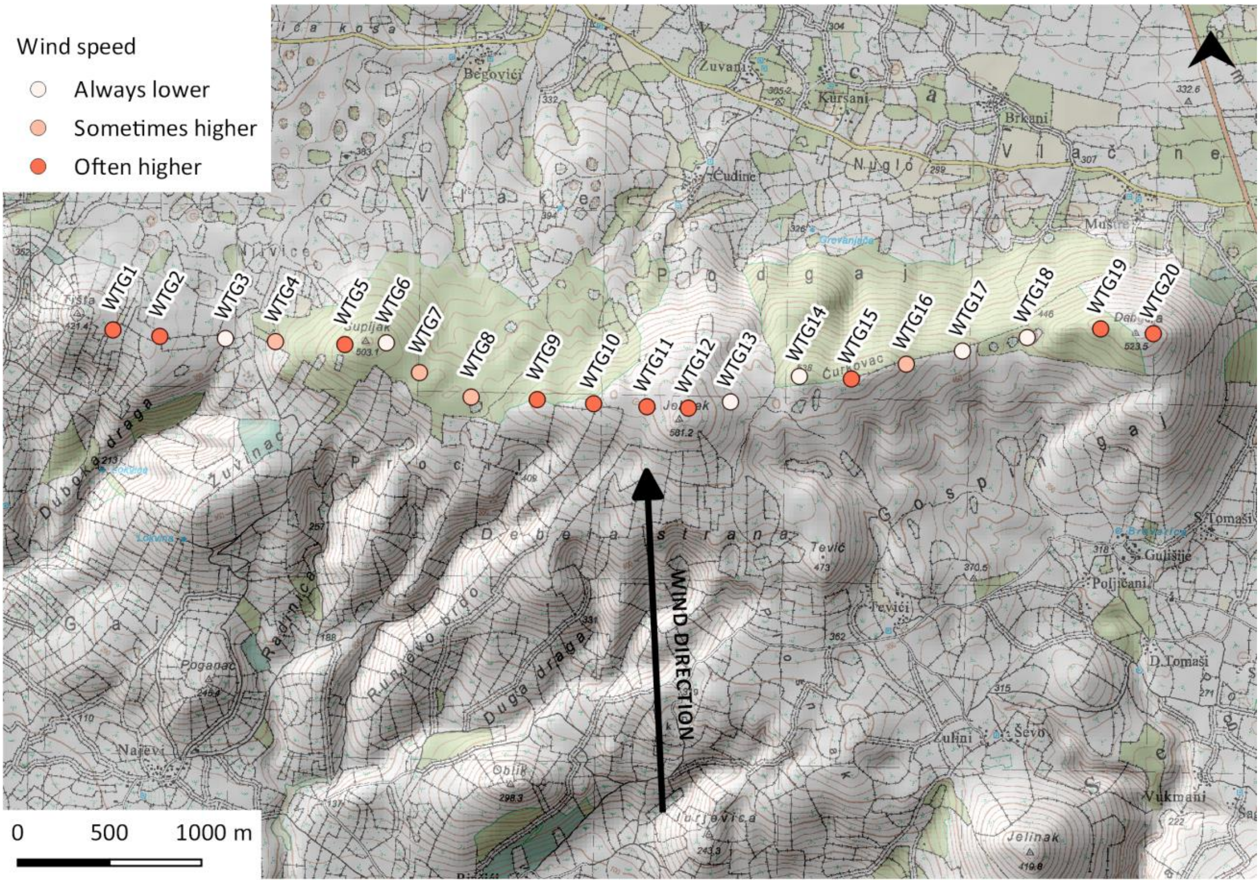


Figure 3-29. Wind speed at each WTG in regards to average wind speed of all WTG's and average wind direction recorded at nacelle height from July to September 2021

3.3 Monitoring of bat collisions

Bat carcasses were found during every month of the survey, except in October. In total, 53 carcasses were found. The carcasses belonged to at least three different bat species: *Hypsugo savii* (27), *Pipistrellus kuhlii* (21) and *Pipistrellus pipistrellus* (1). Four carcasses were in too poor a condition for identification (three were noted as Chiroptera sp. and one as *Pipistrellus* sp.) (Table 3-5). Those were classified as smaller bat species (e.g., *Pipistrellus* spp., *Hypsugo savii*) based on the lengths of their forearms (FA < 36 mm), which is one of the main morphological features in bat species identification (Dietz and von Helversen 2014). The three carcasses in poor condition were discovered in the midsummer (July and August), when carcasses were the most exposed to ants and wasps (Figure 3-30), as well as to faster tissue decay due to higher ambient temperatures. The remaining carcass in poor condition was discovered in September when the interval between the searches was six days.

All species found are rated to have a high collision risk with WTG's because they fly and forage in open space. In contrast, bats species which fly close to vegetation (gleaning bats) have a lower risk of colliding with WTG's (e.g., *Myotis* spp., *Rhinolophus* spp.) (Rodrigues et al. 2014).

Table 3-5. Number of bat carcasses found regarding bat species

SPECIES	NUMBER OF CARCASSES					
	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	TOTAL
Hypsugo savii	3	6	17	1	-	**27**
Pipistrellus kuhlii	1	17	3	-	-	**21**
Chiroptera sp. (FA < 36 mm)	-	2	-	1	-	**3**
Pipistrellus pipistrellus	-	-	1	-	-	**1**
***Pipistrellus* sp.**	-	-	1	-	-	**1**
TOTAL	**4**	**25**	**22**	**2**	**0**	**53**

Figure 3-30. Ants and wasps scavenge on bat carcasses

Most of the carcasses had no apparent external injuries, which could mean that barotrauma was a possible cause of death. Bats experience barotrauma when encountering vortices at blade tips, which can lead to haemothorax (Baerwald 2008). Some of the carcasses had fractures of wing bones (forearm, upper arm, shoulder, elbow). The fractures were most probably a consequence of collision with turbine blades, but it is possible that some were a result of the fall or that they were run over by vehicles after the fall.

The complete list of bat carcasses found with their description is in Appendix V of this document.

All bat species in Croatia are strictly protected by law (Ordinance on Strictly Protected Species, Official Gazette 144/13, 73/16; based on the Nature Protection Act, Official Gazette 80/13, 15/18, 14/19, 127/19). All recorded species are listed as Appendix IV species, i.e. animal and plant species of community interest in need of strict protection, both within and outside Natura 2000 sites (Appendix IV of the Council Directive 92/43/EEC – Habitats Directive) and are protected by the Bern Convention (Appendix II – strictly protected species and Appendix III – protected species of the Convention on the Conservation of European Wildlife and Natural Habitats, 1979) (Table 3-6). Accordingly, a strict protection regime must be implemented for all present bat species as a priority in bat conservation, as well as a legal obligation.

Table 3-6. Protection and IUCN status of bat species found dead in the WF area

SPECIES	ORDINANCE ON STRICTLY PROTECTED SPECIES	IUCN WORLD	IUCN CROATIA	HABITATS DIRECTIVE (APPENDIX NO.)	BERN CONVENTION (APPENDIX NO.)
Hypsugo savii	SP	-	-	IV	II
Pipistrellus kuhlii	SP	LC	-	IV	II
Pipistrellus pipistrellus	SP	LC	-	IV	III

***SP** = strictly protected species; **LC** = least concerned species*
(Sources: Ordinance on Strictly Protected Species, Official Gazette 144/13, 73/16; IUCN Red List of Threatened Species; Antolić et al. 2006; European Council Directive 92/43/EEC; European Council Convention on the Conservation of European Wildlife and Natural Habitats, 1979)

3.3.1 Number of carcasses per WTG

Regarding WTG's, the highest number of carcasses (9) was found at WTG3. The second highest number (6) was at WTG10. Five carcasses were found at WTG1, WTG9 and WTG11 each, four at WTG2 and WTG16, three at WTG15 and WTG17, two at WTG7, WTG12 and WTG13, and one at WTG4, WTG8 and WTG18. At WTG5, WTG6, WTG14, WTG19 and WTG20 no carcasses were found. In total 9 WTG's had mortality higher than average (WTG1, WTG2, WTG3, WTG9, WTG10, WTG11, WTG15, WTG16 and WTG17; average 2.65) (Figure 3-31).

At WTG3, which had the highest number of recorded fatalities, the carcasses were found during every month of the survey, except in October (Figure 3-32).

Mortality was recorded at three out of 14 WTG's with implemented mitigation measures in the first half of July, eight out of 14 in the second half of July, seven out of 14 in the first half of August and one out of 14 in the second half of August (Table 3-7). In September, mortality was not recorded at WTG's with implemented mitigation measures.

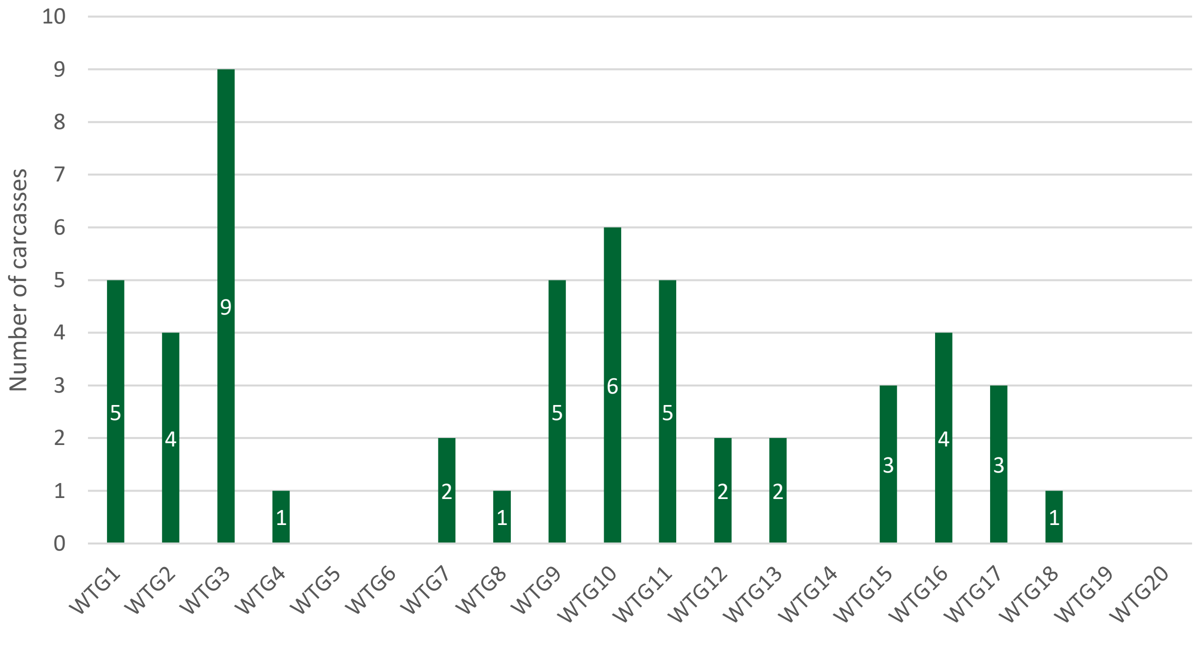


Figure 3-31. Number of bat carcasses found at each WTG

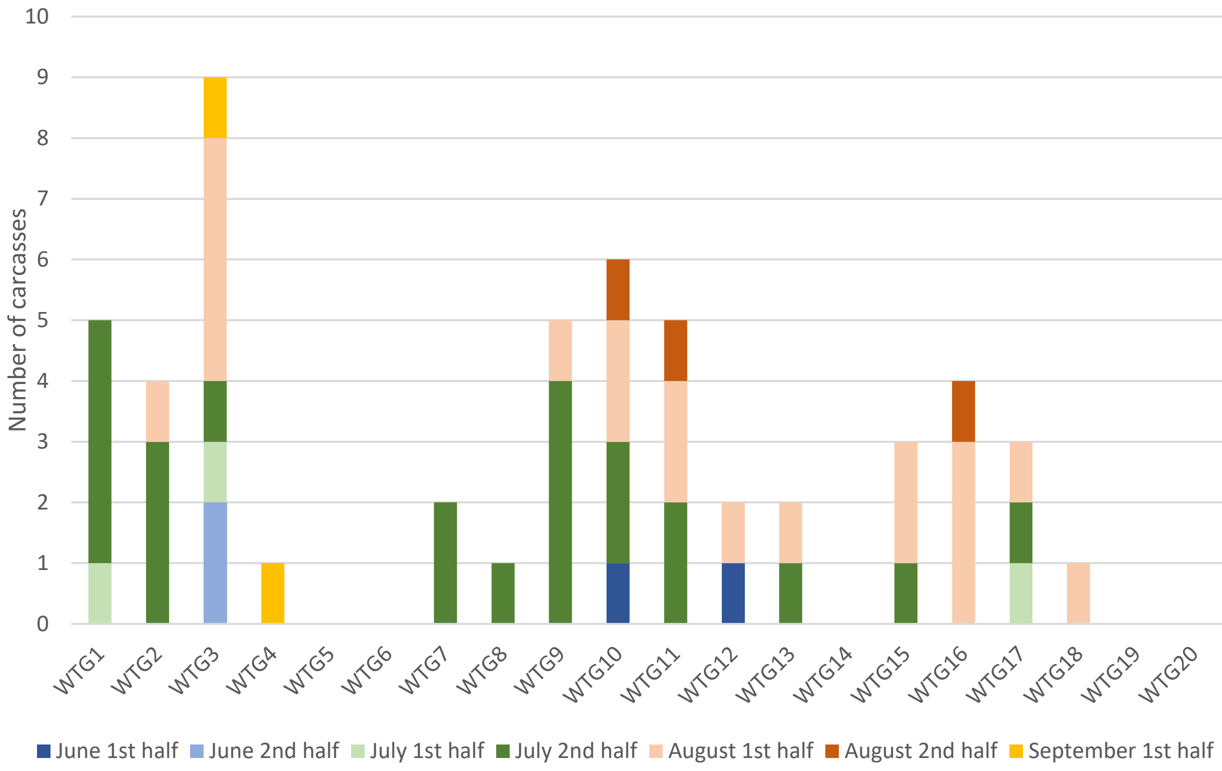


Figure 3-32. Number of bat carcasses found at each WTG per half a month

Table 3-7. Number of bat carcasses found per month at each WTG

WTG	NUMBER OF CARCASSES									
	JUNE 1st HALF	JUNE 2nd HALF	JULY 1st HALF	JULY 2nd HALF	AUGUST 1st HALF	AUGUST 2nd HALF	SEPTEMBER 1st HALF	SEPTEMBER 2nd HALF	OCTOBER	TOTAL
WTG1	-	-	1	4	-	-	-	-	-	**5**
WTG2	-	-	-	3	1	-	-	-	-	**4**
WTG3	-	2	1	1	4	-	1	-	-	**9**
WTG4	-	-	-	-	-	-	1	-	-	**1**
WTG5	-	-	-	-	-	-	-	-	-	**0**
WTG6	-	-	-	-	-	-	-	-	-	**0**
WTG7	-	-	-	2	-	-	-	-	-	**2**
WTG8	-	-	-	1	-	-	-	-	-	**1**
WTG9	-	-	-	4	1	-	-	-	-	**5**
WTG10	1	-	-	2	2	1	-	-	-	**6**
WTG11	-	-	-	2	2	1	-	-	-	**5**
WTG12	1	-	-	-	1	-	-	-	-	**2**
WTG13	-	-	-	1	1	-	-	-	-	**2**
WTG14	-	-	-	-	-	-	-	-	-	**0**
WTG15	-	-	-	1	2	-	-	-	-	**3**
WTG16	-	-	-	-	3	1	-	-	-	**4**
WTG17	-	-	1	1	1	-	-	-	-	**3**
WTG18	-	-	-	-	1	-	-	-	-	**1**
WTG19	-	-	-	-	-	-	-	-	-	**0**
WTG20	-	-	-	-	-	-	-	-	-	**0**
TOTAL	**2**	**2**	**3**	**22**	**19**	**3**	**2**	**0**	**0**	**53**

*WTG's with implemented mitigation measures are marked **yellow***

3.3.2 Bat mortality per month

Most of the carcasses were found in July and August, with a maximum in July (25 carcasses). In June and September less carcasses were found, while at the beginning of October there were no findings (Table 3-5). These numbers reflect entirely the recorded bat activity (Figure 3-1). Most of the carcasses found were *Hypsugo savii* and *Pipistrellus* spp. (Figure 3-33).

Activity of *Pipistrellus* spp. and *Hypsugo savii* was the highest in July and August, same as mortality. This is likely because females give birth in late May and in June, and juveniles can actively fly by the end of July or in August. Adults begin mating in August, therefore, during this period bat activity is at its peak. During the end of July and in August, carcasses of juvenile and subadult individuals of *Pipistrellus* spp. and *Hypsugo savii* were found. Also, there were 23 adult females among the found carcasses, some of them in the period when bats in the area raise their young. Females gathered in maternity colonies, as well as juveniles, often forage closer to their roosts which may indicate that the WF area is within their foraging area. *Pipistrellus* and *Hypsugo* species are often found near human settlements, and they rarely have daily migrations over great distances, so the maternity colonies or other roosts may be located in the nearby settlements (Bristivica, Blizna).

In September, mating continues, and autumn migrations take place. Activity was high, but not as high as in July and August. Activity of some species such as *Tadarida teniotis* and *Nyctalus* spp., on the other hand, was at its peak, which indicates that these species migrate in autumn in higher abundances across the WF area. However, no fatalities were found of these species. It is possible that implemented mitigation measures prevented their mortality.

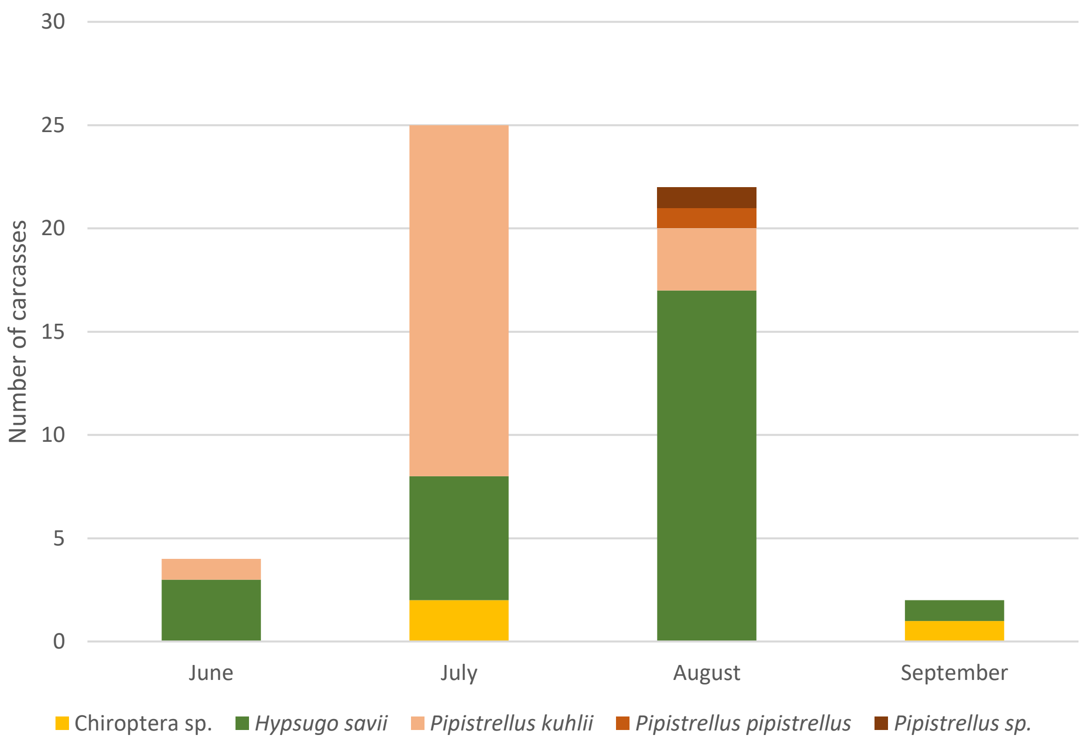


Figure 3-33. Number of bat carcasses found per species per month

3.3.3 Bat mortality in relation to activity

Bat carcasses were usually found after nights of higher bat activity, meaning that bat mortality increases with an increase of bat activity (Figure 3-34). The relation cannot be completely reliable because bat activity was recorded only at two locations, so activity around other WTG's could have been different in the same period.

For both *Pipistrellus kuhlii* and *Hypsugo savii*, mortality increased in correlation with increased activity of the species. Due to the small sample of carcasses found, there is no clear conclusion on relation of mortality and activity for other taxa (Figure 3-35).

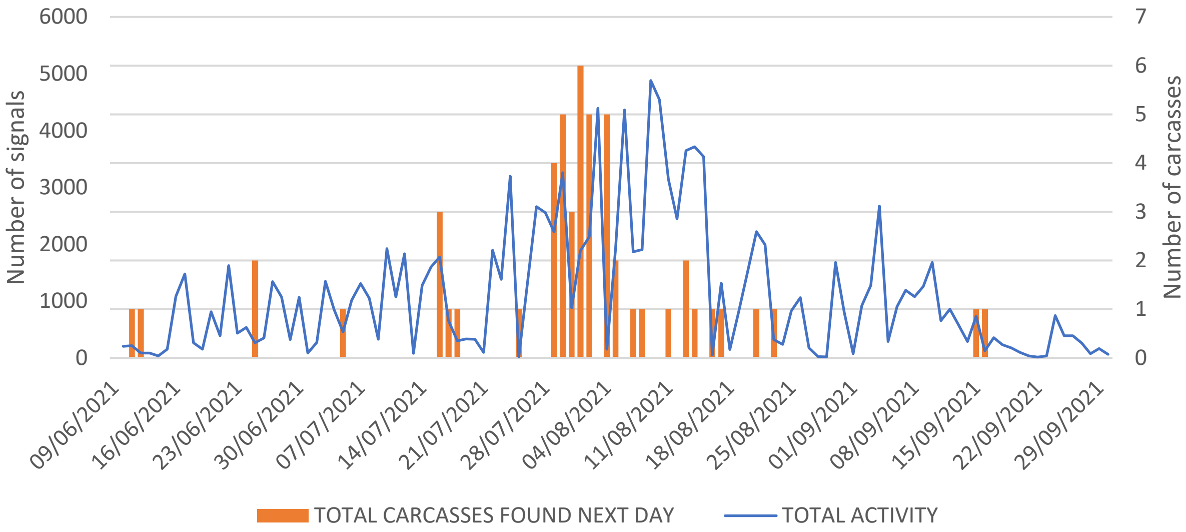


Figure 3-34. Corelation of bat mortality and activity (no daily searches in June and September)

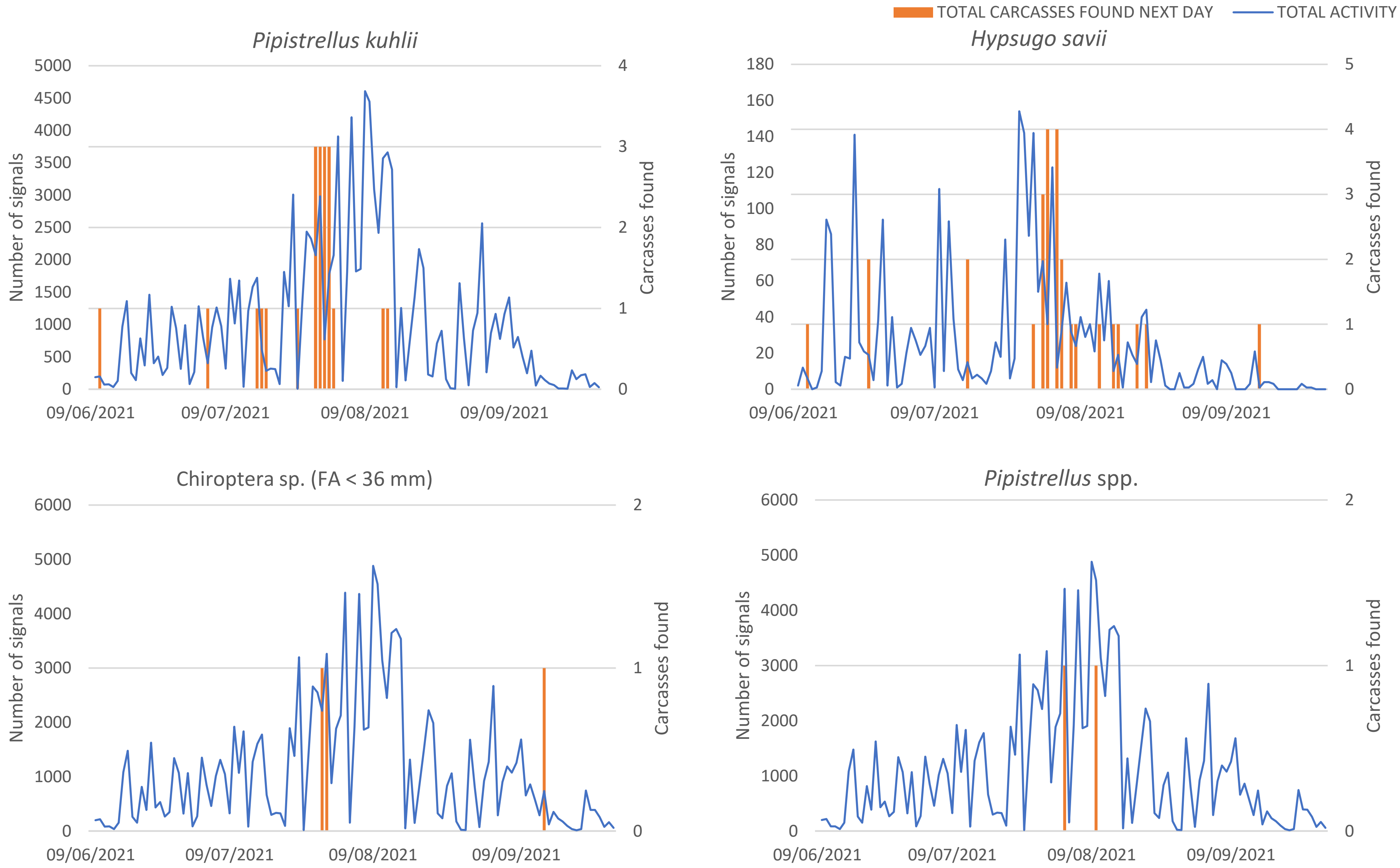


Figure 3-35. Corelation of activity and mortality for four different taxa whose carcasses were found (no daily searches in June and September)

3.3.4 Bat mortality in relation to wind speed

Bat mortality was generally higher in nights with lower wind speed (Figure 3-36Figure 3-36.). This is in accordance with previous conclusion that mortality increases with an increase of bat activity since bat activity was generally higher in nights when wind speed was lower.

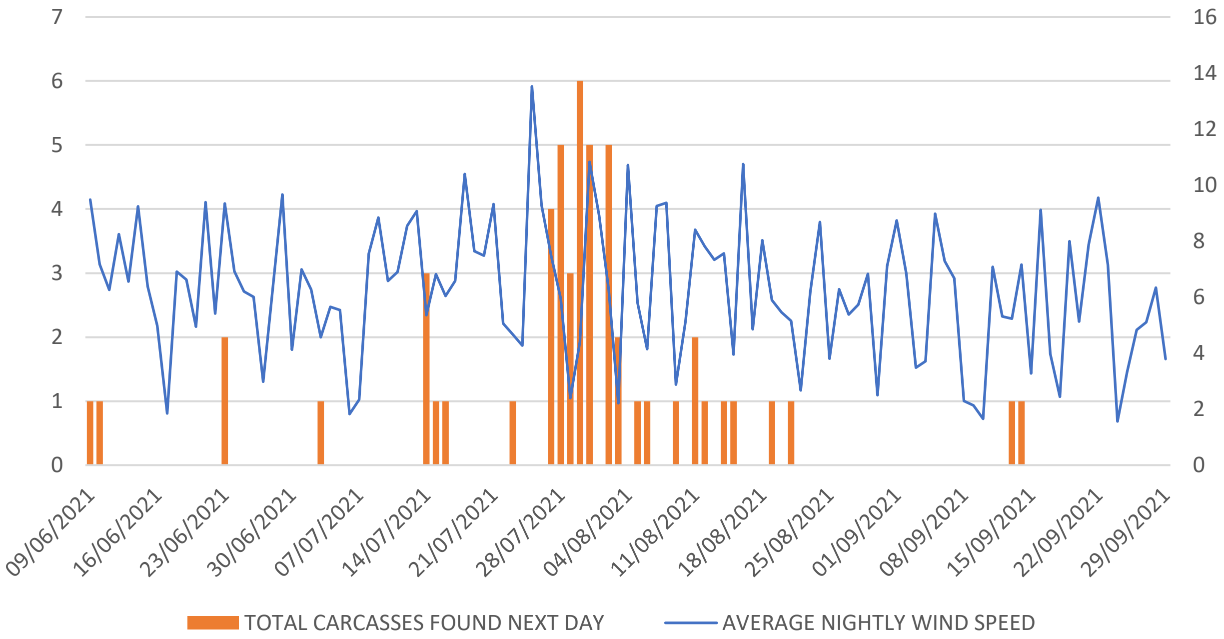


Figure 3-36. Corelation of bat mortality and wind speed (no daily searches in June and September)

Mortality of each taxon individually also shows correlation with lower wind speed (Figure 3-37, Figure 3-38).

Average wind speed at nacelle height in nights directly preceding the days when bat carcasses were found was 5.9 m/s, which is below average wind speed for the whole period of survey. It should be noted that lower wind speed is not the cause of increased bat mortality neither is it dangerous for them – this correlation is due to the increase of bat activity and therefore more interactions with WTG's.

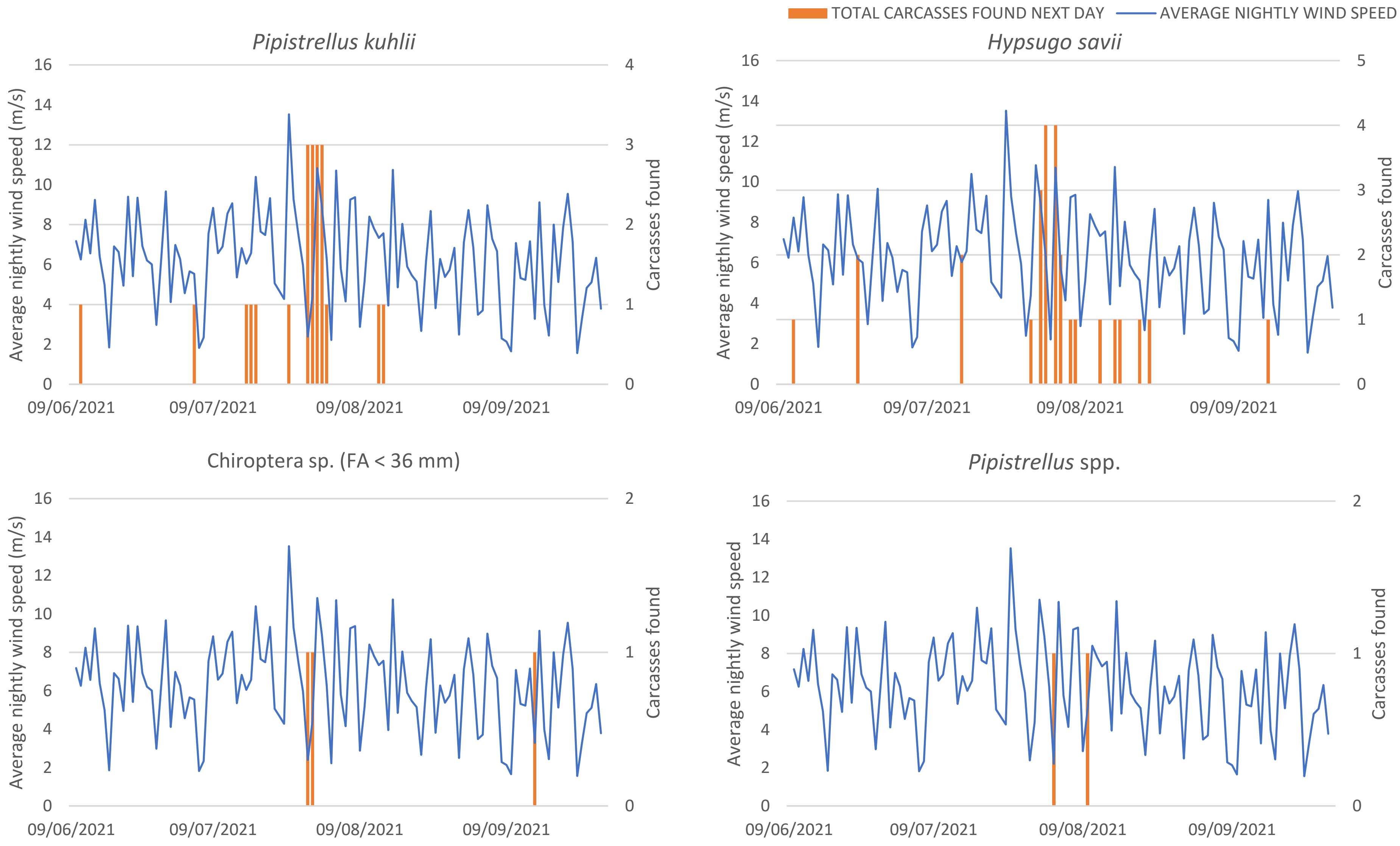


Figure 3-37. Relation of mortality and average wind speed for four different taxa whose carcasses were found (no daily searches in June and September)

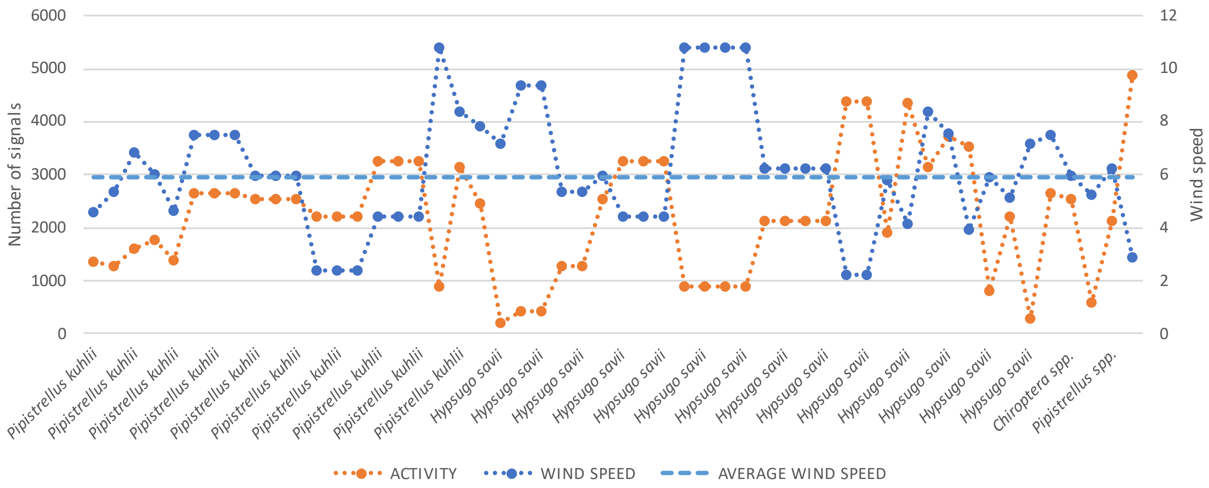


Figure 3-38. Wind speed and activity in the night before the carcass was found for each discovered bat carcass

3.3.5 Bat mortality in relation to mitigation measures

During 2021 blade feathering and increased cut-in speed were implemented during some periods at selected WTG's (Table 1-1). It is assumed that collisions of bats with WTG's do not occur when these mitigation measures are implemented. This was confirmed by the mortality monitoring. Bat carcases were found only after nights when no mitigation measures were implemented at the corresponding WTG, or when mitigation measures were implemented for some time during the night, but when wind speed exceeded the mitigation measure threshold, the turbine blades were rotating again, thus posing a risk for bats (Table 3-8). For some nights only partial data on wind speed was available but based on that data it can be excluded that the measures were implemented throughout those nights.

In 9 cases collisions occurred when the cut-in speed was 5.5 m/s, also in 9 cases undoubtedly no measures were implemented, in 14 cases only blade feathering was implemented, and in 15 cases the cut-in speed was 5.0 m/s. In 6 cases we can't be sure were measures implemented or not. When no mitigation measures were implemented, in one case wind speed was above 5.5 m/s, in 4 cases it was above 3 m/s, while also in 4 cases it was above 5 m/s. Therefore, most collisions occurred on the nights when cut-in speed was 5.0 m/s, followed by nights when only blade feathering was implemented.

In the case of both species found, *Pipistrellus kuhlii* and *Hypsugo savii*, the higher cut-in speed (5.5 m/s) was sometimes not high enough to prevent collisions.

Table 3-8. Bat carcasses found and wind speeds measured the night before

DATE	WTG	SPECIES	NIGHTLY WIND SPEED (m/s)	MITIGATION MEASURES
10/06/2021	WTG12	*Pipistrellus kuhlii* (probably older carcass)	9-11.5	no? (maybe part of the night, if the bat collided some other night)
11/06/2021	WTG10	*Hypsugo savii*	3-11	no
24/06/2021	WTG3	*Hypsugo savii* (2)	5-11	no
04/07/2021	WTG1	*Pipistrellus kuhlii*	1-12	part of the night

DATE	WTG	SPECIES	NIGHTLY WIND SPEED (m/s)	MITIGATION MEASURES
				(< 5 m/s)
15/07/2021	WTG3	*Hypsugo savii*	2-8	part of the night (< 5.5 m/s)
15/07/2021	WTG9	*Hypsugo savii*	1-9	part of the night (< 3 m/s)
15/07/2021	WTG17	*Pipistrellus kuhlii*	2-6	part of the night (< 5 m/s)
16/07/2021	WTG7	*Pipistrellus kuhlii*	4-9	part of the night (< 5.5)
17/07/2021	WTG1	*Pipistrellus kuhlii*	5-10	no
24/07/2021	WTG13	*Pipistrellus kuhlii*	1-8	part of the night (< 5 m/s)
28/07/2021	WTG17	*Pipistrellus kuhlii*	5-8	no
28/07/2021	WTG8	*Pipistrellus kuhlii*	6-9	no
28/07/2021	WTG7	*Pipistrellus kuhlii*	5-9	part of the night (< 5.5 m/s)
28/07/2021	WTG1	Chiroptera sp.	3.5-9	part of the night (< 5 m/s)
29/07/2021	WTG1	*Pipistrellus kuhlii*	1-9	part of the night (< 5 m/s)
29/07/2021	WTG2	*Pipistrellus kuhlii*, *Hypsugo savii*, Chiroptera sp.	0.5-9	part of the night (< 5.5 m/s)
29/07/2021	WTG3	*Pipistrellus kuhlii*	1-8	part of the night (< 5.5 m/s)
30/07/2021	WTG15	*Pipistrellus kuhlii*	0-5	part of the night (< 3 m/s)
30/07/2021	WTG10	*Pipistrellus kuhlii*	0-6	part of the night (< 5 m/s)
30/07/2021	WTG9	*Pipistrellus kuhlii*	0-6	part of the night (< 3 m/s)
31/07/2021	WTG1	*Hypsugo savii*	3-6*	part of the night (< 5 m/s)
31/07/2021	WTG9	*Pipistrellus kuhlii* (2)	2-7*	part of the night (< 3 m/s)
31/07/2021	WTG10	*Hypsugo savii*	2-7.5*	part of the night (< 5 m/s)
31/07/2021	WTG11	*Hypsugo savii*, *Pipistrellus kuhlii*	2-8*	part of the night (< 3 m/s)
01/08/2021	WTG16	*Hypsugo savii*	3-14**	no? (maybe part of the night)
01/08/2021	WTG15	*Pipistrellus kuhlii*	9-13**	no? (maybe part of the night)
01/08/2021	WTG12	*Hypsugo savii*	10-13**	no? (maybe part of the night)
01/08/2021	WTG3	*Hypsugo savii* (2)	7-10**	no? (maybe part of the night)
03/08/2021	WTG16	*Hypsugo savii*	3-8.5	no
03/08/2021	WTG15	*Pipistrellus* spp.	4-9	no
03/08/2021	WTG10	*Hypsugo savii* (2)	4-9	part of the night (< 5 m/s)
03/08/2021	WTG3	*Hypsugo savii*	2.5-9	part of the night (< 5 m/s)
04/08/2021	WTG11	*Hypsugo savii* (2)	1-4	part of the night

DATE	WTG	SPECIES	NIGHTLY WIND SPEED (m/s)	MITIGATION MEASURES
				(< 3 m/s)
06/08/2021	WTG18	*Hypsugo savii*	3-7	part of the night (< 5 m/s)
07/08/2021	WTG9	*Hypsugo savii*	0.5-8	part of the night (< 3 m/s)
10/08/2021	WTG17	*Pipistrellus pipistrellus*	1-7	part of the night (< 5 m/s)
12/08/2021	WTG13	*Hypsugo savii*	4-14	part of the night (< 5 m/s)
12/08/2021	WTG16	*Pipistrellus kuhlii*	4.5-14	no
13/08/2021	WTG2	*Pipistrellus kuhlii*	1.5-13	part of the night (< 5.5 m/s)
15/08/2021	WTG3	*Hypsugo savii*	3-11	part of the night (< 5.5 m/s)
16/08/2021	WTG11	*Hypsugo savii*	1-9	part of the night (< 3 m/s)
20/08/2021	WTG10	*Hypsugo savii*	1-12.5	part of the night (< 5 m/s)
22/08/2021	WTG16	*Hypsugo savii*	1-9	part of the night (< 3 m/s)
14/09/2021	WTG3	Chiroptera sp.	0-10	part of the night (< 3 m/s)
15/09/2021	WTG4	*Hypsugo savii*	2-9	part of the night (< 3 m/s)

*no data after midnight

**no data before midnight

3.4 Searcher efficiency trial

Out of 22 placed bat carcasses during the June trial, seven were removed (probably by scavengers) before they could be found by searchers during first search and one more carcass went missing between first and second search. Out of remaining carcasses 11 were found on the first day of search (73 %), and two more on the second day (93 % in total) (Table 3-9).

Table 3-9. Results of the searcher efficiency trial in June

PLACED CARCASS	WTG	CARCASSES FOUND	
		FIRST SEARCH	SECOND SEARCH
S1	WTG3	+	/
S2	WTG3	+	/
S3	WTG4	+	/
S4	WTG5	+	/
S5	WTG6	/	/
S6	WTG6	-	+
S7	WTG7	/	/
S8	WTG7	-	+
S9	WTG8	+	/
S10	WTG9	+	/
S11	WTG10	/	/
S12	WTG11	+	/
S13	WTG13	-	/
S14	WTG13	+	/

= CARCASS FOUND

= CARCASS NOT FOUND

= CARCASS MISSING

PLACED CARCASS	WTG	CARCASSES FOUND FIRST SEARCH	SECOND SEARCH
S15	WTG14	+	/
S16	WTG16	/	/
S17	WTG16	/	/
S18	WTG16	+	/
S19	WTG18	/	/
S20	WTG19	/	/
S21	WTG20	-	-
S22	WTG20	+	/
TOTAL		**11/15 (73 %)**	**13/14 (93 %)**

The trial was repeated in August with another survey team and showed comparable results. Out of 30 placed bat carcasses, 13 were removed (probably by scavengers) before they could be found by the searchers and two more carcasses went missing between first and second search. Out of the remaining, 10 were found on the first day of the search (59 %), and four more on the second day (93 % in total) (Table 3-10).

Table 3-10. Results of the searcher efficiency trial in August

PLACED CARCASS	WTG	CARCASSES FOUND FIRST SEARCH	SECOND SEARCH
S1	WTG1	+	/
S2	WTG1	/	/
S3	WTG2	/	/
S4	WTG3	+	/
S5	WTG3	+	/
S6	WTG3	/	/
S7	WTG4	/	/
S8	WTG5	+	/
S9	WTG5	+	/
S10	WTG6	/	/
S11	WTG6	/	/
S12	WTG6	/	/
S13	WTG7	-	+
S14	WTG7	-	/
S15	WTG8	+	/
S16	WTG8	/	/
S17	WTG9	-	-
S18	WTG11	+	/
S19	WTG12	+	/
S20	WTG12	-	+
S21	WTG14	+	/
S22	WTG14	+	/
S23	WTG15	-	+
S24	WTG15	/	/
S25	WTG17	/	/
S26	WTG17	/	/
S27	WTG17	/	/
S28	WTG19	-	/
S29	WTG19	-	+
S30	WTG19	/	/
TOTAL		**10/17 (59 %)**	**14/15 (93 %)**

= CARCASS FOUND
= CARCASS NOT FOUND
= CARCASS MISSING

Since the second trial had a larger sample of carcasses, those results were used for further analyses. Mortality estimator GenEst (USGS 2018) was used to estimate searcher efficiency based on the trial results. Searchers successfully found 14 mice carcasses out of 15, which resulted in 42-81 % efficiency (95 % confidence intervals; median 64 %) as estimated by GenEst.

3.5 Carcass persistence trial

Out of 30 placed mouse carcasses, three were removed during the first night after placement (after half a day). Seven carcasses were found to be missing after two nights (after 1.5 days), five carcasses after three nights (after 2.5 days) and four carcasses after four nights (3.5 days). On the 5th night there were no carcasses removed. From the 6th to 8th night, one to three carcasses were removed. After eight nights there were six carcasses remaining (Table 3-11). Average carcass persistence was 3.6 days (Figure 3-39).

Table 3-11. Results of the carcass persistence trial

PLACED CARCASS	**WTG**	**DAYS OF PERSISTENCE**								**TOTAL**
		Day 1 (0.5)	**Day 2 (1.5)**	**Day 3 (2.5)**	**Day 4 (3.5)**	**Day 5 (4.5)**	**Day 6 (5.5)**	**Day 7 (6.5)**	**Day 8 (7.5)**	
M1	WTG1	+	+	+	-					**2.5-3.5**
M2	WTG2	+	+	+	-					**2.5-3.5**
M3	WTG3	+	+	-						**1.5-2.5**
M4	WTG3	+	-							**0.5-1.5**
M5	WTG4	+	-							**0.5-1.5**
M6	WTG4	+	+	-						**1.5-2.5**
M7	WTG4	+	-							**0.5-1.5**
M8	WTG5	+	+	+	+	+	+	+	+	**> 7.5**
M9	WTG5	-								**< 0.5**
M10	WTG5	+	+	-						**1.5-2.5**
M11	WTG6	+	-							**0.5-1.5**
M12	WTG6	+	+	-						**1.5-2.5**
M13	WTG7	+	-							**0.5-1.5**
M14	WTG7	+	+	+	+	+	+	+	-	**6.5-7.5**
M15	WTG8	-								**< 0.5**
M16	WTG9	-								**< 0.5**
M17	WTG10	+	+	+	+	+	+	-		**5.5-6.5**
M18	WTG10	+	+	+	-					**2.5-3.5**
M19	WTG11	+	-							**0.5-1.5**
M20	WTG12	+	+	+	+	+	+	-		**5.5-6.5**
M21	WTG12	+	+	+	+	+	-			**4.5-5.5**
M22	WTG13	+	+	+	+	+	+	+	+	**> 7.5**
M23	WTG15	+	+	+	+	+	+	+	+	**> 7.5**
M24	WTG15	+	+	+	-					**2.5-3.5**
M25	WTG16	+	+	+	+	+	+	+	+	**> 7.5**
M26	WTG17	+	+	-						**1.5-2.5**
M27	WTG19	+	+	+	+	+	+	-		**5.5-6.5**
M28	WTG20	+	+	+	+	+	+	+	+	**> 7.5**
M29	WTG20	+	-							**0.5-1.5**
M30	WTG20	+	+	+	+	+	+	+	+	**> 7.5**
NUMBER OF CARCASSES MISSING		**3**	**7**	**5**	**4**	**0**	**1**	**3**	**1**	

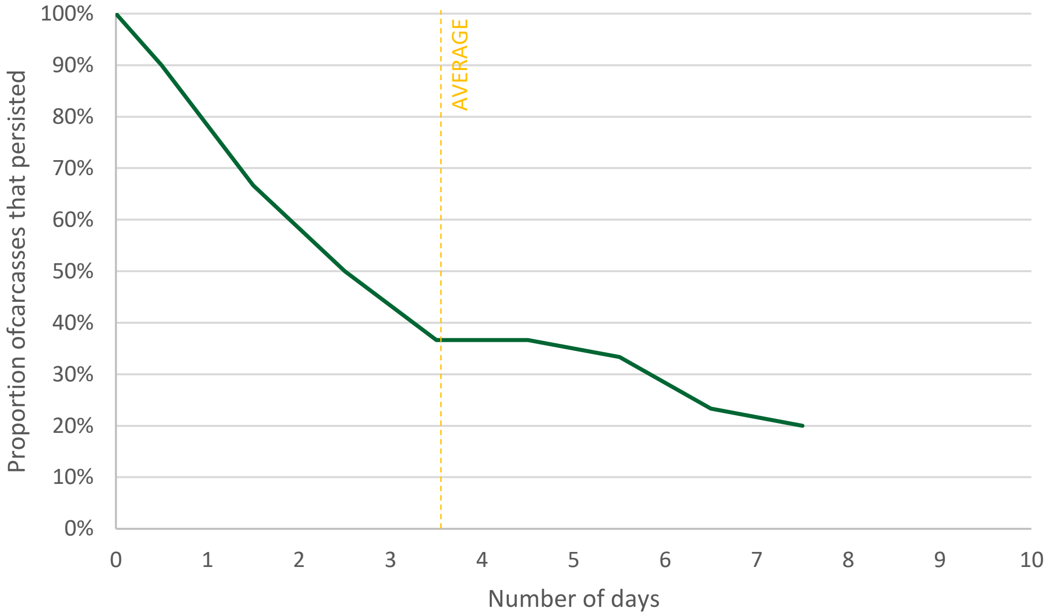


Figure 3-39. Carcass persistence according to the trial

Mortality estimator GenEst (USGS 2018) was used to estimate carcass persistence based on the trial results. Estimation for average carcass persistence was 2.6 days (median) (Figure 3-40).

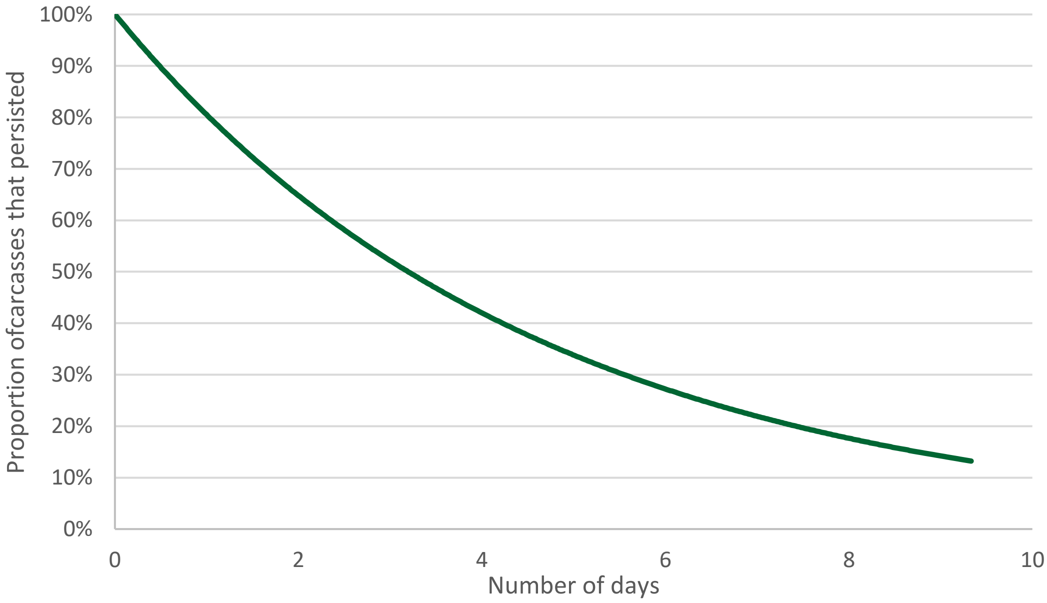


Figure 3-40. Estimated carcass persistence according to GenEst

3.6 Estimation of mortality

To estimate total mortality at wind farm Jelinak, the number of carcasses found during monitoring of bat collisions was corrected for searched area, carcass persistence, searcher efficiency and distance from WTG. Mortality estimator GenEst (USGS 2018) was used, which is the best available statistical mortality estimator (Rabie et al. 2021).

Since only accessible areas of good (high and moderate) visibility were searched within 70 m buffers around WTG's, correction for the searched area had to be made. It was necessary to extrapolate the number of estimated fatalities based on carcasses found in searched areas to unsearched areas. To get that estimation, the size (proportion) of a searched area within the total survey area was calculated, i.e., density weight proportion (DWP). The size of the searched area around a WTG was calculated by summing the total size of high visibility area, and the size of area of moderate visibility up to 1.5 m on both sides of the line walked, based on GPS tracks recorded during all surveys (Appendix IV; Table 3-12).

Table 3-12. Average density weight proportion per turbine

WTG	AVERAGE DWP
WTG1	20.44 %
WTG2	21.51 %
WTG3	14.62 %
WTG4	19.04 %
WTG5	19.22 %
WTG6	18.45 %
WTG7	26.62 %
WTG8	23.52 %
WTG9	15.95 %
WTG10	21.97 %
WTG11	29.12 %
WTG12	20.47 %
WTG13	20.74 %
WTG14	17.74 %
WTG15	24.39 %
WTG16	21.97 %
WTG17	25.58 %
WTG18	20.16 %
WTG19	19.97 %
WTG20	22.34 %
TOTAL	**21.19 %**

For the estimation of total mortality GenEst uses:

- Carcass observations data (results of carcass searches);

- Search dynamics (timetable of carcass searches);

- Searcher efficiency (trial results);

- Carcass persistence (trial results);

- Proportion of searched area (DWP).

The estimated number of bat fatalities from June to October 2021 was 249-467 (95 % confidence intervals; median 342).

GenEst mortality estimator doesn't account for distance of carcasses from WTG. That adjustment is important in total mortality estimation because bats are not equally likely to fall anywhere in the 70 m radius but are, instead, increasingly likely to fall closer to WTG towers (Figure 3-41). That is because carcasses are more likely to fall closer to WTG's and because carcasses are spread over greater areas at greater distances from WTG's (Huso and Dalthorp 2014).

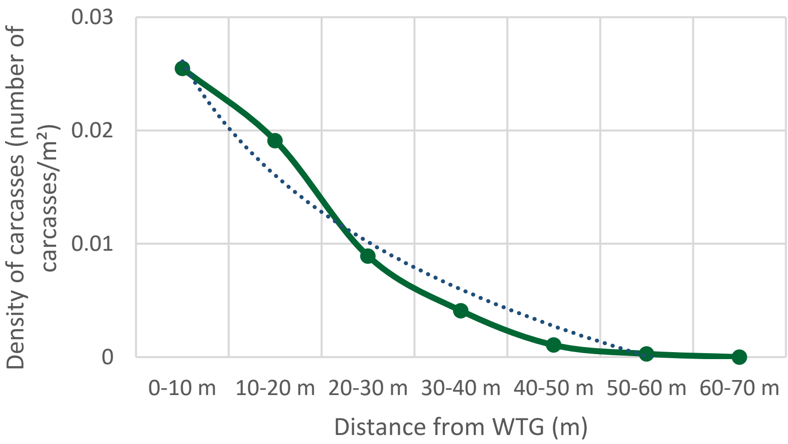


Figure 3-41. Density of carcasses found in regard to distance from a WTG (trendline shown dotted)

When enough data is available to estimate the change in carcass density with distance, a case-specific model can be used to estimate carcass fall distributions. However, when data is not sufficient, such as in this case, empirical models are a better solution (Huso and Dalthorp 2014, Korner-Nievergelt et al. 2019). For that adjustment, the **DL05 estimator** (Huso and Dalthorp 2014) was used. It is based on the assumption that relative density of carcasses decreases as a simple linear logistic function of distance from WTG (Figure 3-42).

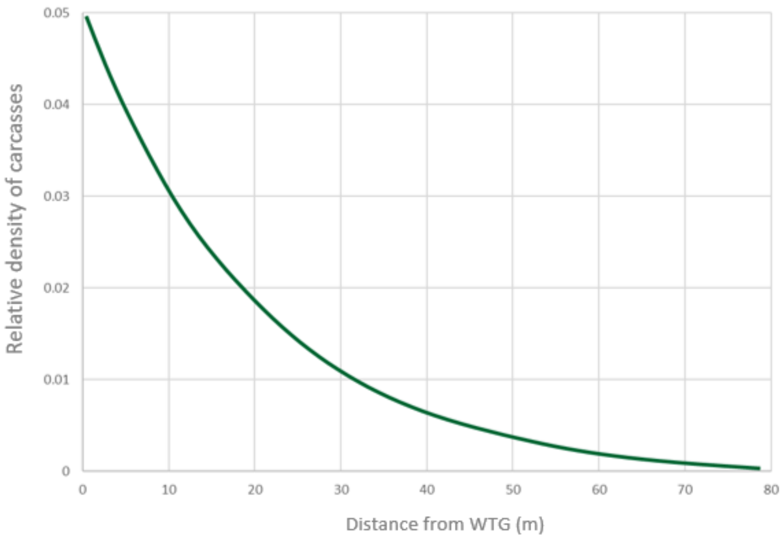


Figure 3-42. Empirical DL05 distribution of fatalities (Huso and Dalthorp 2014)

Locations of discovered carcasses were sorted into 10-meter groups (rings) according to distance from a WTG tower (0-10 m, 10-20 m, etc.). To then adjust for distribution of carcasses, coefficients for each distance category were used. The coefficients were derived from the modelled simple linear logistic function. The decrease of carcass density with distance from a WTG is reflected in the coefficients (Table 3-13).

The estimated number of bat fatalities within each 10-meter group was calculated by multiplying the number of carcasses proportional to the area size of the corresponding 10-meter ring with distribution coefficient.

*estimated number of fatalities = number of fatalities adjusted regarding share of area size * distribution coefficient*

To reach the **final estimate of bat fatalities** at WF Jelinak, estimated numbers of carcasses for each 10-meter group were summed up. Once the equation is applied, a total estimated number of bat fatalities is **76** (Table 3-13).

Table 3-13. Correction of estimated bat fatalities for distance of carcasses from WTG

10-m RING	RING AREA (m^2)	PROPORTION OF RING AREA	NUMBER OF CARCASSES FOUND	ESTIMATED NUMBER OF FATALITIES	DISTRIBUTION COEFFICIENT*	CORRECTED ESTIMATED NUMBER OF FATALITIES
0-10 m	314	1.56 %	8	7	1.00	7
10-20 m	941	4.68 %	18	21	0.79	17
20-30 m	1568	7.80 %	14	35	0.48	17
30-40 m	2195	10.92 %	9	49	0.29	14
40-50 m	2823	14.05 %	3	63	0.18	11
50-60 m	3459	17.21 %	1	77	0.07	5
60-70 m	4081	20.31 %	0	91	0.05	5
TOTAL	**15393**	**100 %**	**53**	**343**		**76**

*(Source: *based on Huso and Dalthorp 2014)*

3.6.1 Estimation of mortality per WTG

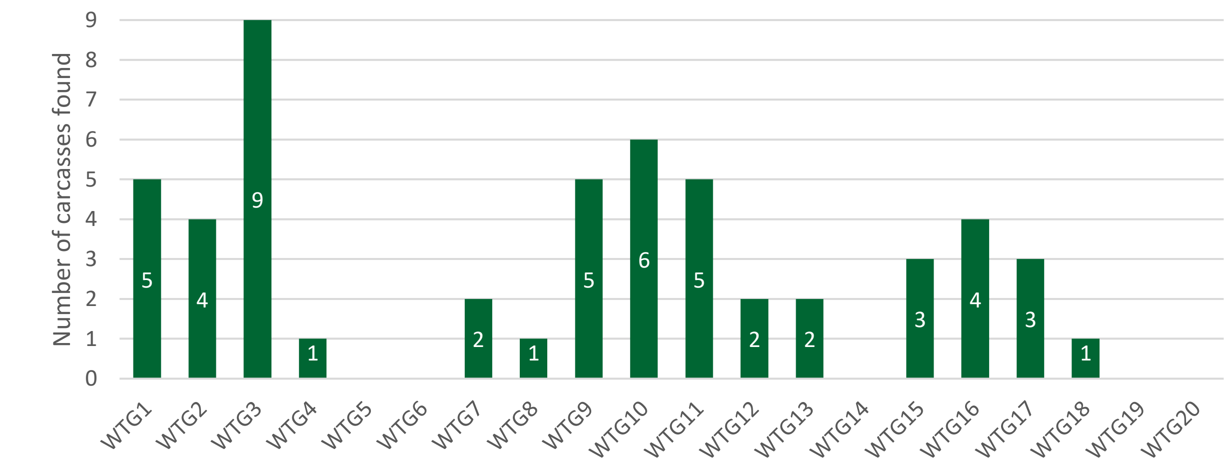
GenEst can also estimate mortality for each WTG. The results of those estimations, as well as estimations corrected for distance of carcasses from WTG is shown below (Table 3-14).

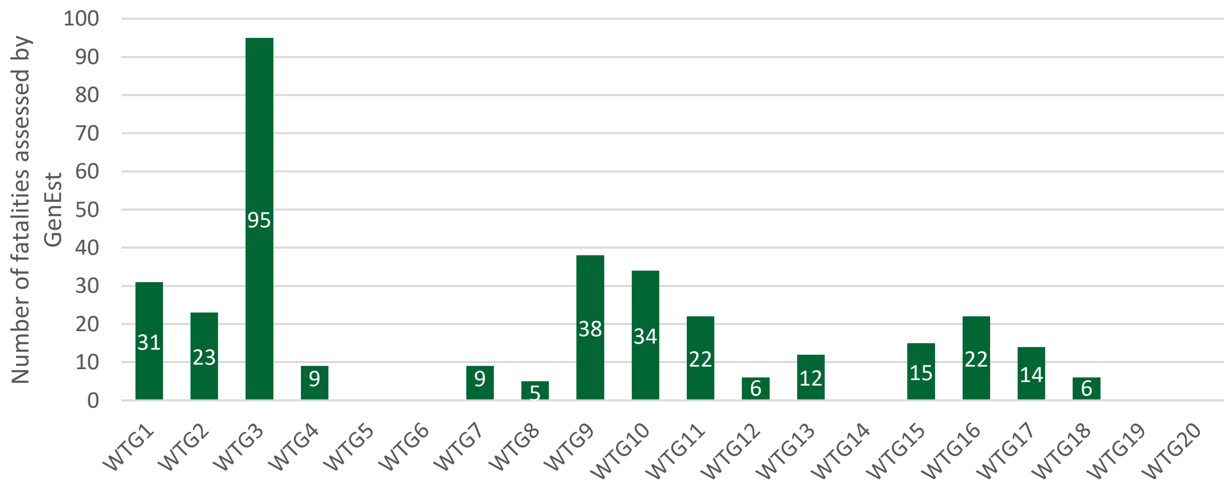
Table 3-14. Estimated number of fatalities per WTG

WTG	GenEst ESTIMATION	CORRECTED ESTIMATED NUMBER OF FATALITIES
WTG1	31	7
WTG2	23	5
WTG3	95	21
WTG4	9	2
WTG5	0	0
WTG6	0	0
WTG7	9	2

WTG	GenEst ESTIMATION	CORRECTED ESTIMATED NUMBER OF FATALITIES
WTG8	5	1
WTG9	38	8
WTG10	34	8
WTG11	22	5
WTG12	6	1
WTG13	12	3
WTG14	0	0
WTG15	15	3
WTG16	22	5
WTG17	14	3
WTG18	6	1
WTG19	0	0
WTG20	0	0

The final assessment of bat mortality per turbine resulted in seven WTG's having higher number of assessed fatalities than average (WTG1, WTG2, WTG3, WTG9, WTG10, WTG11 and WTG16; average 3.05) (Figure 3-43).





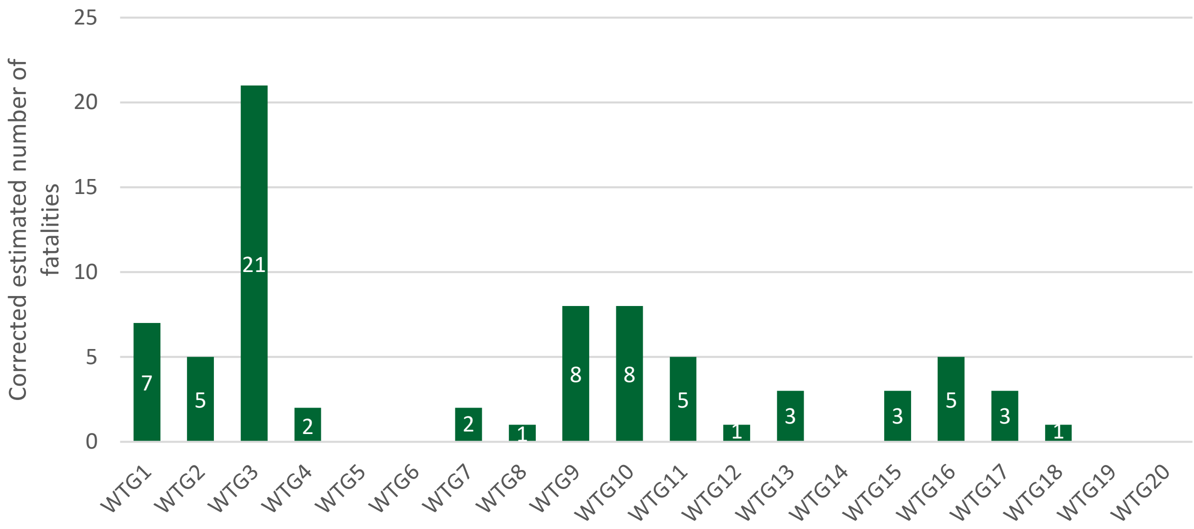


Figure 3-43. Comparison of mortality estimations per turbine

Bat mortality was compared to bat activity, wind speed and mode of operation of WTG's (Figure 3-44). The highest number of fatalities found (9) and assessed (17) was at WTG3 which is located in continuation of the Duboka draga valley characterized by low wind speeds and is surrounded by orchards. It is close to the location of stationary recording point SR1 at which high bat activity was recorded. Above average mortality was also assessed at WTG1, WTG2, WTG9, WTG10, WTG11, WTG15 and WTG16. Most of these WTG's also had high recorded activity. Bat carcasses were also found when mitigation measures were applied, while some WTG's had no additional measures implemented except blade feathering. It seems that relation between bat activity, wind speed and bat mortality is in some cases evident, while in some cases it is not.

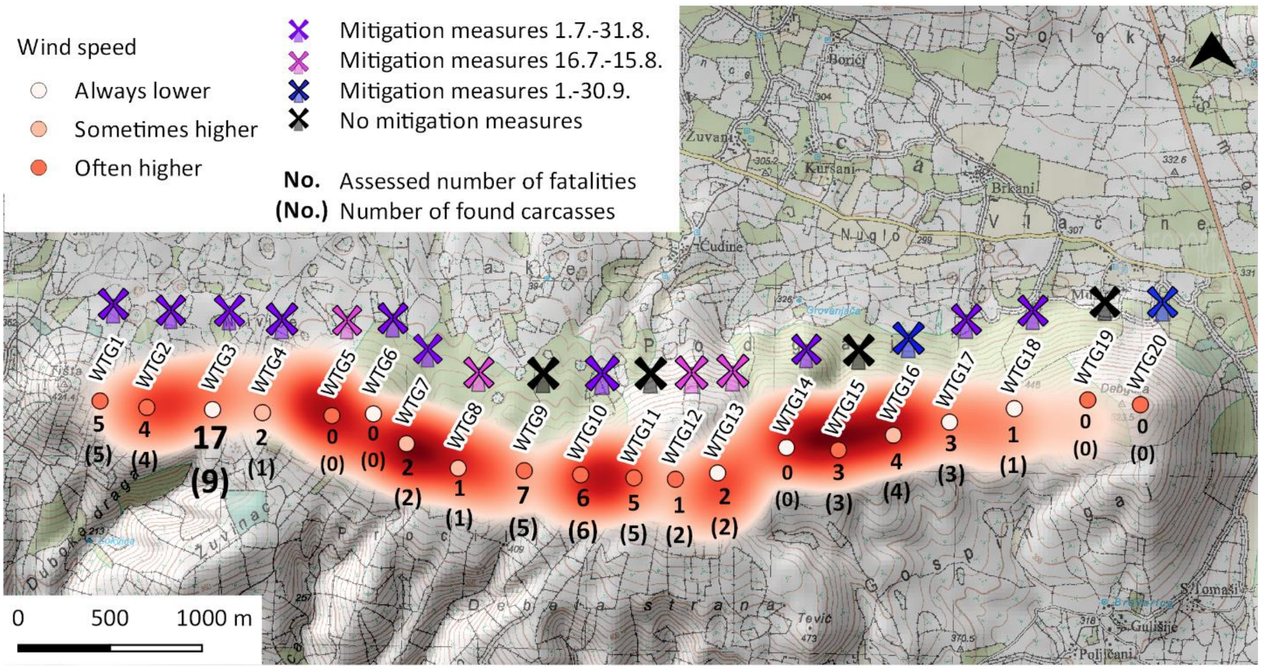


Figure 3-44. Bat mortality compared to bat activity, wind speed and mode of operation of WTG's

3.6.2 Comparison of mortality with previous years

The number of bat carcasses found at wind farm Jelinak during all monitoring years (2013, 2014, 2015, 2016, 2017, 2020 and 2021) was compared (Figure 3-45, Figure 3-46). Field effort for monitoring of bat collision differed between years. Survey dynamics and the number of WTG's surveyed were not the same (Table 3-15), and search dogs were used in some surveys. Also, different modes of wind farm operation (i.e., mitigation measures) were implemented each year (Table 3-16). However, survey design in 2021 was the same as in 2020, which allowed a direct comparison of the monitoring results.

In 2013 mitigation measures were not implemented, so the number of carcasses found was the highest, despite less field effort than in the following years. In 2014, the number of fatalities was significantly lower, most likely because of implementation of mitigation measures on WTG's with highest mortality rates in 2013. At WTG's which were searched more frequently (every day from June to September), more carcasses were found. Mitigation measures were therefore implemented on additional WTG's in 2015, which resulted in further reduction of mortality. In 2015 every-day searches were introduced at all WTG's during July and August, so a high number of carcasses were found at some WTG's which were not that frequently searched in previous years. That resulted in implementation of mitigation measures at more additional WTG's in 2016. Mortality was then reduced even more, and was the lowest in 2017, when mitigation measures were implemented at almost all WTG's. During 2020, search dynamics and mitigation measures remained the same as in 2017, but the number of carcasses found was higher. Higher mortality in 2020 when compared to 2017 can be due to different search dynamics and/or different bat activity between the two years. In 2021 almost the same number of bat carcasses was found as in 2020.

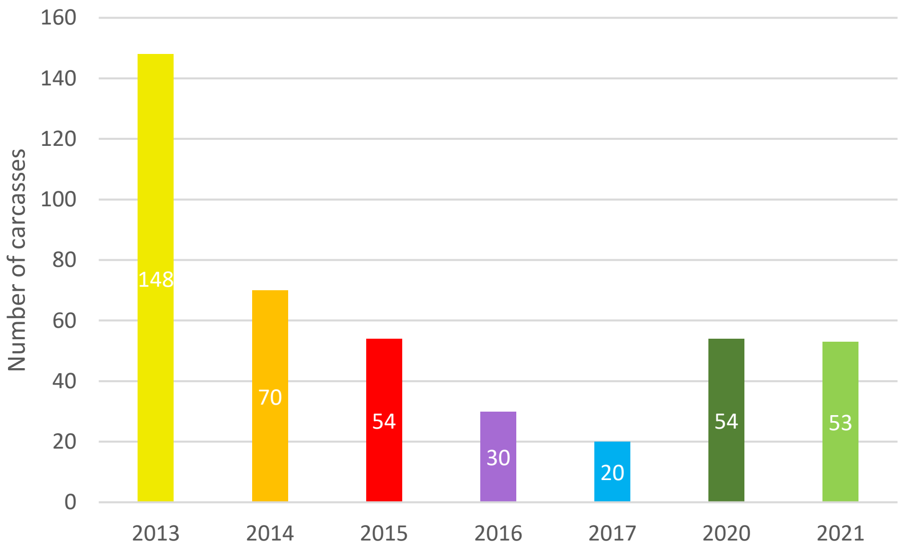


Figure 3-45. Number of bat carcasses found at wind farm Jelinak in 2013, 2014, 2015, 2016, 2017, 2020 and 2021

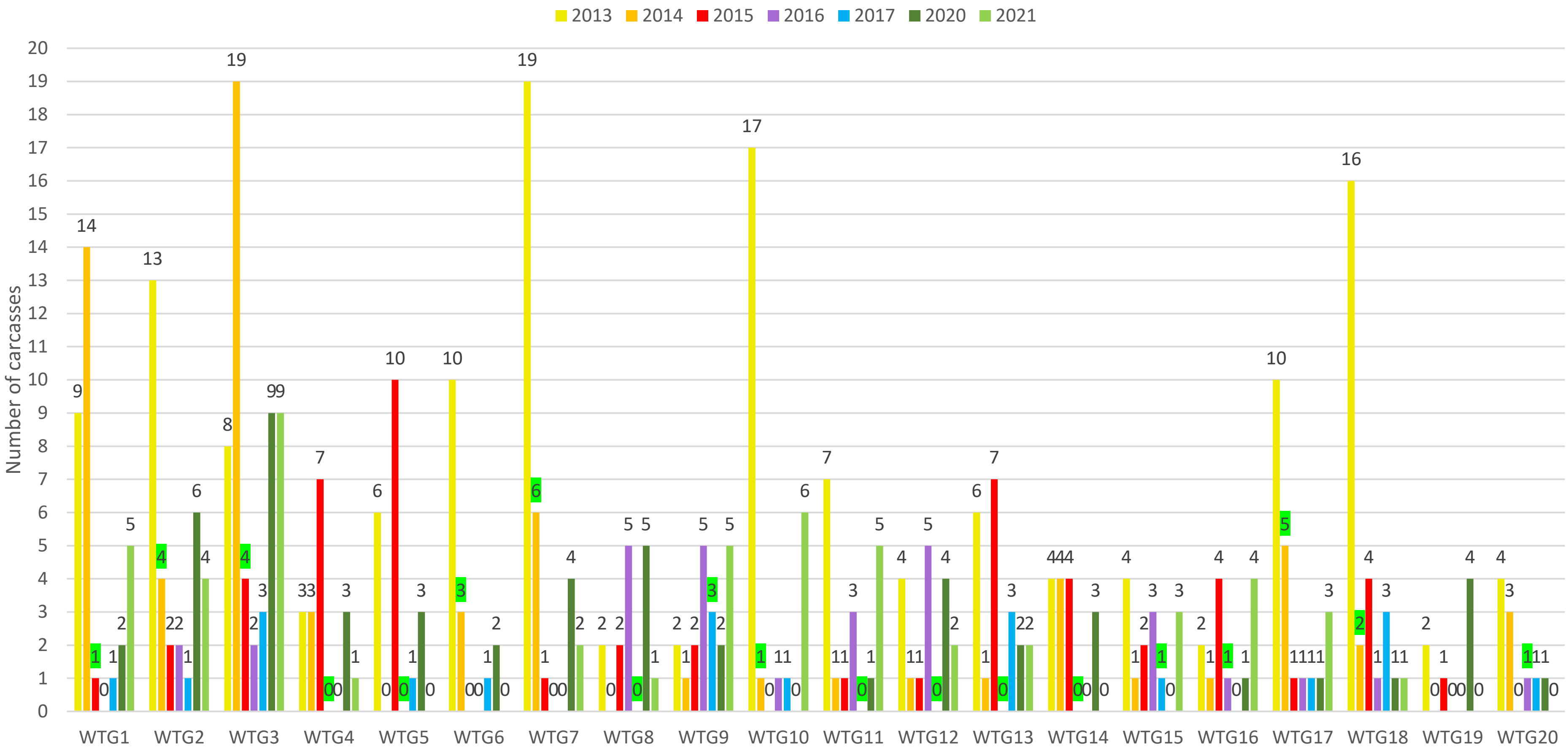


Figure 3-46. Number of bat carcasses per WTG found at wind farm Jelinak in 2013, 2014, 2015, 2016, 2017, 2020 and 2021

*(Number of carcasses when mitigation method was introduced is marked **green**)*

Table 3-15. Survey dynamics for monitoring of bat collisions at WF Jelinak in 2013, 2014, 2015, 2016, 2017, 2020 and 2021

MONTH	SURVEY DYNAMICS						
	2013	2014	2015	2016	2017	2020	2021
March	2 x	2 x	-	-	-	-	-
April	2 x	2 x	-	-	-	-	-
May	2 x	2 x	-	-	-	-	-
June	2 x	2 x	2-day searches every 7 days	2-day searches every 7 days	2-day searches every 7 days	2-day searches every 7 days	2-day searches every 7 days
July	2 x	2 x all WTG's + every day at WTG1, WTG2, WTG3, WTG6, WTG7, WTG10, WTG14, WTG17 and WTG18	every day	every day	every 3 days	every day	every day
August	2 x	2 x all WTG's + every day at WTG1, WTG2, WTG3, WTG6, WTG7, WTG10, WTG14, WTG17 and WTG18	every day	every day	every 3 days	every day	every day
September	2 x	every day at WTG1, WTG2, WTG3, WTG6, WTG7, WTG10, WTG14, WTG17 and WTG18	2-day searches every 7 days	2-day searches every 7 days	2-day searches every 7 days	2-day searches every 7 days	2-day searches every 7 days
October	2 x	-	2-day searches every 7 days	1 two-day search	1 two-day search	1 two-day search	1 two-day search

Table 3-16. Mitigation measures implemented at WF Jelinak in 2013, 2014, 2015, 2016, 2017, 2020 and 2021

Period	Wind turbine generators	Blade feathering	Cut-in speed	Timing
1.7.-30.9.2014.	WTG2, WTG6, WTG7, WTG10, WTG17, WTG18		5.0 m/s	from one hour before sunset until 3 hours after sunset
1.7.-31.8.2015.	WTG1, WTG2, WTG3, WTG6, WTG7, WTG10, WTG17, WTG18		5.0 m/s	9 pm-3 am
1.7.-15.7.2016. & 16.8.-31.8.2016.	WTG1, WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG10, WTG13, WTG14, WTG16, WTG17, WTG18, WTG20	yes	5.0 m/s	9 pm-3 am
16.7.-15.8.2016.	WTG1, WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG10, WTG13, WTG14, WTG16, WTG17, WTG18, WTG20	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
1.7.-15.7.2017. & 16.8.-31.8.2017.	WTG1, WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG10, WTG13, WTG14, WTG16, WTG17, WTG18, WTG20	yes	5.0 m/s	9 pm-3 am
16.7.-15.8.2017.	All except WTG19	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
1.-15.7.2020. & 16.-31.8.2020.	WTG1, WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG10, WTG13, WTG14, WTG16, WTG17, WTG18, WTG20	yes	5.0 m/s	9 pm-3 am
16.7.-15.8.2020.	All except WTG19	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
1.-15.7.2021.	WTG1, WTG10, WTG13, WTG17, WTG18	yes	5.0 m/s	9 pm-3 am
1.-15.7.2021.	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	9 pm-3 am
16.7.-15.8.2021.	WTG1, WTG10, WTG13, WTG17, WTG18	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
16.7.-15.8.2021.	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	from half an hour before sunset until half an hour after sunrise
16.-31.8.2021.	WTG1, WTG10, WTG13, WTG17, WTG18	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
16.-31.8.2021.	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	from half an hour before sunset until half an hour after sunrise
1.-30.9.2021.	WTG5, WTG8, WTG12, WTG13, WTG16, WTG20	yes	5.5 m/s	from half an hour before sunset until 3 am

The activity patterns of bats recorded at stationary points were comparable to those observed in 2020, but with lower overall activity, especially apparent in August (Figure 3-2). Activity patterns of individual taxa showed minor changes compared to 2020, as described in the Chapter 3.1. Spatial distribution of activity along the transect route was also similar in both monitoring years (Chapter 3.2; Figure 3-28).

Bat activity through the night shows also very similar patterns in 2020 and 2021. In both years most of the bat activity remained in the first few hours of the night, which is a key fact to take into consideration when proposing mitigation measures.

While the number of days per month with the highest wind speeds was largely the same as in 2020, the overall activity on those nights in July and August increased (Figure 3-19). In July 2021, around a quarter of total signals were recorded in nights with wind speed above 7 m/s, while in July 2020 it was only 7.12 % of all activity. Also, in August 2021 the percentage rose to more than a third of total signals recorded, while in the same month in 2020 only 17.80 % of all activity was recorded in nights with wind speed above 7 m/s.

In 2021 one less bat carcass was found (54 carcasses were found in 2020 and 53 in 2021). WTG3 remained the WTG with the highest mortality, and the same number of carcasses (9) was found at that WTG in both years.

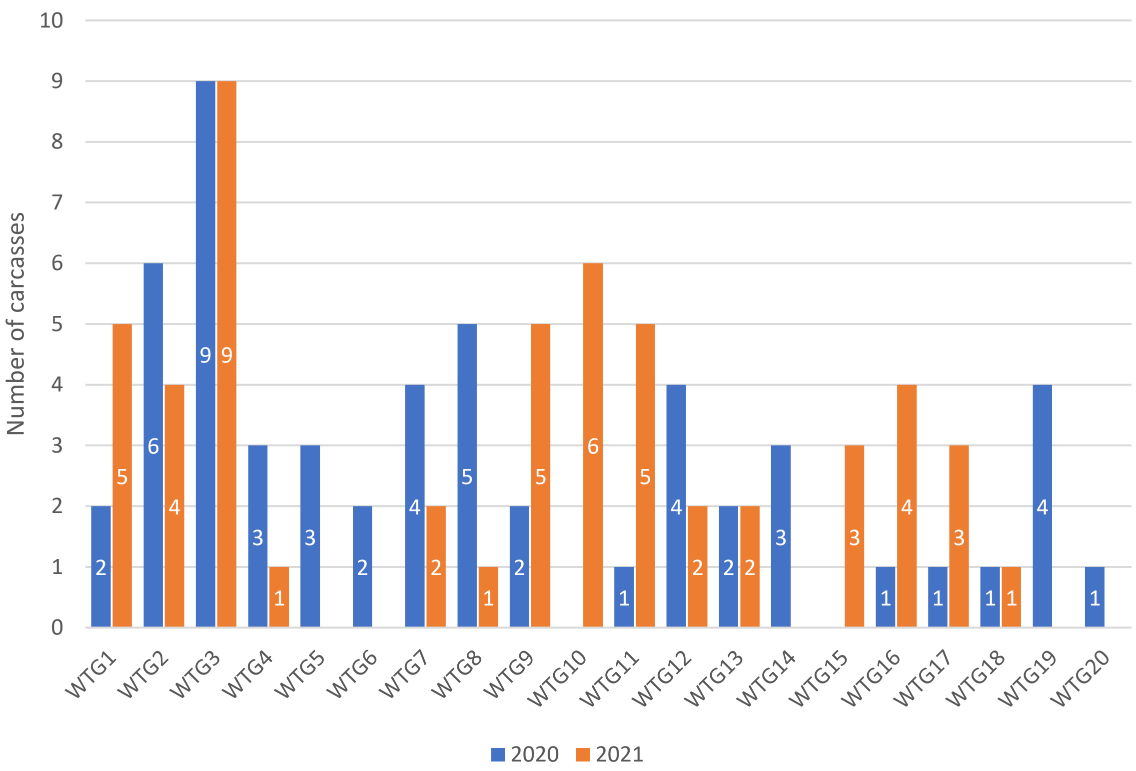


Figure 3-47. Number of bat carcasses found in 2020 and 2021 per WTG

The number of carcasses found was corrected for search dynamics, searched area, carcass persistence and searcher efficiency using GenEst mortality estimator. Additionally, the GenEst estimation was corrected for distance from WTG. In 2020, the final estimation was 90 carcasses. This year, the same GenEst settings were used, as well as the same empirical model for correction for distance from WTG (DL05 estimator). But distribution coefficients were more accurately calculated this time to get better estimations. When using the more accurate distribution coefficients, corrected estimation of fatalities for 2020 is 113. For 2021 it is 76, which is around 1.5 times less fatalities.

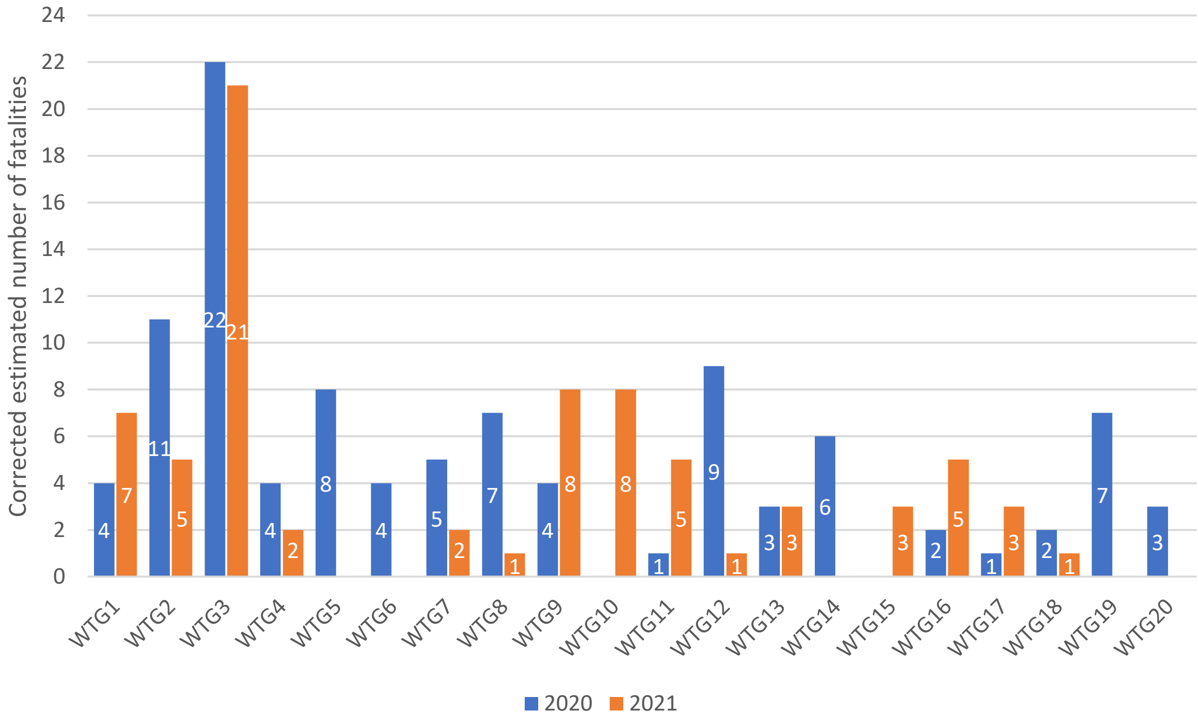


Figure 3-48. Corrected estimated number of bat fatalities in 2020 and 2021 per WTG

4 Mitigation measures proposal

Due to a relatively high estimated mortality at WF Jelinak, which represents a negative impact on local bat populations, mitigation measures are proposed to minimise those impacts to an acceptable level. The only mitigating measures that have been proven effective in Europe are blade feathering and increase of cut-in wind speed (Rodrigues at al. 2014). Blade feathering is the rotation of turbine blades at 90° to prevent them from turning when the wind speed is below the cut-in threshold. Increased cut-in wind speed is the delay in the start of the power production process until the wind speed is at a pre-defined point.

Blade feathering is important for preventing collisions of small bat species, which are the most common species in the WF area and are most active when wind speeds are relatively low (up to 3 m/s). At WF Jelinak, blade feathering below 3 m/s is the default mode of operation of WTG's (Table 4-1).

Table 4-1. Blade feathering implemented at WF Jelinak

PERIOD	WIND TURBINE GENERATORS	BLADE FEATHERING
1.1.-31.12.	all WTG's	0-3 m/s

In 2021, blade feathering and increased cut-in speed were implemented at 14 WTG's from July 1st until August 31st, while at WTG9, WTG11, WTG15, WTG16, WTG19 and WTG20 only blade feathering was implemented (Table 1-1). From September 1st until September 30th blade feathering and increased cut-in speed were implemented at WTG5, WTG8, WTG12, WTG13, WTG16 and WTG20, while only blade feathering was implemented at the rest of the WTG's. The measures were implemented from 9 pm until 3 am between July 1st and July 15th, during the whole night between July 16th and August 31st, and from half an hour before sunset until 3 am in September.

According to WF Jelinak's data, total loss of energy production in 2021 due to bat mitigation measures was 0.61 % of yearly energy production, or 496.9 MWh (Appendix VI).

Most of the bat carcasses (38/53) were found after nights when mitigation measures were implemented for some time during the night, while only some (9/53) were found after nights when no measures were implemented at all. All carcasses belonged to small bat species (*Pipistrellus* spp., *Hypsugo savii*), which are more active during lower wind speeds. However, most carcasses were found after nights with average wind speed of 5.9 m/s at nacelle hight.

More than half carcasses (30/53) were found in a short period at the end of July and start of August (July 28th until August 4th), when the mitigation measures were most strict. It is therefore proposed to increase the cut-in wind speed in the peak bat activity period from July 16th to August 15th for the more sensitive group of WTG's from 5.5 m/s to 6.0 m/s. Also, WTG1 and WTG10 should be included in this group in the peak activity period as an increase in mortality was observed for those turbines.

In the 2020 monitoring report, some WTG's which had increased cut-in speed applied in 2020 (WTG9, WTG11, WTG15, WTG16, WTG19 and WTG20) were assessed to pose a lower collision risk for bats. Based on that, for 2021 only implementation of blade feathering without increased cut-in speed was proposed. However, in 2021 mortality at some of those turbines significantly increased (from 2 to 5 carcasses at WTG9, from 1 to 5 carcasses at WTG11, from 0 to 3 carcasses at WTG15 and from 1 to 4 carcasses at WTG16; Figure 3-47 and Figure 3-48). It is therefore recommended to resume increased cut-in speed at these four WTG's (WTG9, WTG11, WTG15 and WTG16).

Mitigation measures applied in September are assessed to be appropriate and should continue to be implemented. Proposed cut-in wind speed for September is 5.0 m/s.

Based on the above stated conclusions on bat fatalities, the mitigation measures protocol should be as described in the Table 4-2 (additional to blade feathering implemented by default at all WTG's).

Table 4-2. Proposed additional mitigation measures

PERIOD	WIND TURBINE GENERATORS	BLADE FEATHERING	CUT-IN SPEED	TIMING
1.-15.7.	WTG1, WTG9, WTG10, WTG11, WTG13, WTG15, WTG16, WTG17, WTG18	yes	5.0 m/s	9 pm-3 am
	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	9 pm-3 am
16.7.-15.8.	WTG9, WTG11, WTG13, WTG15, WTG16, WTG17, WTG18	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
	WTG1, WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG10, WTG12, WTG14	yes	6.0 m/s	from half an hour before sunset until half an hour after sunrise
16.-31.8.	WTG1, WTG9, WTG10, WTG11, WTG13, WTG15, WTG16, WTG17, WTG18	yes	5.0 m/s	from half an hour before sunset until half an hour after sunrise
	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14	yes	5.5 m/s	from half an hour before sunset until half an hour after sunrise
1.9.-30.9.	WTG5, WTG8, WTG12, WTG13, WTG16, WTG20	yes	5.0 m/s	from half an hour before sunset until 3 am

4.1 Proposed methodology for further monitoring

It is recommended to continue the monitoring program in following years, which would determine the impact of the new mitigation measures plan on bat population protection but also on energy production. Regarding the locations of stationary bat detectors, it is recommended that future monitoring programs include continuous bat call recording at WTG3. This could be achieved by moving the detector from WTG1 to WTG3. This turbine is located in the lowest part of the WF and lays across several linear landscape features. Such features are often commuting routes for bats. The aim of this change in monitoring program would be to get more data about bat activity around that WTG, since it is the WTG with consistently highest mortality rates. There should also be an additional microphone installed at WTG3 at nacelle height to gather more information on species composition in the blade-swept zone.

Future monitoring program should also include visual monitoring of selected WTG's using thermal imaging sensors in order to observe the interaction of bats with WTG towers and blades.

Acoustic monitoring along transect routes is assessed to provide no additional significant data and could be omitted from future monitoring programs.

Methodology of mortality monitoring should be the same as in 2021.

5 Summary

The bat monitoring program for wind farm Jelinak was conducted from June 2021 to October 2021. Monitoring was designed in coordination with monitoring reports from previous years of post-construction monitoring at WF Jelinak and Terms of Reference.

Wind farm Jelinak is located in Split-Dalmatia County, in Trogir hinterland and consists of 20 wind turbine generators (WTG's). Surrounding habitats include eastern Adriatic sub-Mediterranean rocky pastures, thermophilous deciduous downy oak coppice and arable land (orchards).

Impact of the wind farm on bats was monitored by monitoring of bat collisions and bat activity. Bat collisions were monitored by searching for bat carcasses at WTG bases, while bat activity was monitored by continuous bat call recording at stationary locations and periodic bat call recording along a transect route.

Continuous bat call recording was implemented on two WTG locations. Bat detectors were set up to continuously record bat calls each night from June to October. A total of 125,936 signals were recorded. Over 92 % of those were identified to belong to the species of genus *Pipistrellus*. Bat activity was found to be highest in August and lowest in October. Correlation of bat activity with wind speed was analysed and it was found that bat activity decreased with increasing wind speeds, except after the prolonged period of sub-optimal microclimatic conditions for bat activity in mid-July, which caused increased activity during higher wind speeds at the end of July and start of August and potentially resulted with increased mortality.

Periodic bat call recording along the transect route was conducted in July and August, twice each month for two continuous days. The transect route passed along the access road connecting all WTG's. Most of the recorded bat signals were found to belong to species of genus *Pipistrellus*, as well as to *Hypsugo savii*.

Searching for bat carcasses was implemented every seven days for two consecutive days in June and September, every day in July and August, and once for two consecutive days in October. A total of 53 carcasses were found. They belonged to three bat species: *Hypsugo savii* (27), *Pipistrellus kuhlii* (21) and *Pipistrellus pipistrellus* (1). An additional four carcasses could not be identified to a species level, but are considered to belong to either genus *Pipistrellus* or *H. savii* due to their forearm size. Searcher efficiency and carcasses persistence trials were implemented as well, in order to estimate the total number of fatalities. Search results were then analysed and corrected for carcass persistence, searcher efficiency, proportion of searched area, and distance from WTG. Estimation using GenEst estimator tool show a total estimated mortality of 76 bats.

The number of found bat carcasses, as well as estimations of total mortality, when compared to bat activity and recorded wind speeds, indicated a possible negative impact of the WF on bat populations. Therefore, mitigations measures were proposed, that build upon the measures implemented earlier, as well as methodology for further monitoring.

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7 Appendix

Appendix I. Microclimatic conditions recorded during periodic sounds recording on a transect route

SURVEY DATE	START TIME	END TIME	AIR TEMPERATURE (°C)		WIND SPEED (m/s)		AIR HUMIDITY (%)		WEATHER CONDITIONS
			START	END	START	END	START	END	
15.7.2021.	21:00	23:35	22.9	22.0	1.3-2.7	2.8	49.8	49.6	mostly clear
16.7.2021.	20:53	23:26	21.4	21.6	1.9-3.1	1.2-2.9	65.9	62.1	clear
29.7.2021.	20:43	23:09	28.0	27.5	1.0	2.9	44.3	37.3	clear
30.7.2021.	20:45	23:16	27.9	25.7	1.5	0.7	36.5	40.7	clear
12.8.2021.	20:20	22:56	28.4	27.4	2.4-3.4	1.8-2.3	42.2	37.2	clear
13.8.2021.	20:25	23:01	29.8	28.7	2.1-3.8	4.0	32.1	33.8	mostly clear
29.8.2021.	19:59	22:29	18.0	14.0	3.0	-	-	-	clear
31.8.2021.	19:48	22:17	18.8	18.5	1.9-3.1	2.2-3.2	60.0	68.4	clear

Appendix II. Example of a field form for periodic sounds recording on a transect route

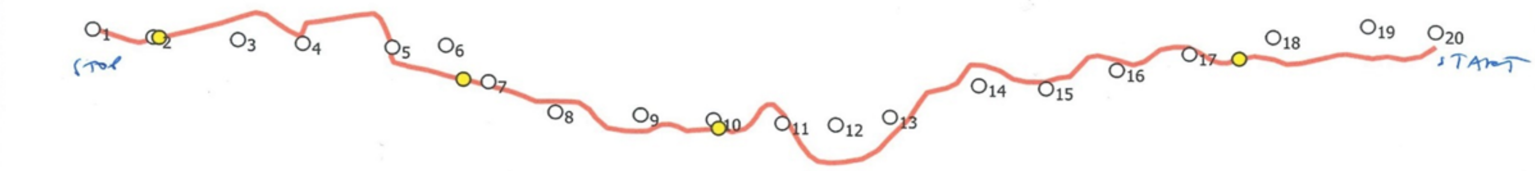
Monitoring šišmiša - VE Jelinak 2021

DATUM: 31.8.2021.	VRIJEME POČETKA: 19:48	VRIJEME ZAVRŠETKA: 22:17

PRISUTNI ISTRAŽIVAČI:	VREMENSKE PRILIKE			
1. MARTA MIKULIĆ	bez oblaka	X	lagana kiša	
2. STIPE REMJE	malo oblaka		kiša	
NAPOMENE:	djelomično oblačno		nevrijeme	
	oblačno		magla	
	NAPOMENA:			

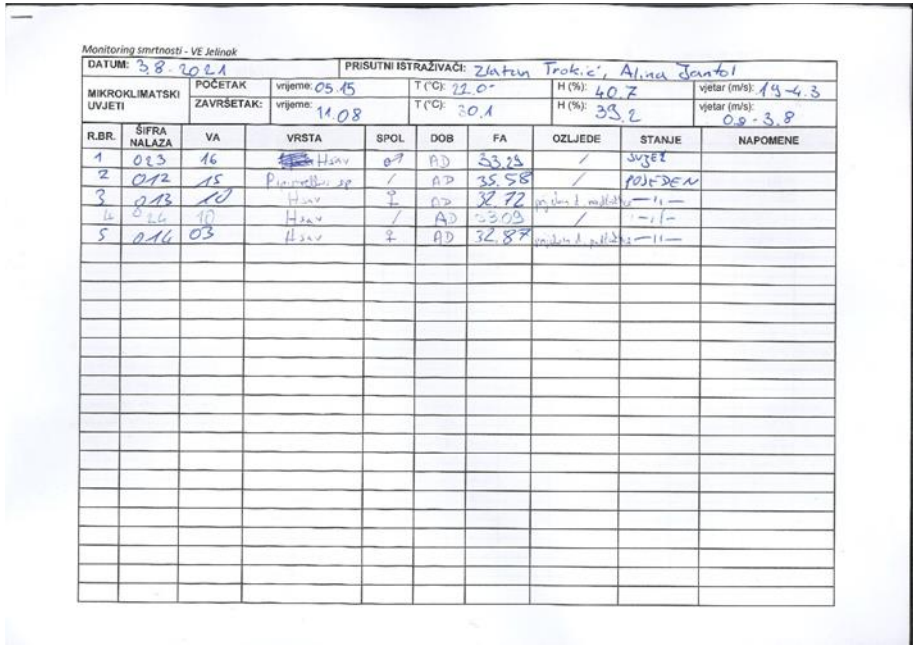
MIKROKLIMATSKI UVJETI			
POČETAK		ZAVRŠETAK	
Vrijeme:	19:56	Vrijeme:	22:19
T (°C):	18,8	T (°C):	18,5
H (%):	60,0	H (%):	68,4
Vjetar (m/s):	1,9-3,1	Vjetar (m/s):	2,2-3,2

SNIMANJE PO TRANSEKTU



ST_2	vrijeme: 22:08 - 22:13	vjetar (m/s): 2,1 - 3,2
ST_6-7	vrijeme: 21:28 – 21:33	vjetar (m/s): 1,0 – 1,8
ST_10	vrijeme: 21:03 - 21:08	vjetar (m/s): 1,5 - 2,7
ST_17-18	vrijeme: 20:06 – 20:11	vjetar (m/s): 1,3

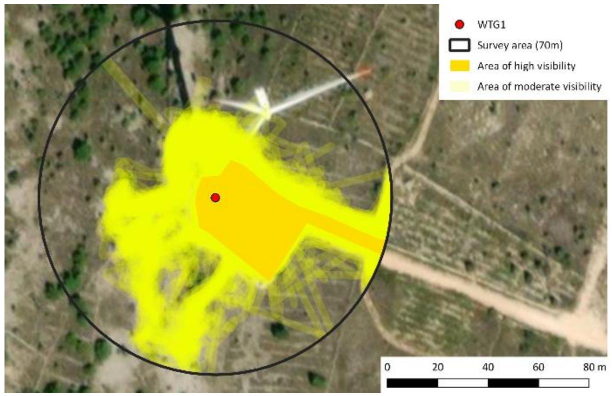
Appendix III. Example of a field form for monitoring of bat collisions

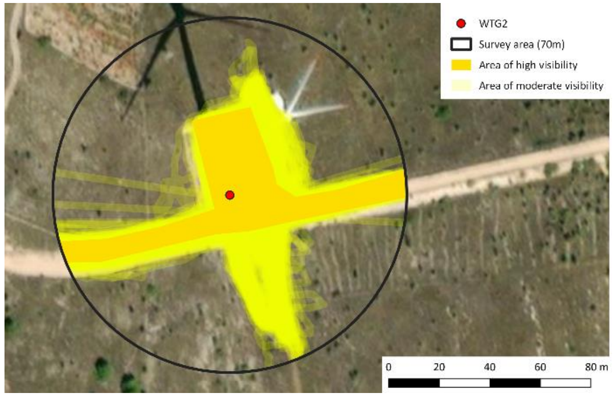

Monitoring smrtnosti - VE Jelinak

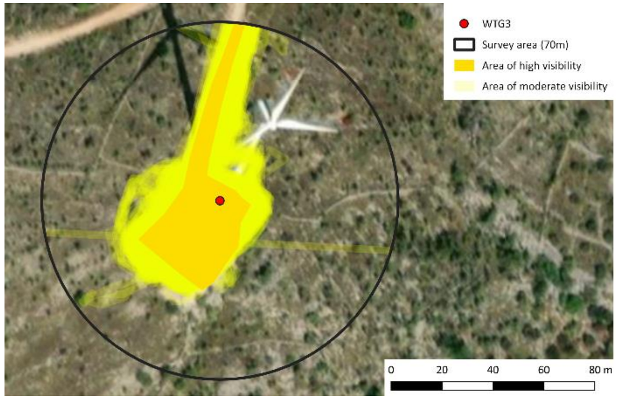
DATUM: 3.8.2021			PRISUTNI ISTRAŽIVAČI: Zlatan Trokić, Alina Jantol		
MIKROKLIMATSKI UVJETI	POČETAK	vrijeme: 05.15	T (°C): 22.0°	H (%): 40.7	vjetar (m/s): 1.9-4.3
	ZAVRŠETAK:	vrijeme: 11.08	T (°C): 30.1	H (%): 39.2	vjetar (m/s): 0.9-3.8

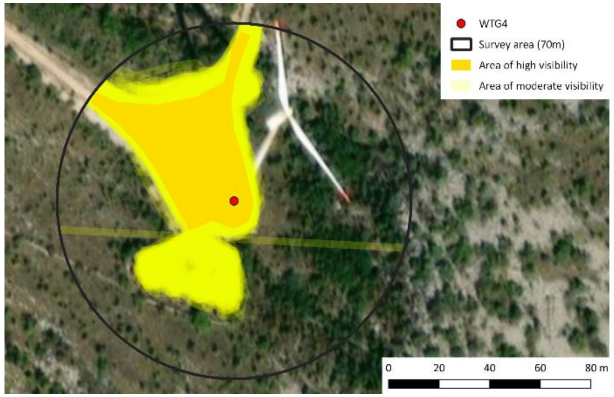
R.BR.	ŠIFRA NALAZA	VA	VRSTA	SPOL	DOB	FA	OZLJEDE	STANJE	NAPOMENE
1	023	16	Hsav	♂	AD	33.29	/	svježe	
2	012	15	Pipistrellus sp.	/	AD	35.58	/	pojeden	
3	013	10	Hsav	♀	AD	32.72	[illegible]	—"—	
4	026	10	Hsav	/	AD	33.09	/	—"—	
5	016	03	Hsav	♀	AD	32.87	[illegible]	—"—	

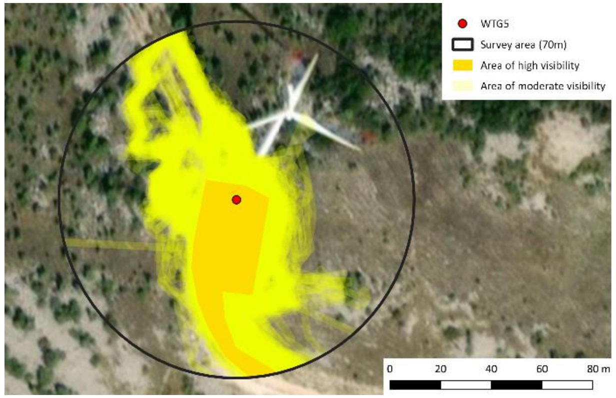
Appendix IV. Areas searched for bat carcasses around each WTG (darker blue indicates more frequent searches)

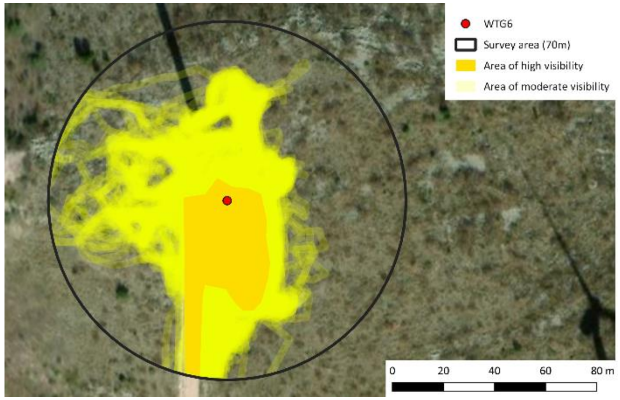


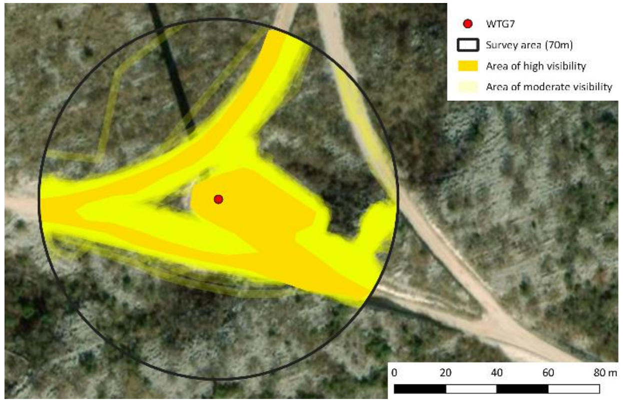


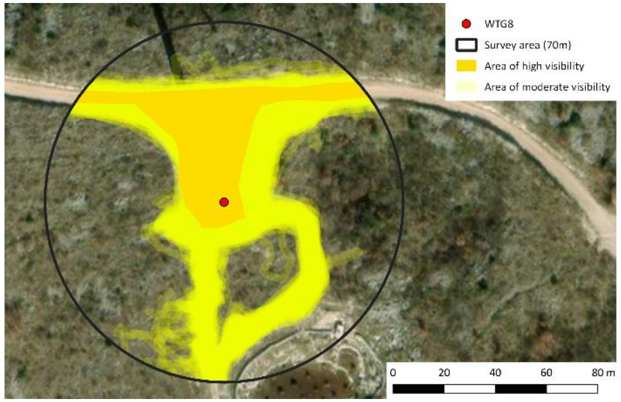


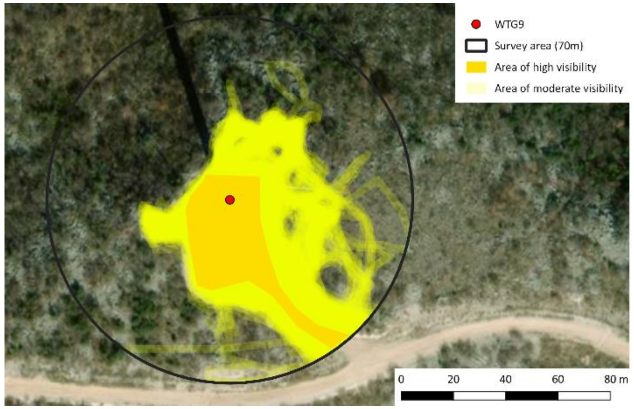

WTG4
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

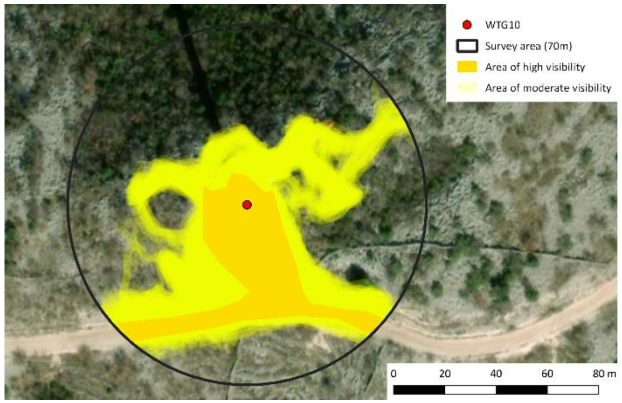

WTG5
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

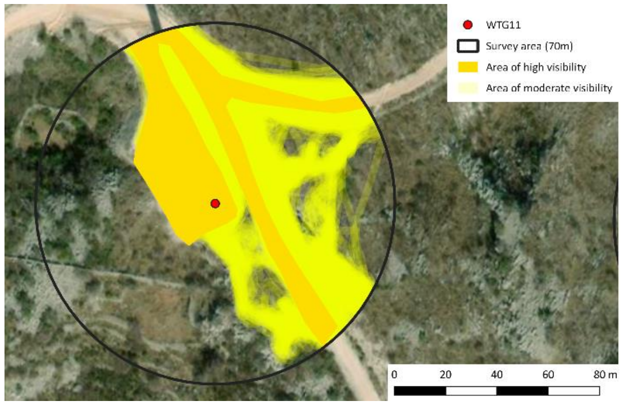

WTG6
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

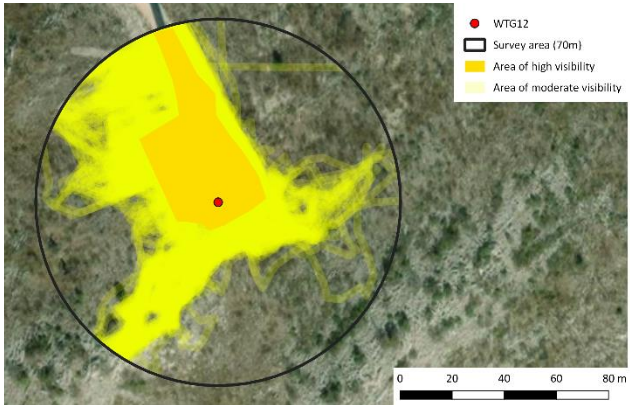

WTG7
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

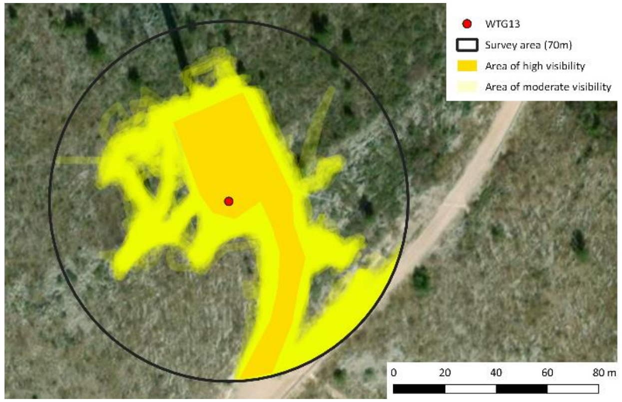

WTG8
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

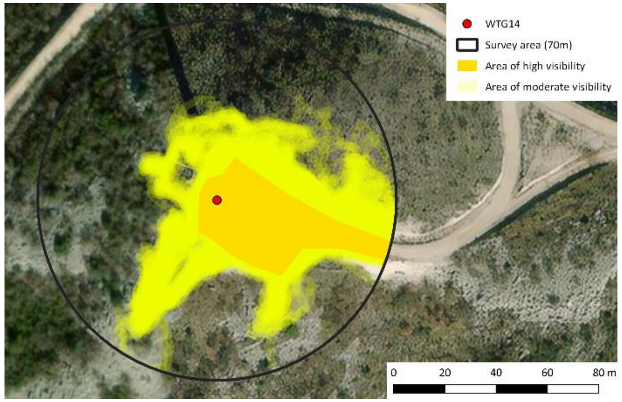

WTG9
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

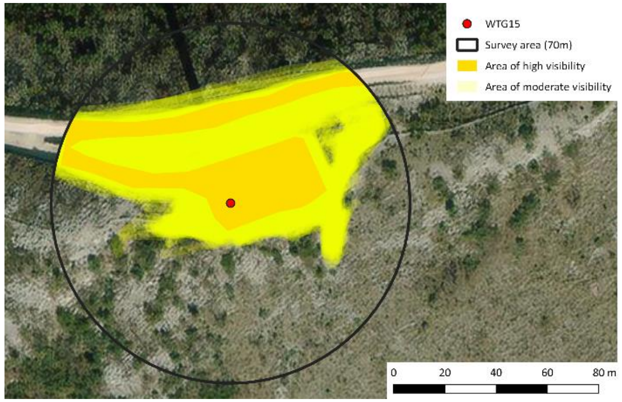

WTG10
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

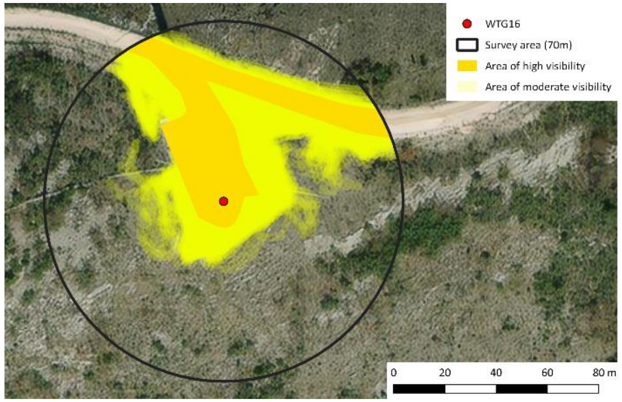

WTG11
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

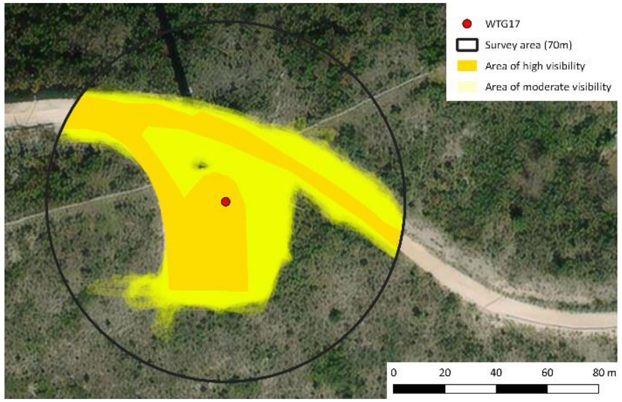

WTG12
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

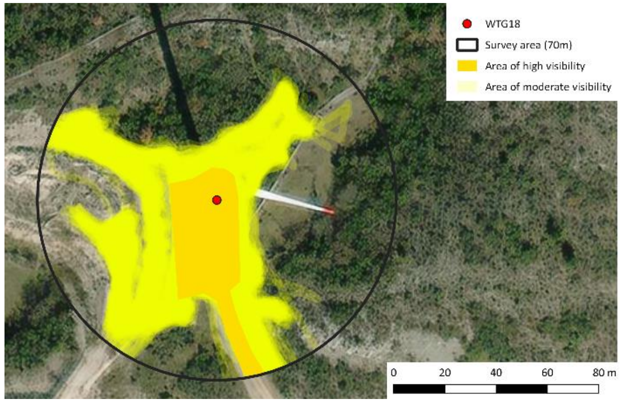

WTG13
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

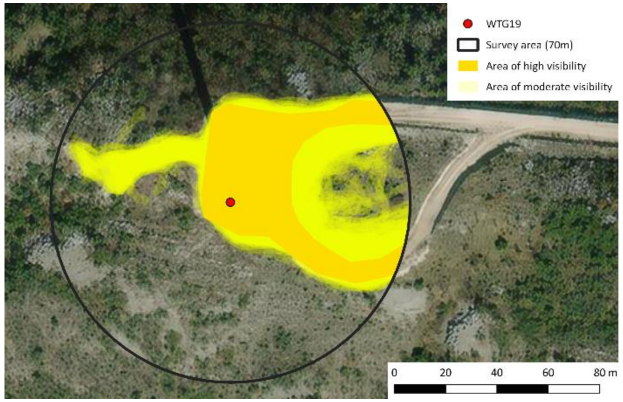

WTG14
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m

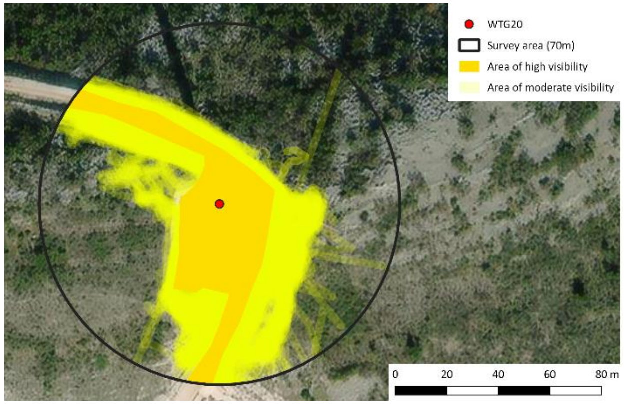

WTG15
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m


WTG16
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m


WTG17
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m


WTG18
Survey area (70m)
Area of high visibility
Area of moderate visibility
0 20 40 60 80 m





(Basemap source: Bing Maps)

Appendix V. Carcasses found during monitoring of bat collision

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
10.6.2021.	WTG12	*Pipistrellus kuhlii*	-*	-**	34.50	*Abdomen was eaten, including reproductive organs **Wing membranes could not be spread due to severe desiccation	Very dry	
11.6.2021.	WTG10	*Hypsugo savii*	Male	Adult	32.20	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
24.6.2021.	WTG3	*Hypsugo savii*	-	Adult	33.50	-	Fresh	
24.6.2021.	WTG3	*Hypsugo savii*	Female	Adult	29.00	Skull injury	Fresh	
4.7.2021.	WTG1	*Pipistrellus kuhlii*	Female	Adult	35.24	Bat was found bisected; head and wings detached from body	Eaten	
15.7.2021.	WTG3	*Hypsugo savii*	Male	Adult	32.20	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
15.7.2021.	WTG9	*Hypsugo savii*	Female	Adult	32.92	Broken upper arm	Fresh	
15.7.2021.	WTG17	*Pipistrellus kuhlii*	Female	Adult	34.27	-	Fresh	
16.7.2021.	WTG7	*Pipistrellus kuhlii*	Female	Adult	33.68	Broken left upper arm	Fresh	
17.7.2021.	WTG1	*Pipistrellus kuhlii*	Male	Adult	33.72	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
24.7.2021.	WTG13	*Pipistrellus kuhlii*	Female	Adult	34.79	Broken right upper arm	Fresh	
28.7.2021.	WTG17	*Pipistrellus kuhlii*	Female	Adult	33.33	-	Fresh	
28.7.2021.	WTG8	*Pipistrellus kuhlii*	Female	Adult	35.76	-	Fresh	
28.7.2021.	WTG7	*Pipistrellus kuhlii*	Female	Adult	34.51	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
28.7.2021.	WTG1	Chiroptera sp. (small species)	-	Adult	33.35	-	Disintegrated	
29.7.2021.	WTG1	*Pipistrellus kuhlii*	Female	Adult	33.93	-	Fresh	
29.7.2021.	WTG2	*Pipistrellus kuhlii*	Female	Adult	33.34	-	Fresh	
29.7.2021.	WTG2	*Hypsugo savii*	Female	Juvenile	32.82	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
29.7.2021.	WTG2	Chiroptera sp.	-	-	32.86	-	Older, eaten	
29.7.2021.	WTG3	*Pipistrellus kuhlii*	Female	Adult	34.99	Broken left forearm	Fresh	
30.7.2021.	WTG15	*Pipistrellus kuhlii*	Female	Juvenile	33.53	Broken both upper arms	Fresh	
30.7.2021.	WTG10	*Pipistrellus kuhlii*	Male	Adult	33.05	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
30.7.2021.	WTG9	*Pipistrellus kuhlii*	Female	Adult	33.73	-	Eaten	
31.7.2021.	WTG1	*Hypsugo savii*	Female	Subadult	35.21	Broken fifth finger on left wing	Fresh	
31.7.2021.	WTG9	*Pipistrellus kuhlii*	-	Adult	34.84	-	Eaten	
31.7.2021.	WTG9	*Pipistrellus kuhlii*	Female	Adult	31.99	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
31.7.2021.	WTG10	*Hypsugo savii*	Female	Subadult	31.89	-	Eaten	
31.7.2021.	WTG11	*Hypsugo savii*	Female	Juvenile	33.82	-	Fresh	
31.7.2021.	WTG11	*Pipistrellus kuhlii*	Female	Juvenile	35.08	-	Fresh	
1.8.2021.	WTG16	*Hypsugo savii*	Female	Adult	33.13	Broken left upper arm	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
1.8.2021.	WTG15	*Pipistrellus kuhlii*	Male	Adult	34.03	-	Not fresh	
1.8.2021.	WTG12	*Hypsugo savii*	Female	Subadult	35.63	-	Eaten	
1.8.2021.	WTG3	*Hypsugo savii*	Female	Juvenile	34.56	-	Fresh	
1.8.2021.	WTG3	*Hypsugo savii*	Male	Juvenile	32.84	-	Not fresh, dry wings	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
3.8.2021.	WTG16	*Hypsugo savii*	Male	Adult	33.29	-	Fresh	
3.8.2021.	WTG15	*Pipistrellus* sp.	-	Adult	35.58	-	Eaten	
3.8.2021.	WTG10	*Hypsugo savii*	Female	Adult	32.72	Broken right upper arm	Eaten	
3.8.2021.	WTG10	*Hypsugo savii*	-	Adult	33.09	-	Eaten	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
3.8.2021.	WTG3	*Hypsugo savii*	Female	Adult	32.87	Broken right upper arm	Eaten	
4.8.2021.	WTG11	*Hypsugo savii*	Female	Subadult	35.37	-	Fresh	
4.8.2021.	WTG11	*Hypsugo savii*	Female	Adult	33.85	-	Fresh	
6.8.2021.	WTG18	*Hypsugo savii*	Male	Adult	35.44	Broken left forearm and upper arm	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
7.8.2021.	WTG9	*Hypsugo savii*	Female	Juvenile	34.49	Broken left elbow	Fresh	
10.8.2021.	WTG17	*Pipistrellus pipistrellus*	Male	Juvenile	33.33	-	Not fresh	
12.8.2021.	WTG13	*Hypsugo savii*	Female	Adult	32.87	-	Fresh	
12.8.2021.	WTG16	*Pipistrellus kuhlii*	Female	Adult	33.67	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
13.8.2021.	WTG2	*Pipistrellus kuhlii*	Female	Adult	-	Scratch dorsally	Fresh	
15.8.2021.	WTG3	*Hypsugo savii*	Female	Adult	35.13	Broken right upper arm	Fresh	
16.8.2021.	WTG11	*Hypsugo savii*	Male	Adult	31.71	Broken both upper arms	Fresh	
20.8.2021.	WTG10	*Hypsugo savii*	Male	Adult	32.82	-	Fresh	

DATE	WTG	SPECIES	SEX	AGE	FA (mm)	INJURIES	STATE OF CARCASS	PHOTO
22.8.2021.	WTG16	*Hypsugo savii*	Female	Adult	34.07	-	Fresh	
14.9.2021.	WTG3	Chiroptera sp.	Female	Adult	35.53	-	Fresh	
15.9.2021.	WTG4	*Hypsugo savii*	-	Adult	34.71	-	Eaten	

Appendix VI. Effects of mitigations measures on WF Jelinak energy production in 2021 (Source: Vjetroelektrana Jelinak Ltd.)

YEAR	MONTHS	CUT-IN SPEED	NUMBER OF TURBINES	TURBINES WITH MITIGATION MEASURES	HOURS PER DAY	MONITORING ON SITE / CONSULTANT	MWH LOSSES DUE TO BAT MITIGATION (MWH)	YEARLY PRODUCTION (MWH)	ENERGY LOSSES DUE TO BAT MITIGATION (%)
2021	1st July -15th July	5m/s	5	WTG1, WTG10, WTG13, WTG17, WTG18	6 hours (from 9 pm to 3 am next morning)	OIKON	496.9	81045.5	0.61
		5,5m/s	9	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14					
	16th July -15th August	5m/s	5	WTG1, WTG10, WTG13, WTG17, WTG18	from half an hour before sunset until half an hour after sunrise				
		5.5m/s	9	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14					
	16th August -31st August	5m/s	5	WTG1, WTG10, WTG13, WTG17, WTG18	from half an hour before sunset until half an hour after sunrise				
		5.5m/s	9	WTG2, WTG3, WTG4, WTG5, WTG6, WTG7, WTG8, WTG12, WTG14					
	1st September-30th September	5.5m/s	6	WTG5, WTG8, WTG12, WTG13, WTG16, WTG20	from half an hour before sunset until 3 am				