Cibuk wind farm

Additional bird survey report (Nov 2011 to July 2012)

Continental Wind Partners

August 2012

Atkins

Plan Design Enable

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Executive summary

Continental Wind Partners (CWP) intends to develop a 160+ MW wind farm project in Serbia. The proposed site is located about 50 km to the north east of Belgrade (in Vojvodina province) and covers an area of approximately 3,716 Hectares.

Baseline data was collected between September 2009 and February 2011 by two teams of local bird specialists, managed by Ecoda Ltd, Germany. However, an EIA scoping report for the CWP Dolovo wind farm in Serbia was produced by Atkins in June 2011. This scoping report identified some disparities between the survey methodologies of the two teams; bird flight data, although thorough, was not suitable for undertaking collision risk analysis (an increasingly used technique which identifies bird species most at risk of collision with wind turbines). In addition, the breeding bird data was not suitable for territory analysis.

In order to enable Collision Risk Analysis to be performed and to bring the data collected in line with the current UK guidance on carrying out an ornithological Impact Assessment for a proposed wind farm, additional survey data was collected between November 2011 and July 2012.

An assessment of the additonal data collected between November 2011 and July 2012 suggests that the findings are consistent with the original baseline data collected between September 2009 and February 2011 and the interpretation of that data:

- A total of 93 species were recorded during the additonal bird surveys between November 2011 and June 2012. This species list is similar to the 117 species recorded between September 2009 and February 2011, with the lower number believed to be reflective of the reduced survey effort.

- The additional vantage point survey data collected between November 2011 and July 2012 supports the findings of the original baseline data (collected between September 2009 and February 2011), identifying the same ten target species with the greatest number of flights: common buzzard, Eurasian kestrel, Eurasian hobby, western marsh harrier, hen harrier, northern goshawk, Eurasian sparrowhawk, greylag goose, greater white-fronted goose and European bee-eater.

- Collision risk analysis of the additional vantage point survey data confirmed that the proposed wind farm is not expected to have a significant impact on any of the target species.

- The breeding bird surveys carried out between March 2012 and July 2012 has identified nine species that bred within the survey squares and a further six species that possibly had breeding territories within or near the breeding squares. Nine of these species were identified as breeding species within the wind farm site in the Environmental and Social Impact Assessment (Atkins, 2012). The Environmental and Social Impact Assessment identified a further eight species believed to breed within the wind farm site, of which seven were recorded during the 2012 breeding surveys, but are not thought to actually breed within the breeding bird squares.

- The breeding bird surveys carried out between March 2012 and July 2012 identified three confirmed common quail territories and a further possible five common quail territories within the breeding bird survey squares. When multiplied by 6.19 to represent the total area of the wind farm site (3,716 Hectares), this equates to approximately 19-50 territories. This gives a mean of 34.5 territories and supports the estimation of 30 common quail territories in the Environmental and Social Impact Assessment (Atkins, 2012).

1. Introduction and overview

Continental Wind Partners (CWP) intends to develop a 160+ MW wind farm project in Serbia. The proposed site is located about 50 km to the north east of Belgrade (in Vojvodina province) and covers an area of approximately 3,716 ha.

Bird surveys were undertaken between September 2009 and February 2011 by two teams of local bird specialists, managed by Ecoda Ltd, Germany. Team 1 consisted of,Javor Rašajski and Milovan Nešić and Team 2 consisted of Milan Paunović, Marko Raković, Milivoj Vučanović and Branko Karapandža (MM Consulting and Fauna C&M).

In April 2011 Atkins were instructed by CWP to assess the work conducted by Ecoda and produce an Environmental and Social Impact Assessment (Atkins, 2012[1]). As part of the process, an EIA scoping report for the CWP Dolovo wind farm in Serbia was produced by Atkins in June 2011. During this process some limitations within the existing survey methodology were identified, including the bird baseline data collection and analysis. Some disparities between the survey methodologies of the two teams had been noted, and flight data, although thorough, was not suitable for undertaking collision risk analysis (an increasingly used technique which identifies bird species most at risk of collision with wind turbines). In addition, the breeding bird data was not suitable for territory analysis.

In order to perform Collision Risk Analysis and to bring the survey methodology and thus data collected in line with the current UK guidance on carrying out an ornithological Impact Assessment for a proposed wind farm, additional survey data was collected between November 2011 and July 2012.

The aim of this additional data collection was to enable collision risk analysis and breeding bird population analysis to be conducted. These analyses have now been carried out and are presented in this report.

2. Methodology

There is no standard European bird survey methodology guidance for wind farm assessments, therefore standard guidance documents for UK wind farm assessments have been used to inform the additional bird surveys. Several UK guidance documents were reviewed by an Atkins ecologist in September 2011 when devising the ornithological survey and assessment methodology for the project:

- *Guidelines for Baseline Ecological Assessment (IEA, 1995)*[2]
- *Technical Information Note TIN069: Assessing the effects of onshore windfarms on birds (Natural England, 2010)*[3].
- *Survey Methods for use in Assessing the Impacts of Onshore Windfarms on Bird Communities (Scottish Natural Heritage, 2005)*[4];
- *Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas (Scottish Natural Heritage, 2006)*[5];

[1] Atkins (2012) *Cibuk Wind Farm Environmental and Social Impact Assessment.*
[2] Institute of Environmental Assessment (1995) *Guidelines for Baseline Ecological Assessment*.
[3] Natural England (2010) *Assessing the effects of onshore wind farms on birds*. Peterborough: Natural England.
[4] Scottish Natural Heritage (2005) *Survey methods for use in assessing the impacts of onshore windfarms on bird communities*. Scottish Natural Heritage.

- *Windfarms and Birds: Calculating a Theoretical Collision Risk Assuming no Avoiding Action* (*Scottish Natural Heritage*, 2000)[6]; and,
- *Bird Monitoring Methods*[7].

2.1. Field survey

Surveys were carried out by two local expert bird surveyors (Goran Sekulic, Institute for Nature Conservation of Serbia and Stefan Skoric, University of Belgrade), under the management and assistance of an Atkins ornithologist (Paul Watts). The following survey protocol was designed to bring the baseline data collected in line with the current UK guidance on carrying out an ornithological Ecological Impact Assessment for a proposed wind farm:

- 36 hours of Vantage Point (VP) survey work at six Vantage Point locations (total of 216 hours) during the 2011-2012 winter season (November 2011 to early March 2012);
- 36 hours of Vantage Point survey work at six Vantage Point locations (total of 216 hours) during the 2012 breeding bird season (mid-March 2012 to July 2012);
- Nine breeding bird surveys during the 2012 breeding season (mid-March 2012 to July 2012).

This approach ensured that the survey work covers a full winter and breeding season, in accordance with Natural England and Scottish Natural Heritage guidance. The proposed wind farm site is not considered to be significant for migrating birds during spring and autumn (Ecoda, 2011[8]) and therefore did not require additional survey effort during these periods.

Vantage point (VP) surveys

For the original baseline data collected between September 2009 and February 2011, 5 VP locations were used by Team 1, and 6 VP locations were used by Team 2 (Ecoda, 2011).

The 6 VP locations used by Team 2 were considered to give sufficient coverage of the wind farm site to gain an understanding of the use of the airspace by flying birds. These VPs were used for the additional surveys in 2011-2012, with the exception of VP5, which was originally located on the edge of Deliblato Sands (1.3km from the wind farm site) and has been relocated to the edge of the wind farm site to allow better coverage of the wind farm area. All VPs are all located at the outer edge of the wind farm site (allowing coverage of the wind farm site, whilst avoiding disturbance of birds within the wind farm site), with the exception of VP3 which is located at the edge of the Deliblato Sands Important Bird Area, approximately 1km to the east of the proposed wind farm site. See Figure 1, page 10, for a map of the VP locations.

Winter VP surveys

Thirty-six hours of survey were conducted at each VP during the winter season (November 2011 to early March 2012), following Natural England guidance (Natural England, 2010) and Scottish Natural Heritage survey guidance (Scottish Natural Heritage, 2005).

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[5] Scottish Natural Heritage (2006) *Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas*. Scottish Natural Heritage.

[6] Scottish Natural Heritage (2000) *Windfarms and Birds: Calculating a Theoretical Collision Risk Assuming no Avoiding Action.* Scottish Natural Heritage.

[7] Gilbert, G., Gibbon, D. and Evans, J. (1998) *Bird monitoring methods: a manual of survey techniques for key UK species*. Sandy: Royal Society for the Protection of Birds.

[8] Ecoda (2011) *Expert opinion on the expected impact on birds* Ecoda Consulting

In accordance with guidelines, surveys lasted two hours per VP, with a gap of at least 15 minutes between each survey.

Surveys were undertaken in a range of weather conditions (as long as suitable visibility was achievable), as weather may affect the behaviour and flight patterns of birds. Start times varied, ensuring that surveys were undertaken throughout the day, between dawn and dusk for each VP over the winter season. See Appendix A for a full list of survey dates, start times and weather details.

Breeding season VP surveys

Thirty-six hours of survey were conducted at each VP during the breeding season (mid-March 2012 to July 2012), following Natural England guidance (Natural England, 2010) and Scottish Natural Heritage survey guidance (Scottish Natural Heritage, 2005).

In accordance with guidelines, surveys lasted two hours per VP, with a gap of at least 15 minutes between each survey.

Surveys were undertaken in a range of weather conditions (as long as suitable visibility is achievable), as weather may affect the behaviour and flight patterns of birds. Start times varied, ensuring that surveys were undertaken throughout the day for each VP over the breeding season. See Appendix A for a full list of survey dates, start times and weather details.

Target species

The baseline surveys carried out between September 2009 and February 2011 focused on a total of 32 target species considered to be particularly vulnerable to wind farms (Ecoda, 2011). These species are target species due to their national and international significance, as well as due to their specific biometrics (such as body length, wing span), flight behaviour and potential sensitivity to the alteration of their habitats by the construction of wind farm infrastructures.

The aim of the additional vantage point surveys carried out between November 2011 and July 2012 was to enable collision risk analysis to be carried out on these target species. Therefore the same list of 32 target species was used for these additional vantage point surveys.

Table 1 shows a list of the target species, along with their international conservation status.

Table 1. List of target species and their protected status (taken from Atkins, 2012) – see below table for explanation of names and abbreviations

Species	Bern	Bonn	Bird Directive	Birdlife International (2004)	IUCN
Great cormorant	III				
Pygmy cormorant	II		I	SPEC 1	
Black-crowned night heron	II		I	SPEC 3	
Purple heron	II		I	SPEC 3	
White stork	II	II	I	SPEC 2	
Bean goose	II		IIa		
Greater white-fronted goose	II/III		IIb, IIIb		
Greylag goose	II/III		IIa, IIIb		
European honey buzzard	II	II	I		
White-tailed eagle	II	I	I	SPEC 1	

Western marsh harrier	II	II	I		
Hen harrier	II	II	I	SPEC 3	
Montagu's harrier	II	II	I		
Northern goshawk	II	II			
Eurasian sparrowhawk	II	II			
Common buzzard	II	II			
Rough-legged buzzard	II	II			
Booted eagle	II	II	I	SPEC 3	
Common kestrel	II	II	I	SPEC 3	
Red-footed falcon	II	II	I	SPEC 3	NT
Merlin	II	II	I	SPEC 3	
Eurasian hobby	II	II	I		
Saker falcon	II	II	I	SPEC 1	VU
Peregrine falcon	II	II	I		
Common crane	II	II	I	SPEC 2	
Long-eared owl	II				
Eurasian scops owl	II			SPEC 2	
Little owl	II			SPEC 3	
Barn owl	II			SPEC 3	
Tawny owl	II				
European bee-eater	II	II		SPEC 3	
European roller	II	II	I	SPEC 2	NT

Explanations for Table 1

Column heading	Convention description	Protected status
Bern	Convention on the Conservation of European Wildlife and Natural Habitats	II: strictly protected fauna species.
		III: protected fauna species.
Bonn	Bonn Convention on the Conservation of Migratory Species of Wild Animals	I: Endangered migratory species.
		II: Migratory species conserved by agreements.
Birds Directive	2009/147/EC of the European Parliament and of the Council of 30	I: The species mentioned in Annex I shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution.
		IIa: The species referred to in Annex II, Part A may be hunted in the geographical sea

	November 2009 on the conservation of wild birds	and land area where this Directive applies.
		IIb: The species referred to in Annex II, Part B may be hunted only in the Member States in respect of which they are indicated.
		IIIa: The activities referred to in paragraph 1 shall not be prohibited in respect of the species referred to in Annex III, Part A, provided that the birds have been legally killed or captured or otherwise legally acquired.
		IIIb: Member States may, for the species listed in Annex III, Part B, allow within their territory the activities referred to in paragraph 1, making provision for certain restrictions, provided that the birds have been legally killed or captured or otherwise legally acquired.
Birdlife International (2004):	Bird Species of European Conservation Concern	SPEC 1: Species of global conservation concern, i.e. classified as globally threatened, near threatened or data deficient (BIRDLIFE INTERNATIONAL 2004a).
		SPEC 2: Concentrated in Europe and with an unfavourable conservational status.
		SPEC 3: Not concentrated in Europe but with an unfavourable conservational status.
IUCN	European IUCN Red List Category	VU: vulnerable
		NT: near threatened

Data collection

During the vantage point surveys (November 2011 - July 2012), details of all target species seen or heard were recorded. Information recorded included: species, sex (where possible), number, flight direction, location, flight duration and flight height. Vantage Point locations are shown on Figure 1.

Flight heights were recorded at 5 different height categories (<50m, 50m-100m, 100m-150m, 150m-200m, >200m). This was consistent with the original baseline vantage point surveys as outlined in Ecoda (2011). Any flights that fell between the heights of 50m and 200m were within the sweeping range of the proposed wind turbine blades (turbine sweep is expected to fall between 60-80m and 180-200m) and were therefore considered to be at potential collision risk height.

For the duration of a flight made by a target species, the flight height was recorded every 15 seconds. This was important as this enabled an amount of time spent within the potential collision risk height (50m-200m) to be established for each target species: an essential statistic for collision risk analysis.

All target species flights were hand drawn on a map. A different map was used for each survey, and clear target notes allowed each hand drawn flight to be associated with the correct flight details. See Appendix B for flight maps for each target species recorded at each VP.

During the vantage point surveys, all species seen or heard were recorded, enabling a full site list to be established.

Breeding bird surveys

The original baseline bird surveys undertaken between September 2009 and February 2011 provided limited coverage of breeding birds within the wind farm site.

The Environmental and Social Impact Assessment determined that breeding common quail are likely to be displaced up to 200m from any wind turbine within the proposed wind farm site, equating to an expected displacement from approximately 20% of the entire wind farm site. The Environmental and Social Impact

Assessment estimated that approximately 30 pairs of common quail breed within the wind farm site and provided mitigatory habitat creation options based on this.

Further breeding bird surveys were carried out in line with UK guidance (NE, 2010), allowing breeding territory distributions to be established for all birds, including common quails.

Nine surveys were carried out, twice monthly between mid-March 2012 and July 2012.

The wind farm site consists entirely of intensive arable land, with a network of tracks and roads lined sparsely with hedges and patches of relic steppe grassland (for a detailed description see Phase 1 section of the Environmental and Social Impact Assessment (Atkins, 2012)). As the habitat is homogenous across the site, it is considered that a detailed assessment of a representative proportion of the site, would allow an accurate extrapolated estimation of the breeding populations within the wind farm site as a whole.

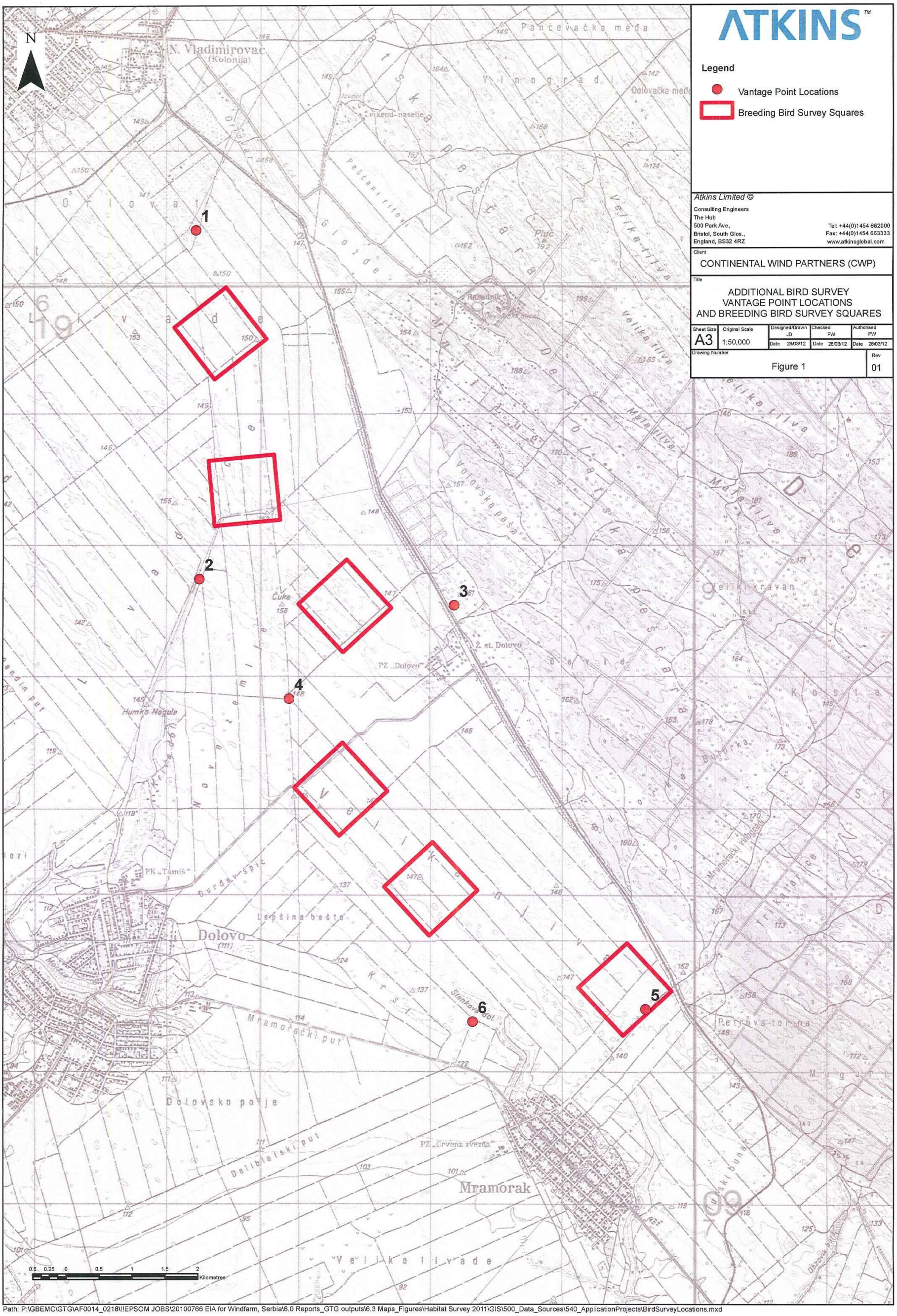
Six squares, each 1km^2, were selected. These squares were chosen as they were spread across the wind farm site and contained sufficient tracks to allow survey access within 200m of every point within the survey area; this access was considered sufficient to allow all vocal birds within the survey area to be recorded due to the open habitats present. The survey squares are shown in Figure 1.

Each survey visit consisted of two surveyors, each covering 3 x 1km^2 squares (therefore covering 6 x 1km^2 squares between them).

Surveys started shortly after sunrise, when birds are the most active and the starting point and direction of the survey route was varied each time to ensure that there was no tendency for any part of the survey area to be visited earlier or later in the day. Surveys were undertaken in fair weather conditions (i.e. not in heavy rain, poor visibility or wind greater than Beaufort 4[9]).

Blank maps of the survey route and boundary were used by the surveyor for each survey. All birds observed and any behavioural activity (such as singing, carrying food) was recorded on a map for each survey. The map also included details of date, start and finish time, sunrise time and weather. See Appendix A for a list of survey dates, start times and weather.

[9] Beaufort scale is an empirical measure for describing wind speed, ranging from 0 (calm) to 12 (hurricane). Beaufort 4 = moderate breeze (11-16 knots)



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Legend

- Vantage Point Locations
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Client: CONTINENTAL WIND PARTNERS (CWP)

Title: ADDITIONAL BIRD SURVEY
VANTAGE POINT LOCATIONS
AND BREEDING BIRD SURVEY SQUARES

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Figure 1: Vantage Point Locations

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2.2. Data analysis

Vantage point surveys

Collision risk analysis has been carried out on the target species flight data collected between November 2011 and July 2012. The analysis has used the data collected to estimate the total amount of time that each target species spends within the site at collision risk height over the period of a year. This has then been used to estimate the number of passes through a wind turbine that each target species will make per year, which is then converted into an estimation of number of collisions per year for each target species, based on their known avoidance rates.

The collision risk analysis process is described in detail in Appendix C.

Breeding bird surveys

Each survey square was surveyed nine times during the 2012 breeding season, allowing breeding bird population estimates to be established for each survey area.

After all visits were completed, the information obtained for each species was transferred onto a separate map, the species map. Registrations on the species maps fall more or less neatly into clusters and the maps are analysed to establish the number of territories present with the survey area (Gilbert *et al.*, 1998[10]).

Due to the uniform arable habitat within the site, it is considered possible to estimate the total breeding bird populations of the whole wind farm site by extrapolating the number of territories recorded within the breeding bird survey areas. The total population estimate for the whole survey area (600 ha) can be multiplied by 6.19 to estimate the total populations within the wind farm site (3,716 ha).

3. Results

The additional surveys (vantage point surveys and breeding bird surveys) carried out between November 2011 and July 2012 recorded a total of 93 species. Of these, 55 species are believed to breed within or near the wind farm site.

See Appendix D for a full list of species and their breeding status within the wind farm.

3.1. Vantage point surveys

A total of 91 species were recorded during the 432 hours of vantage point surveys carried out at 6 vantage points between November 2011 and July 2012.

Thirteen target bird species were recorded flying at rotor height (the height between the upper and lower turbine blades): northern goshawk, European sparrowhawk, hen harrier, Eurasian kestrel, saker falcon, black kite, common buzzard, greylag goose, white-fronted goose, white stork, common crane, European bee-eater and great cormorant.

An additional species, black stork, was not on the target species list, but was recorded during the vantage point surveys and has been treated as a target species. Black stork was also recorded flying at rotor height.

All 14 target species (including black stork) were recorded within the survey area during surveys undertaken between November 2011 and July 2012. A further 5 target species (Western marsh harrier, pallid harrier,

[10] Gilbert, G., Gibbon, D., Evans, J. (1998) 'Bird Monitoring Methods; a manual of survey techniques for key UK species'. Sandy:RSPB.

merlin, Eurasian hobby and white-tailed eagle) were recorded within the survey area, but not at rotor height and were therefore not at collision risk and were excluded from the collision risk calculations.

It was not always possible to differentiate between white-fronted geese and greylag geese (although flocks that could be identified suggested proportions of at least 90% greylag geese to 10% white-fronted geese). Therefore, both species have been recorded and analysed as a single group: 'grey geese'.

For each target species flight, the flight time (in 15 second periods) can be multiplied by the number of birds in flight to give the total flight time. For example:

30 common cranes flying for 45 seconds = 30 x 45 = 1350 seconds total flight time

1 buzzard flying for 180 seconds = 1 x 180 = 180 seconds total flight time

Table 2 shows the flight details of all 19 target species (including black stork) recorded during the vantage point surveys.

Table 2. Flight details of target species recorded during vantage point surveys (November 2011 to June 2012)

Target species group	Species	Total no. of flights	Total no. of flights that pass within collision risk height	Percentage (%) of flights that pass within collision risk height	Total flight time (seconds)	Total flight time (seconds) at collision risk height (50m – 200m)
Raptors	Common buzzard	246	72	29	37530	10585
	Eurasian kestrel	80	7	9	7995	750
	Western marsh harrier	16	0	0	2145	0
	Eurasian sparrowhawk	15	1	7	825	120
	Hen harrier	13	4	31	2190	465
	Northern goshawk	9	4	44	1590	345
	Eurasian hobby	7	0	0	495	0
	Merlin	6	0	0	165	0
	Saker falcon	5	1	20	285	45
	Black kite	1	1	100	345	300
	White-tailed eagle	1	0	0	165	0
	Pallid harrier	1	0	0	135	0
Waterfowl	Grey goose species (greater white-fronted goose and greylag goose)	153	68	44	1522035	835335
Storks and cranes	White stork	6	5	83	3465	2955
	Common crane	4	3	75	390	165

	Black stork	2	1	50	450	90
Cormorants	Great cormorant	2	2	100	4140	1740
Passerines	European bee-eater	32	10	31	4800	1230

The total flight time at collision risk height (final column of Table 2) has been used to carry out collision risk analysis on the 13 species (counting greylag geese and greater white-fronted geese as a single group) with flights recorded at a collision risk height.

The aim of collision risk analysis is to establish an annual mortality estimate for each target species. The findings of the collision risk analysis are shown in Table 3; the collision risk analysis process itself is described in detail in Appendix C.

Table 3. Collision risk analysis results for target bird species

Target species group	Species	Predicted number of collisions per year	Predicted number of years per collision
Raptors	Common buzzard	0.90	1.1
	Eurasian kestrel	0.43	2.3
	Eurasian sparrowhawk	0.03	38
	Black kite	0.03	36
	Northern goshawk	0.03	36
	Hen harrier	0.02	51
	Saker falcon	0.01	74
Waterfowl	Grey goose species (greater white-fronted goose and greylag goose)	56	0.02
Storks and cranes	White stork	0.56	1.8
	Common crane	1.9	0.53
	Black stork	0.02	58
Cormorants	Great cormorant	0.31	3.2
Passerines	European bee-eater	0.43	2.4

3.2. Breeding bird surveys

A total of 47 species were recorded during the breeding bird surveys carried out between March and July 2012, of which 31 species are thought to breed within or near the wind farm site (see Appendix D for a full list of species and their breeding status).

A review of the breeding bird surveys has identified nine species that were confirmed to have breeding territories within the survey squares: common quail, corn bunting, crested lark, Eurasian skylark, European bee-eater, European stonechat, red-backed shrike, tawny pipit and yellow wagtail. See Appendix E for territory maps for each of the six breeding bird squares.

Seven of these species were identified in the Environmental and Social Impact Assessment (Atkins, 2012) as breeding within the wind farm survey area. European bee-eater and tawny pipit were not identified as breeding within the wind farm survey area in the Environmental and Social Impact Assessment, but have been confirmed as breeding during the additional bird surveys (a pair of European bee-eaters were observed at a nest hole and tawny pipits were observed singing and seen carrying food).

The 2012 breeding bird surveys also recorded a further 6 species considered to have possible breeding territories within or near the breeding bird squares: blackcap, chaffinch, common whitethroat, Eurasian kestrel, Eurasian tree sparrow and house sparrow. Of these, Eurasian kestrel was confirmed as breeding in the Environmental and Social Impact Assessment, and Eurasian tree sparrow and house sparrow were thought to probably breed within the wind farm survey area.

The Environmental and Social Impact Assessment identified a further eight species as breeding within the wind farm survey area: common buzzard, common cuckoo, common pheasant, European magpie, grey partridge, hooded crow, turtle dove and whinchat.

All of these species, with the exception of grey partridge, were recorded during the breeding bird surveys carried out between March 2012 and June 2012. These species are all believed to breed within the wind farm site or immediate surrounds but are not considered to actually breed within the breeding bird squares.

Table 4 gives a list of bird species identified as breeding within the wind farm survey area in the Environmental and Social Impact Assessment or recorded as confirmed or possible breeding during the 2012 breeding bird surveys.

Table 4. Breeding status of birds within the proposed wind farm site

Species	Breeding status in Environmental and Social Impact Assessment (Atkins, 2012)	Breeding status in 2012 breeding bird surveys
Blackcap	Not recorded as breeding within wind farm survey area	Probably breeds within or near survey squares
Common buzzard	Breeds within wind farm survey area	Breeds within or on outskirts of wind farm site, but not within survey squares
Common cuckoo	Breeds within wind farm survey area	Breeds within wind farm site, but not within survey squares
Common pheasant	Breeds within wind farm survey area	Breeds within or on outskirts of wind farm site, but not within survey squares
Common quail	Breeds within wind farm survey area	Breeds within survey squares
Common whitethroat	Not recorded as breeding within wind farm survey	Probably breeds within or near survey squares

	area	
Corn bunting	Breeds within wind farm survey area	Breeds within survey squares
Crested lark	Breeds within wind farm survey area	Breeds within survey squares
Eurasian kestrel	Breeds within wind farm survey area	Breeds within wind farm site, probably breeds near survey squares
Eurasian skylark	Breeds within wind farm survey area	Breeds within survey squares
European bee-eater	Not recorded as breeding within wind farm survey area	Breeds within survey squares
European magpie	Breeds within wind farm survey area	Breeds within wind farm site, but not within survey squares
European stonechat	Breeds within wind farm survey area	Breeds within survey squares
Grey partridge	Breeds within wind farm survey area	Breeds within wind farm site, but not within survey squares
Hooded crow	Breeds within wind farm survey area	Breeds within or on outskirts of wind farm site, but not within survey squares
House sparrow	Probably breeds within wind farm survey area	Breeds within wind farm site, probably breeds near survey squares
Red-backed shrike	Breeds within wind farm survey area	Breeds within survey squares
Tawny pipit	Not recorded as breeding within wind farm survey area	Breeds within survey squares
Eurasian tree sparrow	Probably breeds within wind farm survey area	Breeds within wind farm site, probably breeds near survey squares
Turtle dove	Breeds within wind farm survey area	Breeds within wind farm site, but not within survey squares
Whinchat	Breeds within wind farm survey area	Possibly breeds within wind farm site, but not within survey squares
Yellow wagtail	Breeds within wind farm survey area	Breeds within survey squares

The survey squares covered an area of 600 ha and were considered to fairly reflect the whole wind farm site, covering the intensively farmed open fields and the network of tracks and roads with sparse hedgerows.

Due to the fair representation of the habitat within the whole wind farm site, it is considered reasonable to multiply the number of breeding territories recorded within the 600 ha covered by the breeding bird surveys by 6.19 to estimate the total populations within the wind farm site (3,716 ha).

Table 5 shows the estimated number of breeding territories for birds recorded within each survey square and the extrapolated estimation of the total number of breeding squares within the whole wind farm site.

Table 5. Estimated breeding territories within the wind farm site

	Common quail	European skylark	Red-backed shrike	Yellow wagtail	Tawny pipit	Crested lark	Corn bunting	European stonechat	Eurasian kestrel	House sparrow	Eurasian tree sparrow	Blackcap	Common chaffinch	European bee-eater	Common whitethroat
Square 1	2 possible territories	6 confirmed territories	2 confirmed territories	1 possible territory	2 possible territories	1 possible territory									
Square 2	1 confirmed territory, 1 possible territory	8 confirmed territories, 1 possible territory	3 confirmed territories	2 confirmed territories	1 possible territory	1 confirmed territory, 1 possible territory	2 confirmed territories	1 confirmed territory, 1 possible territory	1 possible territory						
Square 3	2 confirmed territories, 1 possible territory	10 confirmed territories	3 confirmed territories	3 confirmed territories, 1 possible territory	1 confirmed territory		2 confirmed territories, 1 possible territory								
Square 4	1 possible territory	8 confirmed territories	1 confirmed territory, 1 possible territory							1 possible colony		1 possible territory	1 possible territory		
Square 5		9 confirmed territories, 2 possible territories		1 confirmed territory											
Square 6		8 confirmed territories	2 confirmed territories				2 confirmed territories	1 confirmed territory			1 possible colony			1 confirmed territory	1 possible territory
Total for all 6 squares	3 confirmed territories, 5 possible territories	49 confirmed territories, 3 possible territories	11 confirmed territories, 1 possible territory	6 confirmed territories, 2 possible territories	1 confirmed territory, 3 possible territories	1 confirmed territory, 2 possible territories	6 confirmed territories, 1 possible territory	2 confirmed territories, 1 possible territory	1 possible territory	1 possible colony	1 possible colony	1 possible territory	1 possible territory	1 confirmed territory	1 possible territory
Extrapolated value for whole survey area	**19-50 territories**	**303-322 territories**	**68-74 territories**	**37-50 territories**	**6-25 territories**	**6-19 territories**	**37-43 territories**	**12-19 territories**	**0-6 territories**	**0-6 colonies**	**0-6 colonies**	**0-6 territories**	**0-6 territories**	**6 territories**	**0-6 territories**

(x 6.19)																

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4. Discussion

4.1. Collision risk

Six target species are predicted to have a single collision fatality every 20 years or longer:

- Eurasian sparrowhawk (one fatality every 38 years);
- Black kite (one fatality every 36 years);
- Northern goshawk (one fatality every 36 years);
- Hen harrier (one fatality every 51 years);
- Saker falcon (one fatality every 74 years);
- Black stork (one fatality every 58 years)

It is considered that these species can be immediately excluded from any potential significant collision impacts as a result the proposed wind farm. This is because the rate of collision fatality is so low that it would not have an impact on the population size of these birds at a local, regional or country scale, when considered against environmental factors such as habitat change and climate change.

For the remaining seven species (including greylag geese and greater white-fronted geese combined in a single group) that cannot be immediately excluded, population estimates have been collated from Ecoda (2011). In addition, background adult mortality rates (juvenile mortality rates are higher, so using adult mortality only is considered to provide a precautious underestimate) have been established from Robinson (2005)[11]. The background mortality rates are based on UK populations, but these are considered to give a fair indication of population background mortality rates throughout Europe.

Background mortality rates were not available for white stork and European bee-eater, so a precautionary level of 10% annual mortality has been used.

- An estimate of 10% annual mortality for white stork is believed to be a cautious estimate. This has been based the lowest annual mortality rate of any closely related species: common crane has an annual mortality rate of 10%, grey heron has an annual mortality rate of 28% and little egret has an annual mortality rate of 29%.
- An estimate of 10% annual mortality for European bee-eater is believed to be a cautious estimate for a passerine species. The closely related common kingfisher has an annual mortality rate of 72%.

Based on the estimated population size and the background mortality rates, it has been possible to estimate an annual mortality figure for each target species population. Table 6 assesses whether the predicted number of collisions per year as a result of the proposed wind farm will have a significant impact on the annual mortality of each target species population at a level of 5% significance.

The predicted collision rates are considered to be non-significant on the bird populations for all target species

[11] Robinson, R. (2005) BirdFacts: profiles of birds occurring in Britain and Ireland (BTO Research Report 407). BTO, Thetford.

Table 6. Significance of annual mortality estimates of target species recorded at collision risk height during the additional vantage point surveys (November 2011 – July 2012)

Species	Estimated population size	Background adult mortality rate (taken from Robinson, 2005)	Annual regional mortality number	Predicted number of collisions per year	Significance (5% of background mortality = significant)
Common buzzard	1600-2000 in Vjovodina region	10%	160-200	0.90	Not significant at a regional level
Eurasian kestrel	2,600-3,400 Vjovodina region	31%	806-1054	0.43	Not significant at a regional level
Grey goose species (greater white-fronted goose and greylag goose)	10,000 – 15,000 greater white-fronted geese winter in Serbia and Montenegro	28%	2800-4200	56	Not significant at a national level
	>240,000 greylag geese breed in Europe	17%	>40800		Not significant at a European level
White stork	2,000-2,200 in Vjovodina region	Not known, estimated to be 10% (precautionary rate based on common crane)	200-220	0.56	Not significant at a regional level
Common crane	148,000-220,000 breeding population in Europe	10%	14,800-22,000	1.9	Not significant at a European level
Great cormorant	2,000-2,400 in Vjovodina region	12%	240-288	0.31	Not significant at a regional level
European bee-eater	2,000-4,000 in Vjovodina region	Not known, precautionary estimate of 10% used	200-400	0.43	Not significant at a regional level

However, due to the limited availability of data on Serbia's birds, target species population sizes were not available at a regional level for greater white-fronted goose, greylag goose and common crane. For these target species, only European population estimates were available, and therefore Table 6 is only able to concludes that greater white-fronted goose, greylag goose and common crane will not be significantly affected by the proposed wind farm at a European population level.

These three target species have been discussed in greater detail below.

Grey geese (greylag goose and greater white-fronted goose)

It was only possible to establish estimates of greylag geese at a European level (>240,000) and greater white-fronted geese at a national level (10,000-15,000).

An annual mortality of 56 grey geese would not be significant (at 5% significance) with a background mortality of 17%, if regional wintering populations reached 6,590. During the winter surveys, it was noted that grey geese were not abundant throughout the region and were not restricted to the proposed wind farm site. With flocks of up to 1000 geese recorded during the vantage point surveys, it is considered likely that the regional population exceeds 6,590.

As described in the Environmental and Social Impact Assessment (Atkins, 2012), greylag geese and greater white-fronted geese are expected to be displaced from the wind farm to alternative foraging grounds, rather than being at risk of collision.

It is considered that the combination of (i) numbers of grey geese overwintering in the region likely to exceed 6,590 (due to the large numbers observed throughout the region), and (ii) the expectation that the estimated collision rate of 56 birds a year is an overestimate (due to predicted displacement rather than collision as described in Atkins, 2012), means that the proposed wind farm will have a non significant impact on the regional greylag goose and greater white-fronted goose populations.

Common crane

It was only possible to establish estimates of common cranes at a European level (148,000-220,000).

An annual mortality of 1.9 common cranes would not be significant (at 5% significance) with a background mortality of 10%, if regional passage populations reached 380.

Common cranes were only recorded passing through the site on 4 occasions (with flocks of up to 60 birds recorded). Birdlife International (France) describes the European common crane migration[12], with up to 45,000 common cranes passing south through Hungary (typically at heights of 200-1000m) on their way to winter in Spain. It is therefore considered that this major common crane passage is likely to occur across the wider regional area, with numbers passing through the Vojvodina region far exceeding 380 birds.

Therefore it is considered that the predicted collision mortality of 1.9 birds per year will have a non significant impact on the regional common crane populations.

4.2. Breeding birds

The Environmental and Social Impact Assessment (Atkins, 2012) estimated that approximately 30 pairs of common quail breed within the wind farm site. It was estimated that approximately 20% of the wind farm common quail population will be displaced by the operational turbines, equating to 6 common quail territories.

During the 2012 breeding bird surveys, common quails were recorded in 4 squares, with three breeding territories confirmed and a further five possible common quail territories (where birds were recorded on single occasions).

When multiplied by 6.19 to represent the total area of the wind farm site, an extrapolation of the confirmed and possible common quail territories within the squares produced an estimate of 19-50 territories within the wider wind farm site. This gives a mean of 34.5 territories and supports the 30 common quail territories estimated in the Environmental and Social Impact Assessment (Atkins, 2012).

It is considered that the 2012 breeding bird survey data supports the findings of the Environmental and Social Impact Assessment (Atkins, 2012), estimating a similar number of common quail breeding territories, and therefore supporting the proposed mitigating habitat creation of 4.5 ha of fallow strips and flower-rich field margins over 250 m from any wind turbines.

[12] Ligue pour Protection des Oiseaux *The common crane (*http://champagne-ardenne.lpo.fr/English/e_grue_cendree.htm; accessed 17th August 2012)

5. Summary

The additonal data collected between November 2011 and July 2012 has enabled collision risk analysis and breeding bird territory analysis to be carried out. The findings support the interpretation of the original baseline data collected between September 2009 and February 2011:

- A total of 93 species were recorded during the additonal bird surveys between November 2011 and June 2012. This species list is similar to the 117 species recorded between September 2009 and February 2011, with the lower number believed to be reflective of the reduced survey effort.

- The additional vantage point survey data collected between November 2011 and July 2012 supports the findings of the original baseline data (collected between September 2009 and February 2011), identifying the same ten target species with the greatest number of flights: common buzzard, Eurasian kestrel, Eurasian hobby, western marsh harrier, hen harrier, northern goshawk, Eurasian sparrowhawk, greylag goose, greater white-fronted goose and European bee-eater.

- Collision risk analysis of the additional vantage point survey data confirmed that the proposed wind farm is not expected to have a significant impact on any of the target species.

- The breeding bird surveys carried out between March 2012 and July 2012 has identified nine species that bred within the survey squares and a further six species that possibly had breeding territories within or near the breeding squares. Nine of these species were identified as breeding species within the wind farm site in the Environmental and Social Impact Assessment (Atkins, 2012). The Environmental and Social Impact Assessment identified a further eight species believed to breed within the wind farm site, of which seven were recorded during the 2012 breeding surveys, but are not thought to actually breed within the breeding bird squares.

- The breeding bird surveys carried out between March 2012 and July 2012 identified three confirmed common quail territories and a further possible five common quail territories within the breeding bird survey squares. When multiplied by 6.19 to represent the total area of the wind farm site, this equates to approximately 19-50 territories. This gives a mean of 34.5 territories and supports the 30 common quail territories estimated in the Environmental and Social Impact Assessment (Atkins, 2012).

Appendix A. Survey details

Survey type	Location	Survey No.	Date	Start Time	Weather
Vantage Point	VP1	1	22/01/2012	08:00	3°C, overcast (100%), light W wind, light rain/snow stopped after 1 hour, good visibility.
Vantage Point	VP1	2	22/01/2012	12:55	6°C, 20% cloud cover, light NW wind, dry, good visibility.
Vantage Point	VP1	3	23/01/2012	08:00	5°C, 10% cloud cover, dry, clear visibility.
Vantage Point	VP1	4	23/01/2012	10:15	5°C, 20% cloud cover, dry, clear visibility.
Vantage Point	VP2	1	15/01/2012	11:48	1°C, 90% cloud, NW strong wind, dry, good visibility.
Vantage Point	VP2	2	21/01/2012	08:36	0°C, clear sky, dry, clear visibility.
Vantage Point	VP2	3	22/01/2012	10:25	4°C, 40% cloud cover, dry, clear visibility.
Vantage Point	VP2	4	23/01/2012	12:50	7°C, 5% cloud cover, dry, clear visibility.
Vantage Point	VP3	1	21/01/2012	11:00	50% cloud cover, NW wind, dry, clear visibilty.
Vantage Point	VP3	2	21/01/2012	13:15	0°C, 30% visibility, NW wind, dry, clear visibility.
Vantage Point	VP3	3	22/01/2012	08:16	5°C, 80% cloud cover, dry, clear visibility.
Vantage Point	VP3	4	29/01/2012	07:49	5°C, 20% cloud cover, dry, clear visibility.
Vantage Point	VP4	1	15/01/2012	09:35	-1°C, 20% cloud cover, strong NW wind, dry, clear visibility.
Vantage Point	VP4	2	21/01/2012	11:25	4°C, 70% cloud cover, strong NW wind, dry, clear visibility.
Vantage Point	VP4	3	21/01/2012	13:40	4°C, 50% cloud cover, strong NW wind, dry, clear visibility.
Vantage Point	VP4	4	23/01/2012	07:30	2-3°C, 7 okta cloud cover, still, dry, clear visibility.
Vantage Point	VP5	1	21/01/2012	08:05	0°C, 20% cloud cover, NW wind, dry, clear visibility.
Vantage Point	VP5	2	22/01/2012	11:00	5°C, 80% cloud cover, dry, clear visibility.
Vantage Point	VP5	3	22/01/2012	13:10	5°C, 5% cloud cover, dry, clear visibility.
Vantage Point	VP5	4	29/01/2012	10:15	0°C, 10% cloud cover, dry, clear visibility.
Vantage Point	VP6	1	15/01/2012	07:14	-3°C, 80% cloud cover, later 50%, strong NWwind, dry, clear visibility.
Vantage Point	VP6	2	23/01/2012	09:55	5-6°C, 5 okta cloud cover, still, dry, clear visibility.
Vantage Point	VP6	3	23/01/2012	12:10	5°C, 1 okta cloud cover, NW wind, dry, clear visibility.
Vantage Point	VP6	4	29/01/2012	12:33	-3°C, 20% cloud cover, dry, clear visibility.
Vantage Point	VP1	1	28/02/2012	06:55	2-3°C, overcast (100%), NE strong wind, dry, good visibility.
Vantage Point	VP1	2	28/02/2012	09:10	4-5°C, 60% cloud cover, 30% in the second hour, NE strong wind, dry, good visibility.
Vantage Point	VP1	3	29/02/2012	10:00	5-6°C, clear, NW light wind, dry, good visibility.
Vantage Point	VP1	4	29/02/2012	12:15	7-8°C, clear, NW light wind, dry, good visibility.
Vantage Point	VP2	1	25/02/2012	10:00	5-6°C, 70% cloud cover, 20% in second hour, NW moderate wind, dry, good visibility.
Vantage Point	VP2	2	25/02/2012	12:15	7-8°C, clear, NW light wind, dry, good visibility.
Vantage Point	VP2	3	26/02/2012	08:05	-1°C, over cast (100%), NW light wind, dry, good visibility (2km).
Vantage Point	VP2	4	26/02/2012	10:20	3-4°C, overcast (100%), mist, NW light wind, dry, good visibility (2km).
Vantage Point	VP3	1	23/02/2012	08:20	-3°C, cloud cover 2 okta, moderate NW wind, clear visibility.
Vantage Point	VP3	2	27/02/2012	10:05	0°C, cloud cover 0 okta, clear visibility.
Vantage Point	VP3	3	28/02/2012	12:48	5°C, cloud cover 1 okta, clear visibility.
Vantage Point	VP3	4	29/02/2012	08:38	0°C, cloud cover 5 okta, clear visibility.
Vantage Point	VP4	1	25/02/2012	07:05	5°C, 70% cloud cover, NW moderate wind, dry, good visibility.
Vantage Point	VP4	2	26/02/2012	12:55	3°C, 90% cloud cover, calm, light NW wind, dry, good visibility.
Vantage Point	VP4	3	28/02/2012	12:15	7°C, clear, moderate N wind, dry, good visibility.

Vantage Point	VP4	4	29/02/2012	07:05	-1°C, clear with mist, calm with light W wind later, dry, good visibility (2km).
Vantage Point	VP5	1	23/02/2012	10:45	0°C, cloud cover 3 okta, moderate NW wind, clear visibility.
Vantage Point	VP5	2	27/02/2012	12:32	3°C, clear, clear visibility.
Vantage Point	VP5	3	28/02/2012	08:10	2°C, cloud cover 3 okta,clear visibility.
Vantage Point	VP5	4	29/02/2012	13:17	°C, cloud cover okta,clear visibility.
Vantage Point	VP6	1	23/02/2012	13:04	0°C, clear, moderate NW wind, clear visibility.
Vantage Point	VP6	2	27/02/2012	07:38	-2°C, clear, clear visibility.
Vantage Point	VP6	3	28/02/2012	10:23	5°C, cloud cover 4 okta, clear visibility.
Vantage Point	VP6	4	29/02/2012	11:00	0°C, cloud cover 5 okta, clear visibility.
Vantage Point	VP1	1	18/03/2012	09:00	15°C, clear, dry, clear visibility
Vantage Point	VP1	2	18/03/2012	11:15	20°C, clear, dry, strong wind, clear visibility
Vantage Point	VP1	3	24/03/2012	07:15	11°C, clear, dry, still, clear visibility
Vantage Point	VP1	4	25/03/2012	11:55	20°C, cloud cover 1 okta, moderate breeze, clear visibility, dry
Vantage Point	VP2	1	13/03/2012	08:46	15°C, clear, dry, clear visibility
Vantage Point	VP2	2	18/03/2012	11:02	20°C, clear, dry, moderate breeze, clear visibility
Vantage Point	VP2	3	24/03/2012	09:30	20°C, clear, dry, moderate breeze, clear visibility
Vantage Point	VP2	4	24/03/2012	11:45	20°C, cloud cover 1 okta, moderate breeze, clear visibility, dry
Vantage Point	VP3	1	18/03/2012	13:55	20°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP3	2	19/03/2012	08:49	5°C, cloud cover 2 okta, gentle breeze, clear visibility, dry
Vantage Point	VP3	3	27/03/2012	07:25	8°C, cloud cover okta 1, still, clear visibility, dry
Vantage Point	VP3	4	30/03/2012	10:07	10°C, cloud cover okta 8, moderate breeze, clear visibility, dry
Vantage Point	VP4	1	18/03/2012	13:45	20°C, clear, gentle breeze, clear visibility, dry
Vantage Point	VP4	2	19/03/2012	08:13	15°C, cloud cover okta 3, dry, clear visibility
Vantage Point	VP4	3	27/03/2012	12:10	20°C, cloud cover okta 3, dry, still, clear visibility
Vantage Point	VP4	4	30/03/2012	12:18	10°C, cloud cover okta 8, moderate breeze, clear visibility, dry
Vantage Point	VP5	1	19/03/2012	11:39	20°C, cloud cover okta 2, moderate breeze, clear visibility, dry
Vantage Point	VP5	2	19/03/2012	13:54	20°C, cloud cover okta 2, moderate breeze, clear visibility, dry
Vantage Point	VP5	3	27/03/2012	09:43	12°C, cloud cover okta 1, still, clear visibility, dry
Vantage Point	VP5	4	30/03/2012	07:43	7°C, cloud cover okta 7, moderate breeze, clear visibility, dry
Vantage Point	VP6	1	19/03/2012	11:29	5°C, cloud cover 1 okta, gentle breeze, clear visibility, dry
Vantage Point	VP6	2	19/03/2012	13:44	5°C, cloud cover 3 okta, gentle breeze, clear visibility, dry
Vantage Point	VP6	3	25/03/2012	07:10	10°C, clear, still, clear visibility, dry
Vantage Point	VP6	4	25/03/2012	09:25	15°C, clear, dry, clear visibility, dry
Vantage Point	VP1	1	16/04/2012	15:40	20°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP1	2	21/04/2012	07:10	10°C, cloud cover okta 7, moderate breeze, clear visibility, dry
Vantage Point	VP1	3	21/04/2012	09:25	13°C, cloud cover okta 5, moderate breeze, clear visibility, dry
Vantage Point	VP1	4	30/04/2012	13:20	30°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP2	1	16/04/2012	13:20	20°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP2	2	22/04/2012	08:27	12°C, cloud cover okta 7, moderate breeze, clear visibility, dry
Vantage Point	VP2	3	22/04/2012	10:42	15°C, cloud cover okta 7, moderate breeze, clear visibility, dry
Vantage Point	VP2	4	30/04/2012	15:45	30°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP3	1	06/04/2012	09:32	13°C, cloud cover okta 2, moderate breeze, clear visibility, dry
Vantage Point	VP3	2	09/04/2012	06:50	7°C, cloud cover okta 7, still, clear visibility, dry
Vantage Point	VP3	3	17/04/2012	11:48	15°C, cloud cover okta 4, moderate breeze, clear visibility, dry
Vantage Point	VP3	4	25/04/2012	06:48	7°C, cloud cover okta 5, still, clear visibility, dry
Vantage Point	VP4	1	16/04/2012	11:05	17°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP4	2	21/04/2012	12:10	15°C, cloud cover okta 5, moderate breeze, clear visibility, dry

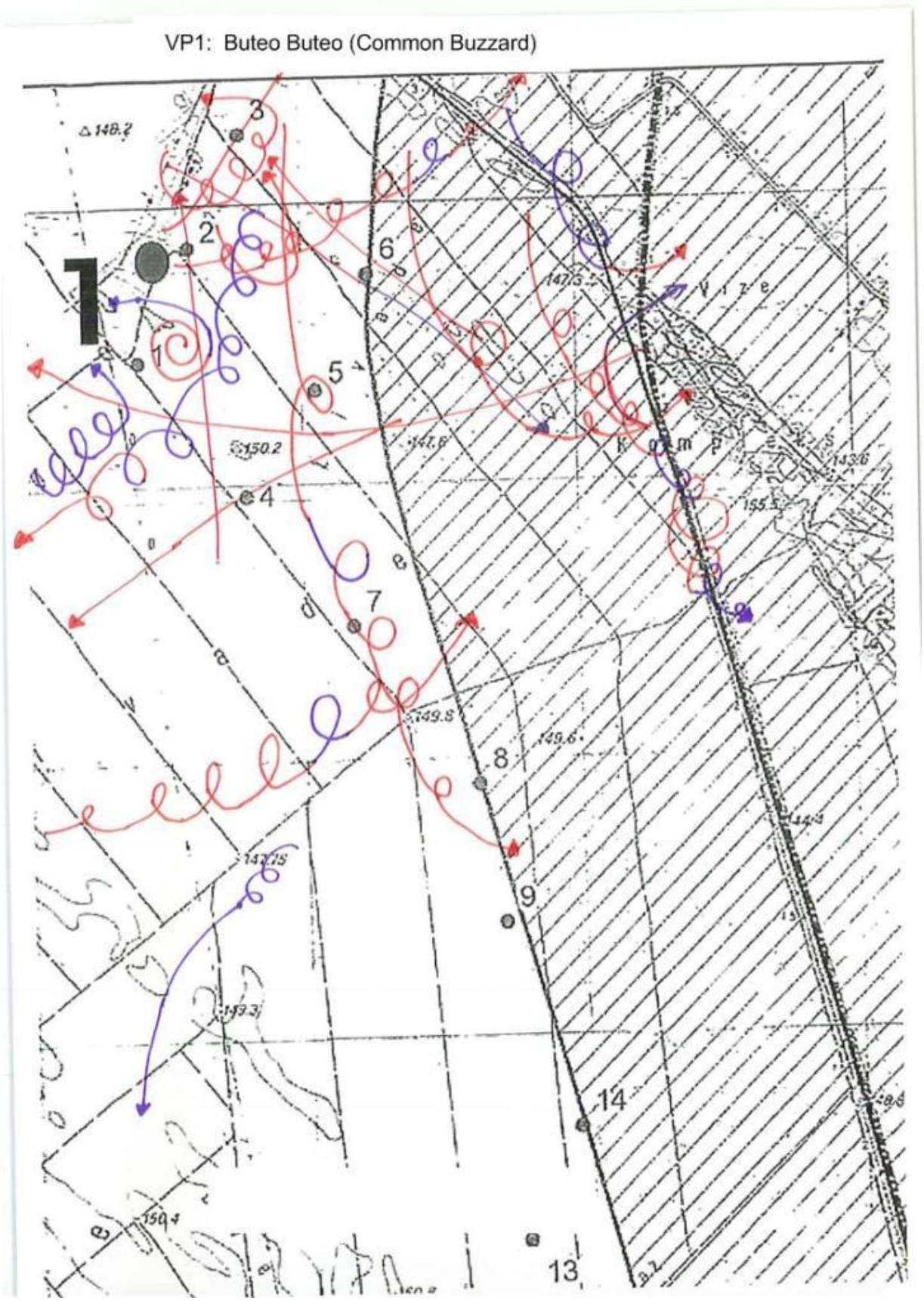
Vantage Point	VP4	3	22/04/2012	06:10	7°C, cloud cover okta 4, moderate breeze, clear visibility, dry
Vantage Point	VP4	4	30/04/2012	18:00	27°C, clear, moderate breeze, clear visibility, dry
Vantage Point	VP5	1	06/04/2012	07:10	10°C, cloud cover okta 3, moderate breeze, dry, clear visibility
Vantage Point	VP5	2	09/04/2012	11:15	10°C, cloud cover okta 6, still, dry, clear visibility
Vantage Point	VP5	3	17/04/2012	09:20	10°C, cloud cover okta 4, moderate breeze, dry, clear vsibility
Vantage Point	VP5	4	25/04/2012	11:23	13°C, cloud cover okta 5, still, dry, clear visibility
Vantage Point	VP6	1	06/04/2012	11:55	15°C, cloud cover okta 2, moderate breeze, dry, clear visibility
Vantage Point	VP6	2	09/04/2012	09:07	10°C, cloud cover okta 8, still, dry, clear visibility
Vantage Point	VP6	3	17/04/2012	07:05	10°C, cloud cover okta 2, moderate breeze, dry, clear visibility
Vantage Point	VP6	4	25/04/2012	09:10	10°C, cloud cover okta 5, still, dry, clear visibility
Vantage Point	VP1	1	12/05/2012	06:05	13°C, clear, still, dry, clear visibility
Vantage Point	VP1	2	15/05/2012	08:20	24°C, clear, gentle breeze, dry, clear visibility
Vantage Point	VP1	3	19/05/2012	10:55	20°C, cloud cover okta 1, moderate breeze, dry, clear visibility
Vantage Point	VP1	4	19/05/2012	13:10	20°C, cloud cover okta 1, moderate breeze, dry, clear visibility
Vantage Point	VP2	1	12/05/2012	10:35	29°C, clear, light breeze, dry, clear visibility
Vantage Point	VP2	2	19/05/2012	08:30	15°C, clear, light breeze, dry, clear visibility
Vantage Point	VP2	3	21/05/2012	12:10	20°C, cloud cover okta 8, stong wind, dry, clear visibility
Vantage Point	VP2	4	29/05/2012	07:49	15°C, cloud cover okta 8, moderate breeze, dry, clear visibility
Vantage Point	VP3	1	19/05/2012	11:27	20°C, cloud cover okta 1, moderate breeze, dry, clear visibility
Vantage Point	VP3	2	19/05/2012	13:43	22°C, cloud cover okta 1, gentle breeze, dry, clear visibility
Vantage Point	VP3	3	28/05/2012	07:10	15°C, cloud cover okta 3, dry, clear visibility
Vantage Point	VP3	4	30/05/2012	09:30	20°C,cloud cover okta 3, light breeze, dry, clear visibility
Vantage Point	VP4	1	19/05/2012	11:30	20°C, cloud cover okta 3, dry, still, clear visibility
Vantage Point	VP4	2	19/05/2012	13:30	20°C, cloud cover okta 2, still, dry, clear visibility
Vantage Point	VP4	3	21/05/2012	12:05	20°C, cloud cover okta 7, strong wind, dry, clear visibility
Vantage Point	VP4	4	29/05/2012	10:00	15°C, cloud cover okta 8, moderate breeze, light rain, clear visibility
Vantage Point	VP5	1	19/05/2012	08:46	15°C, clear, still, dry, clear visibility
Vantage Point	VP5	2	20/05/2012	09:36	20°C, cloud cover okta 1, moderate breeze, dry, clear visibility
Vantage Point	VP5	3	20/05/2012	11:51	20°C, cloud cover okta 3, dry, gentle breeze, clear visibility
Vantage Point	VP5	4	28/05/2012	09:25	15°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP6	1	19/05/2012	08:39	17°C, clear,still, dry, clear visibility
Vantage Point	VP6	2	20/05/2012	09:45	20°C, clear, still, dry, clear visibility
Vantage Point	VP6	3	20/05/2012	12:00	29°C, cloud okta 3, light breeze, dry, clear visibility
Vantage Point	VP6	4	28/05/2012	11:39	15°C, cloud okta 1, still dry, clear visibility
Vantage Point	VP1	1	09/06/2012	18:10	22°C, cloud cover okta 3, moderate breeze, dry, clear visibility
Vantage Point	VP1	2	24/06/2012	06:30	24°C, clear, gentle breeze, dry, clear visibility
Vantage Point	VP1	3	29/06/2012	14:15	33°C, clear, still, dry, clear visibility
Vantage Point	VP1	4	29/06/2012	16:30	32°C, clear, still, dry, clear visibility
Vantage Point	VP2	1	09/06/2012	15:55	24°C, cloud cover okta 5, moderate breeze, dry, clear visibility
Vantage Point	VP2	2	23/06/2012	09:45	29°C, clear, light breeze, dry, clear visibility
Vantage Point	VP2	3	23/06/2012	12:00	31°C, clear, light breeze, dry, clear visibility
Vantage Point	VP2	4	29/06/2012	07:25	22°C, clear, light breeze, dry, clear visibility
Vantage Point	VP3	1	12/06/2012	07:10	22°C, cloud cover okta 2, moderate breeze, dry, clear visibility
Vantage Point	VP3	2	15/06/2012	11:13	30°C, clear, still, dry, clear visibility
Vantage Point	VP3	3	20/06/2012	09:21	24°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP3	4	22/06/2012	11:04	30°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP4	1	09/06/2012	13:40	25°C, cloud cover okta 3, strong wind, dry, clear visibility
Vantage Point	VP4	2	23/06/2012	07:30	24°C, clear, gentle breeze, dry, clear visibility

Vantage Point	VP4	3	24/06/2012	09:00	28°C, clear, moderate breeze, dry, clear visibility
Vantage Point	VP4	4	24/06/2012	11:15	34°C, clear, light breeze, dry, clear visibility
Vantage Point	VP5	1	12/06/2012	09:27	27°C, clear, moderate breeze, clear visibility
Vantage Point	VP5	2	15/062012	06:47	25°C, cloud cover okta 3, still, dry, clear visibility
Vantage Point	VP5	3	20/06/2012	11:43	30°C, cloud cover okta 2, still, dry, clear visibility
Vantage Point	VP5	4	22/06/2012	08:45	25°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP6	1	12/06/2012	11:35	30°C, clear, moderate breeze, dry, clear visibility
Vantage Point	VP6	2	15/06/2012	08:55	25°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP6	3	20/06/2012	07:03	20°C, cloud cover okta 4, still, dry, clear visibility
Vantage Point	VP6	4	22/06/2012	06:37	23°C, clear, still, dry, clear visibility
Vantage Point	VP1	1	07/07/2012	07:30	25°C, cloud cover okta 1, gentle breeze, dry, clear visibility
Vantage Point	VP1	2	07/07/2012	09:45	30°C, clear, gentle breeze, dry, clear visibility
Vantage Point	VP1	3	08/07/2012	10:32	30°C, clear, gentle breeze, dry, clear visibility
Vantage Point	VP1	4	14/07/2012	06:40	22°C, clear, still, dry, clear visibility
Vantage Point	VP2	1	07/07/2012	07:50	25°C, clear, moderate breeze, dry, clear visibility
Vantage Point	VP2	2	07/07/2012	10:05	27°C, clear, light breeze, clear visibility
Vantage Point	VP2	3	14/07/2012	09:05	26°C, clear, still, dry, clear visibility
Vantage Point	VP2	4	27/07/2012	18:20	26°C, cloud cover okta 4, still, dry, clear visibility
Vantage Point	VP3	1	06/07/2012	09:20	30°C, cloud cover okta 1, gentle breeze, dry, clear visibility
Vantage Point	VP3	2	06/07/2012	11:35	30°C, cloud cover okta 1, gentle breeze, dry, clear visibility
Vantage Point	VP3	3	07/07/2012	07:32	30°C, cloud cover okta 2, still, dry, clear visibility
Vantage Point	VP3	4	07/07/2012	12:35	35°C, clear, gentle breeze, dry, clear visibility
Vantage Point	VP4	1	07/07/2012	12:40	32°C, clear, light breeze, dry, clear visibility
Vantage Point	VP4	2	08/07/2012	10:40	30°C, clear, still, dry, clear visibility
Vantage Point	VP4	3	10/07/2012	11:21	32°C, cloud cover okta 4, still, dry, clear visibility
Vantage Point	VP4	4	16/07/2012	06:43	25°C, cloud cover okta 2, still, dry, clear visibility
Vantage Point	VP5	1	06/07/2012	09:25	32°C, cloud cover okta 1, gentle breeze, dry, clear visibility
Vantage Point	VP5	2	06/07/2012	11:25	35°C, clear, still, dry, clear visibility
Vantage Point	VP5	3	16/07/2012	08:43	25°C, cloud cover okta 2, still, dry, clear visibility
Vantage Point	VP5	4	16/07/2012	11:08	30°C, cloud cover okta 3, still, dry, clear visibility
Vantage Point	VP6	1	07/07/2012	09:48	35°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP6	2	07/07/2012	11:48	35°C, cloud cover okta 1, still, dry, clear visibility
Vantage Point	VP6	3	27/07/2012	13:45	27°C, cloud cover okta 5, light breeze, dry, clear visibility
Vantage Point	VP6	4	27/07/2012	16:00	28°C, cloud cover okta 5, moderate breeze, dry, clear visibility
Breeding bird survey	Survey square 1	1	29/03/2012	10:35	sunny, still, dry
Breeding bird survey	Survey square 1	2	11/04/2012	06:10	sunny, strong wind, dry
Breeding bird survey	Survey square 1	3	28/04/2012	07:35	15°C, sunny, still, dry
Breeding bird survey	Survey square 1	4	18/05/2012	05:30	10°C, cloud cover okta 3, moderate breeze, dry
Breeding bird survey	Survey square 1	5	25/05/2012	08:15	20°C, sunny, light breeze, dry
Breeding bird survey	Survey square 1	6	16/06/2012	08:20	20°C, sunny, still, dry
Breeding bird survey	Survey square 1	7	27/06/2012	05:45	20°C, sunny, still, dry
Breeding bird survey	Survey square 1	8	14/07/2012	05:20	sunny, still, dry
Breeding bird survey	Survey square 1	9	15/07/2012	09:45	sunny, still, dry

Breeding bird survey	Survey square 2	1	29/03/2012	09:10	sunny, still, dry
Breeding bird survey	Survey square 2	2	11/04/2012	07:30	sunny, strong breeze, dry
Breeding bird survey	Survey square 2	3	28/04/2012	06:15	sunny, still, dry
Breeding bird survey	Survey square 2	4	18/05/2012	06:45	10°C, cloud cover okta 2, moderate breeze, dry
Breeding bird survey	Survey square 2	5	25/05/2012	06:50	20°C, sunny, light breeze, dry
Breeding bird survey	Survey square 2	6	16/06/2012	06:10	20°C, sunny, still, dry
Breeding bird survey	Survey square 2	7	27/06/2012	07:15	20°C, sunny, still, dry
Breeding bird survey	Survey square 2	8	08/07/2012	09:05	sunny, still, dry
Breeding bird survey	Survey square 2	9	15/07/2012	06:20	sunny, still, dry
Breeding bird survey	Survey square 3	1	29/03/2012	07:35	sunny, still, dry
Breeding bird survey	Survey square 3	2	11/04/2012	08:50	sunny, strong breeze, dry
Breeding bird survey	Survey square 3	3	28/04/2012	08:55	20°C, sunny, still, dry
Breeding bird survey	Survey square 3	4	18/05/2012	07:40	10°C, cloud cover okta 2, still, dry
Breeding bird survey	Survey square 3	5	20/05/2012	07:45	sunny, still, dry
Breeding bird survey	Survey square 3	6	16/06/2012	07:30	20°C, sunny, still, dry
Breeding bird survey	Survey square 3	7	27/06/2012	08:30	25°C, sunny, still ,dry
Breeding bird survey	Survey square 3	8	08/07/2012	07:30	sunny, still, dry
Breeding bird survey	Survey square 3	9	15/07/2012	08:15	sunny, still, dry
Breeding bird survey	Survey square 4	1	28/03/2012	09:55	sunny, still, dry
Breeding bird survey	Survey square 4	2	04/04/2012	07:00	cloud cover okta 3, moderate breeze, dry
Breeding bird survey	Survey square 4	3	24/04/2012	09:45	cloud cover okta 5, still dry
Breeding bird survey	Survey square 4	4	25/05/2012	07:10	15°C, cloud cover okta 1, still, dry
Breeding bird survey	Survey square 4	5	30/05/2012	09:10	20°C, cloud cover okta 1, still, dry
Breeding bird survey	Survey square 4	6	13/06/2012	09:12	sunny, still, dry
Breeding bird survey	Survey square 4	7	23/06/2012	06:38	sunny, still, dry
Breeding bird survey	Survey square 4	8	06/07/2012	07:13	sunny, still, dry
Breeding bird survey	Survey square 4	9	18/07/2012	08:55	cloud cover okta 2, still, dry
Breeding bird survey	Survey square 5	1	28/03/2012	08:35	sunny, still, dry
Breeding bird survey	Survey square 5	2	04/04/2012	08:25	cloud cover okta 3, moderate breeze, dry
Breeding bird survey	Survey square 5	3	24/04/2012	07:15	cloud cover okta 7, still, dry
Breeding bird survey	Survey square 5	4	21/05/2012	09:55	cloud cover okta 8, strong breeze, dry

Breeding bird survey	Survey square 5	5	30/05/2012	06:47	cloud cover okta 2, moderate breeze, dry
Breeding bird survey	Survey square 5	6	13/06/2012	11:25	sunny, still, dry
Breeding bird survey	Survey square 5	7	23/06/2012	09:05	sunny, still, dry
Breeding bird survey	Survey square 5	8	10/07/2012	07:10	cloud cover okta 3, still, dry
Breeding bird survey	Survey square 5	9	18/07/2012	11:02	cloud cover okta 2, still, dry
Breeding bird survey	Survey square 6	1	28/03/2012	07:15	sunny, still, dry
Breeding bird survey	Survey square 6	2	04/04/2012	09:40	cloud cover okta 3,moderate breeze, dry
Breeding bird survey	Survey square 6	3	24/04/2012	08:30	cloud cover okta 7, still, dry
Breeding bird survey	Survey square 6	4	21/05/2012	07:05	cloud cover okta 8, strong breeze, dry
Breeding bird survey	Survey square 6	5	30/05/2012	11:30	sunny, moderate breeze, dry
Breeding bird survey	Survey square 6	6	13/06/2012	06:50	sunny, gentle breeze, dry
Breeding bird survey	Survey square 6	7	23/06/2012	01:12	sunny, still, dry
Breeding bird survey	Survey square 6	8	10/07/2012	09:03	sunny, still, dry
Breeding bird survey	Survey square 6	9	18/07/2012	06:43	sunny, still, dry

Appendix B. Vantage point bird flight maps


VP1: Buteo Buteo (Common Buzzard)
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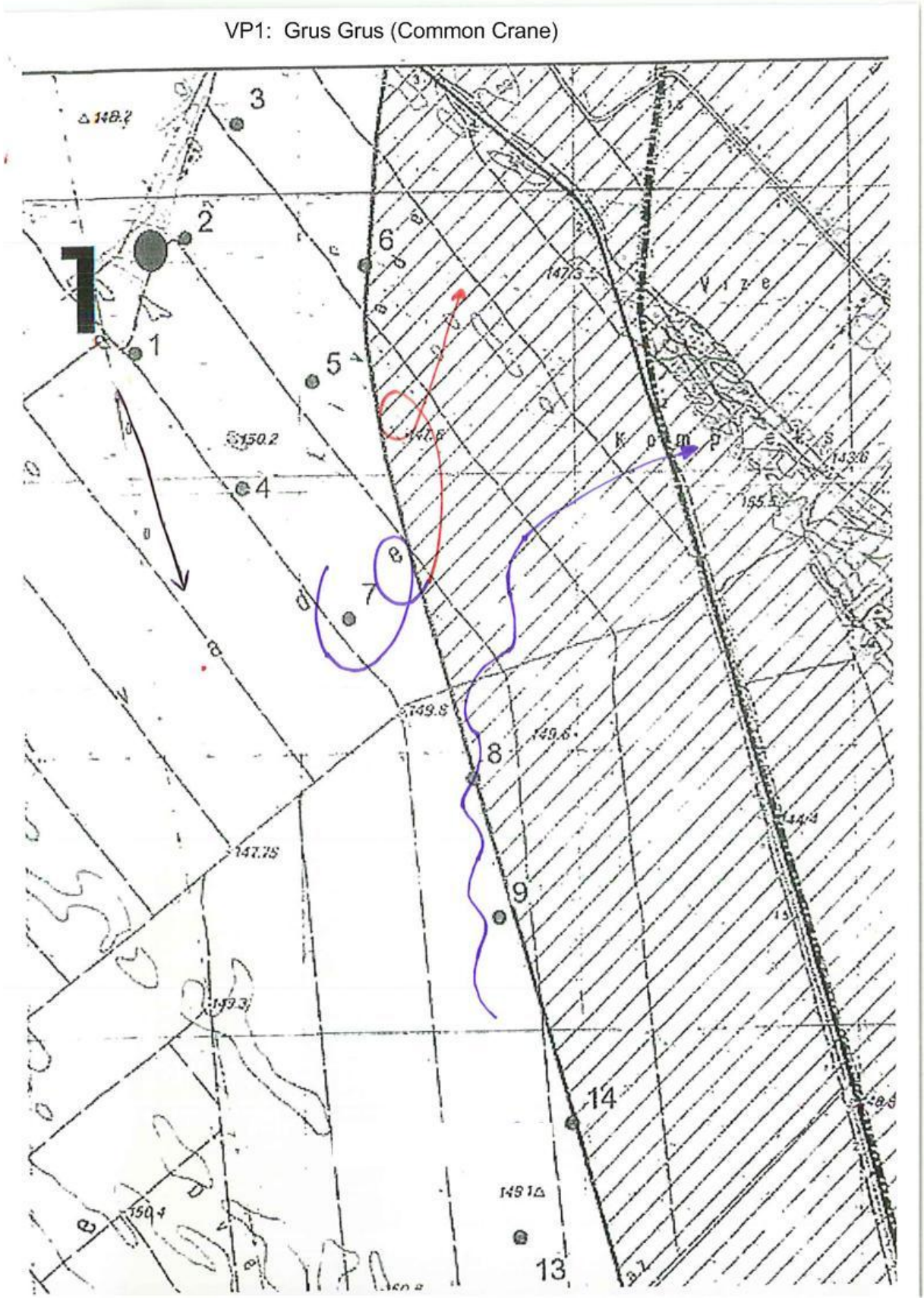
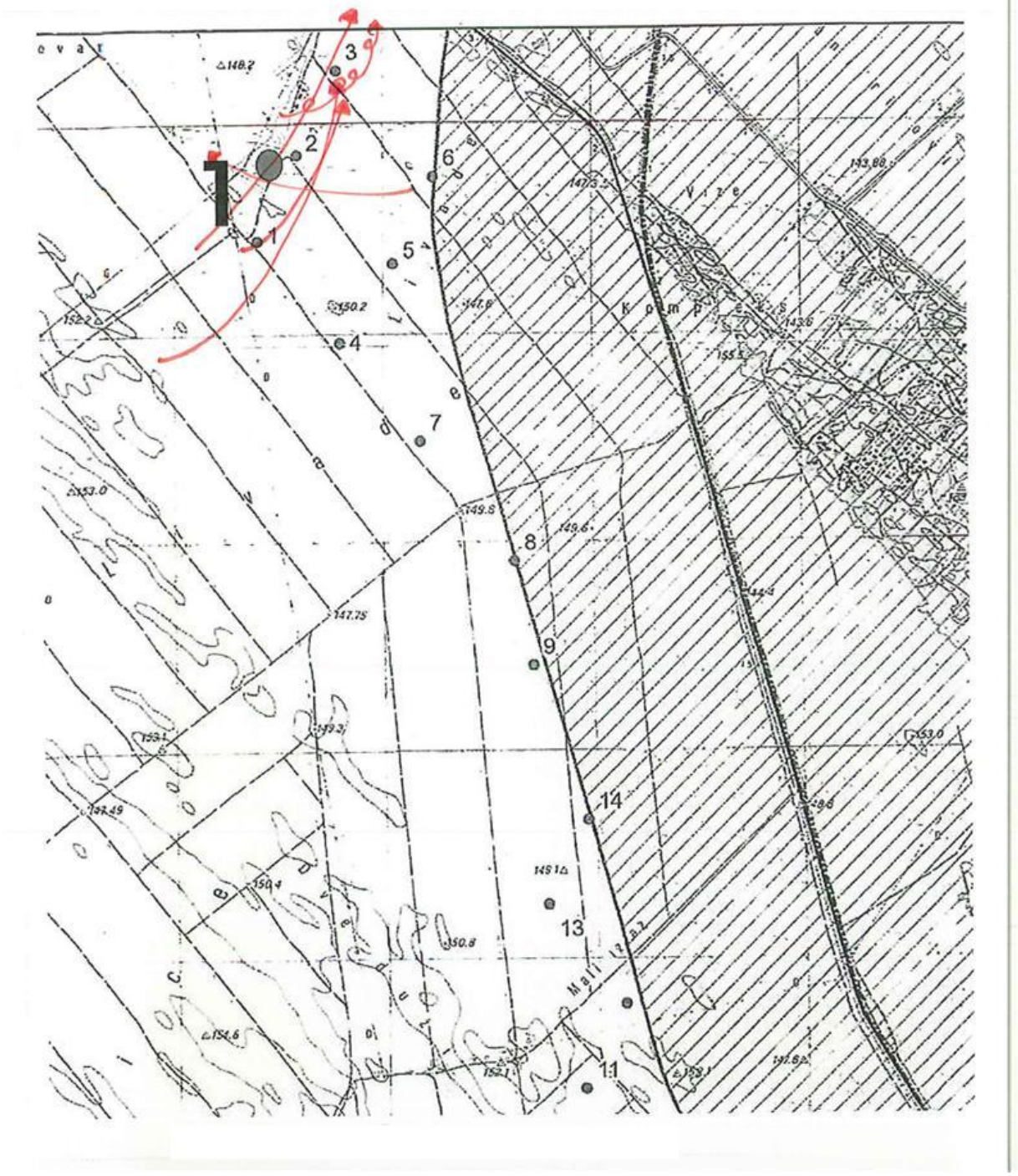
150.2
149.8
149.6
149.3
150.4
147.5
147.6
155.5
Vize
Kamp

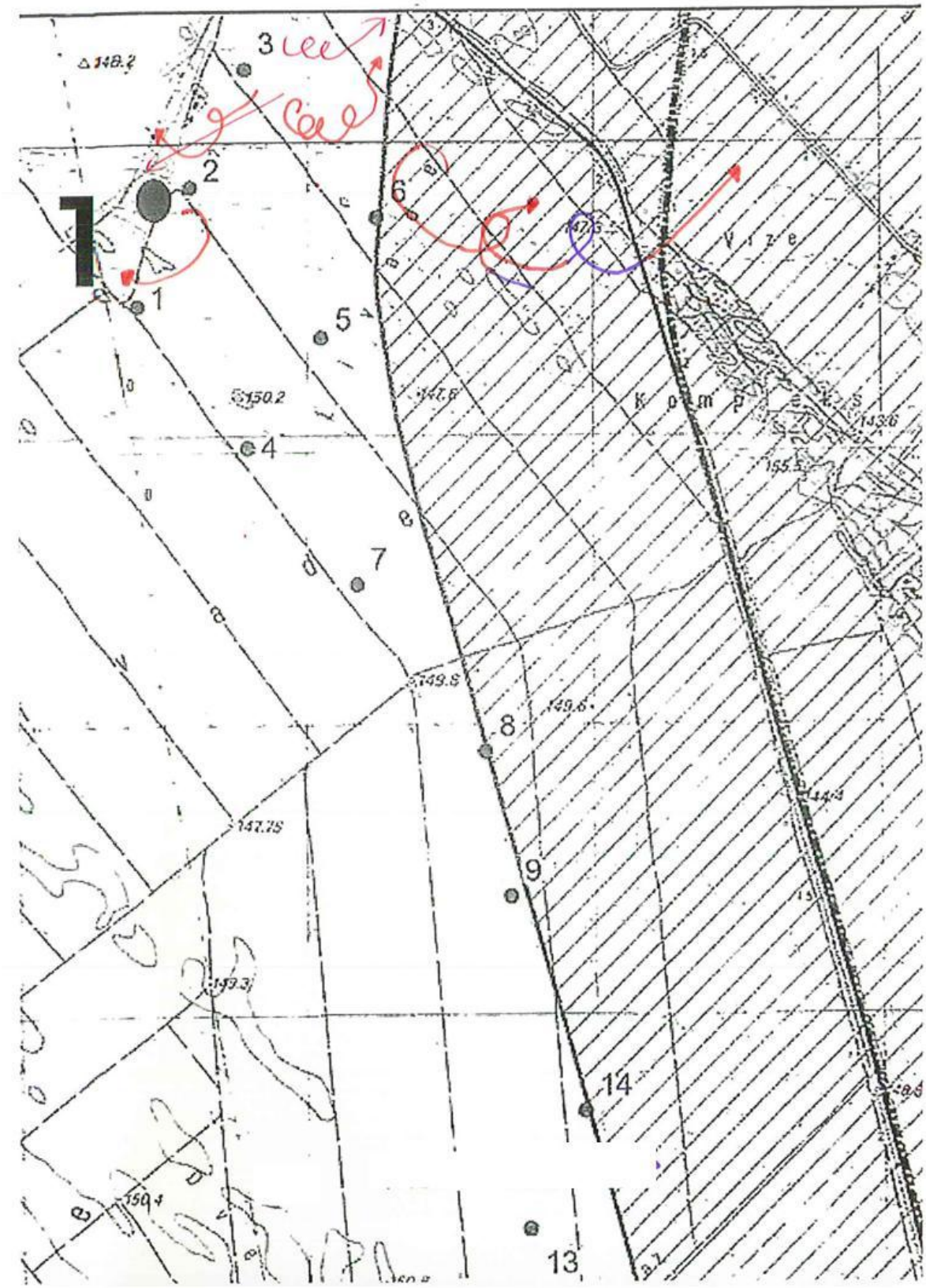
VP1: Grus Grus (Common Crane)



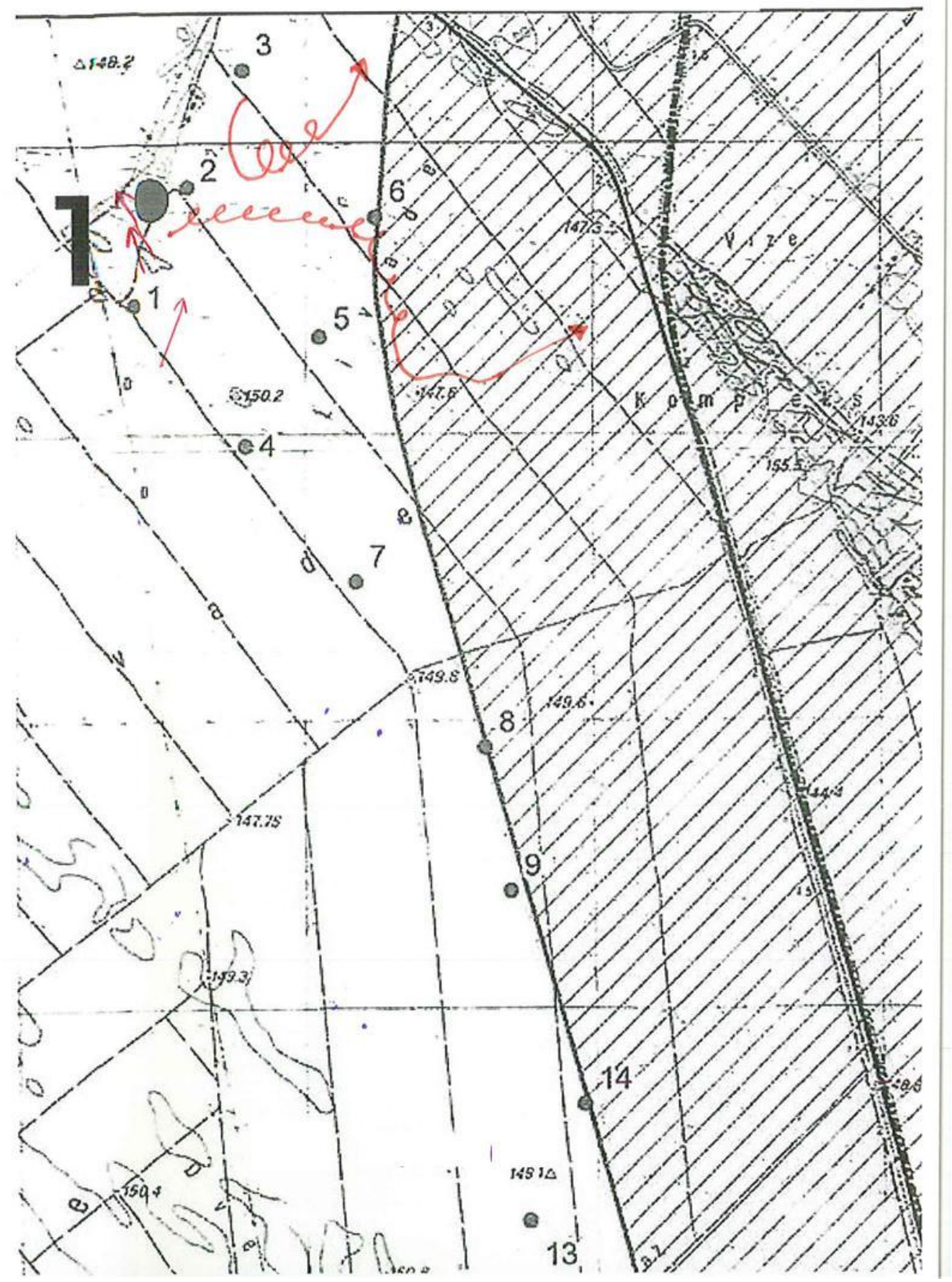
VP1: Falco Subbuteo (Eurasian Hobby)

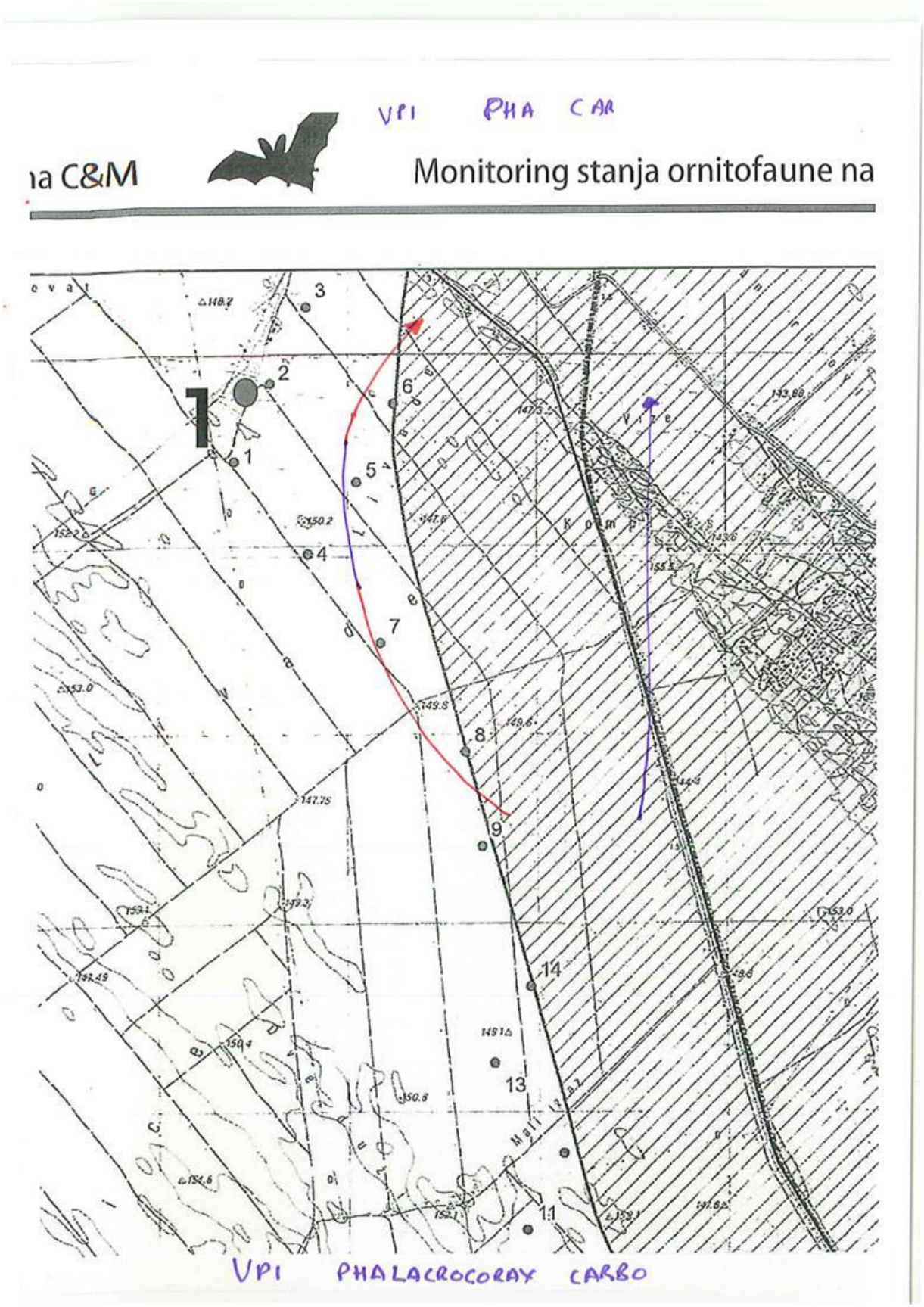


VP1: Falco Tinnunculus (Eurasian Kestrel)



VP1: Accipiter gentilus (Northern Goshawk)

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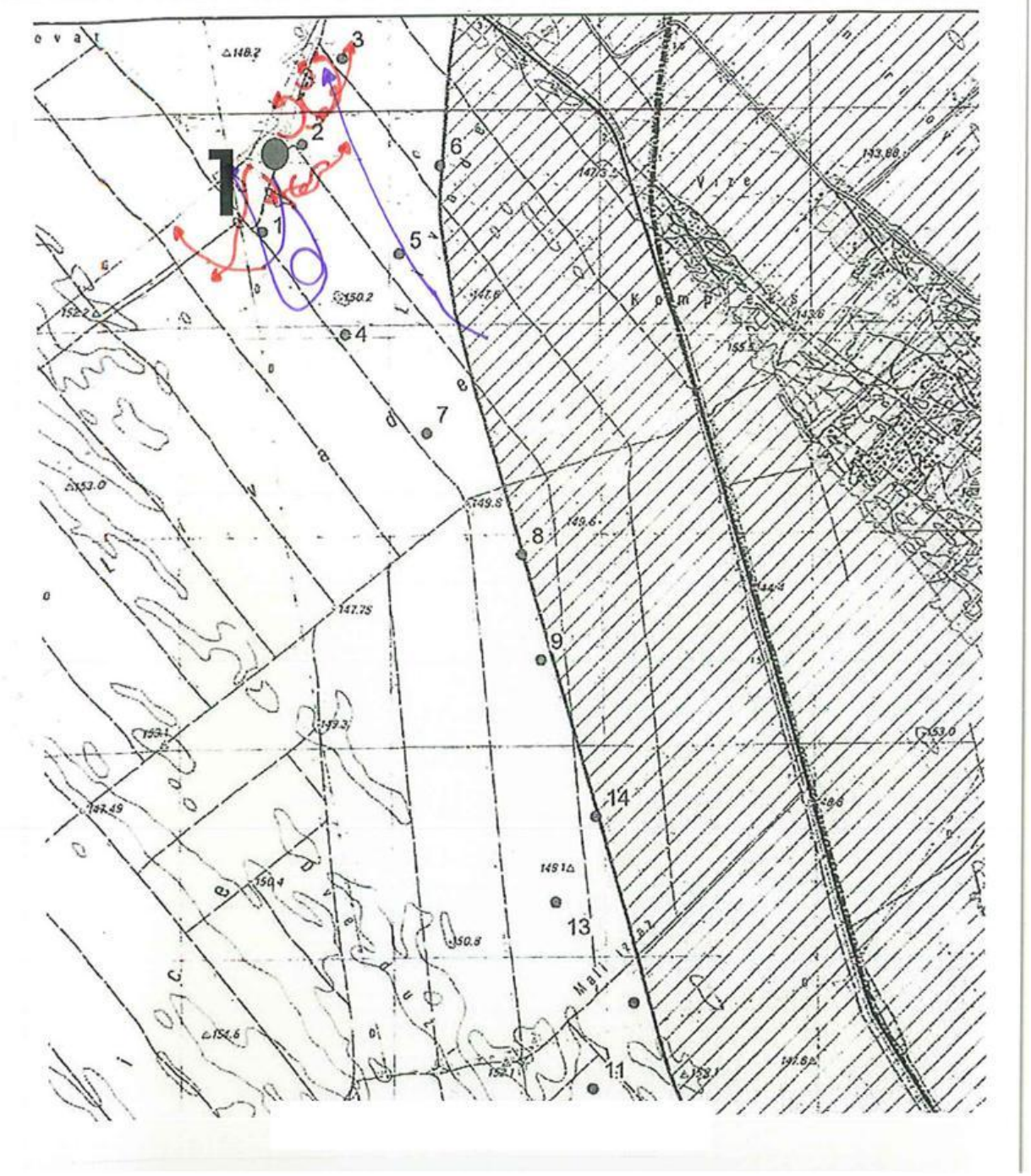
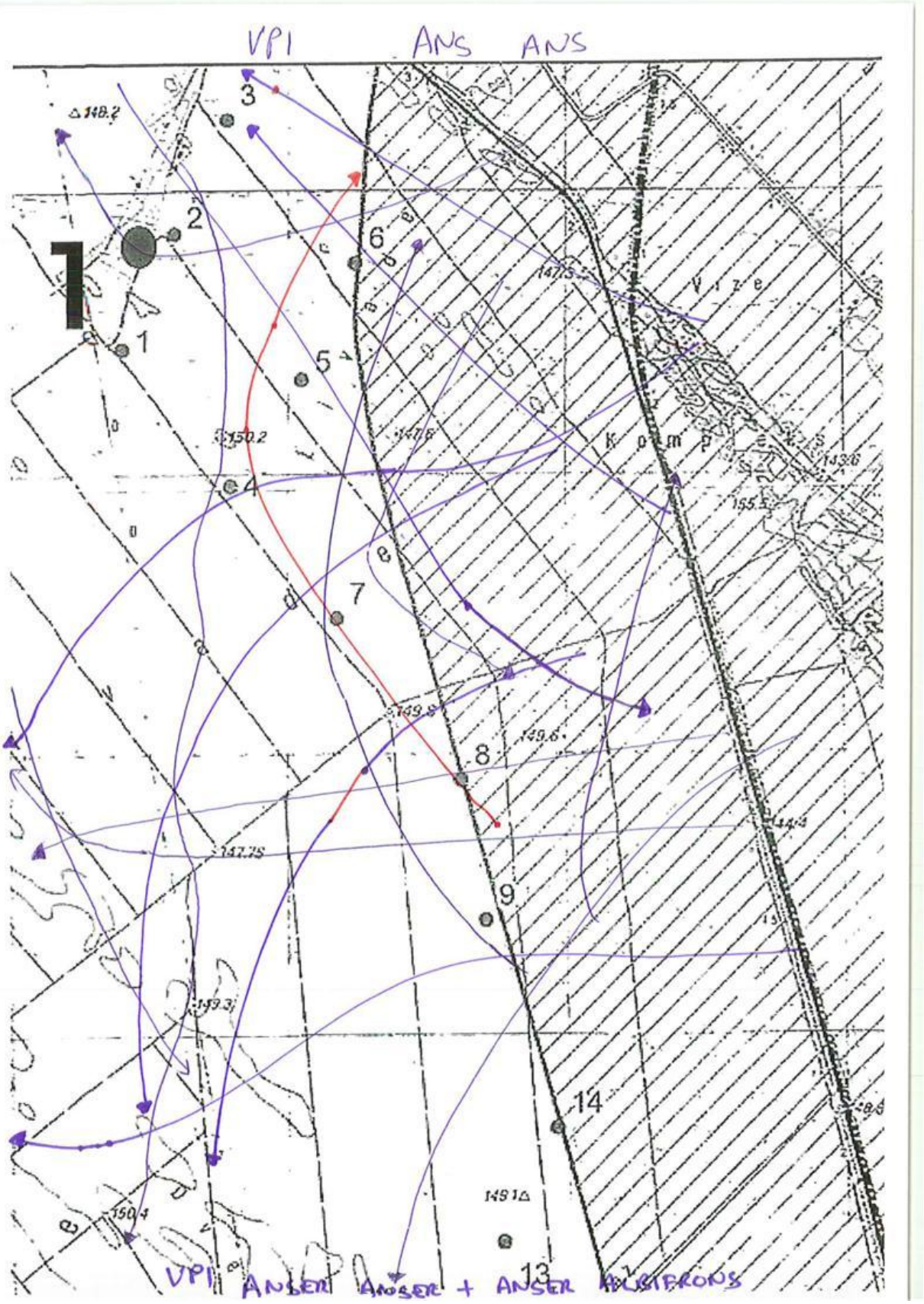
VPI PHALACROCORAX CARBO

VP1: Merops Apiaster (European Bee-eater)




VP1
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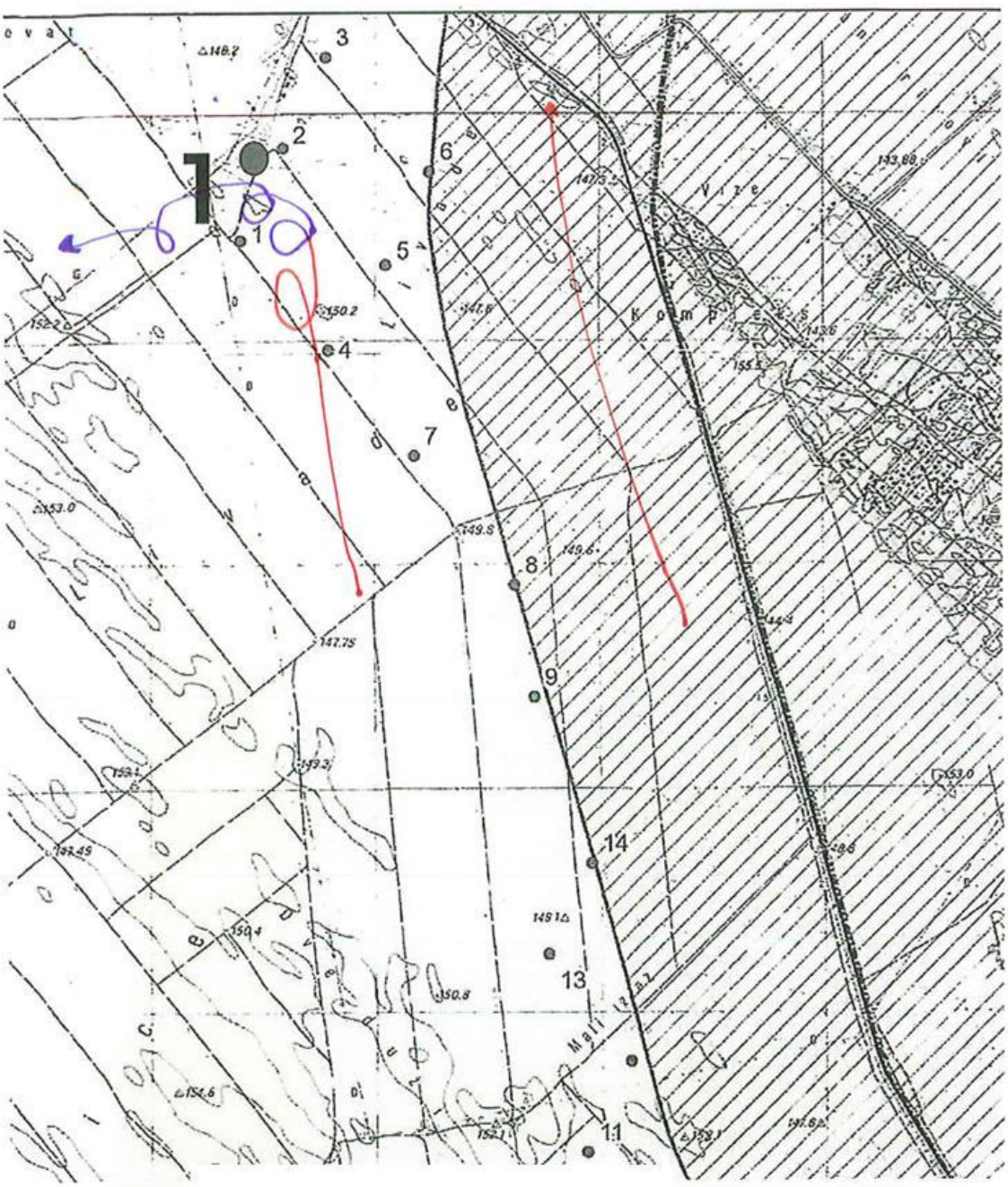
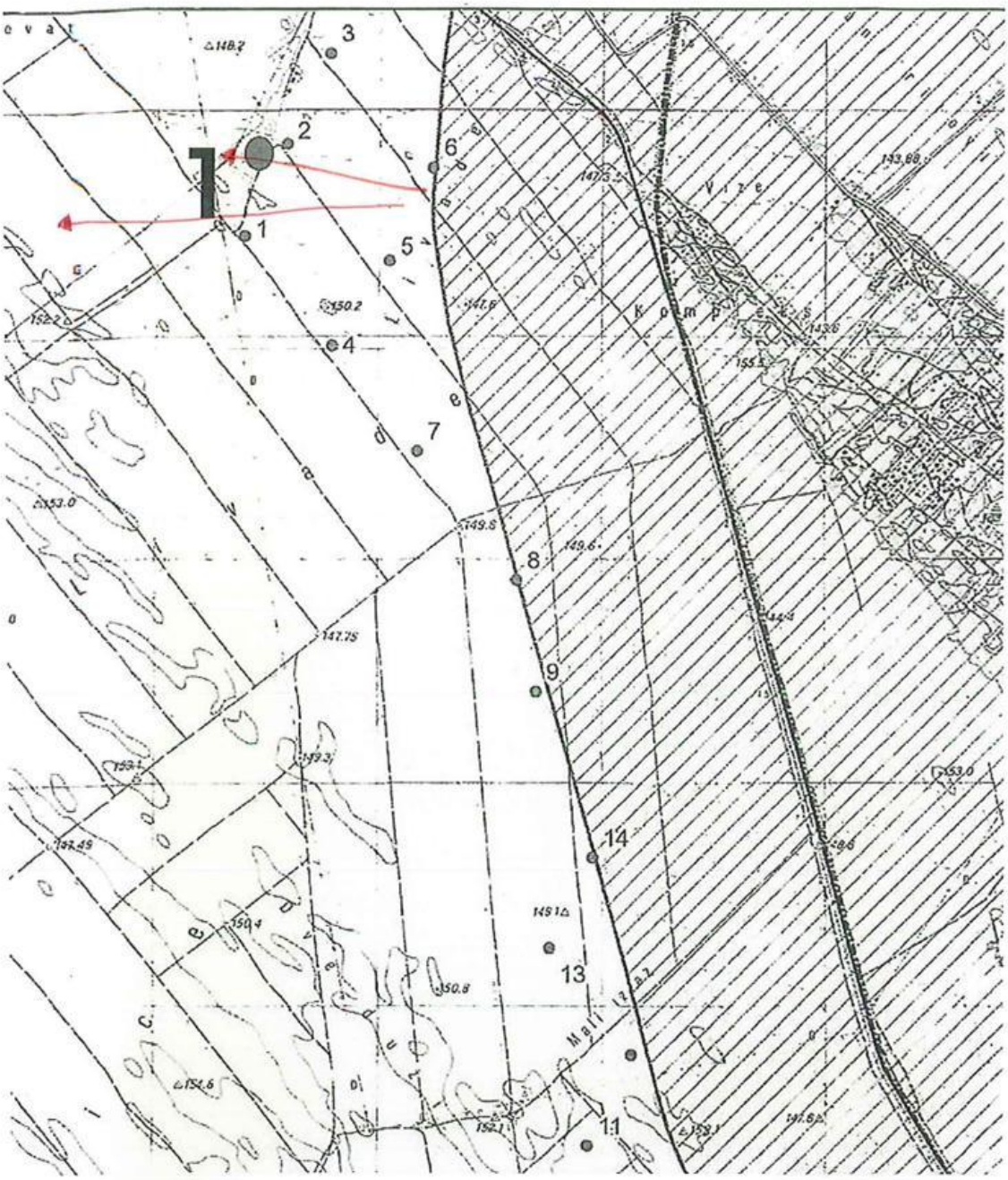
VP1 ANSER ANSER + ANSER ALBIFRONS

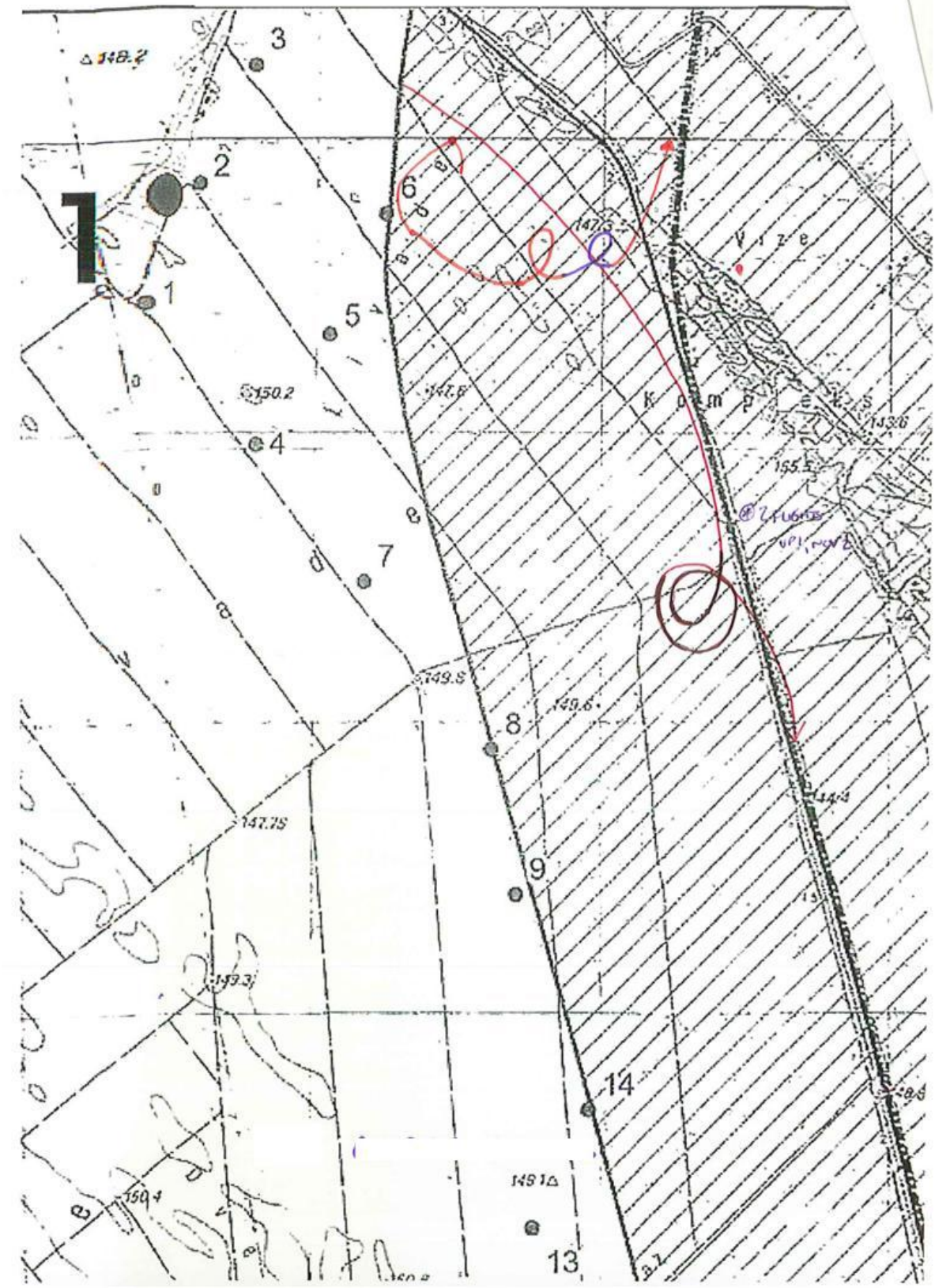
VP1: Circus cyaneus (Hen Harrier)



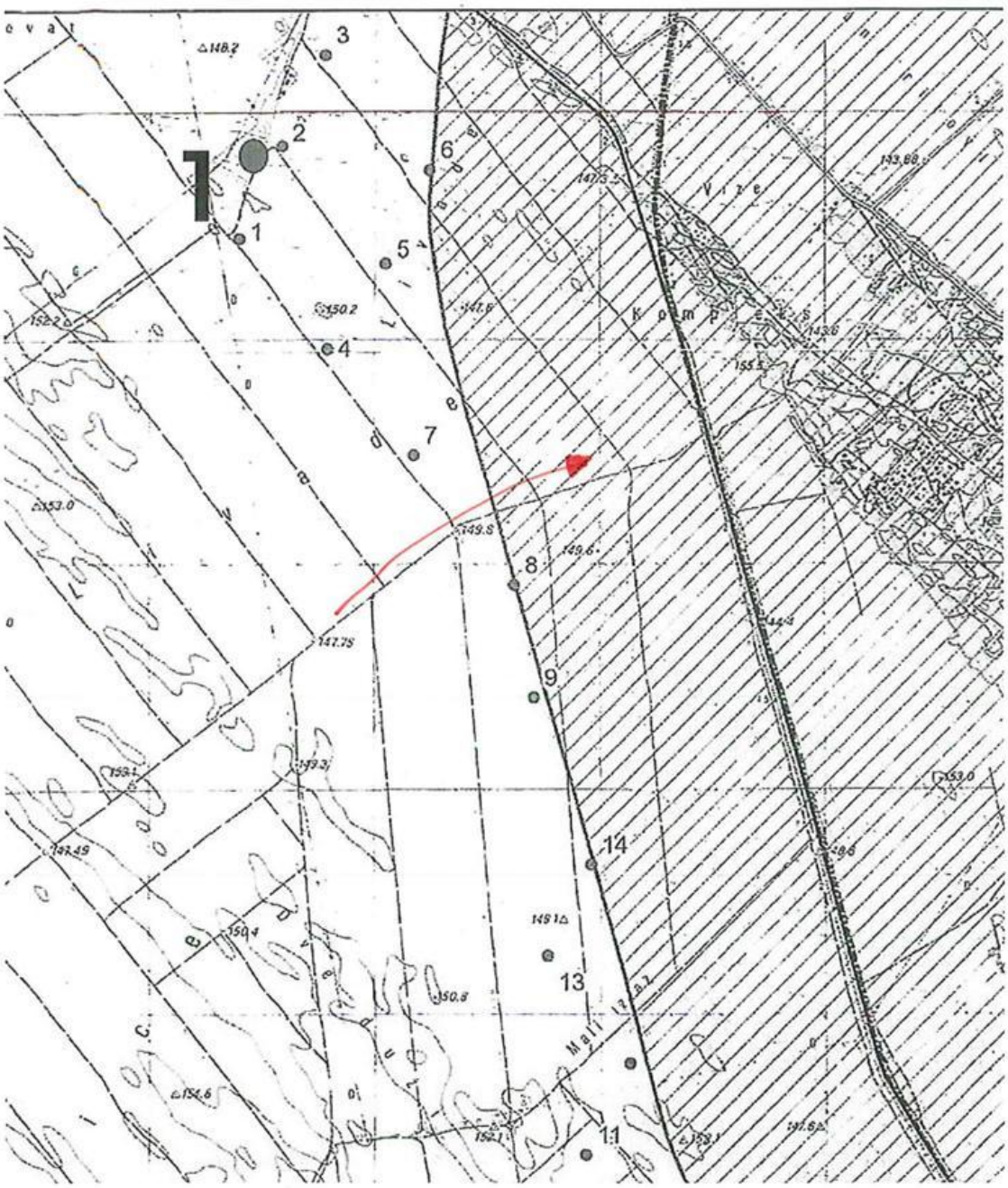
VP1: Falco columbarius (Merlin)



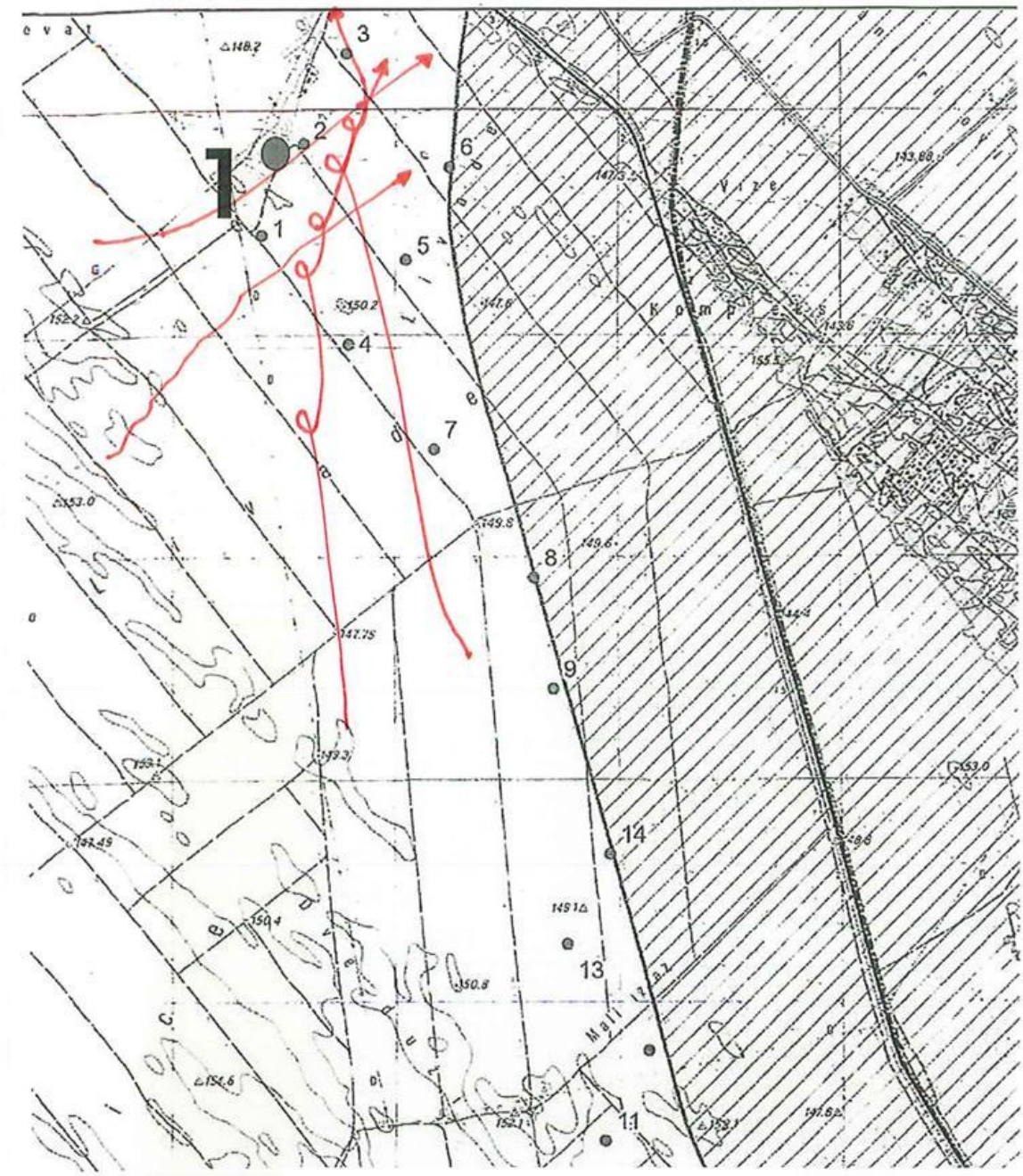
VP1: Accipiter gentilus (Northern Goshawk)



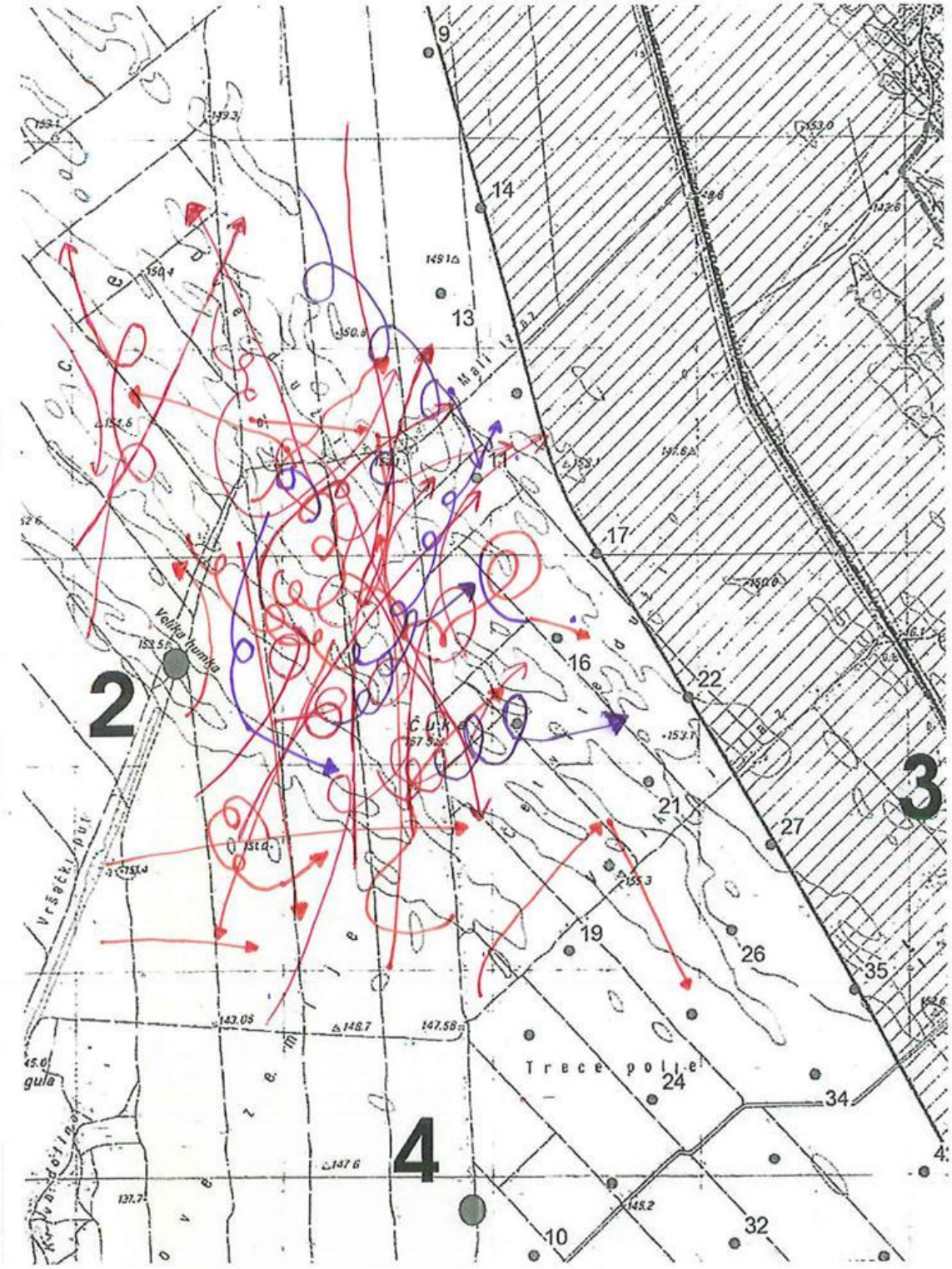
VP1: Falco cherrug (Saker Falcon)



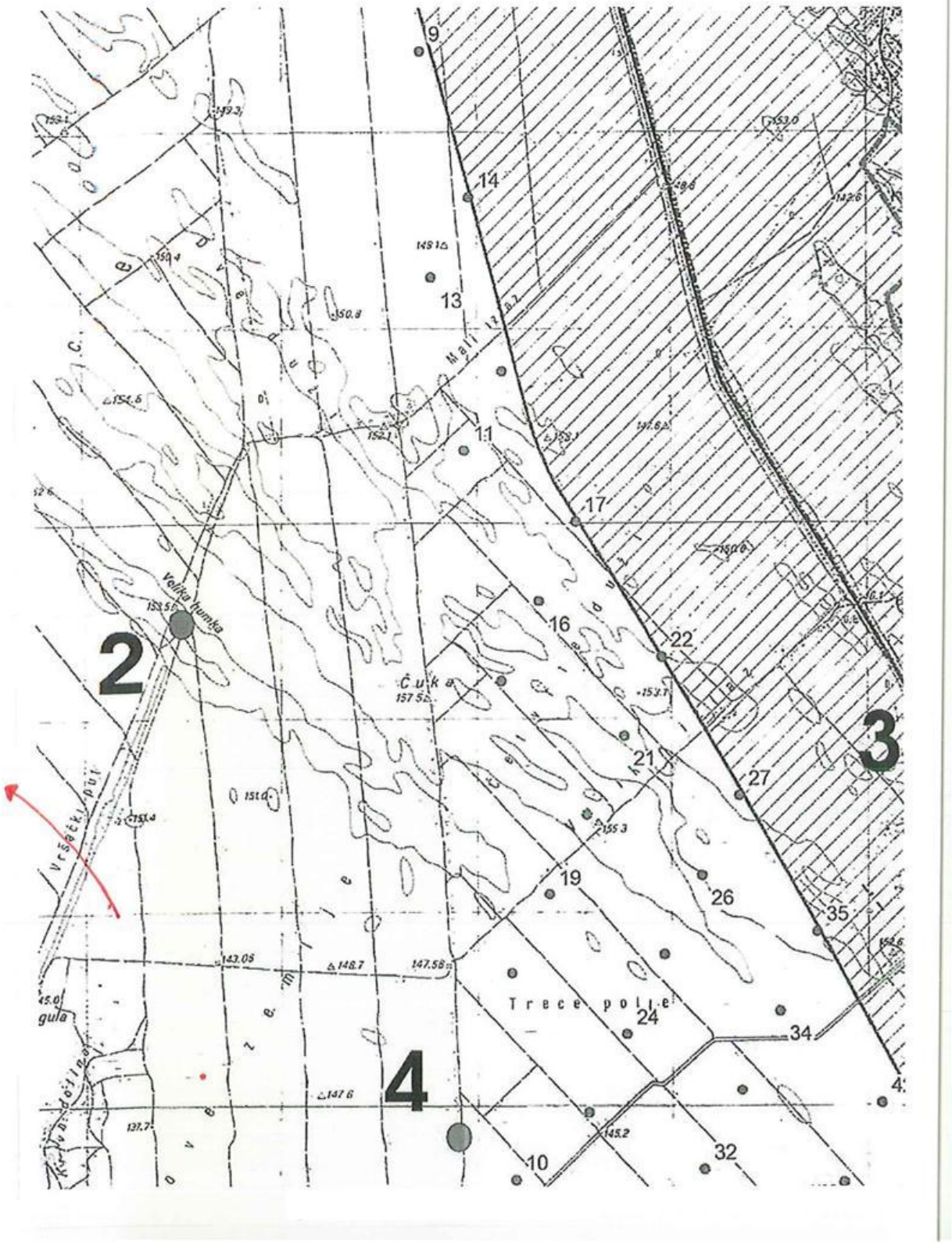
VP1: Circus aeruginosus (Western Marsh Harrier)



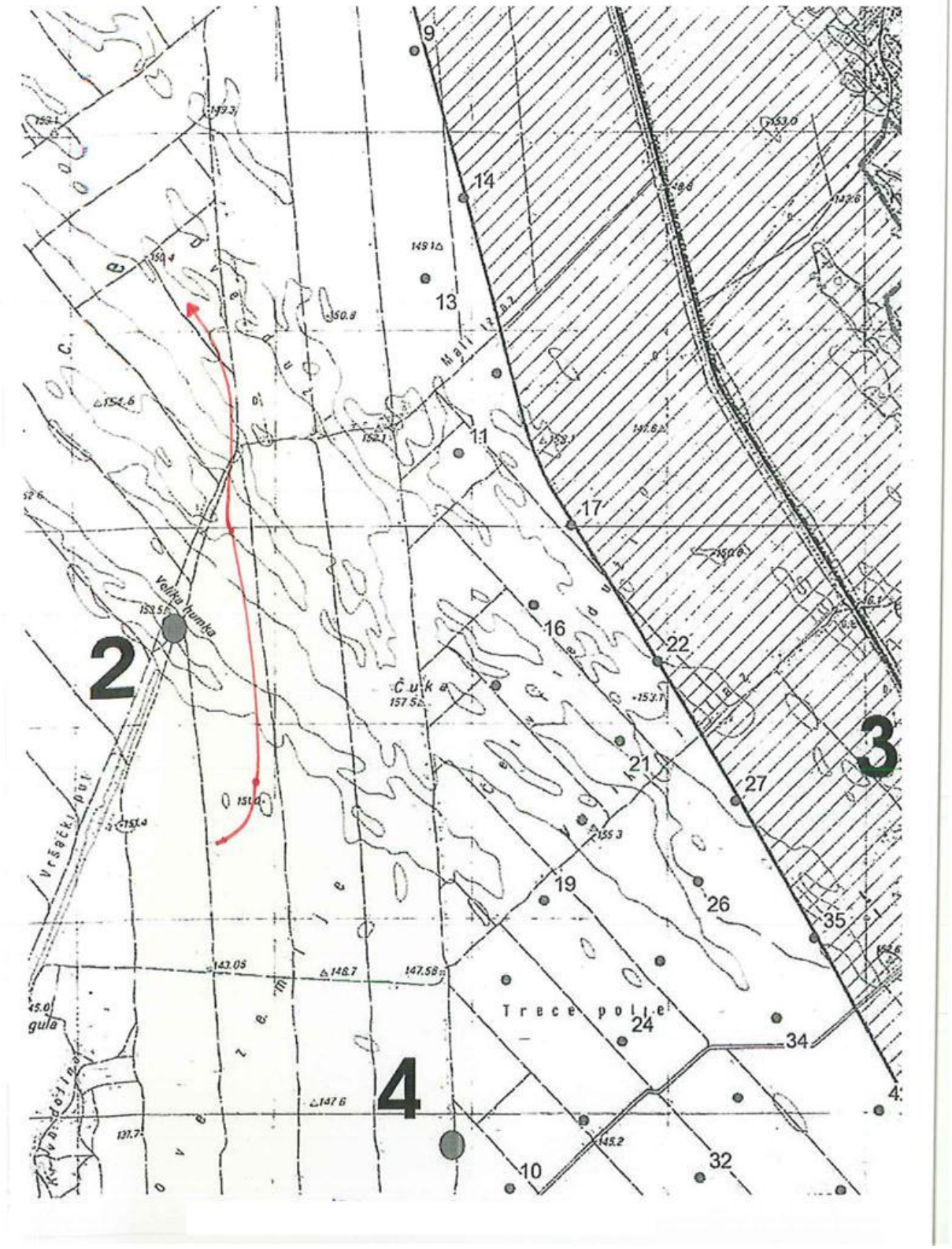
VP2: Buteo buteo (Common Buzzard)



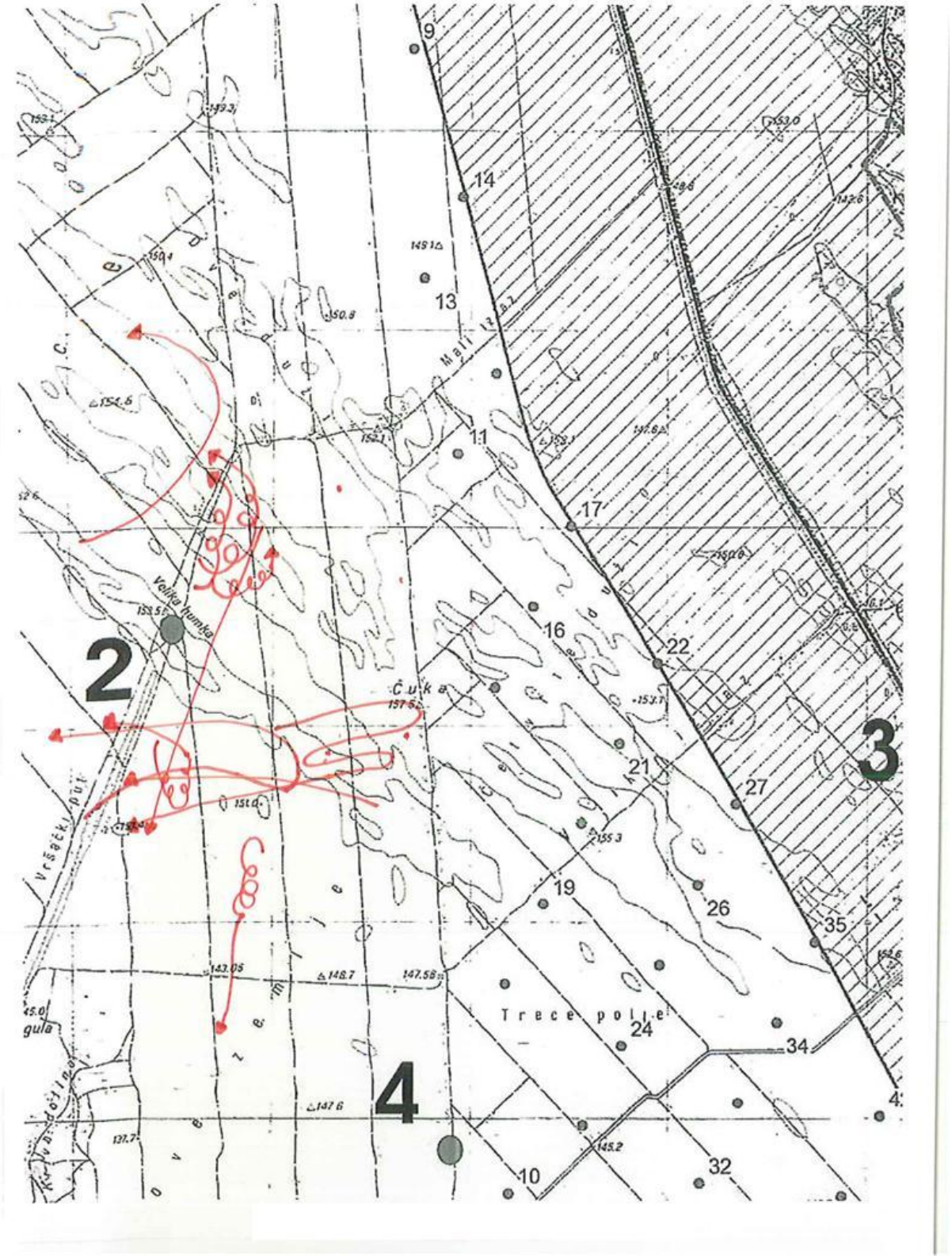
VP2: Grus Grus (Common Crane)



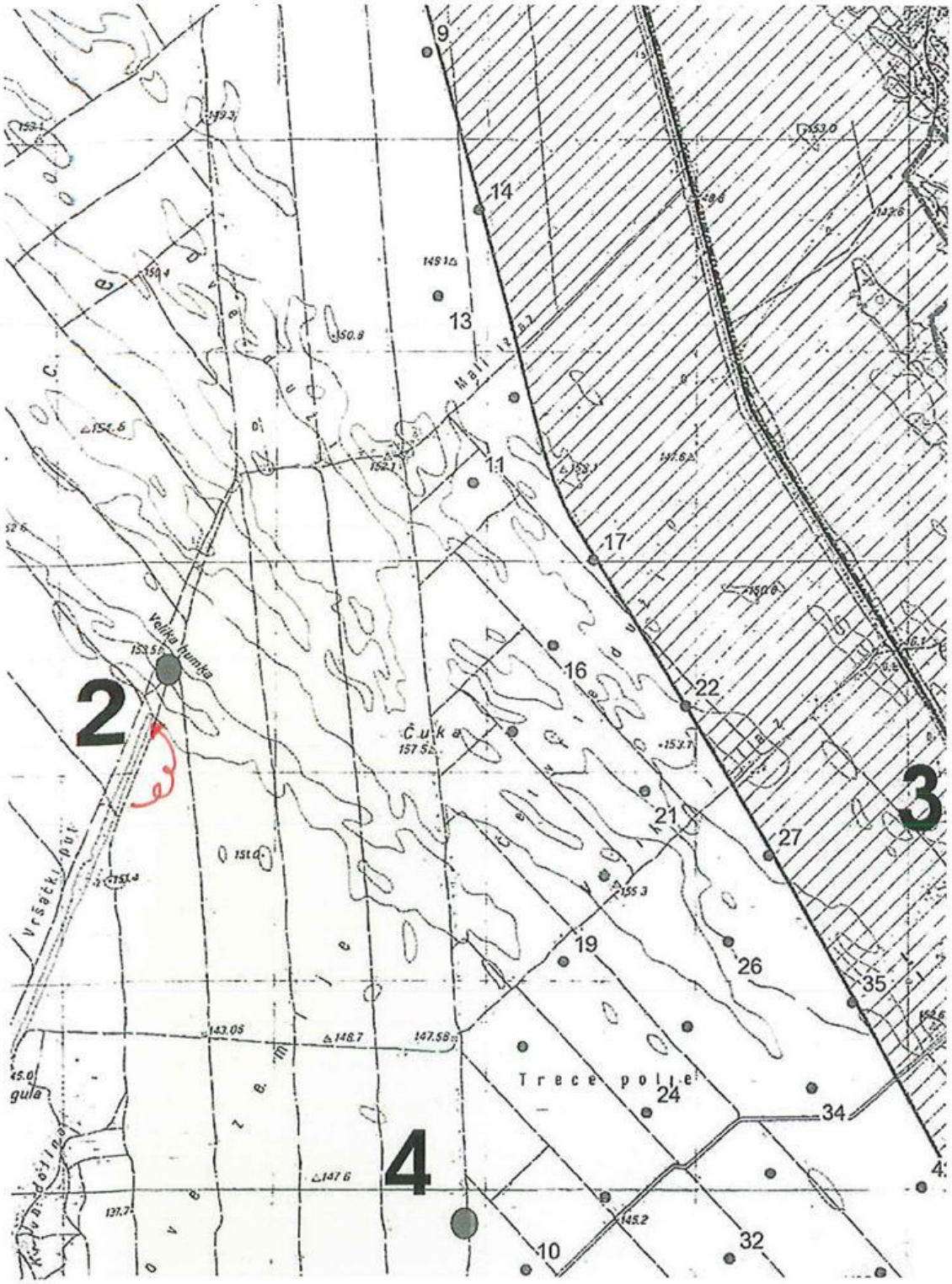
VP2: Falco Subbuteo (Eurasian Hobby)



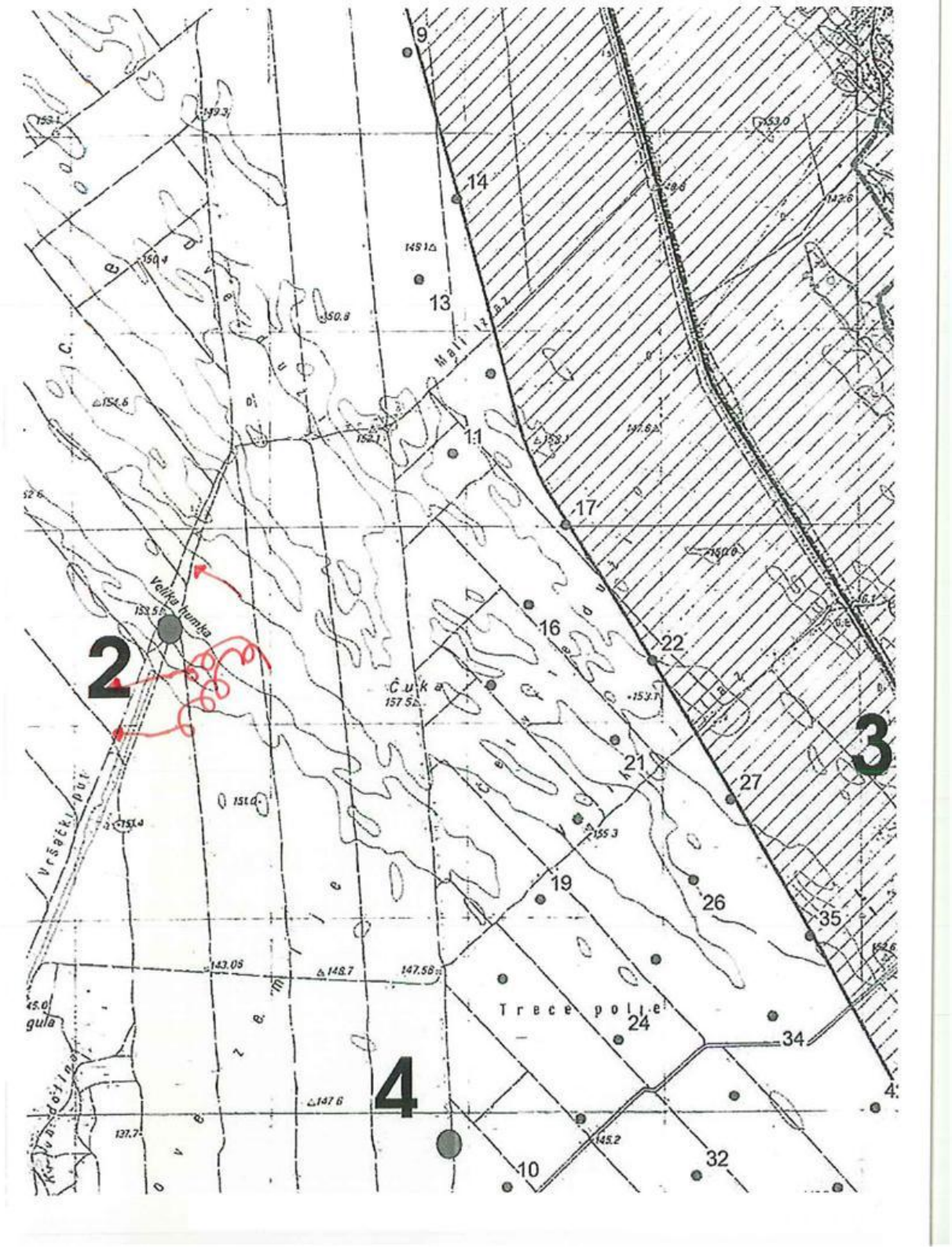
VP2: Falco tinnunculus (Eurasian Kestrel)



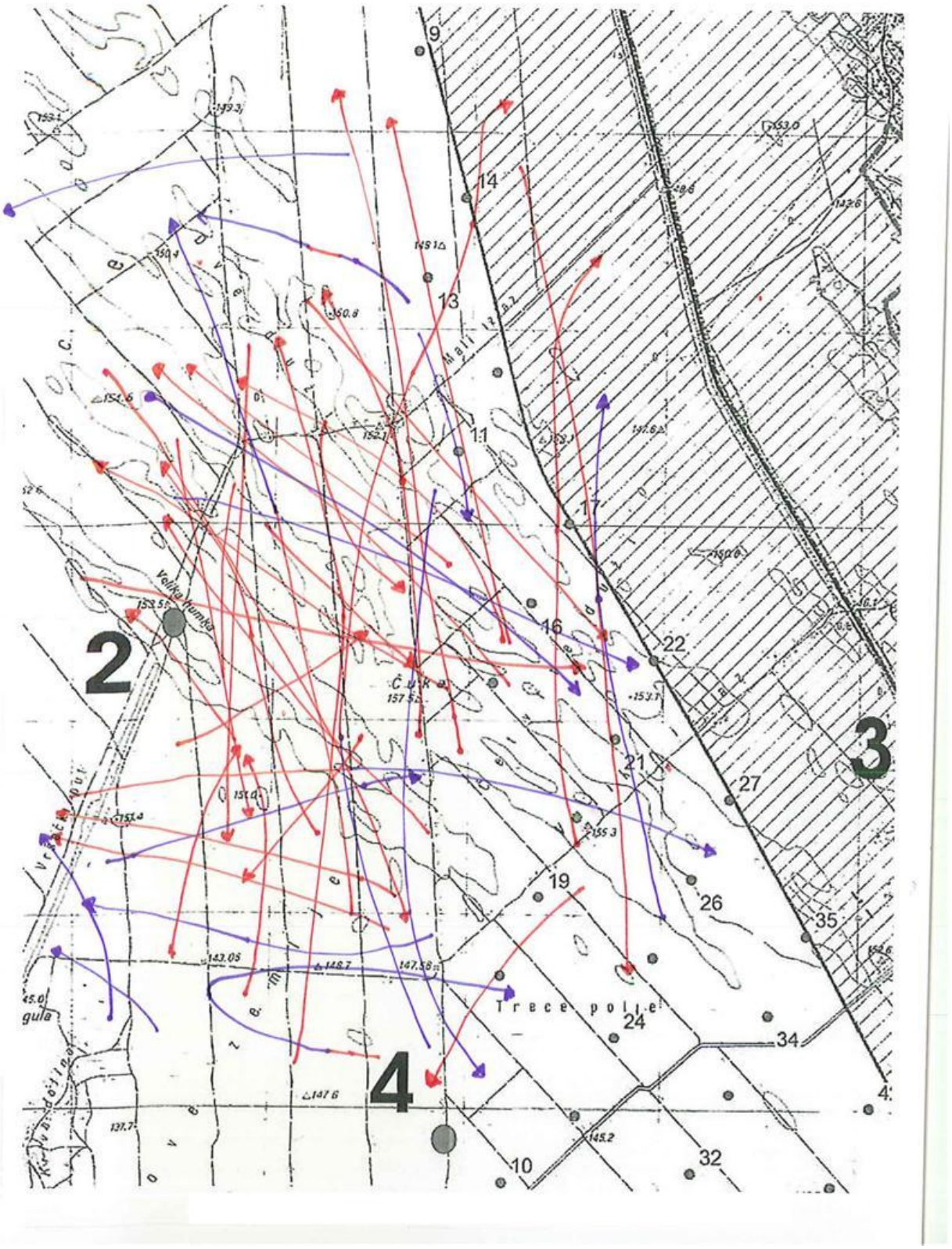
VP2: Accipiter nisus (Eurasian Sparrowhawk)



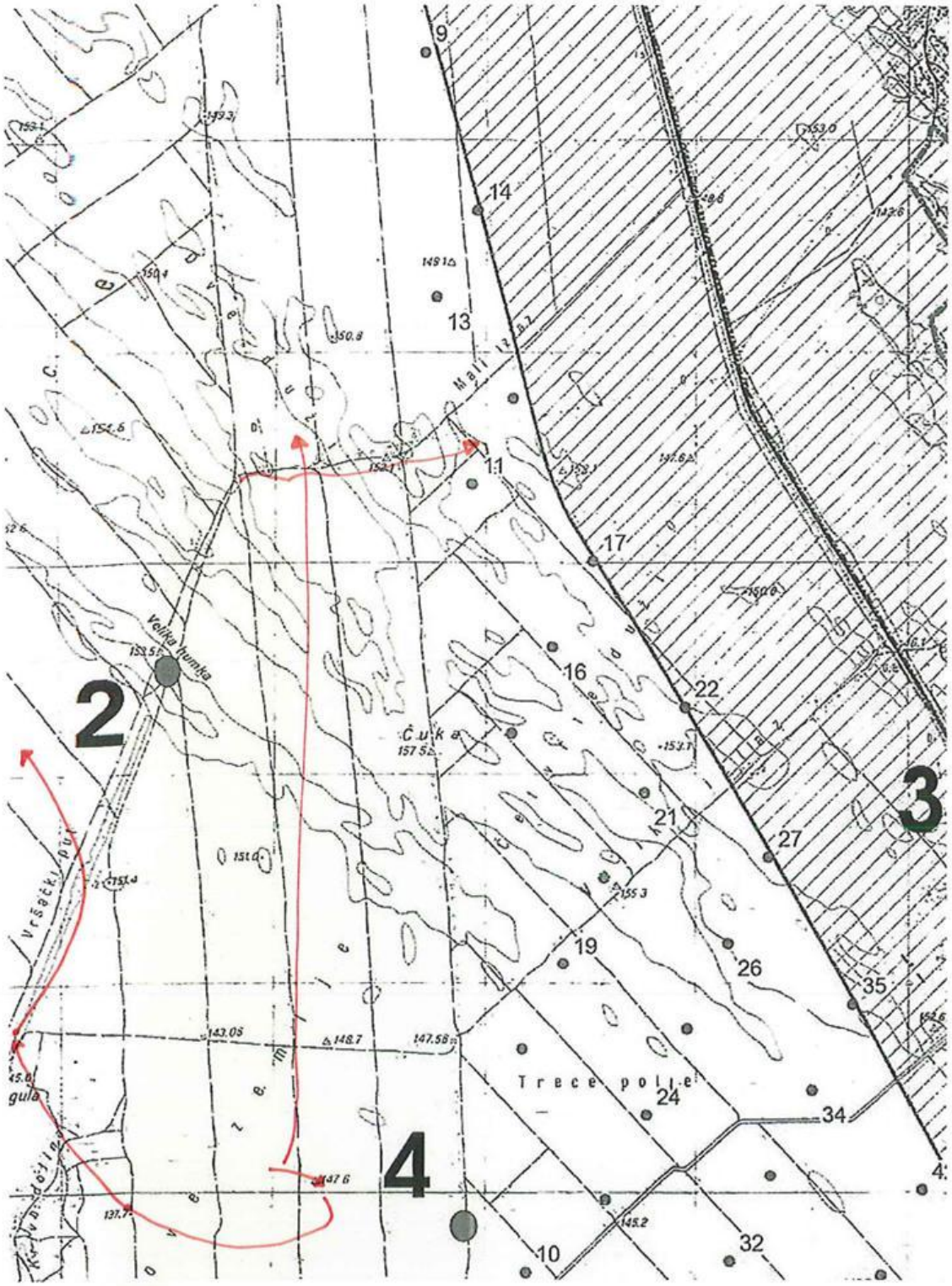
VP2: Merops Apiaster (European Bee-eater)



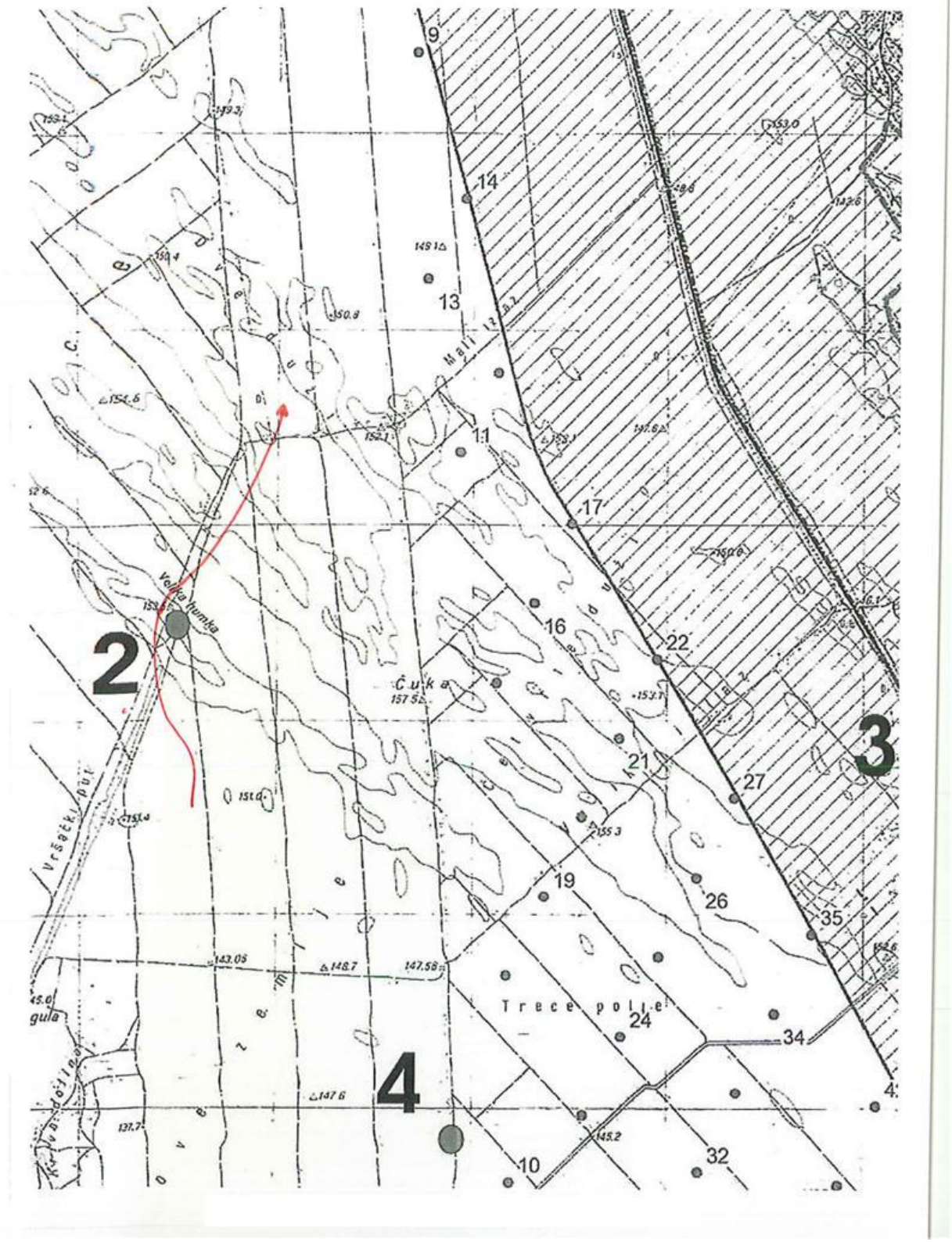
VP2: Anser Anser & Anser Albifrons (Grey geese (greylag goose and greater white-fronted goose))



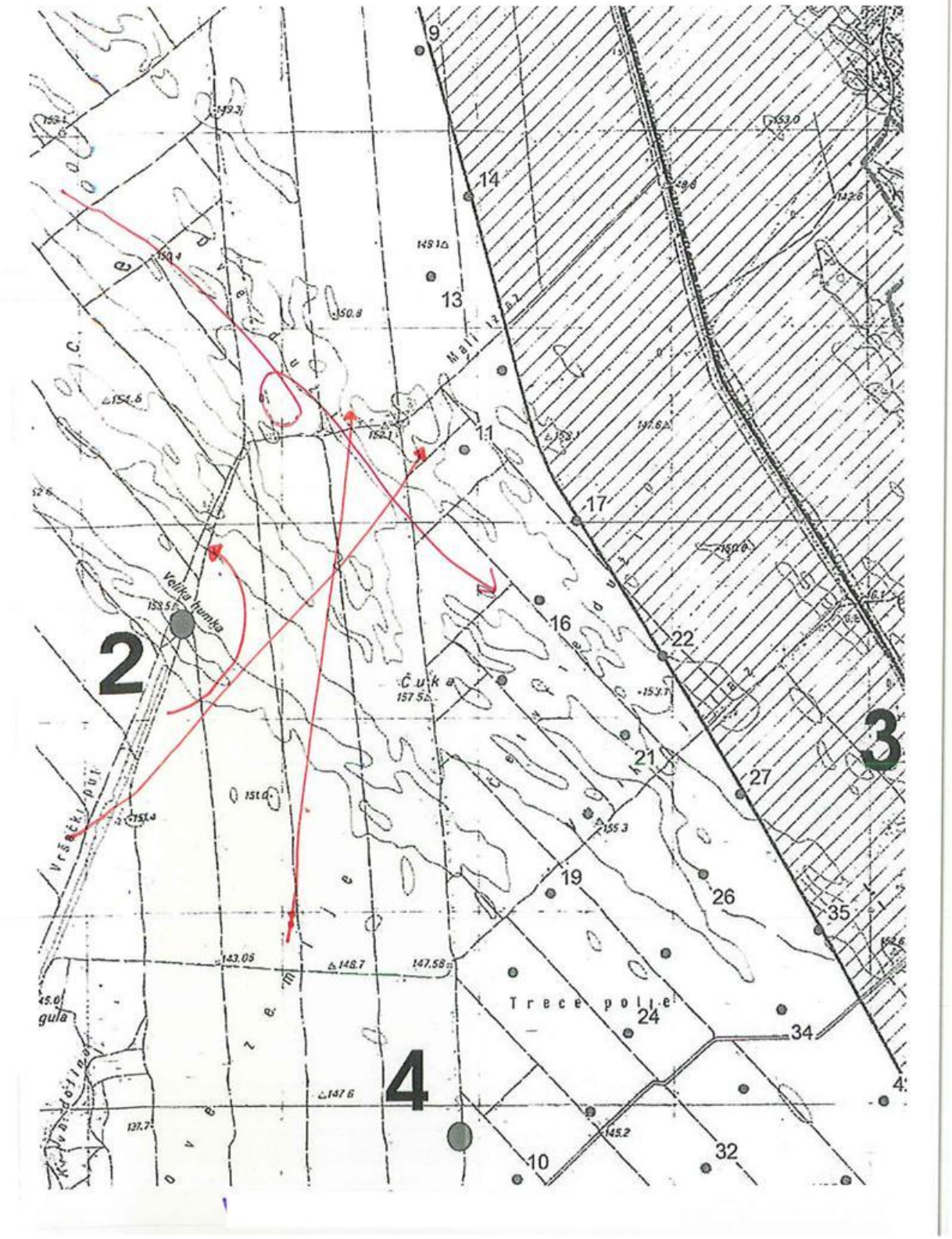
VP2: Circus Cyaneus (Hen Harrier)



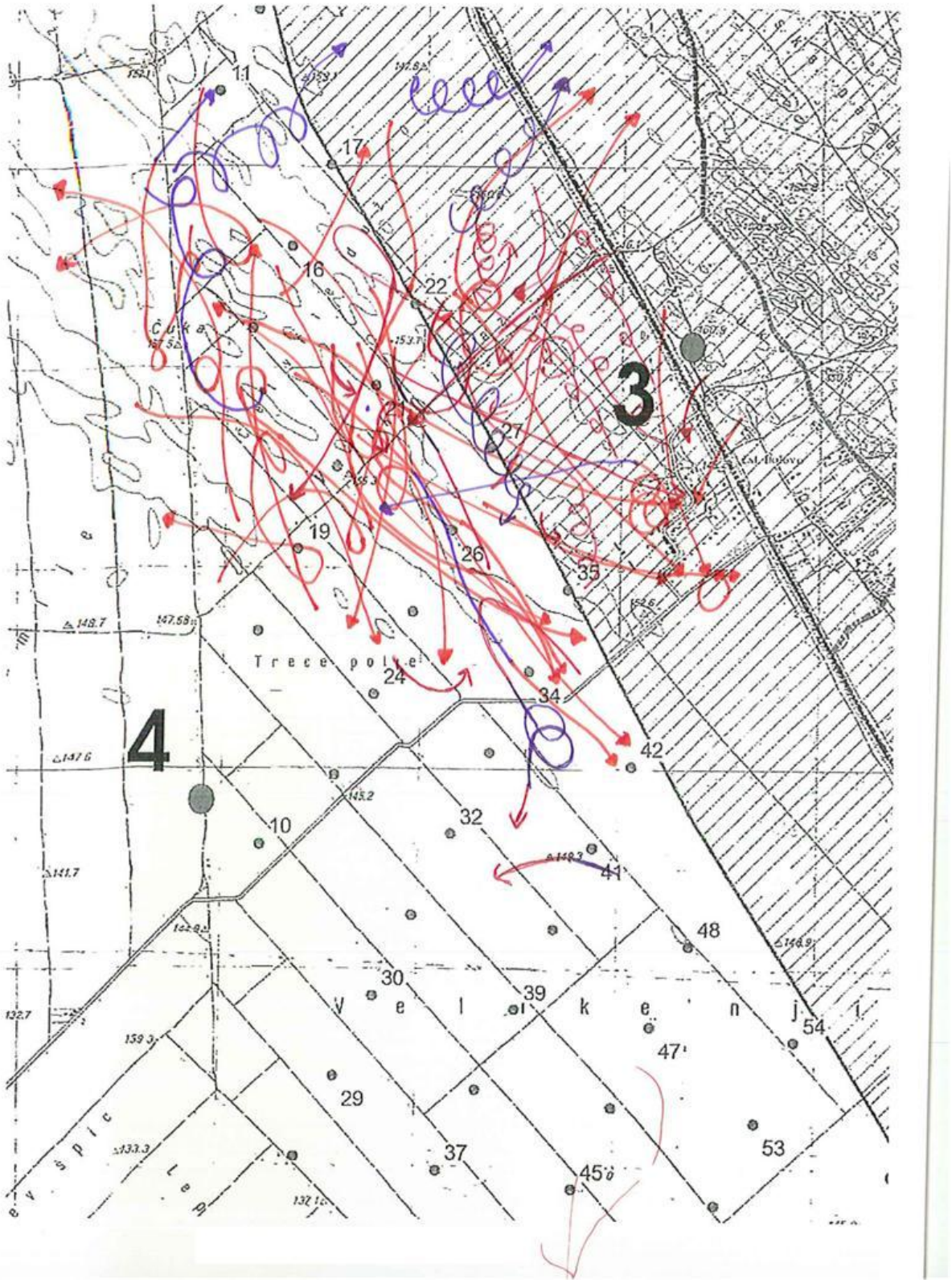
VP2: Circus Macrourus (Montagu's Harrier)



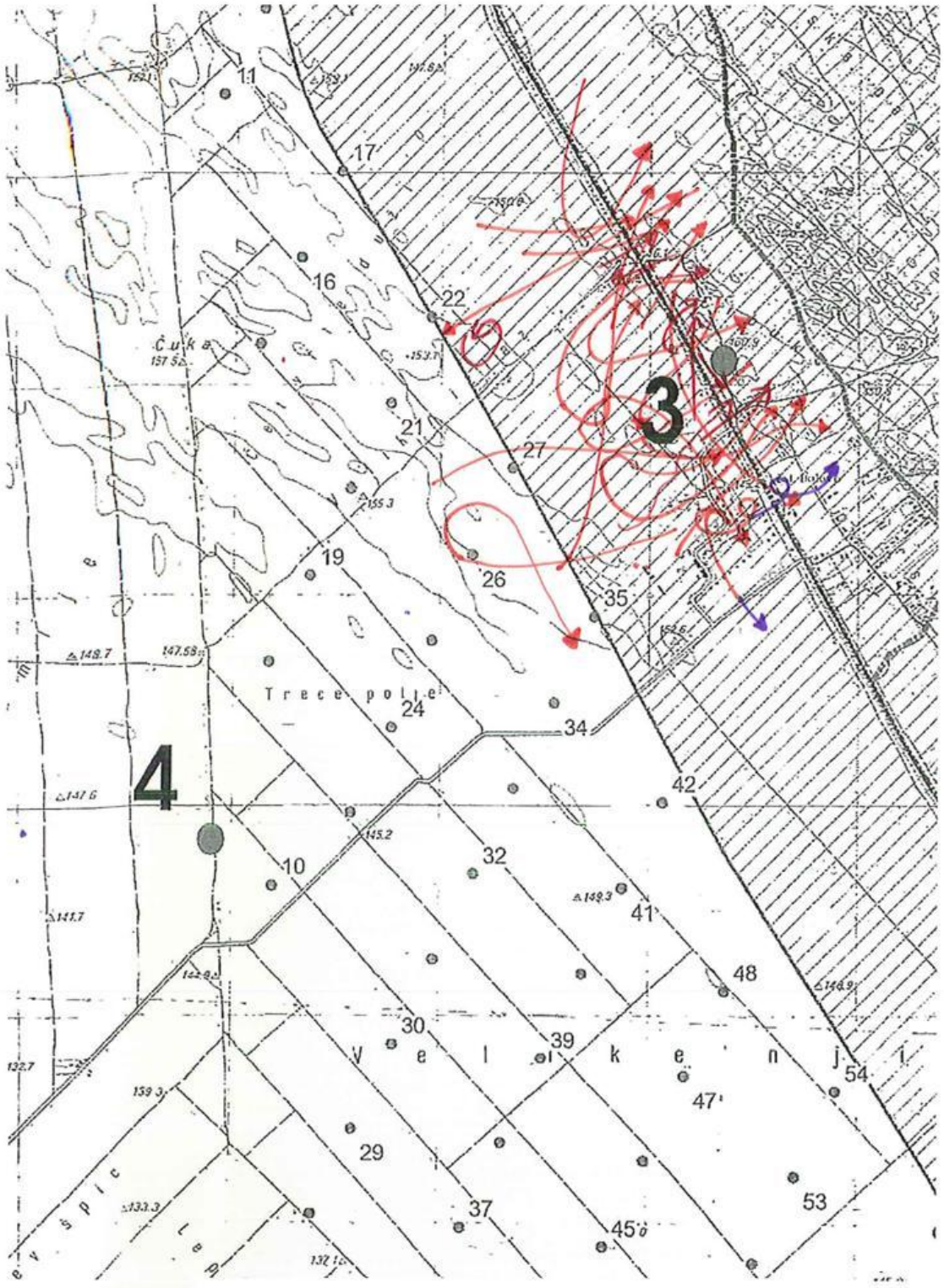
VP2: Circus Aeruginosus (Western Marsh Harrier)



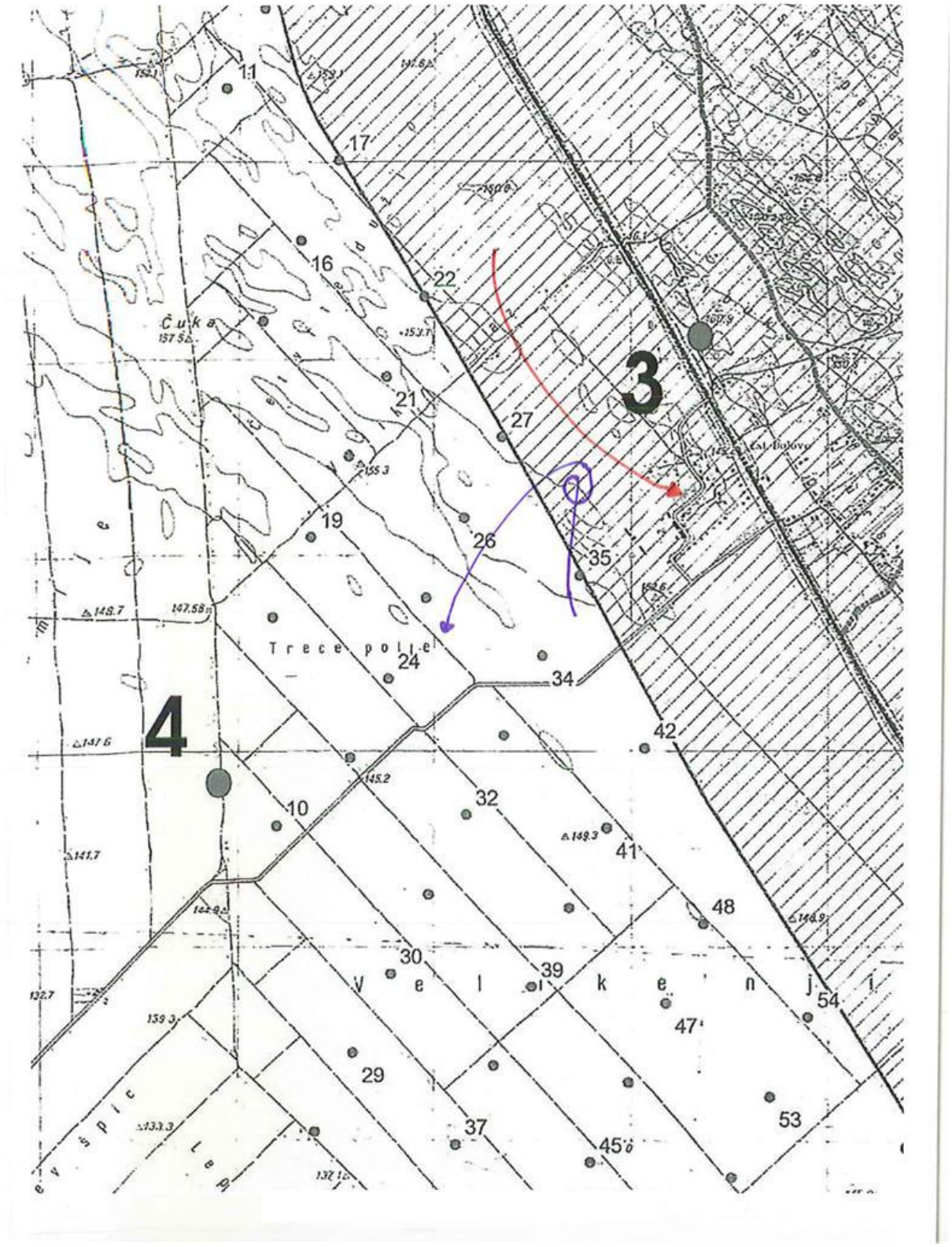
VP3: Buteo Buteo (Common Buzzard)



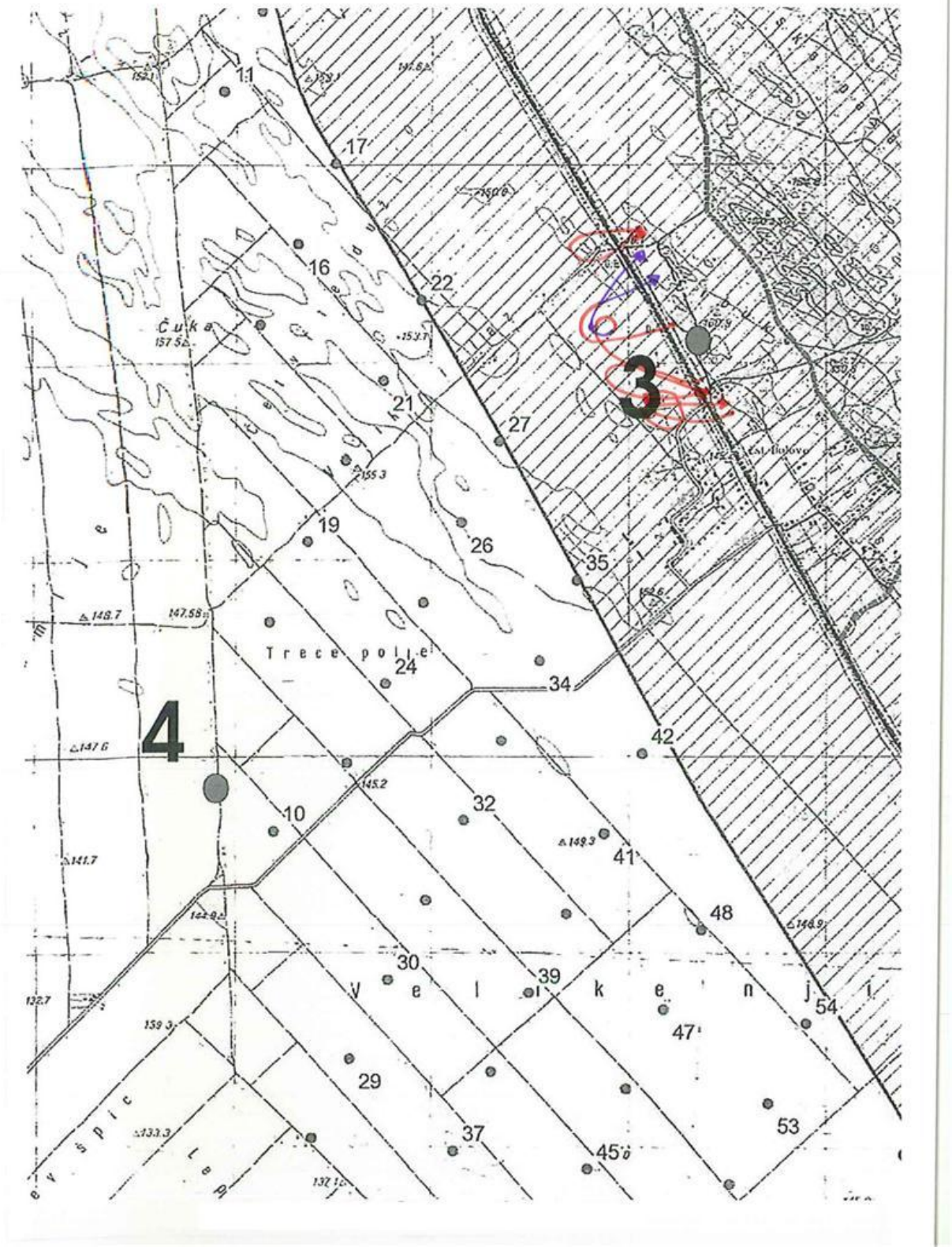
VP3: Falco Tinnunculus (Eurasian Kestrel)



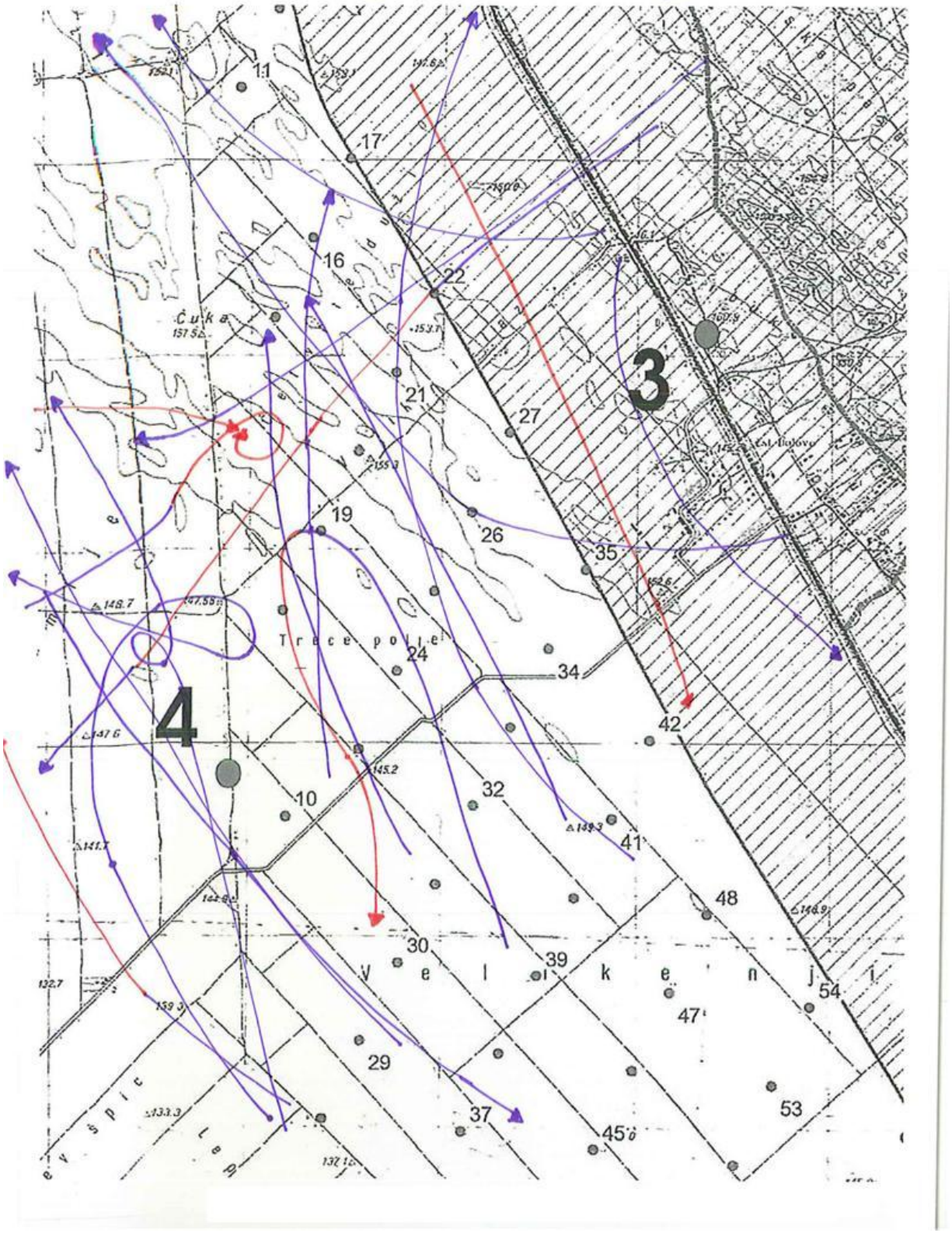
VP3: Accipiter Nisus (Eurasian Sparrowhawk)



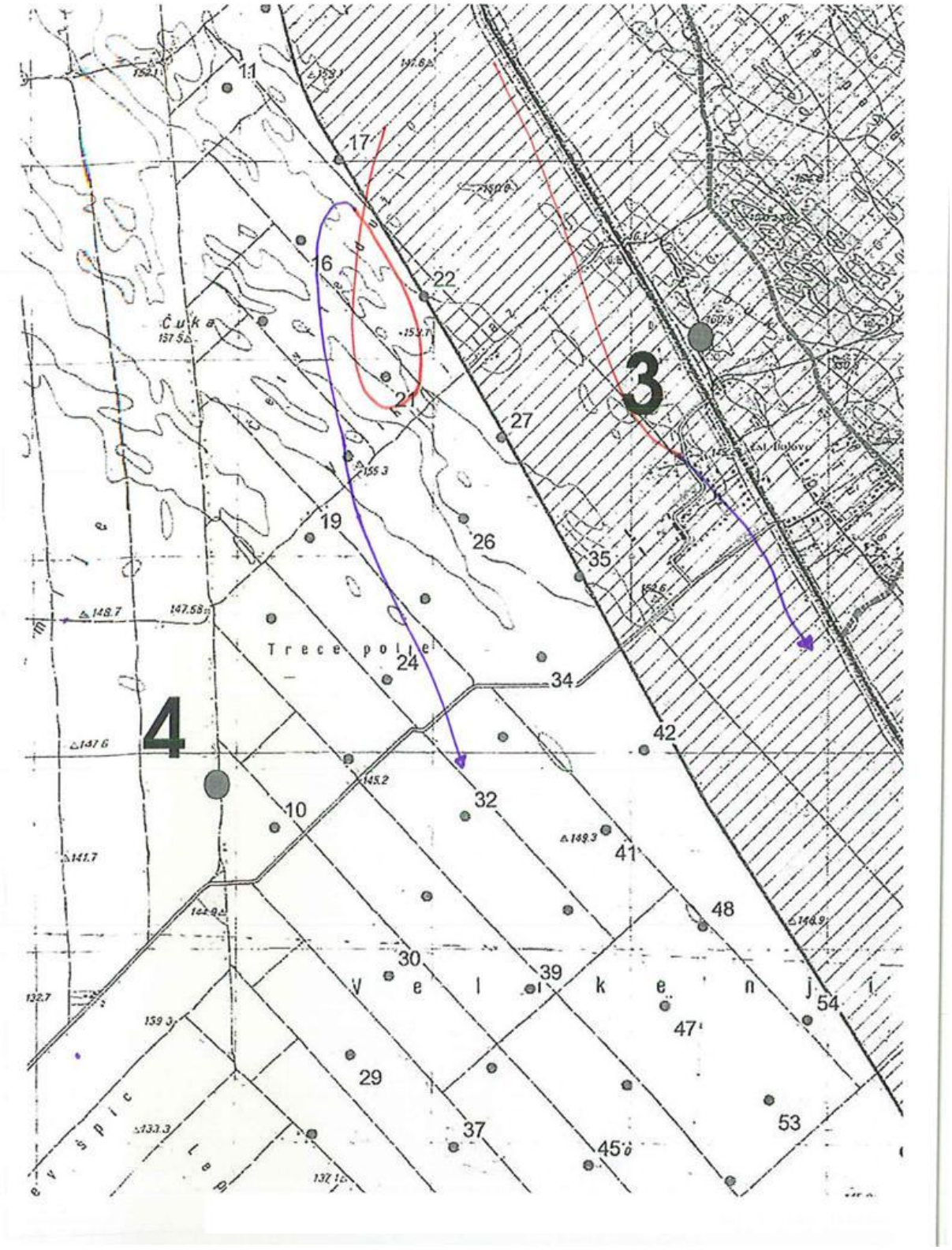
VP3: Merops Apiaster (European Bee-Eater)



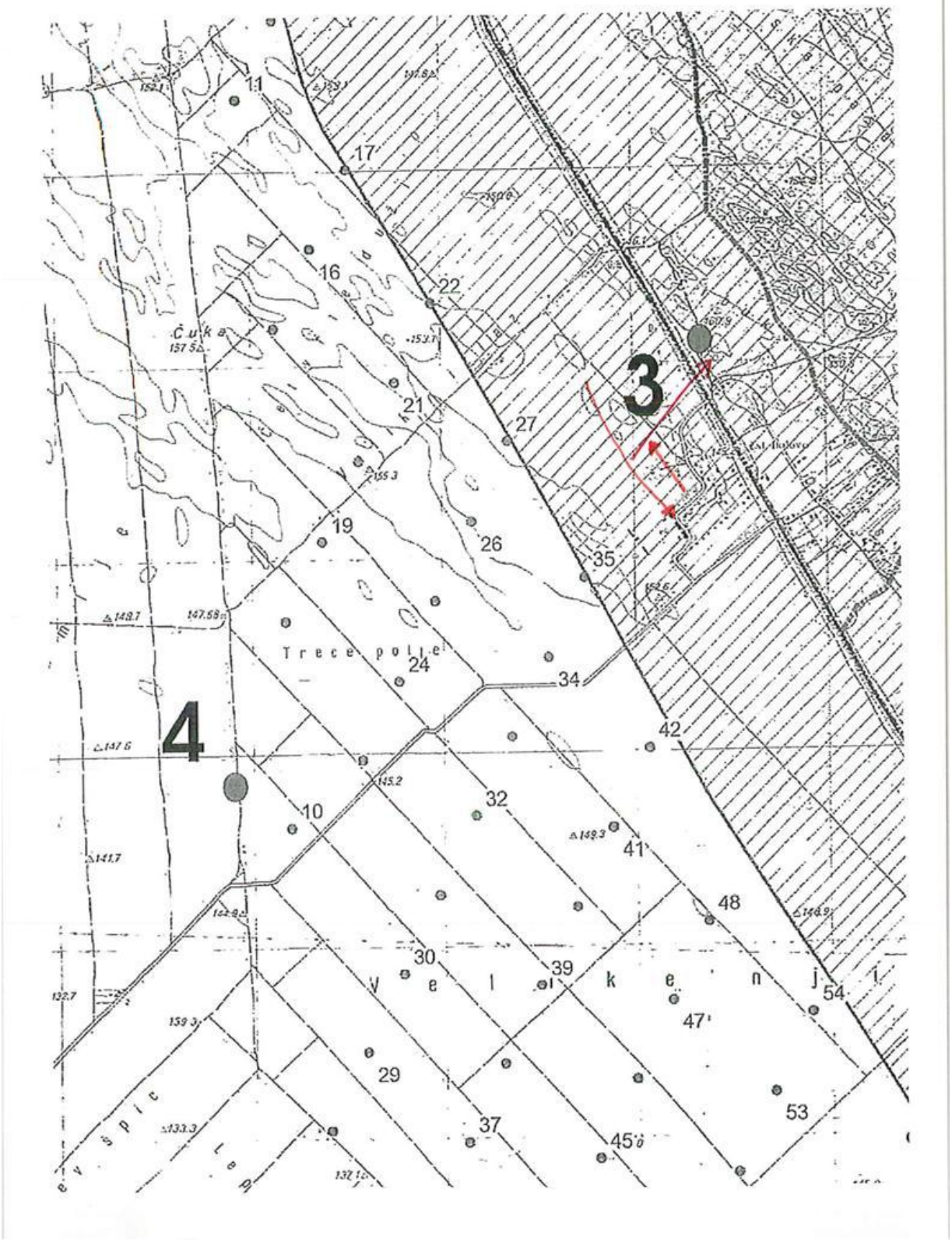
VP3: Anser Anser & Anser Albifron (Grey Geese (greylag goose and greater white-fronted goose)



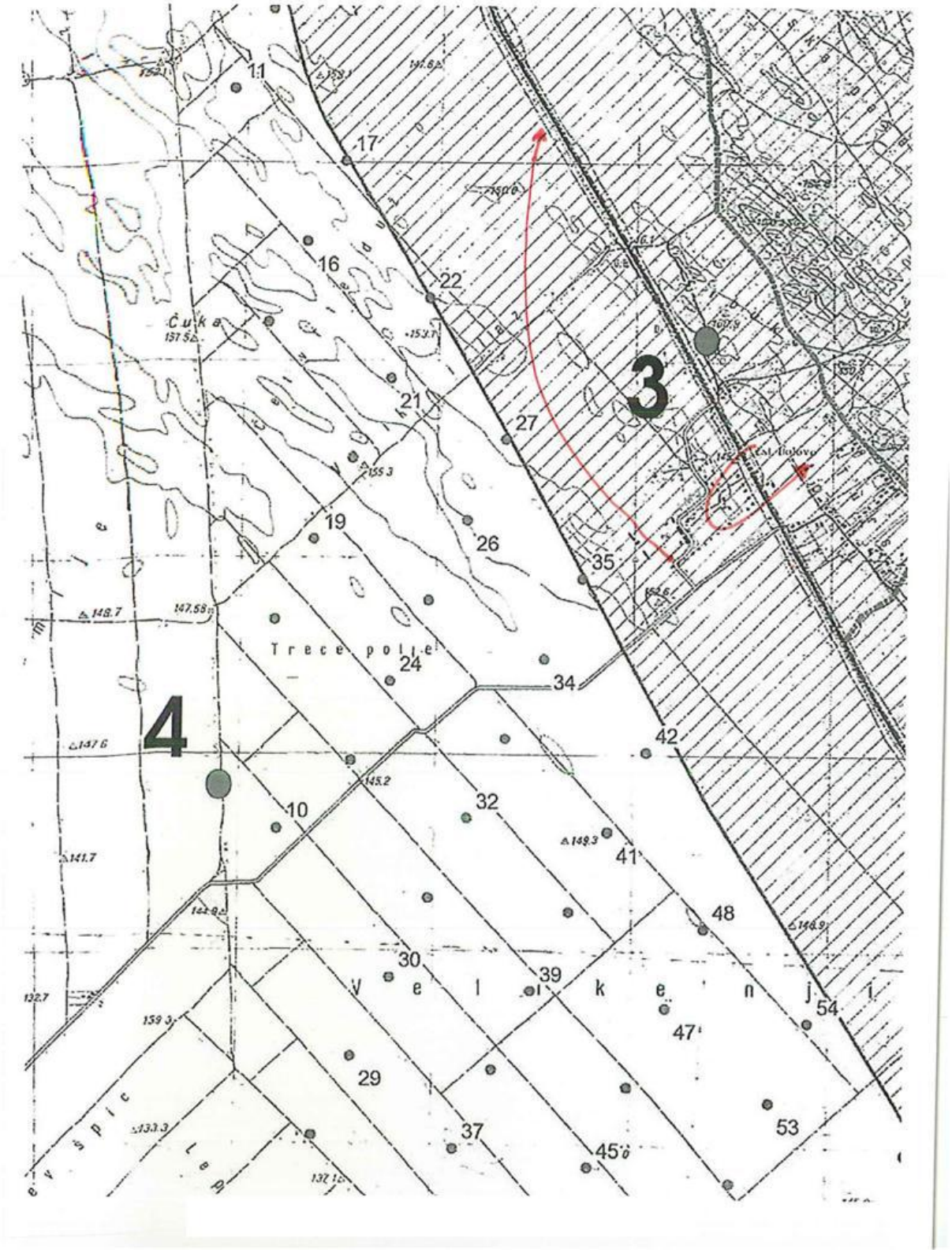
VP3: Circus Cyaneus (Hen Harrier)



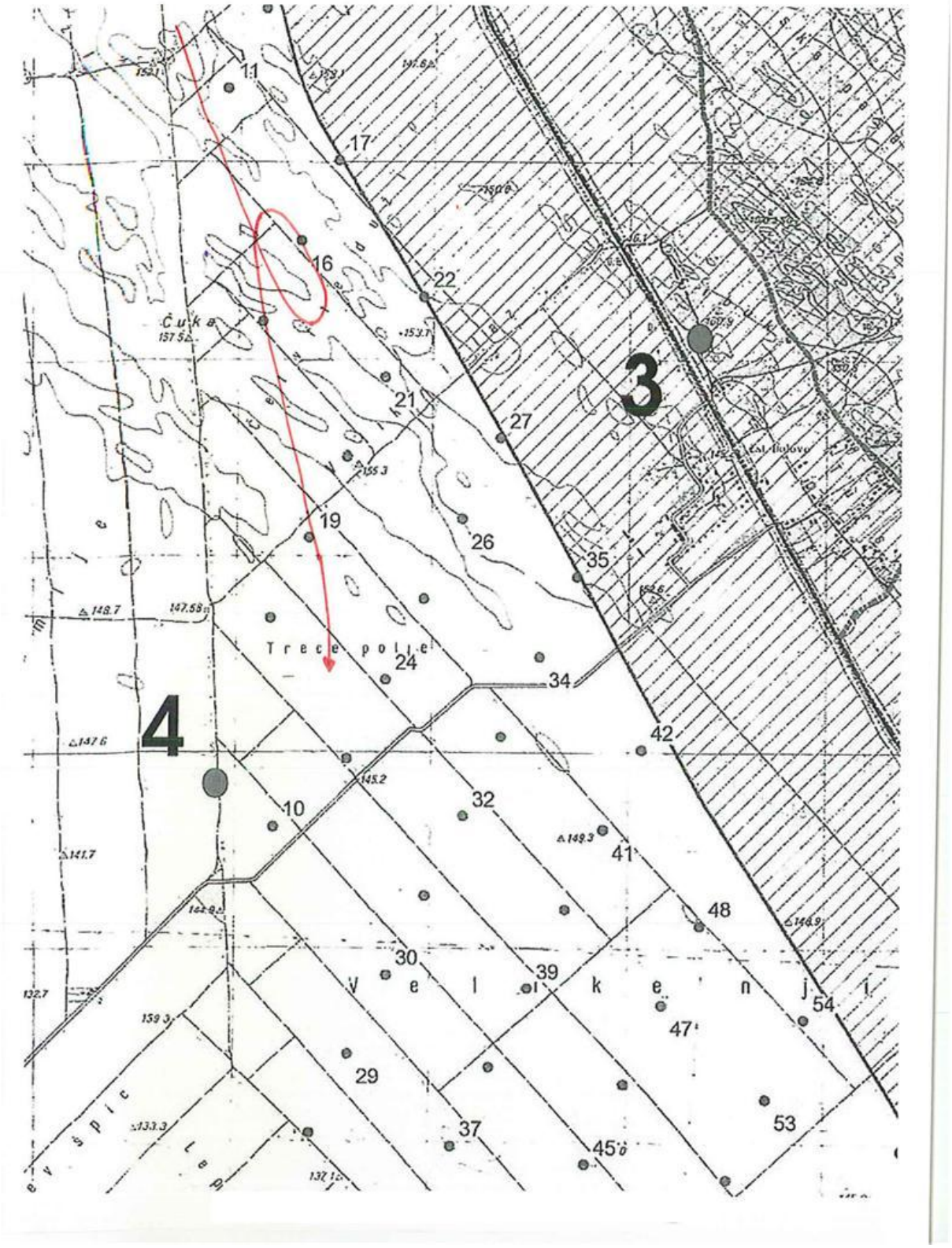
VP3: Falco Columarius (Merlin)



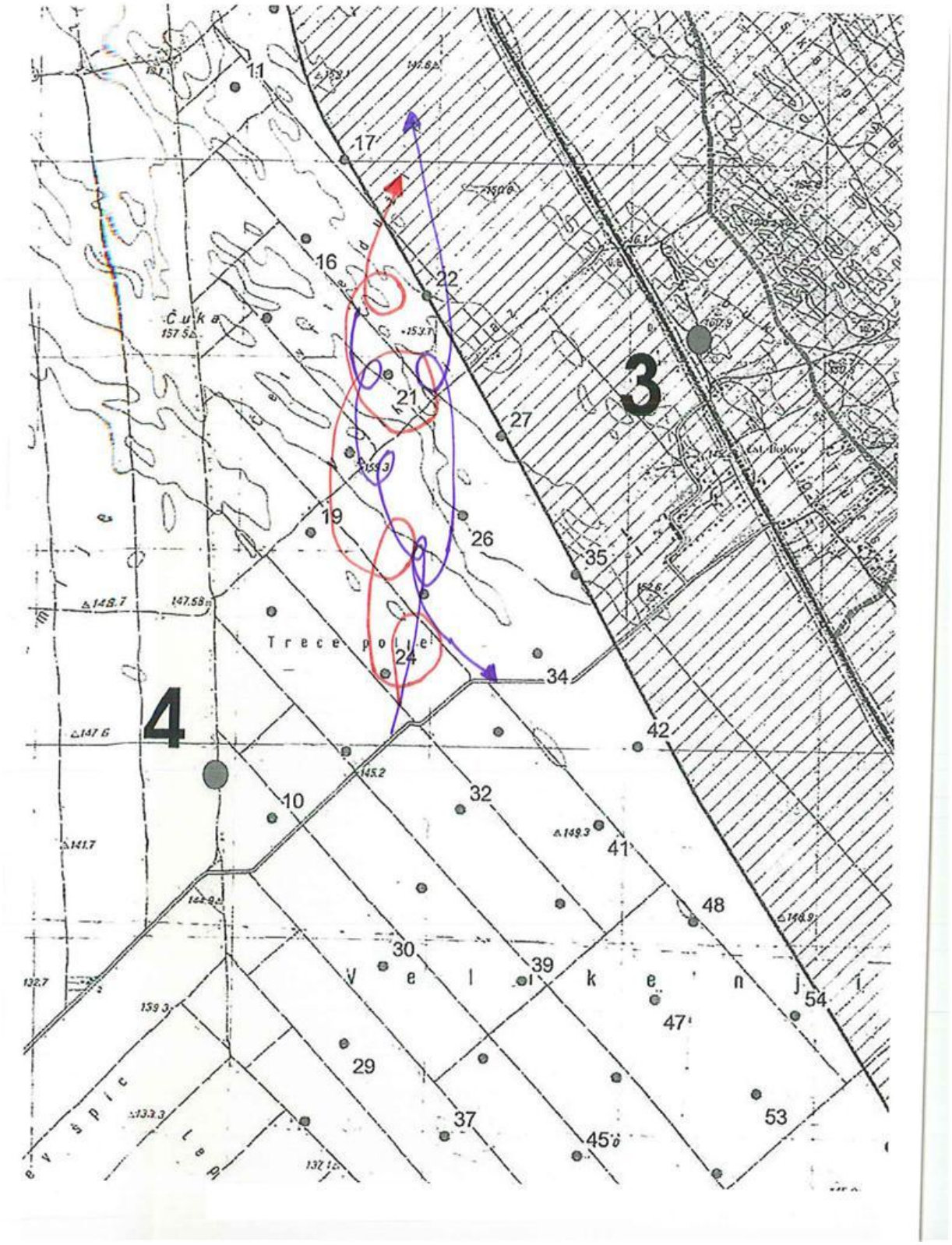
VP3: Accipiter Gentilus (Northern Goshawk)



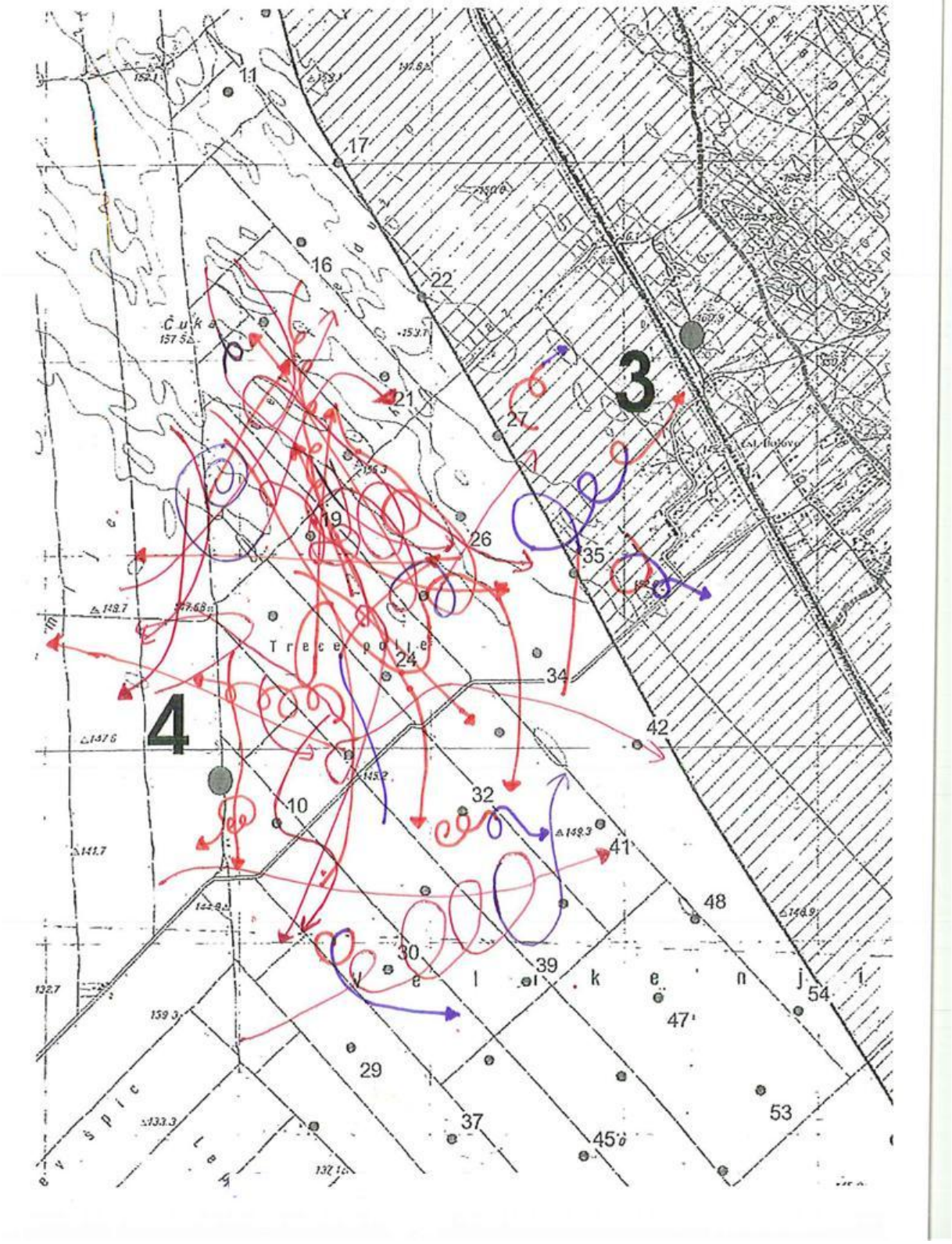
VP3: Circus Aeruginosus (Western Marsh Harrier)



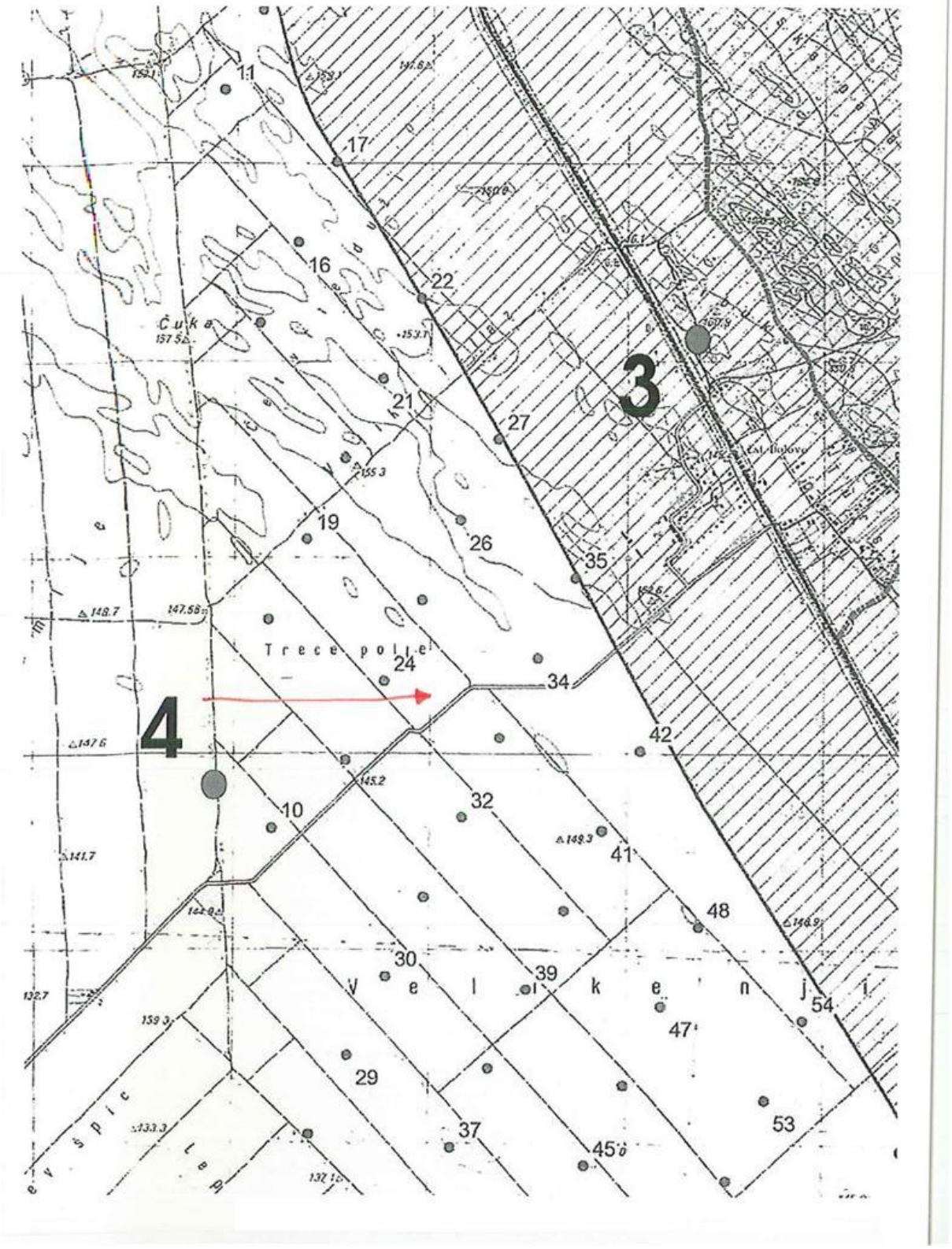
VP3: Ciconia ciconia (White Stork)



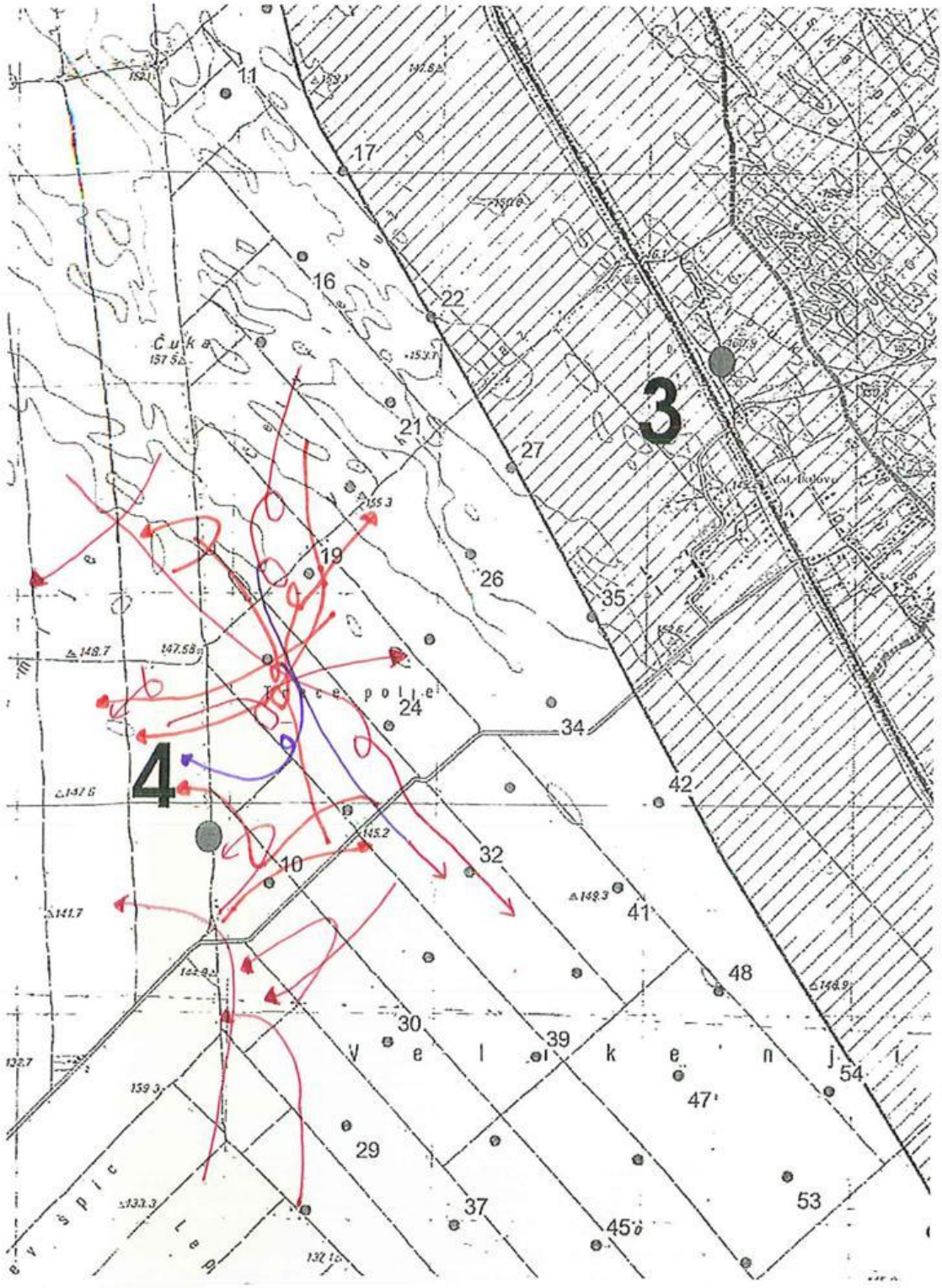
VP4: Buteo Buteo (Common Buzzard)



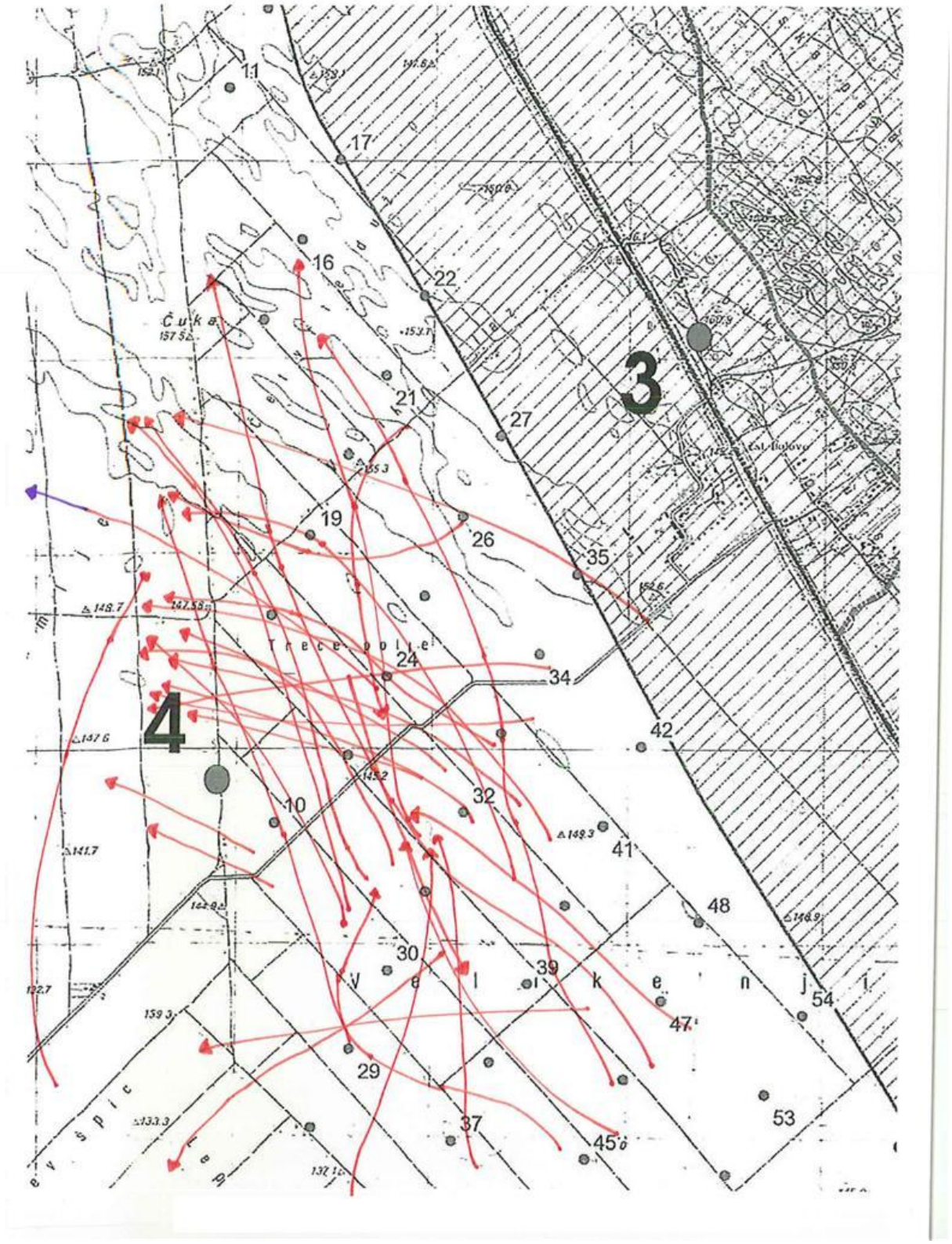
VP4: Falco Subbuteo (Eurasion Hobby)



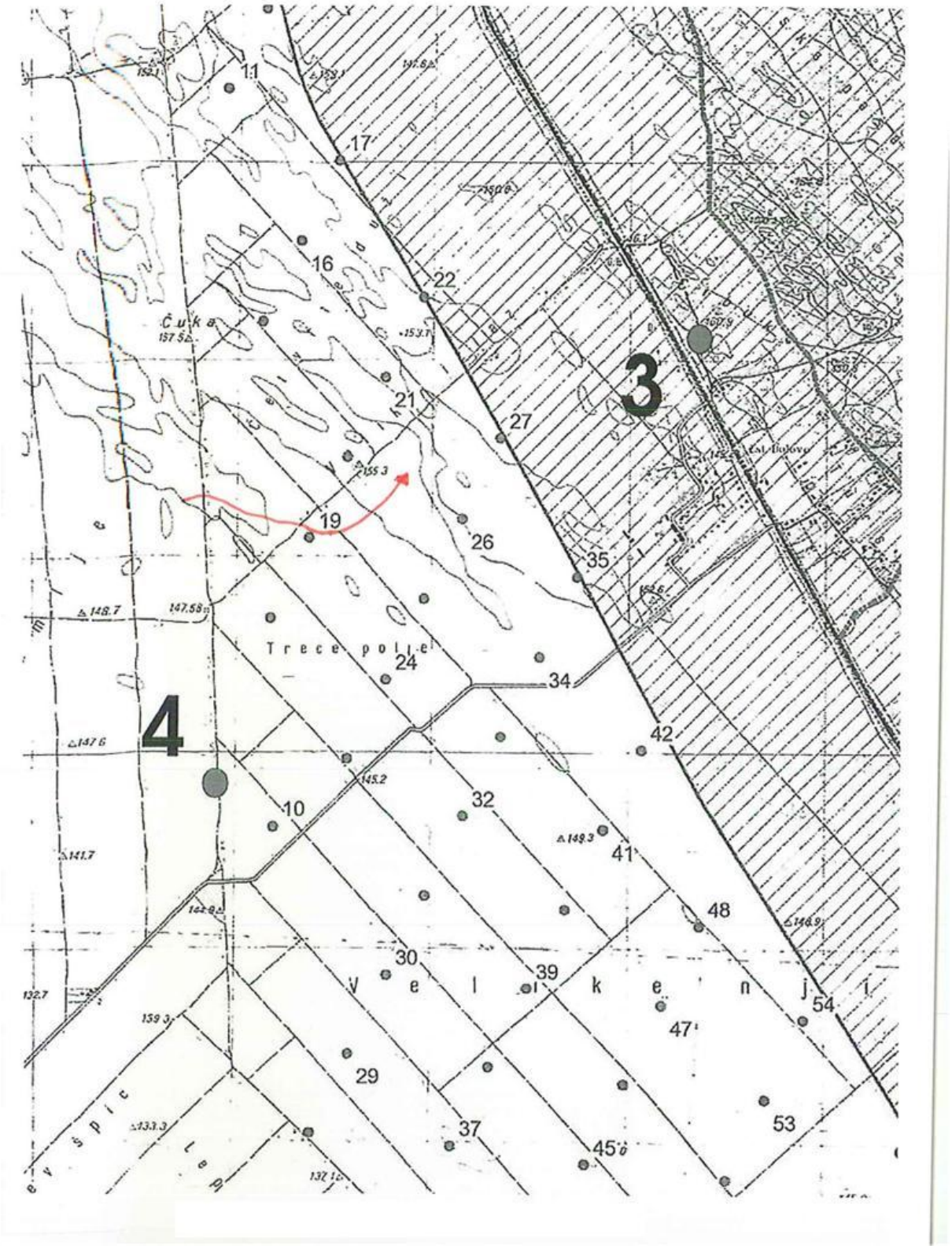
VP4: Falco tinnunculus (European Kestrel)



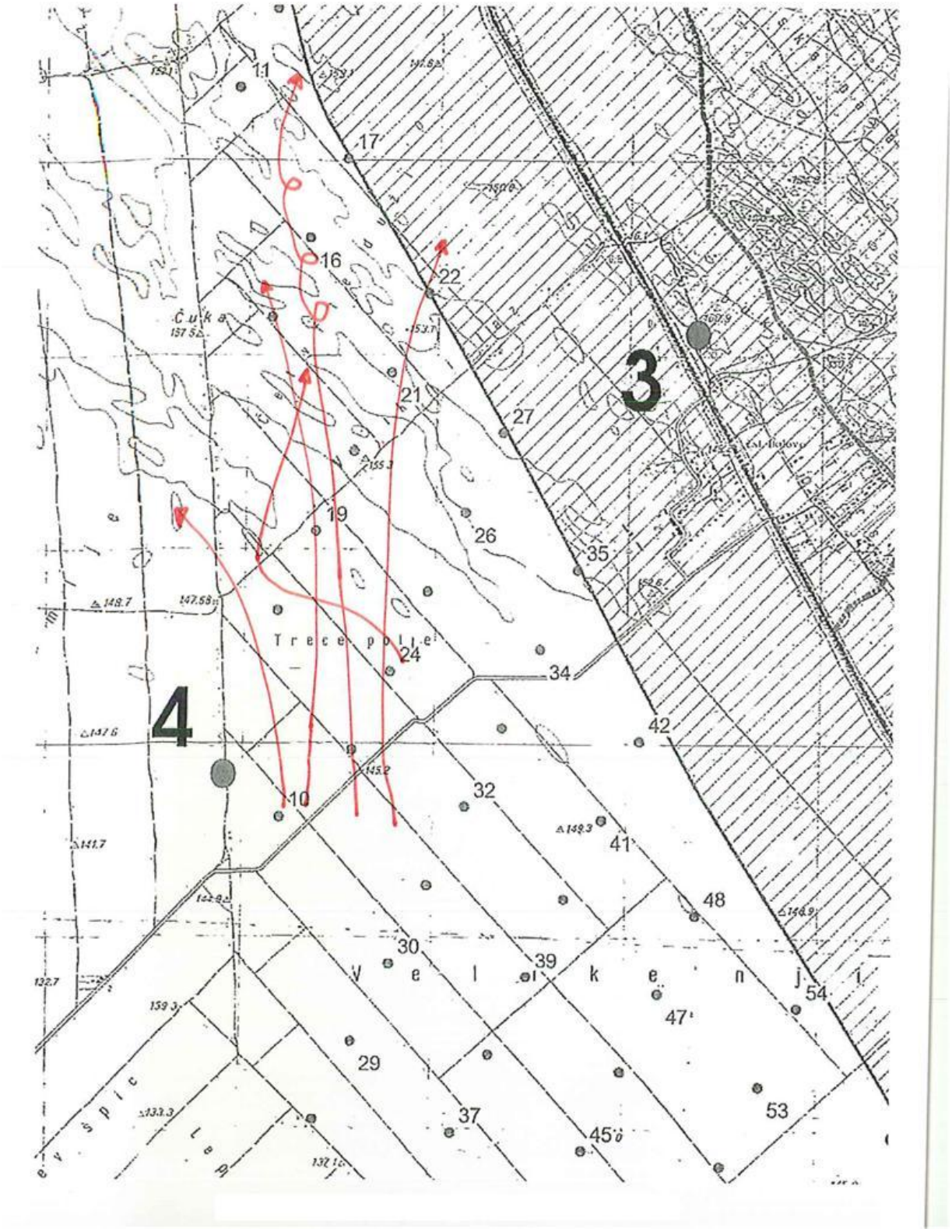
VP4: Anser Anser & Anser Albifrons (Grey Geese (greylag goose and greater white-fronted goose))



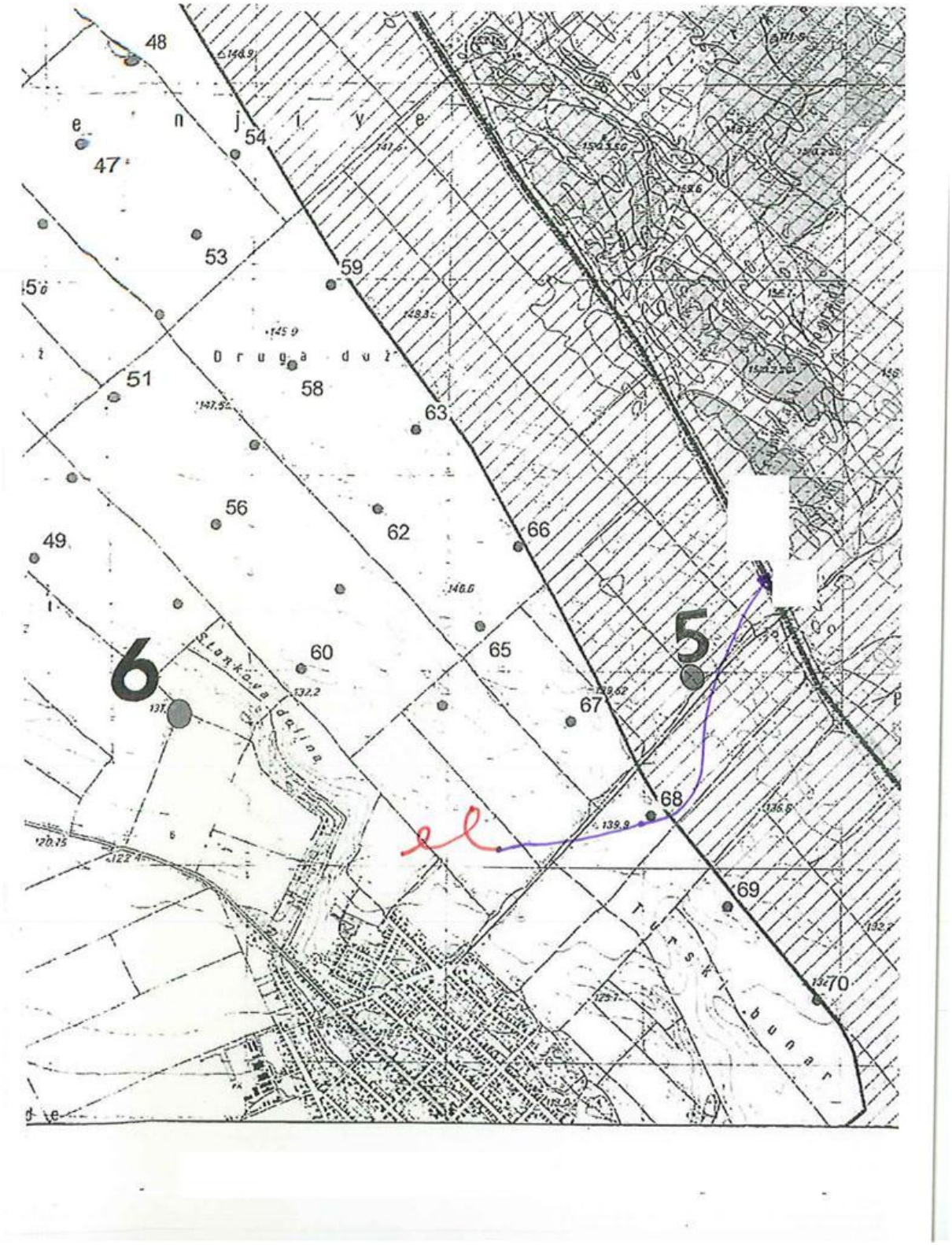
VP4: Falco cherrug (Saker Falcon)



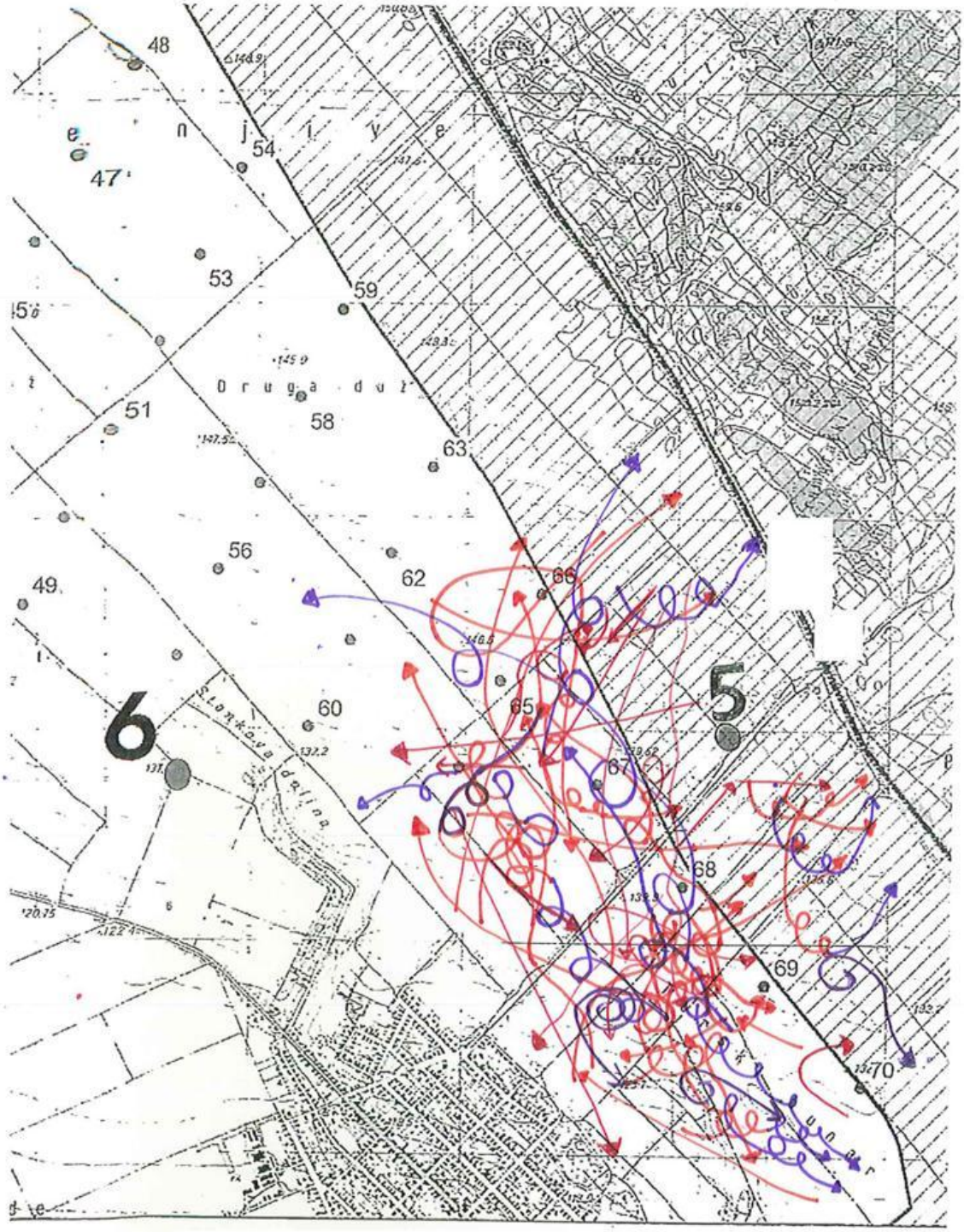
VP4: Circus Aeruginosus (Western Marsh Harrier)



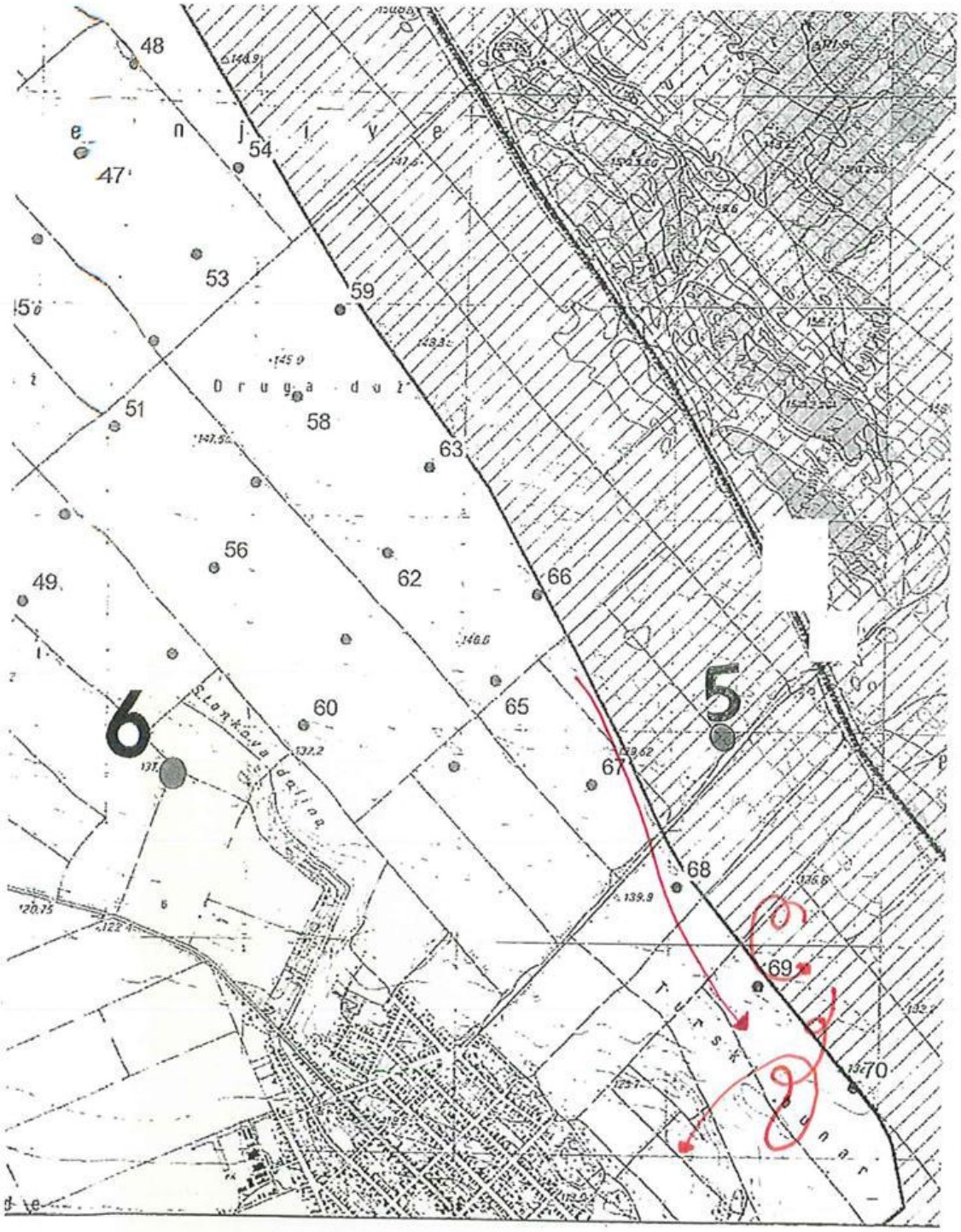
VP5: Milvus Migrans (Black Kite)



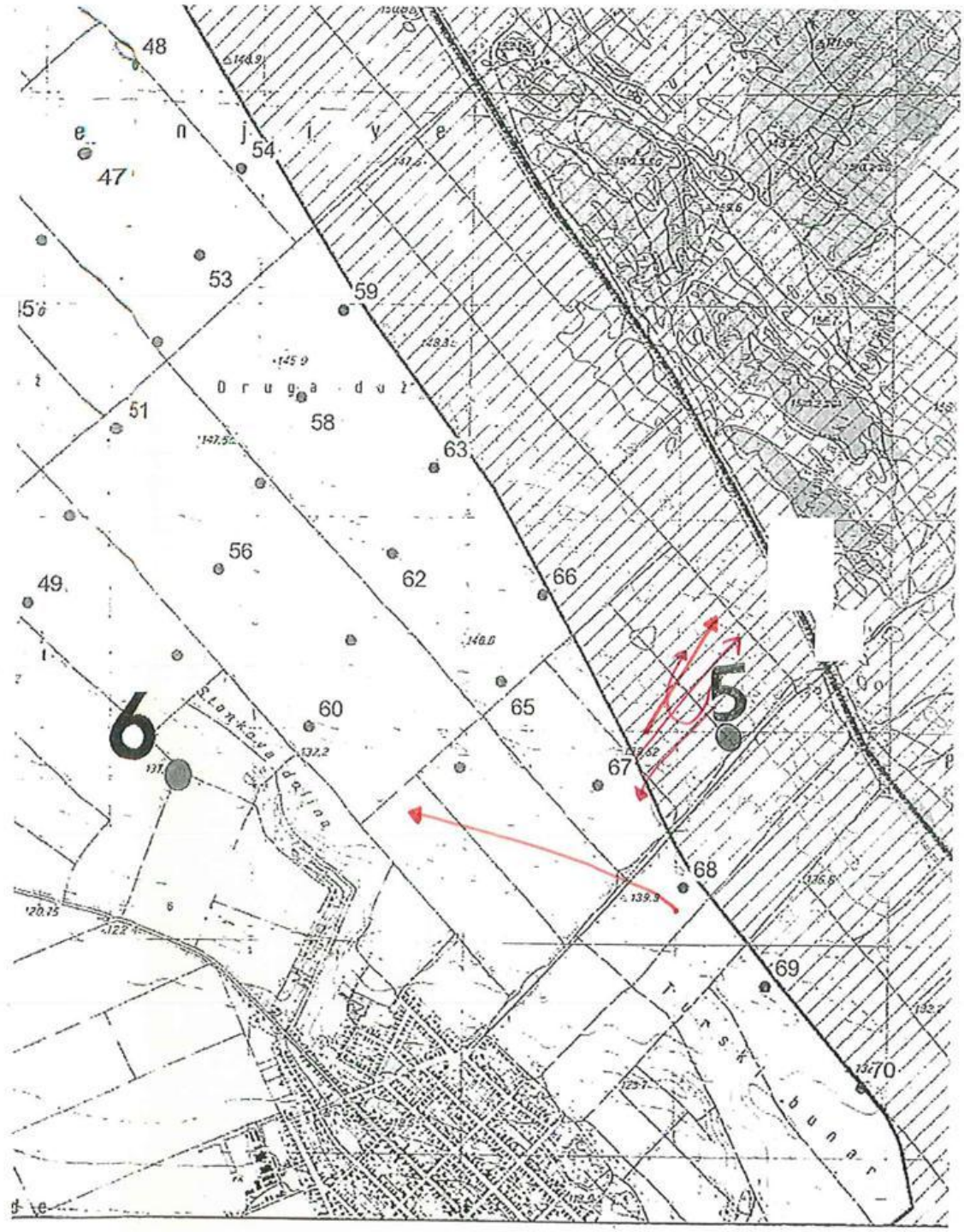
VP5: Buteo Buteo (Common Buzzard)



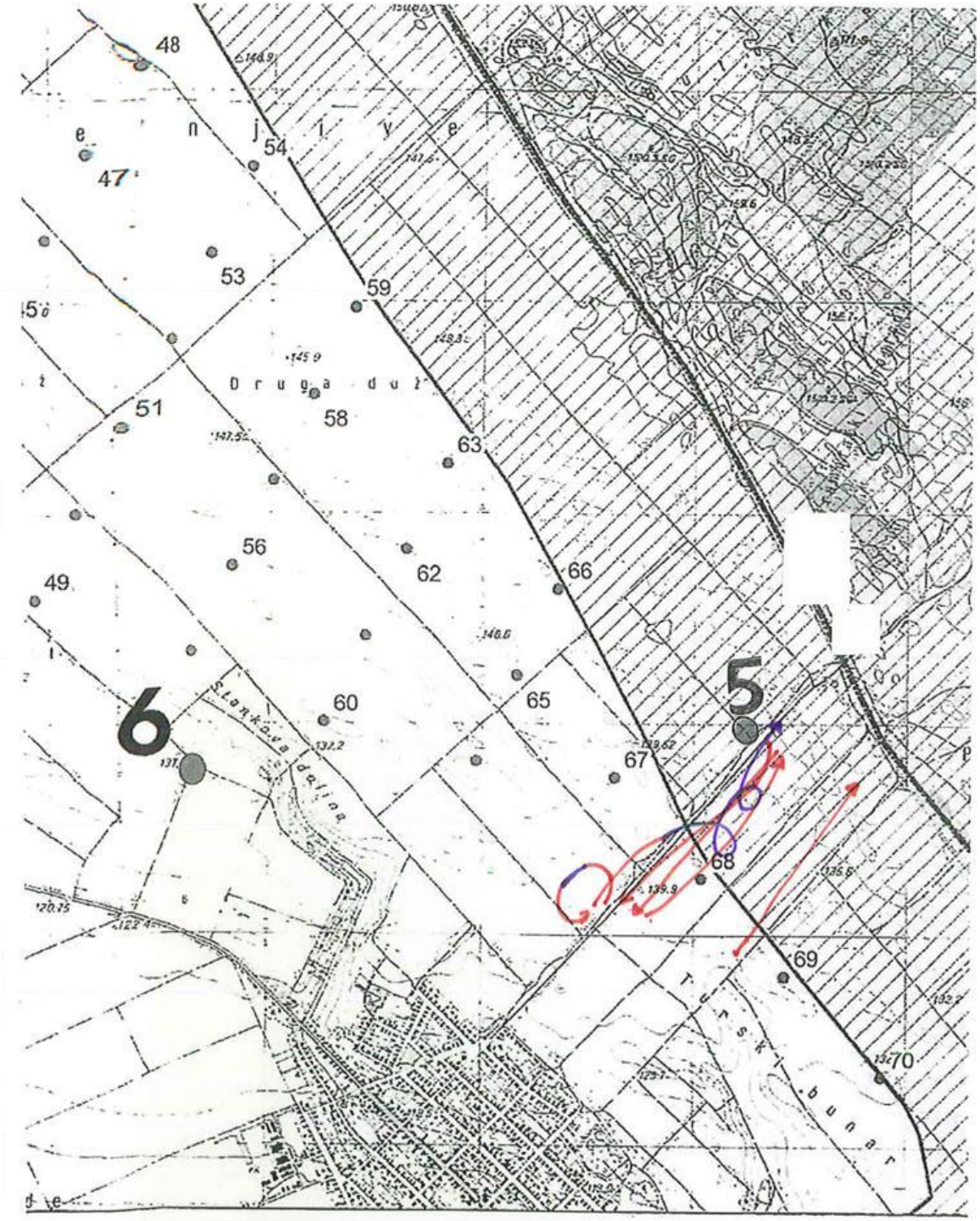
VP5: Falco Tinnunculus (Eurasian Kestrel)



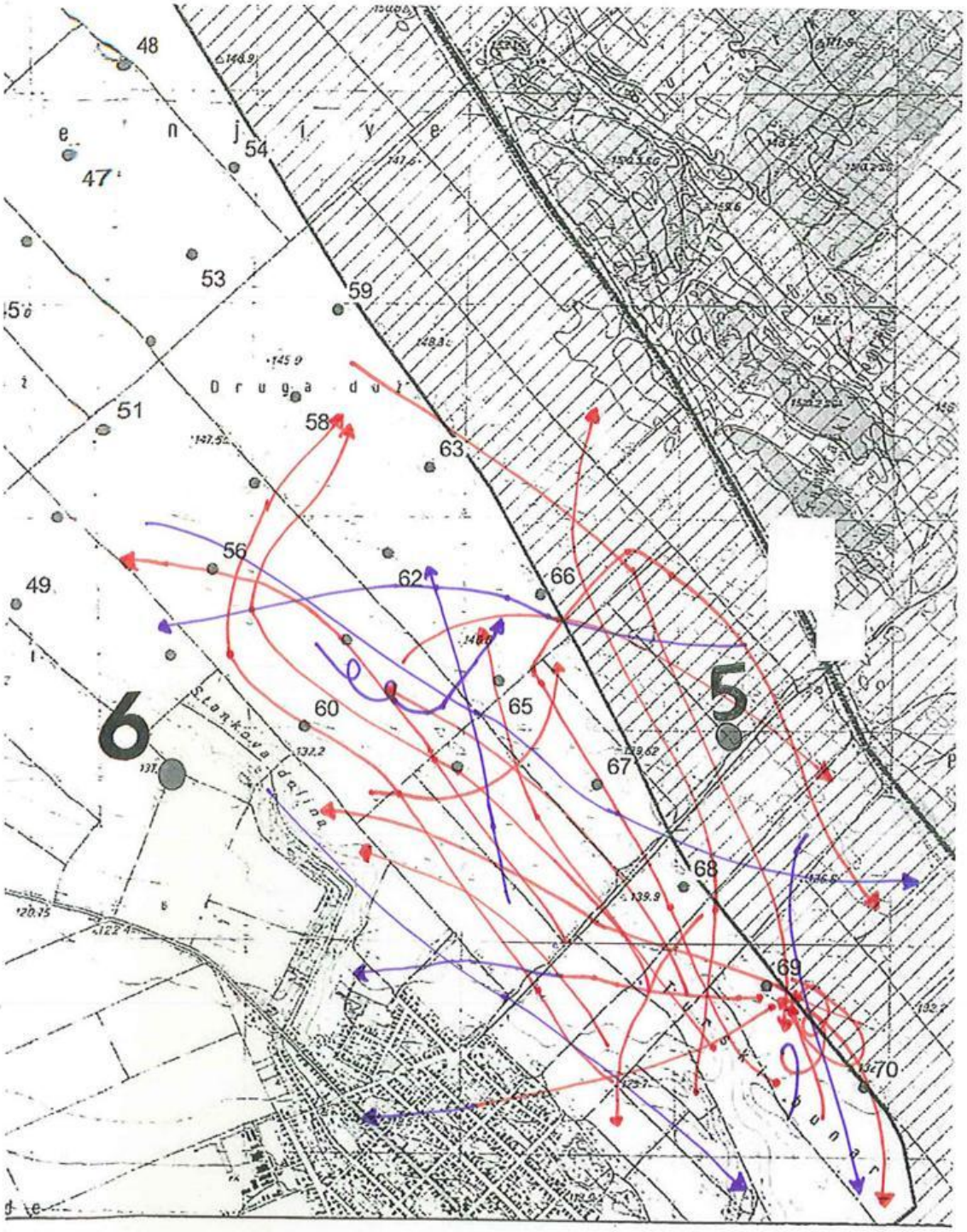
VP5: Accipiter Nisus (Eurasian Sparrowhawk)



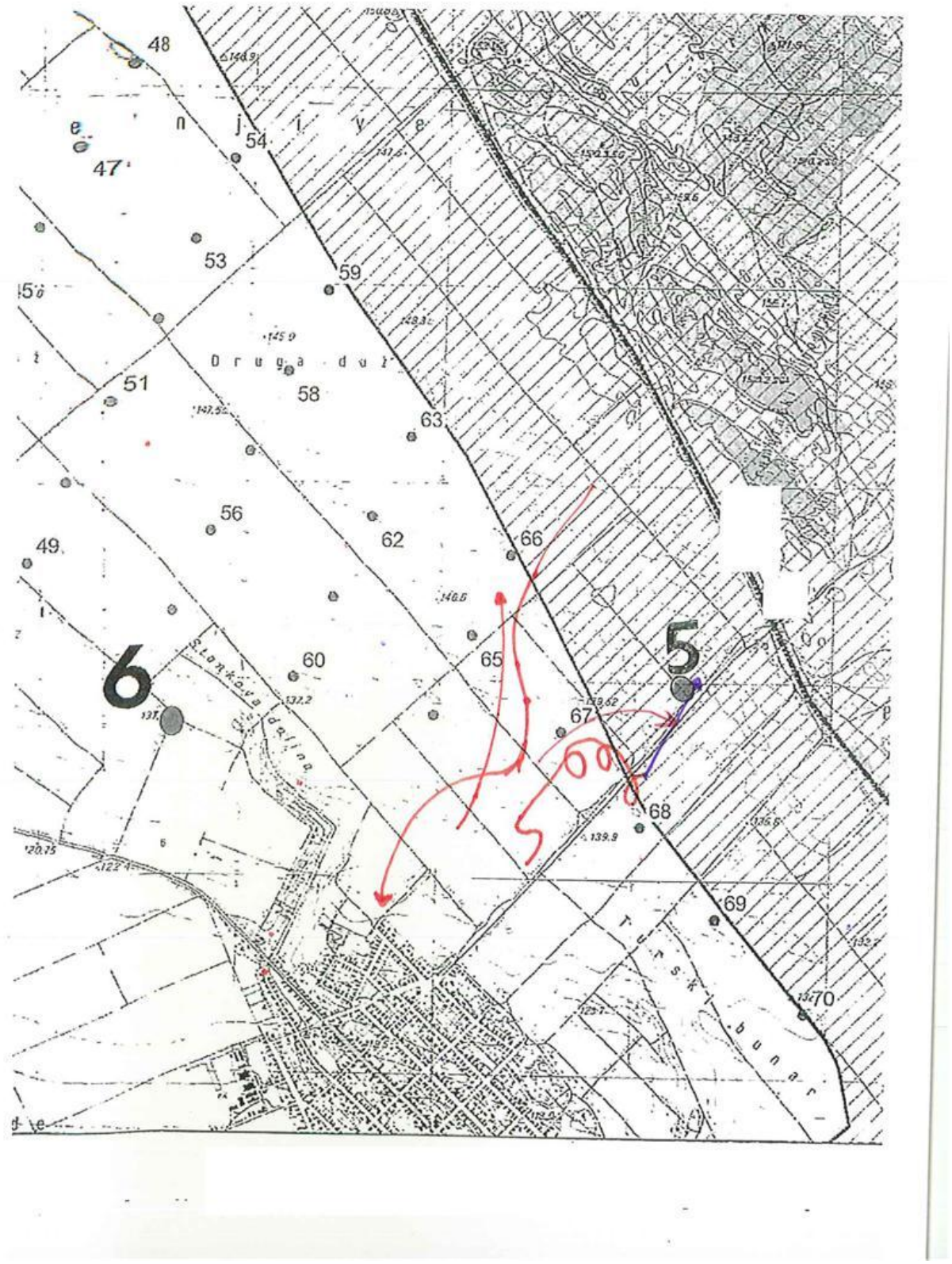
VP5: Merops Apiaster (European Bee-eater)



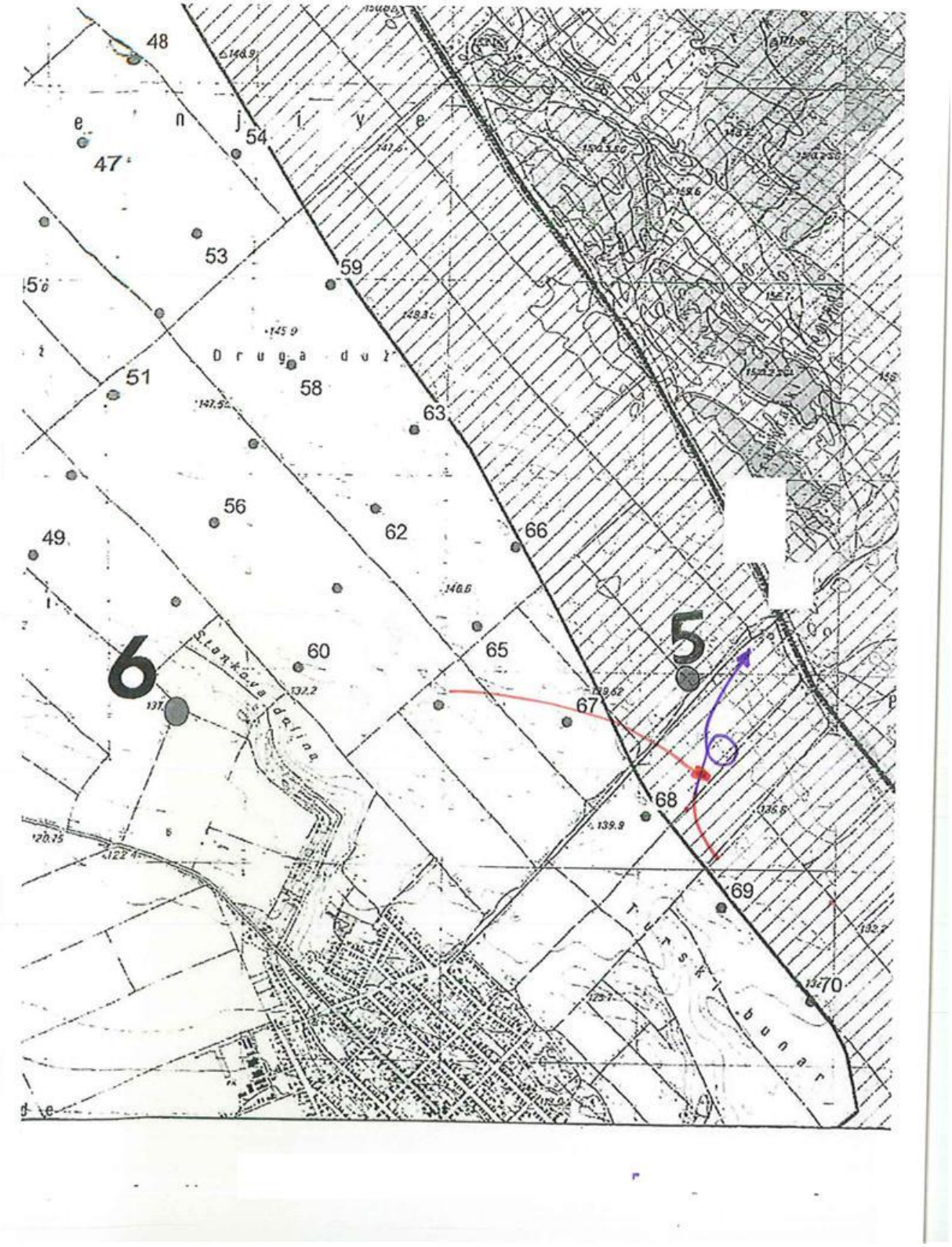
VP5: Anser Anser & Anser Albifrons (Grey Geese (greylag goose and greater white-fronted goose))



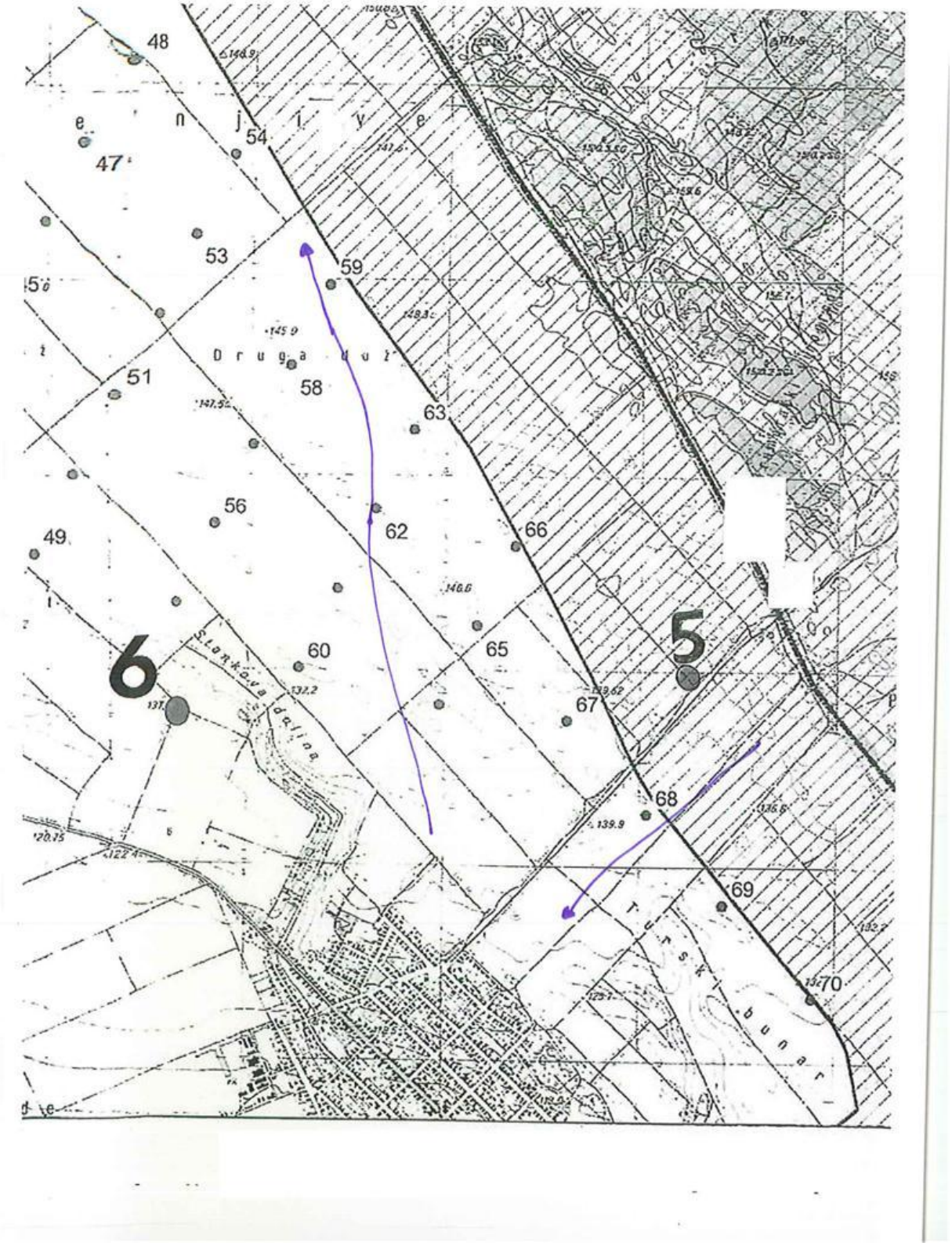
VP5: Accipiter Gentilus (Northern Goshawk)



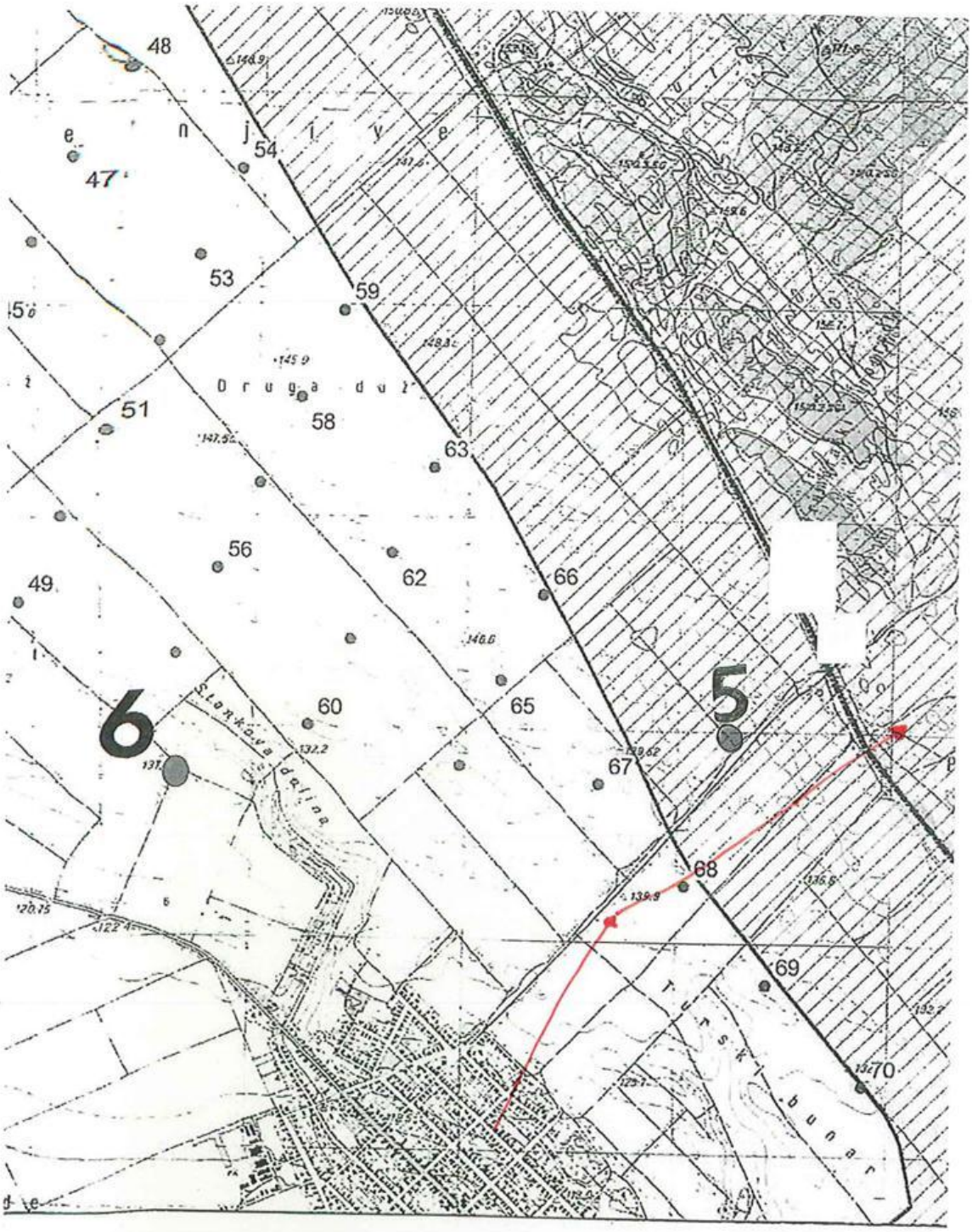
VP5: Falco Cherrug (Saker Falcon)



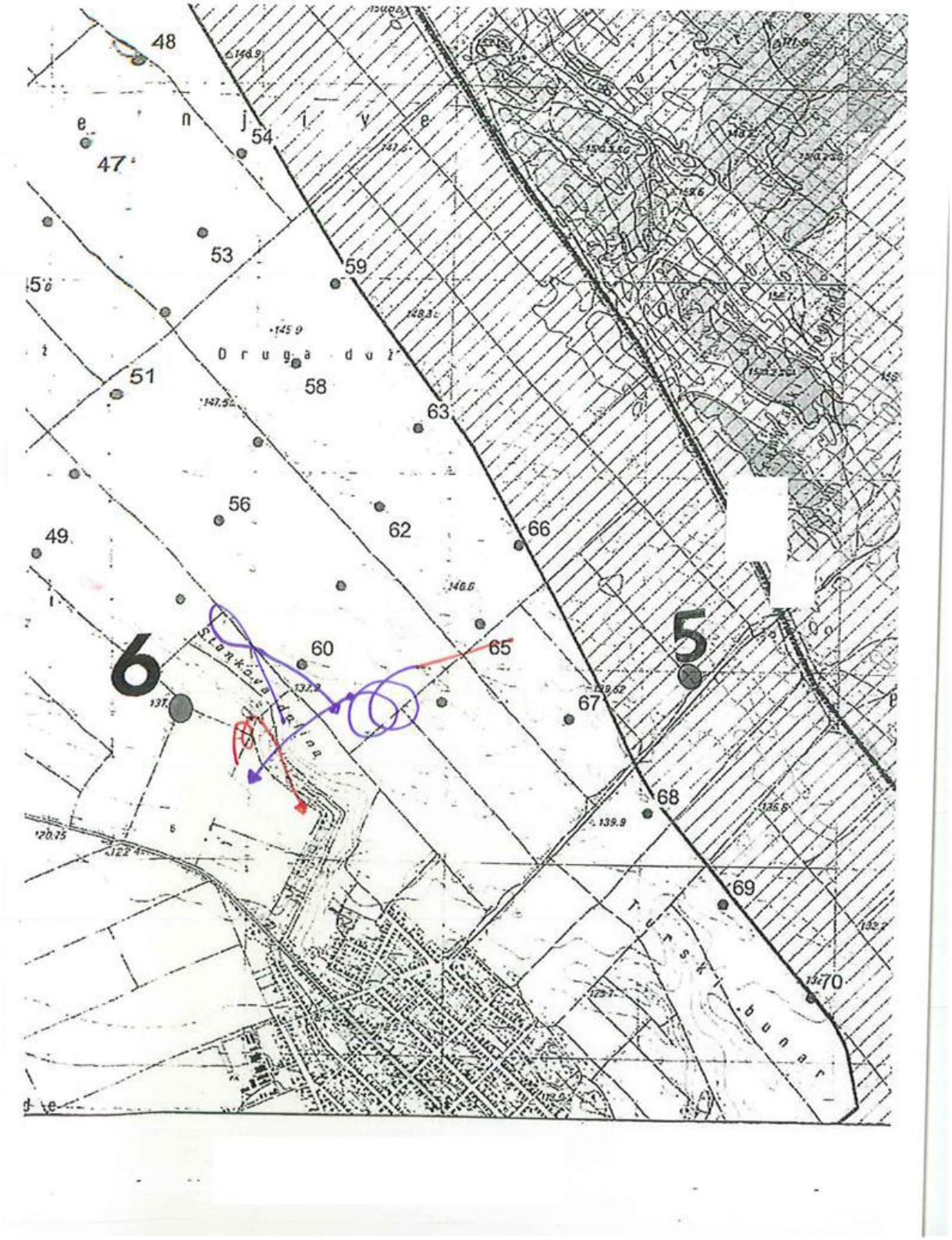
VP5: Ciconia Ciconia (White Stork)



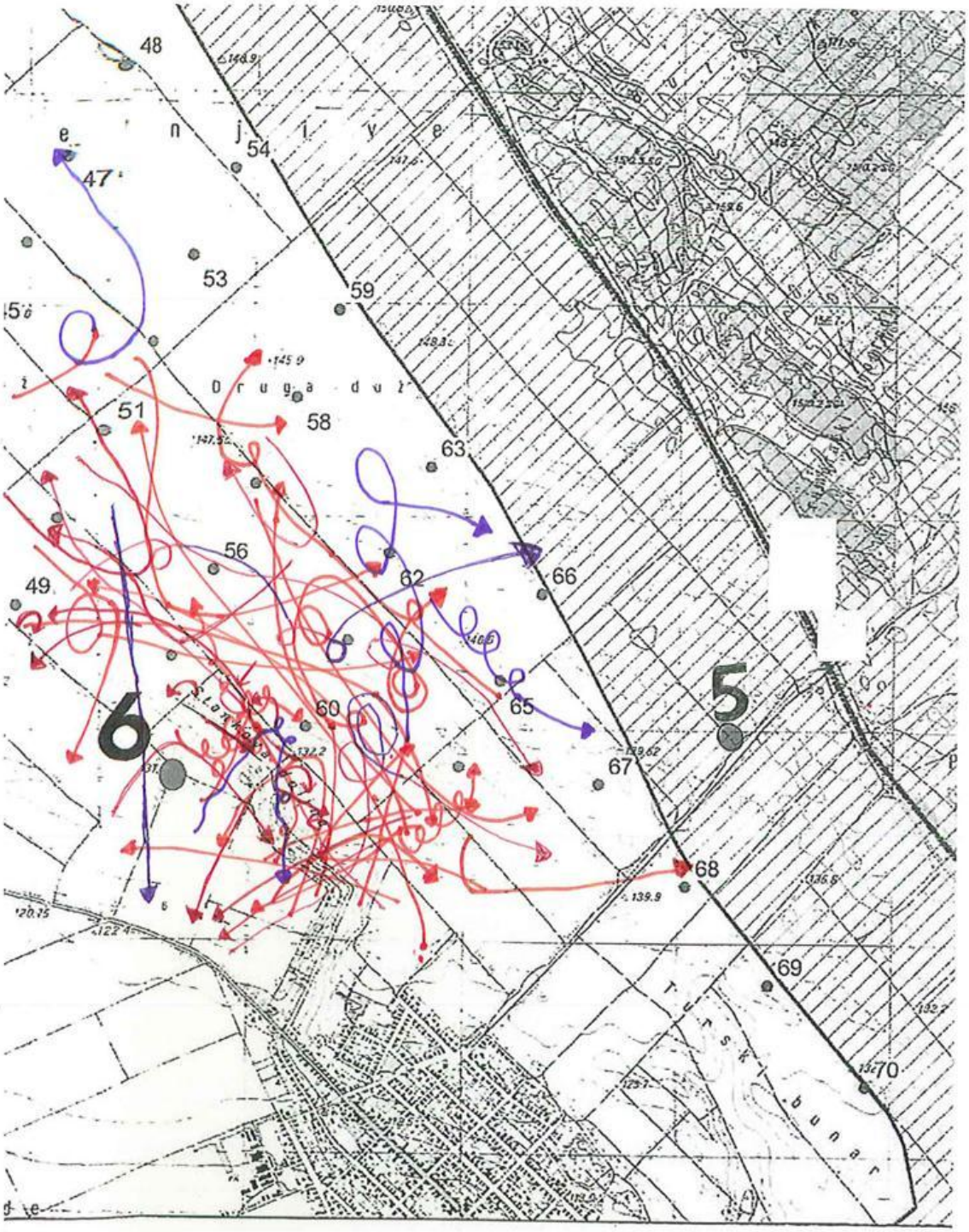
VP5: Haliaeetus alba (White-tailed Eagle)



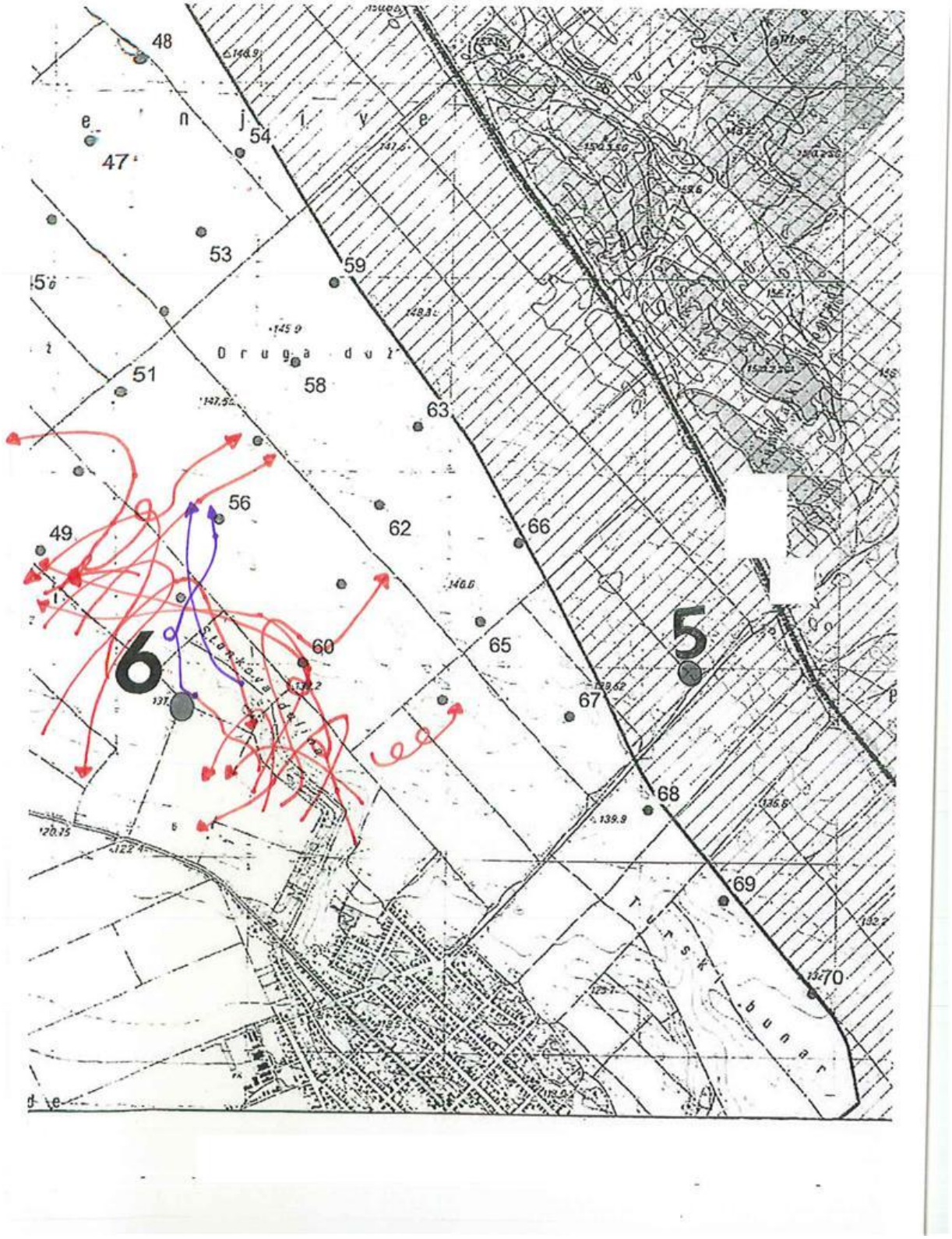
VP6: Ciconia Nigris (Black Stork)



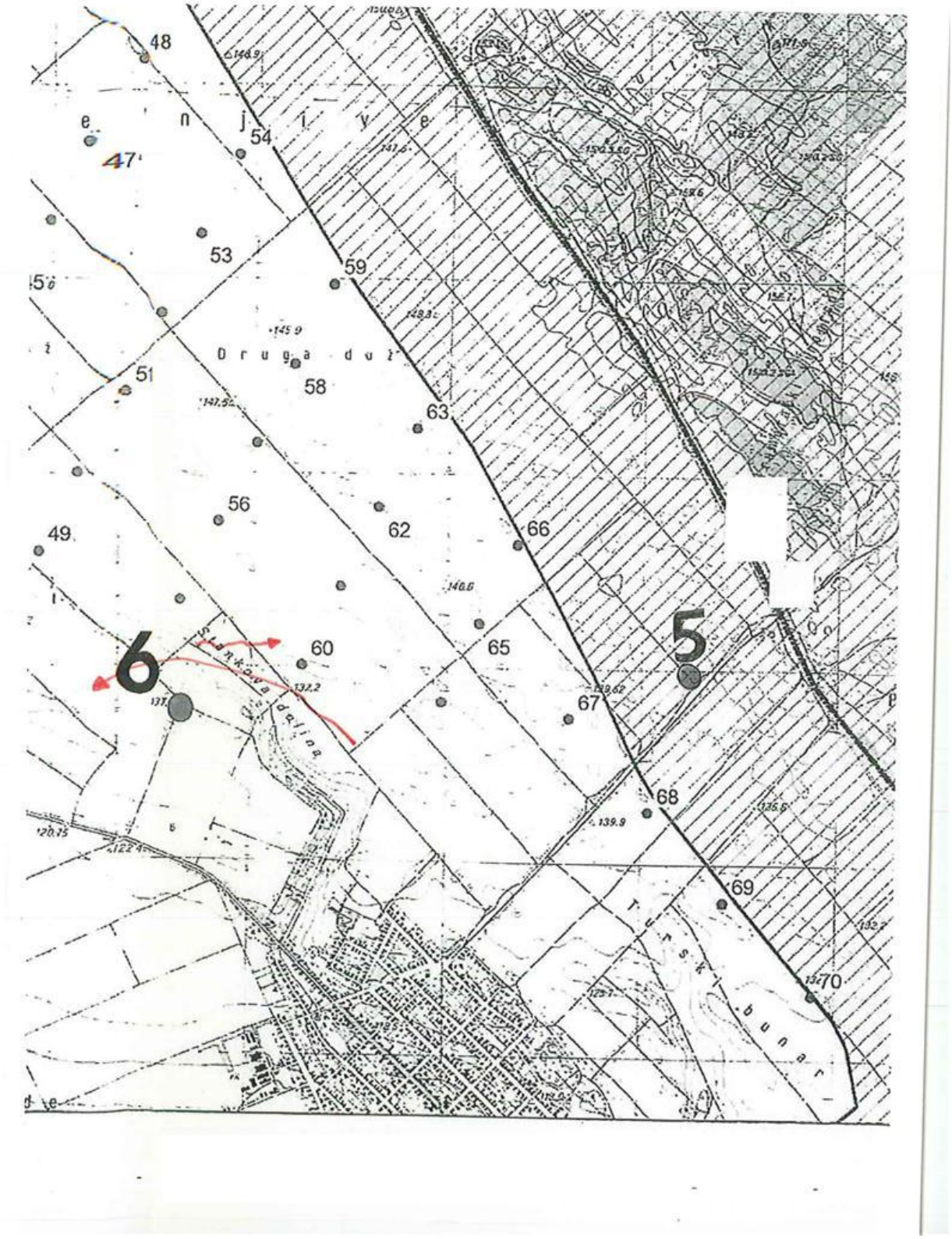
VP6: Buteo Buteo (Common Buzzard)



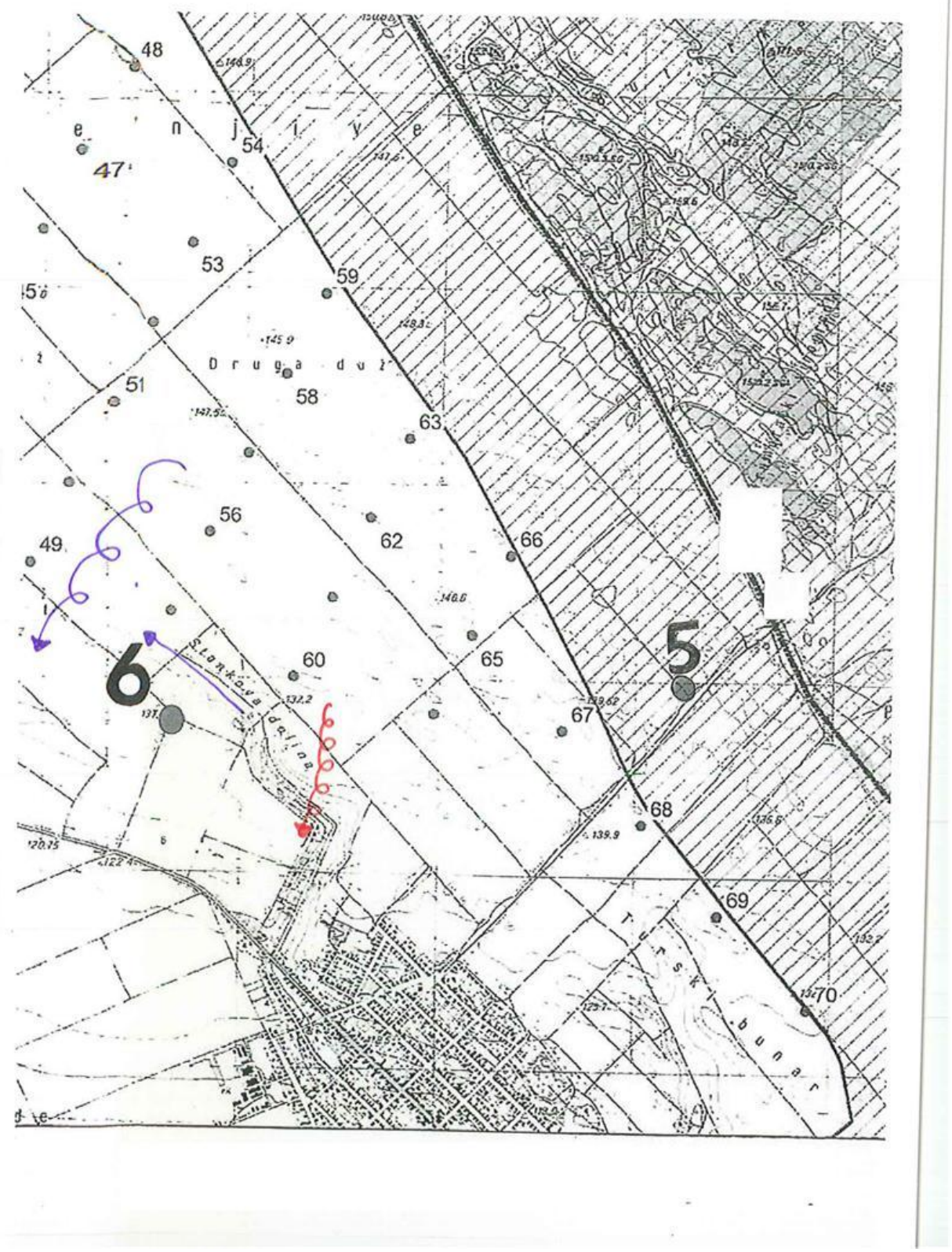
VP6: Falco Tinnunculus (Eurasian Kestrel)



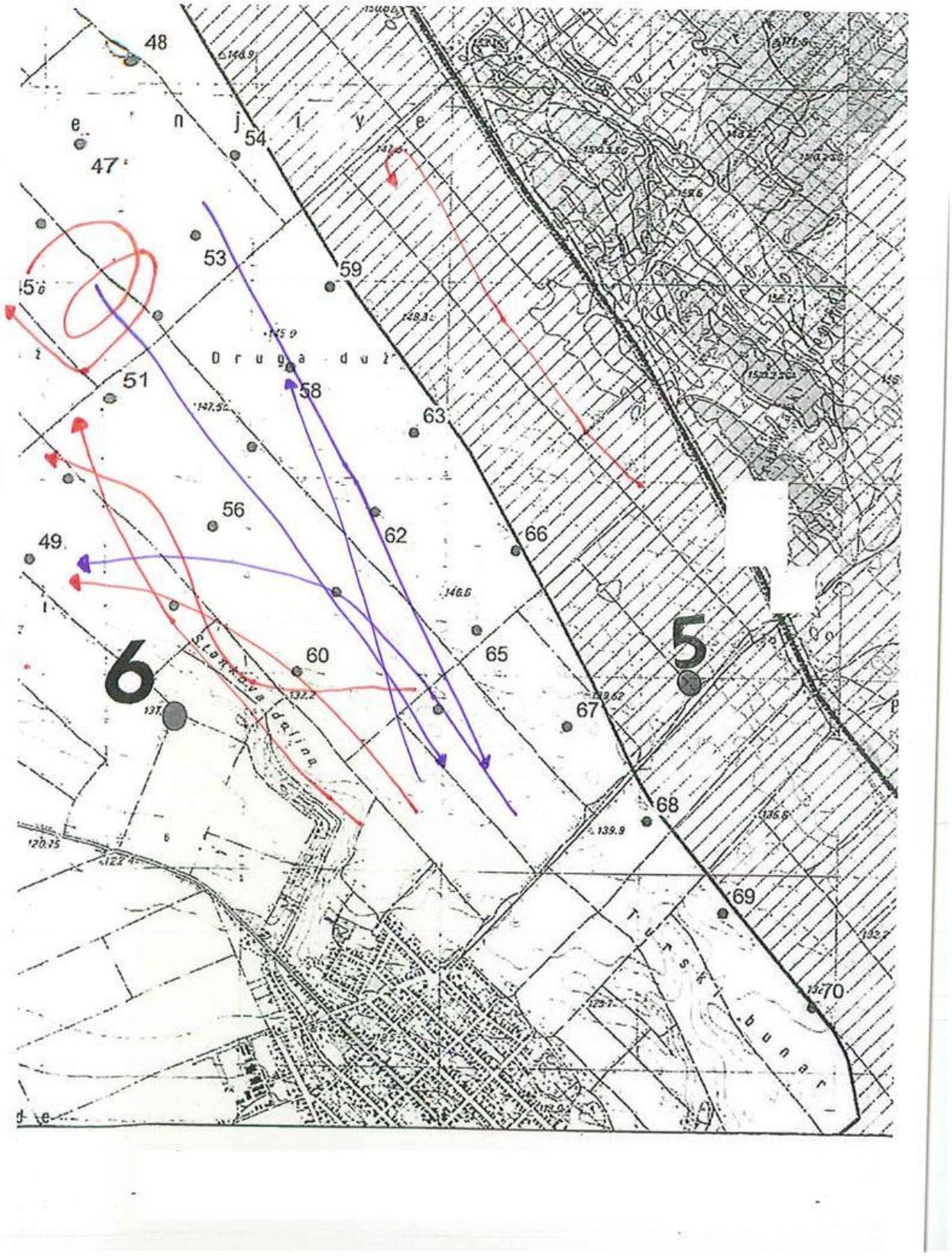
VP6: Accipiter Nisus (Eurasian Sparrowhawk)



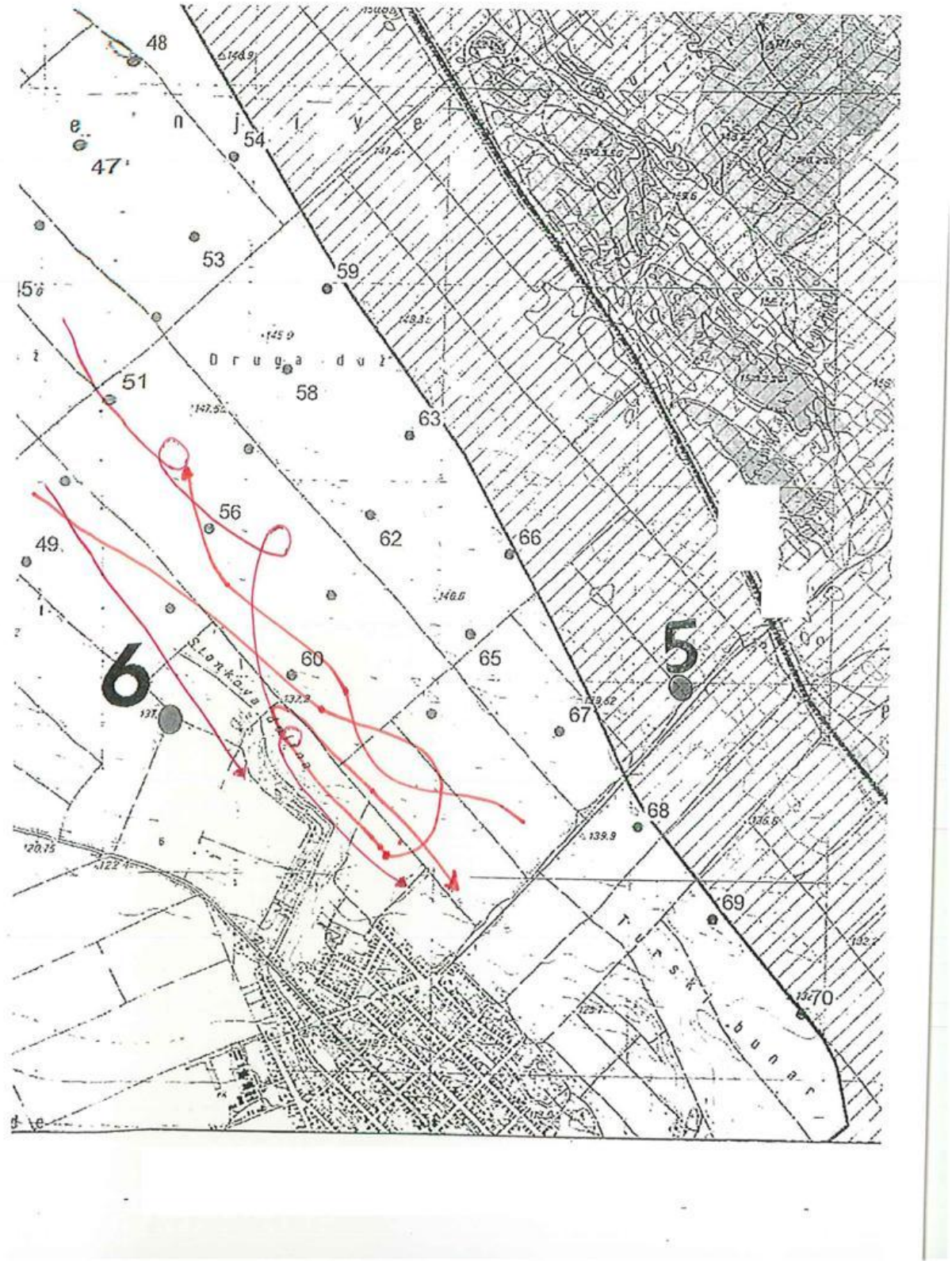
VP6: Merops Apiaster (European Bee-eater)



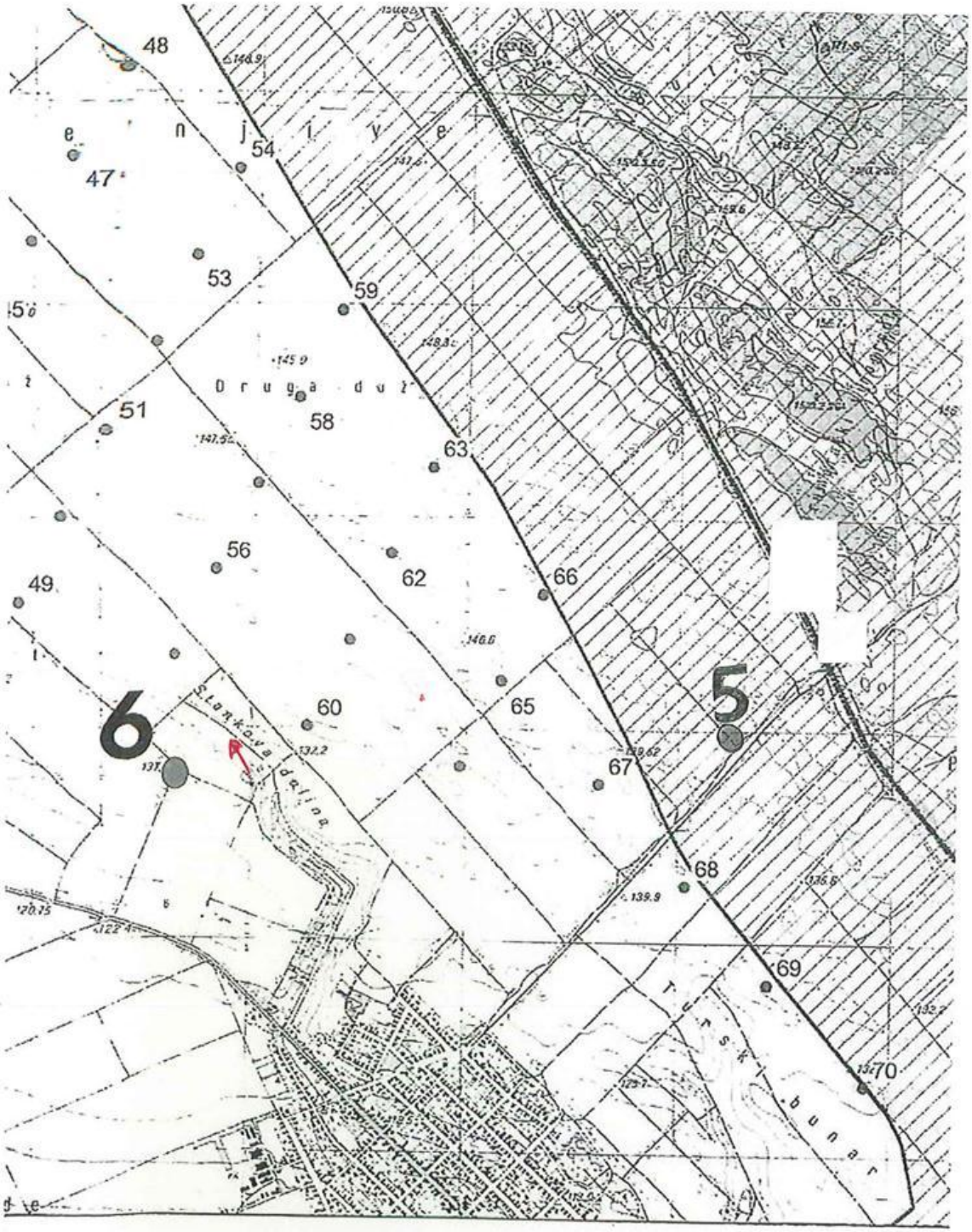
VP6: Anser Anser & Anser Albifrons (Grey Geese (greylag goose and greater white-fronted goose))



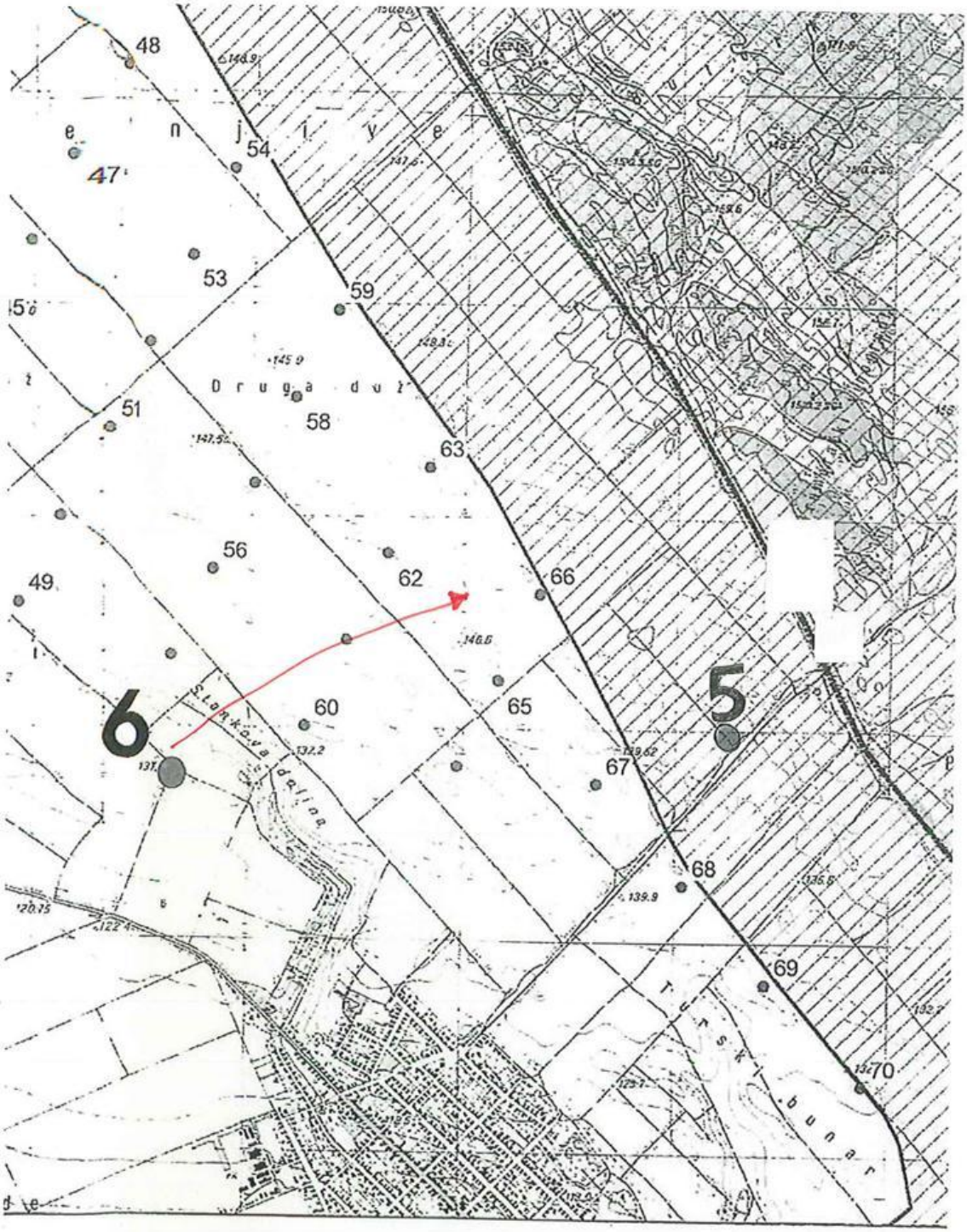
CP6: Circus Cyaneus (Hen Harrier)



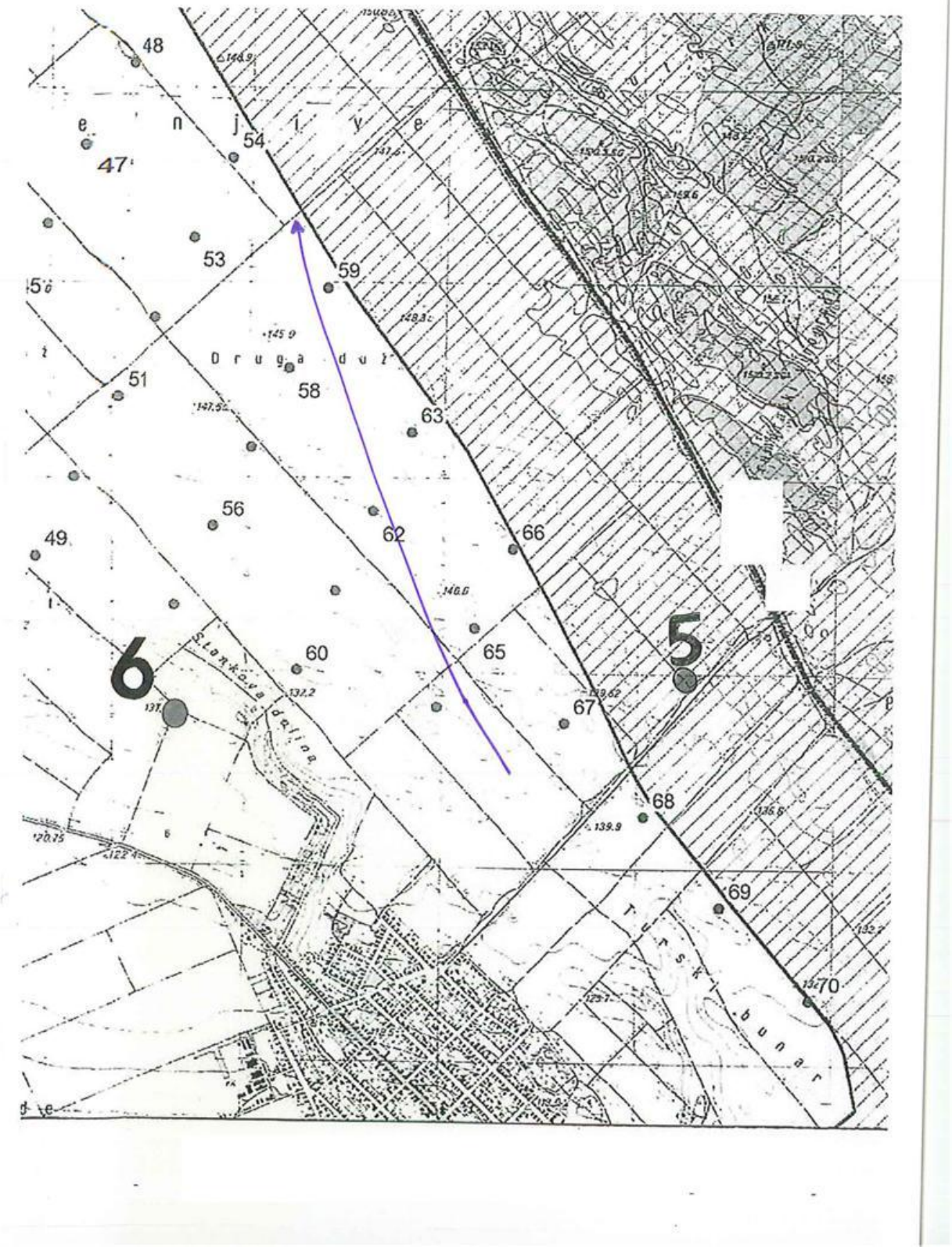
VP6: Falco Columbarius (Merlin)



VP6: Circus Aeruginosus (Western Marsh Harrier)



VP6: Ciconia Ciconia (White Stork)



Appendix C. Collision Risk Analysis

Methodology

The collision risk calculations followed the methodology outlined in the Scottish Natural Heritage (SNH) guidance *Windfarms and Birds: Calculating a theoretical collision risk assuming no avoiding action* (SNH, 2000[13]).

Thirteen target bird species were recorded flying at rotor height (the height between the upper and lower turbine blades): northern goshawk, European sparrowhawk, hen harrier, Eurasian kestrel, saker falcon, black kite, common buzzard, greylag goose, white-fronted goose, white stork, common crane, European bee-eater and great cormorant.

It was not always possible to differentiate between white-fronted geese and greylag geese (although flocks that could be identified suggested proportions of at least 90% greylag geese to 10% white-fronted geese). Therefore, both species have been recorded and analysed as a single group: 'grey geese'.

An additional species, black stork, was not on the target species list, but was recorded during the vantage point surveys and has been treated as a target species. Black stork was also recorded flying at rotor height.

All 14 target species (including black stork) were recorded within the survey area during surveys undertaken between November 2011 and July 2012. A further 5 target species (Western marsh harrier, pallid harrier, merlin, Eurasian hobby and white-tailed eagle) were recorded within the survey area, but not at rotor height and were therefore not at collision risk and were excluded from the collision risk calculations.

The volume of airspace within the vantage point visual envelopes at rotor height is known as the collision risk zone. For the target species recorded at collision risk height, the amount of time spent within the collision risk zone was calculated. Each recorded flight time within the collision risk zone was multiplied by the number of birds recorded during that flight. These flight times were then added together to give a total flight time within the collision risk zone for all target species over the 9 month survey period (November 2011 to July 2012).

All recorded flights within the collision risk zone are averaged across this volume of airspace. The proportion of this airspace taken up by the turbine blades is used to calculate the amount of time that each target species spends within the rotor sweep volume[14] over the course of the survey period.

SNH (2000) describes two methods of calculating collision risk:

1. For birds that make regular flights through a windfarm, and

2. For birds using the whole windfarm space.

As can be seen from the target species flight maps in Appendix B, the majority of flights did not follow regular paths, and so method 2 was chosen to estimate collision risk for target species.

The calculation of potential collision risk involves four stages:

Stage 1. The first stage is to calculate the amount of time each target species was present throughout the year within the rotor sweep volume of the proposed turbine. This is based on the observed flight activity during the survey period (in this case November 2011 – July 2012) and the parameters and design of the wind turbine. Based on the amount of time each target species spends

[13] Scottish Natural Heritage. (2000). Windfarms and Birds: Calculating a Theoretical Collision Risk Assuming no Avoiding Action

[14] This is the space that the turbine blades occupy and can be taken as the diameter of turbine blades x the width of turbine blades (see Fig 2, SNH 2000).

within the rotor sweep volume, and their known average flight speeds, it is possible to estimate the number of transits through the rotor sweep volume that each target species would make over the survey period (264 days). This can be extrapolated to estimate the number of transits through the rotor sweep volume per year.

Stage 2. The proportion of transits through the rotor sweep volume that will result in a collision between the bird and a wind turbine blade are then estimated, based on the size of turbine blades, the rotor period (time for one revolution of rotor), the size of the bird and the average speed of the bird. All predicted collisions are presumed to be fatal. This provides an estimate of the number of fatalities per season (or per year) for the wind farm but assumes that there is no avoidance action to prevent a collision.

Stage 3. The third stage of the calculation involves applying an avoidance factor. Avoidance rates are still unknown for many species. However, guidance by Scottish Natural Heritage (*Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model*, SNH, 2010[15]) proposes that a default avoidance rate of 98% should be used. For some species where detailed analysis has been undertaken, the guidance provides more specific avoidance values: 'grey geese' (greylag geese and greater white-fronted geese) and hen harriers have an avoidance rate of 99%, whereas kestrels have a lower avoidance rate of 95%.

Stage 4. The final stage of the calculation involves applying an estimate of downtime for the turbines, and reducing the predicted collisions per year accordingly.

The output from each table is identified by a letter in bold, which is carried through to subsequent tables within this analysis.

Stage 1 –

The data from this study has been used to calculate the number of transits through the rotor sweep volume that each target species would make for the 9 month survey period. Thirty-six hours of survey have been undertaken for the summer and winter periods, giving a total of 72 hours.

The proposed turbines will have a maximum rotor diameter of 126m and will occupy a height range between 60-80m and 180-200m. All birds recorded within the height range of 50m – 200m were considered to be at collision risk. As such, some birds recorded within the collision risk height range will not be within the rotor height range of the chosen turbine design, and so collision risk value will be overestimated for some species. A correction factor of 0.84 (126m rotor diameter ÷ 150m collision risk range) is applied to reduce this overestimation.

[15] Scottish Natural Heritage. (2010). Use of Avoidance rates in the SNH Wind Form Collision Risk Model.

Table 1: Calculating total flight time within the collision risk zone

Species	'Grey geese'	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon
Total flight time within collision risk zone (seconds)	835,335	10,585	9,420	2,955	1,740	1,230	750	465	345	300	120	90	45
Total flight time within collision risk zone (hours)	232.04	2.47	2.32	0.82	0.48	0.34	0.21	0.13	0.10	0.08	0.03	0.03	0.01
Flight time in hours per survey hour	3.22	0.04	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flight time in hours per survey hour with correction factor (**a**)	2.71	0.03	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

N.B. The 'grey geese' category above refers to greylag and white-fronted geese combined.

Table 2: Flight Data

Using the flight time per survey hour (**a**) calculated above in Table 1, the predicted daily flight time of each species, and the duration of the study, Table 2 below extrapolates the bird occupancy within the collision risk volume.

All target species recorded are diurnal and are generally only active (and therefore flying) during daylight hours. For the purpose of this assessment, it was assumed that these species are active for an average of up to 12 hours per day over the survey period.

Species	'Grey geese'	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon
Flight time in hours per survey hour (**a**)	2.71	0.03	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average daylight flight period (in hours) per day during study (estimated)	12	12	12	12	12	12	12	12	12	12	12	12	12
Duration of study (days)	264	264	264	264	264	264	264	264	264	264	264	264	264
Assumed activity during the study in hours (**b**)	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168
Predicted occupancy time (hours) within visual envelope collision risk volume: **a** x **b**	8576	109	97	30	18	13	7.7	4.8	3.5	3.1	1.2	0.9	0.5
Bird occupancy (seconds) within visual envelope collision risk volume	30,873,982	391,222	348,163	109,217	64,310	45,461	27,720	17,186	12,751	11,088	4,435	3,326	1,663

Table 3: Calculating bird occupancy within wind farm site

There were six VPs and due to the flat open nature of the site, it was considered possible to survey a visual envelope of 2km with a 180^0 field of view from each VP for larger species (grey geese, white stork, black stork, common crane, great cormorant, northern goshawk, common buzzard, hen harrier, black kite). The visual envelope has been reduced to 1km for smaller species (Eurasian kestrel, saker falcon, European sparrowhawk and European bee-eater) to allow for reduced detectability at a distance. The total area surveyed (**A)** was then calculated:

- 6 VPs with a 2km visual envelope = 3,770 hectares
- 6 VPs with a 1km visual envelope = 942 hectares

Species	'Grey geese'	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon
Bird occupancy (seconds) within visual envelope collision risk volume	30,873,982	391,222	348,163	109,217	64,310	45,461	27,720	17,186	12,751	11,088	4,435	3,326	1,663
Visual envelope (hectares)	3,770	3,770	3,770	3,770	3,770	942	942	3,770	3,770	3,770	942	3,770	942
Wind farm site area (hectares) (**A**)	3,716	3,716	3,716	3,716	3,716	3,716	3,716	3,716	3,716	3,716	3,716	3,716	3,716
Bird occupancy (seconds) within wind farm site collision risk volume (**c**)	30,431,755	385,618	343,176	107,652	63,389	179,334	109,350	16,940	12,569	10,929	17,496	3,279	6,561

Once the bird occupancy within collision risk volume (**C**) has been calculated for each species (Table 3), it is then necessary to establish the number of transits through the turbine rotors each species would have made over the survey period (Table 6). This is done by establishing the flight speed, body length and wingspan of each species (Table 4) and by establishing the windturbine parameters (Table 5), to allow the volume of air space swept out by the wind turbines.

Table 4: Biometric Data

Body length (including tail) and wingspan measurements taken from Svensson (2009[16]).

The values of Body length (**L**), Wingspan (**W**) and Flight speed (**v**) have been treated as fixed values. The majority of flight speeds have been taken from Bruderer and Boldt (2001[17]), although grey geese, merlin and saker falcon have been taken from alternate sources, referenced in Table 4 below. Calculations have typically been derived from small data sets, and assume birds are flying at constant speed. However, it should be noted that flight speeds may only have a limited influence on collision estimates[18].

Species	'Grey geese'[19]	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon[20]
Flight speed m/s (**v**)	18.9	11.0	14.5	13.5	16.7	12.2	12.3	11.4	9.7	12.1	11.5	15.4	14.4
Body length average m (**L**)	0.79	0.52	1.08	1.03	0.86	0.27	0.34	0.5	0.57	0.53	0.35	0.98	0.51
Wingspan average m (**W**)	1.59	1.2	2.01	1.99	1.35	0.38	0.73	1.08	1.05	1.43	0.69	1.89	1.17

[16] Svensson, L., Mullarney, K. and Zetterstrom, D. (2009) Collin Bird Guide: 2nd Edition. Collins:Italy.
[17] Bruderer, B. and Boldt, A. (2001) *Flight charateristics of bird: .I radar measurements of speeds*. Ibis, 143, 178-204.
[18] Madders and Whitfield. (2006). *Upland raptors and the assessment of wind farm impacts.* Ibis, 148, 43-56.
[19] Speakman, J.R. and Banks, D. (1998) *The function of flight formations in greylag geese; energy saving or orientation?* Ibis, 140, 280-287.
[20] Based on peregrine falcon flight speed, taken from Cochran, W. (1986) *Speed of flapping flight of merlins and peregrine falcons* The Condor, 88, 397-398.

Table 5: Wind turbine Parameters

The volume of airspace within the wind farm site at rotor height is known as the collision risk zone.

Measurement	Symbol	Value	Comments
Wind farm site area (m^2)	**A**	37,160,000	
Rotor height (m)	**h**	126	Difference between upper and lower rotor height
Collision risk zone (m^3) **A** x **h**	**Vw**	4,682,160,000	
Number of turbines	**N**	57	
Rotor blade radius (m)	**r**	63	Specification provided by Continental Wind Partners
Width of rotor blade (m)	**d**	4.0	Specification provided by Continental Wind Partners

Calculation of the number of bird transits through the rotors over the 9 months of survey is based on the 'Birds using windfarm airspace' approach outlined in Stage 1 of *Windfarms and Birds: Calculating a theoretical collision risk assuming no avoiding action* (SNH, 2000) using data from Tables 3, 4 and 5 above. Results of this calculation can be viewed in Table 6 below.

Table 6: Collision Risk Calculation

Species	**Grey geese**	**Common buzzard**	**Common crane**	**White stork**	**Great cormorant**	**European bee-eater**	**Eurasian kestrel**	**Hen harrier**	**Northern goshawk**	**Black kite**	**European sparrowhawk**	**Black stork**	**Saker falcon**
Combined volume swept out by the wind turbine rotors **Vr = N** x πr^2 x (**d**+**L**)	3,404,847	3,212,925	3,607,432	3,571,891	3,451,051	3,035,219	3,084,977	3,198,708	3,244,912	3,220,033	3,092,085	3,536,350	3,205,817
Bird occupancy in seconds within collision risk volume (**c**)	30,431,755	385,618	343,176	107,652	63,389	179,334	109,350	16,940	12,569	10,929	17,496	3,279	6,561
Bird occupancy (sec) of the volume swept by the rotors **d** = **c** x **Vr/Vw**	22,130	265	264	82	47	116	72	12	9	8	12	3	4
Bird flight speed **v** (m/s)	18.9	11.0	14.5	13.5	16.7	12.2	12.3	11.4	9.7	12.1	11.5	15.4	14.4
Time for bird to make a transit through the rotor (sec) **t = (d + L) / v**	0.25	0.41	0.35	0.37	0.29	0.35	0.35	0.39	0.47	0.37	0.38	0.32	0.31
Number of bird transits through the rotors over 9 months **e = d / t**	87,318	644	755	221	161	332	204	29	19	20	31	78	14

Table 7: Annual estimates

The calculations so far have estimated the number of bird transits over the nine month period (264 days) over which the surveys were carried out. The original baseline data collected by Ecoda established that the site is not important for migratory birds, with the majority of birds being resident (e.g. common buzzard, Eurasian kestrel) or over-wintering (e.g. grey geese). Therefore the bird activity over the months not covered in the additional bird surveys (August – October) are considered to have similar or reduced bird activity to those included in the additional bird survey period (November 2011 to July 2012, which included the spring migration period).

The number of bird transits through the rotors over the 9 month period (264 days) can therefore be extrapolated (multiplied by 1.38) to calculate the number of bird transits in a single year.

Due to the presence of grey geese being restricted purely to January and February, no records would be expected in the months of August to October. Therefore the number of grey geese transits has not been extrapolated, as the existing value is already considered to be an annual total.

Species	**Grey geese**	**Common buzzard**	**Common crane**	**White stork**	**Great cormorant**	**European bee-eater**	**Eurasian kestrel**	**Hen harrier**	**Northern goshawk**	**Black kite**	**European sparrowhawk**	**Black stork**	**Saker falcon**
Number of bird transits through the rotors over 9 months **e = d / t**	87,318	644	755	221	161	332	204	29	19	20	31	8	14
Number of bird transits through the rotors over 1 year	87,318	890	1,044	305	222	459	282	41	26	28	42	11	20

Stage 2 - Estimation of collision risk assuming no avoiding action

The information in the Table 7 below is input into the Band Model (SNH, 2000[21]) to generate a collision probability for each bird species (**P**) in Table 8 below, based on the bird size, flight speed and the turbine dimensions and details.

Table 7: Details required for the Band Model to calculate the probability of a bird being hit when flying through the rotor

Measurement	Value	Comments
Number of blades	3	
Maximum chord (m)	4.0	Specification provided by Continental Wind Partners
Pitch (degrees)	6	Specification provided by Continental Wind Partners
Flapping or gliding	0	0 = flapping (1 = gliding)
Rotor diameter (m)	126	Specification provided by Continental Wind Partners
Rotor period (sec)	6.5	Specification provided by Continental Wind Partners

[21] Band, W., Madders, M. and Whitfield, D.P. (2006) Developing field and analytical methods to assess avian collision risk at wind farms; cited in De Lucas, M., Janss, G. and Ferrer, M. 'Birds and Wind Power' Barcelona, Spain: Lynx Edicions

Table 8: Estimate of number of collisions assuming no avoiding action

Species	Grey geese	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon
Average collision probability (**P**) [SNH 2000]	6.4	6.3	7.8	7.8	6.5	4.9	5.3	6.1	6.7	6.3	5.4	7.3	5.9
Estimated number of collisions per year without avoidance **e** x **P** / 100	5,588	56	81.5	23.8	14.4	22.5	11	2.5	1.7	1.8	1.7	0.77	0.9

Stage 3 – Applying the avoidance factor

Table 9 shows the predicted number of collisions per year for all species (the collision risk). Collision avoidance rates are taken from SNH (2010). A default avoidance rate of 98% has been used, with the exception of three target species, where the guidance provides more specific avoidance values: 'grey geese' (greylag geese and greater white-fronted geese) and hen harriers have an avoidance rate of 99%, whereas kestrels have a lower avoidance rate of 95%.

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Table 9: Application of the collision avoidance rate

Species	Grey geese	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon
Estimated number of collisions per year without avoidance **e** x **P** / 100	5,588	56	81.5	23.8	14.4	22.5	11	2.5	1.7	1.8	1.7	0.77	0.9
Avoidance rate taken from SNH (2010)	99%	98%	98%	98%	98%	98%	95%	99%	98%	98%	98%	98%	98%
Average number of predicted collisions per year using avoidance rate (**f**)	55.88	1.1	1.6	0.48	0.29	0.45	0.54	0.02	0.03	0.04	0.03	0.02	0.02

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Stage 4 - Adjustment for rotor downtime and unsuitable flight conditions

The predicted number of collisions per year for each species per year has been adjusted to allow for rotor downtime and unsuitable flight conditions. . High and low wind speeds will reduce the operational time of the turbine to approximately 80% (**g**) of its life. Estimates have been provided by Continental Wind Partners

Table 10: Predicted collisions for each species per year using a 20% estimate for rotor downtime

Species	Grey geese	Common buzzard	Common crane	White stork	Great cormorant	European bee-eater	Eurasian kestrel	Hen harrier	Northern goshawk	Black kite	European sparrowhawk	Black stork	Saker falcon
Adjusted average number of predicted collisions per year **f x g**	44.71	0.90	1.3	0.38	0.23	0.36	0.43	0.02	0.03	0.03	0.03	0.01	0.01
Number of years per collision	0.02	1.1	0.77	2.63	4.3	2.78	2.3	51	36	36	38	81	74

Appendix D. Full list of species recorded during additional surveys (November 2011 – July 2012)

Species	Scientific name	Breeding status	Record survey type
Barn swallow	*Hirundo rustica*	Probably breeding near wind farm site	Vantage point survey and breeding bird survey
Barred warbler	*Sylvia nisoria*	Passage only	Vantage point survey
Black stork	*Ciconia nigris*	Passage only	Vantage point survey and breeding bird survey
Blackbird	*Turdus merula*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Blackcap	*Sylvia atricapilla*	Breeding within wind farm site	Vantage point survey
Black-headed bunting	*Emberiza melanocephala*	Breeding within or just outside wind farm site	Vantage point survey
Blue tit	*Parus caeruleus*	Breeding within or just outside wind farm site	Vantage point survey
Brambling	*Fringila montifringila*	Wintering/passage only	Vantage point survey
Caspian gull	*Larus cachinnans*	Wintering/passage only	Vantage point survey
Chiffchaff	*Phyloscopus collybita*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Common buzzard	*Buteo buteo*	Breeding near wind farm site	Vantage point survey and breeding bird survey
Common chaffinch	*Fringilla coelebs*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Common crane	*Grus grus*	Wintering/passage only	Vantage point survey
Common crossbill	*Loxia curvirostra*	Passage only	Vantage point survey
Common cuckoo	*Cuculus canorus*	Breeding within wind farm site	Vantage point survey
Common house martin	*Delichon urbicum*	Probably breeding near wind farm site	Vantage point survey
Common nightingale	*Luscinia megarhynchos*	Breeding within wind farm site	Vantage point survey
Common pheasant	*Phasianus colchicus*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Common quail	*Coturnix coturnix*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Common raven	*Corvus corax*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Common starling	*Sturnus vulgaris*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Common swift	*Apus apus*	Passage only	Vantage point survey
Common whitethroat	*Sylvia communis*	Breeding within wind farm site	Vantage point survey and breeding bird survey

Corn bunting	*Emberiza calandra*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Crested lark	*Galerida cristata*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Eurasian collared dove	*Streptopelia decaocto*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Eurasian golden oriole	*Oriolus oriolus*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Eurasian hobby	*Falco subbeteo*	Breeding near wind farm site	Vantage point survey and breeding bird survey
Eurasian hoopoe	*Upupa epops*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
Eurasian jay	*Garrulus glandarius*	Breeding within or just outside wind farm site	Vantage point survey
Eurasian kestrel	*Falco tinninculus*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Eurasian linnet	*Carduelis cannabina*	Breeding within wind farm site	Vantage point survey
Eurasian magpie	*Pica pica*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Eurasian siskin	*Carduelis spinus*	Wintering/passage only	Vantage point survey
Eurasian skylark	*Alauda arvensis*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Eurasian sparrowhawk	*Accipiter nisus*	Breeding near wind farm site	Vantage point survey and breeding bird survey
Eurasian tree sparrow	*Passer montanus*	Breeding within wind farm site	Vantage point survey and breeding bird survey
European bee-eater	*Merops apiaster*	Breeding within wind farm site	Vantage point survey and breeding bird survey
European golden plover	*Pluvialis apricaria*	Passage only	Vantage point survey
European goldfinch	*Carduelis carduelis*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
European greenfinch	*Carduelis chloris*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
European sand martin	*Riparia riparia*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
European serin	*Serinus serinus*	Wintering/passage only	Vantage point survey and breeding bird survey
European stonechat	*Saxicola torquata*	Breeding within wind farm site	Vantage point survey and breeding bird survey
European turtle dove	*Streptopelia turtur*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Feral pigeon	*Columba livia (domesticated)*	Breeding within wind farm site	Vantage point survey
Fieldfare	*Turdus pilaris*	Wintering/passage only	Vantage point survey
Great cormorant	*Phalacrocorax carbo*	Passage only	Vantage point survey and breeding bird survey
Great grey shrike	*Lanius excubitor*	Wintering/passage only	Vantage point survey
Great reed warbler	*Acrocephalus arundinaceus*	Passage only	Vantage point survey
Great spotted woodpecker	*Dendrocops major*	Breeding within or just outside wind farm site	Vantage point survey
Great tit	*Parus major*	Breeding within or just outside wind farm site	Vantage point survey
Great white egret	*Egreta alba*	Passage only	Vantage point survey
Greater white-fronted goose	*Anser albifrons*	Wintering/passage only	Vantage point survey

Grey heron	*Ardea cineria*	Passage only	Vantage point survey and breeding bird survey
Grey partridge	*Perdix perdix*	Breeding within or just outside wind farm site	Vantage point survey
Greylag goose	*Anser anser*	Wintering/passage only	Vantage point survey
Hawfinch	*Coccothraustes coccothraustes*	Wintering/passage only	Vantage point survey
Hen harrier	*Circus cyaneus*	Wintering/passage only	Vantage point survey
Hooded crow	*Corvus cornix*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey
House sparrow	*Passer domesticus*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Lesser grey shrike	*Lanius minor*	Passage only	Vantage point survey and breeding bird survey
Lesser whitethroat	*Sylvia curruca*	Passage only	Vantage point survey
Long-tailed tit	*Aegithalos caudatus*	Breeding within or just outside wind farm site	Vantage point survey
Mallard	*Anas platyrhynchos*	Passage only	Vantage point survey
Marsh warbler	*Acrocephalus palustris*	Passage only	Breeding bird survey
Meadow pipit	*Anthus pratensis*	Wintering/passage only	Vantage point survey and breeding bird survey
Merlin	*Falco columbarius*	Wintering/passage only	Vantage point survey
Mistle thrush	*Turdus viscivorus*	Wintering/passage only	Vantage point survey
Montagu's harrier	*Circus pygargus*	Passage only	Breeding bird survey
Northern goshawk	*Accipiter gentilus*	Breeding near wind farm site	Vantage point survey and breeding bird survey
Northern lapwing	*Vanellus vanellus*	Passage only	Vantage point survey and breeding bird survey
Northern pintail	*Anas acuta*	Passage only	Vantage point survey
Northern wheatear	*Oenanthe oenanthe*	Passage/probably breeding near wind farm site	Vantage point survey and breeding bird survey
Pallid harrier	*Circus macrourus*	Wintering/passage only	Vantage point survey
Red-backed shrike	*Lanius collurio*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Redwing	*Turdus iliacus*	Wintering/passage only	Vantage point survey
Reed bunting	*Emberiza schoeniclus*	Breeding within or just outside wind farm site	Vantage point survey
Rook	*Corvus frugilegus*	Probably breeding near wind farm site	Vantage point survey and breeding bird survey
Ruff	*Philomachus pugnax*	Passage only	Vantage point survey
Saker falcon	*Falco cherrug*	Breeding near wind farm site	Vantage point survey
Spotted flycatcher	*Muscicapa striata*	Passage/probably breeding near wind farm site	Vantage point survey and breeding bird survey
Tawny pipit	*Anthus campestris*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Western jackdaw	*Corvus monedula*	Breeding within or just outside wind farm site	Vantage point survey
Western marsh harrier	*Circus aeruginosus*	Wintering/passage only	Vantage point survey and breeding bird survey
Whinchat	*Saxicola rubetra*	Possibly breeding within wind farm site	Vantage point survey and breeding bird survey
White stork	*Ciconia ciconia*	Passage only	Vantage point survey
White wagtail	*Motacilla alba*	Breeding within wind farm site	Vantage point survey
White-tailed eagle	*Haliaeetus alba*	Wintering/passage only	Vantage point survey

Woodlark	*Lullula arborea*	Passage only	Vantage point survey
Woodpigeon	*Columba palumbus*	Breeding within wind farm site	Vantage point survey
Yellow wagtail	*Motacilla flava*	Breeding within wind farm site	Vantage point survey and breeding bird survey
Yellowhammer	*Emberiza citrinella*	Breeding within or just outside wind farm site	Vantage point survey and breeding bird survey

Appendix E. Breeding bird square territory maps

Key

=Blackcap

= Corn bunting

= Common chaffinch

= Crested lark

= Red-backed shrike

= House sparrow

= Eurasian kestrel

= European bee-eater

= Common quail

= Eurasian skylark

= European stonechat

= Tawny pipit

= Eurasian tree sparrow

= Yellow wagtail

= Common whitethroat

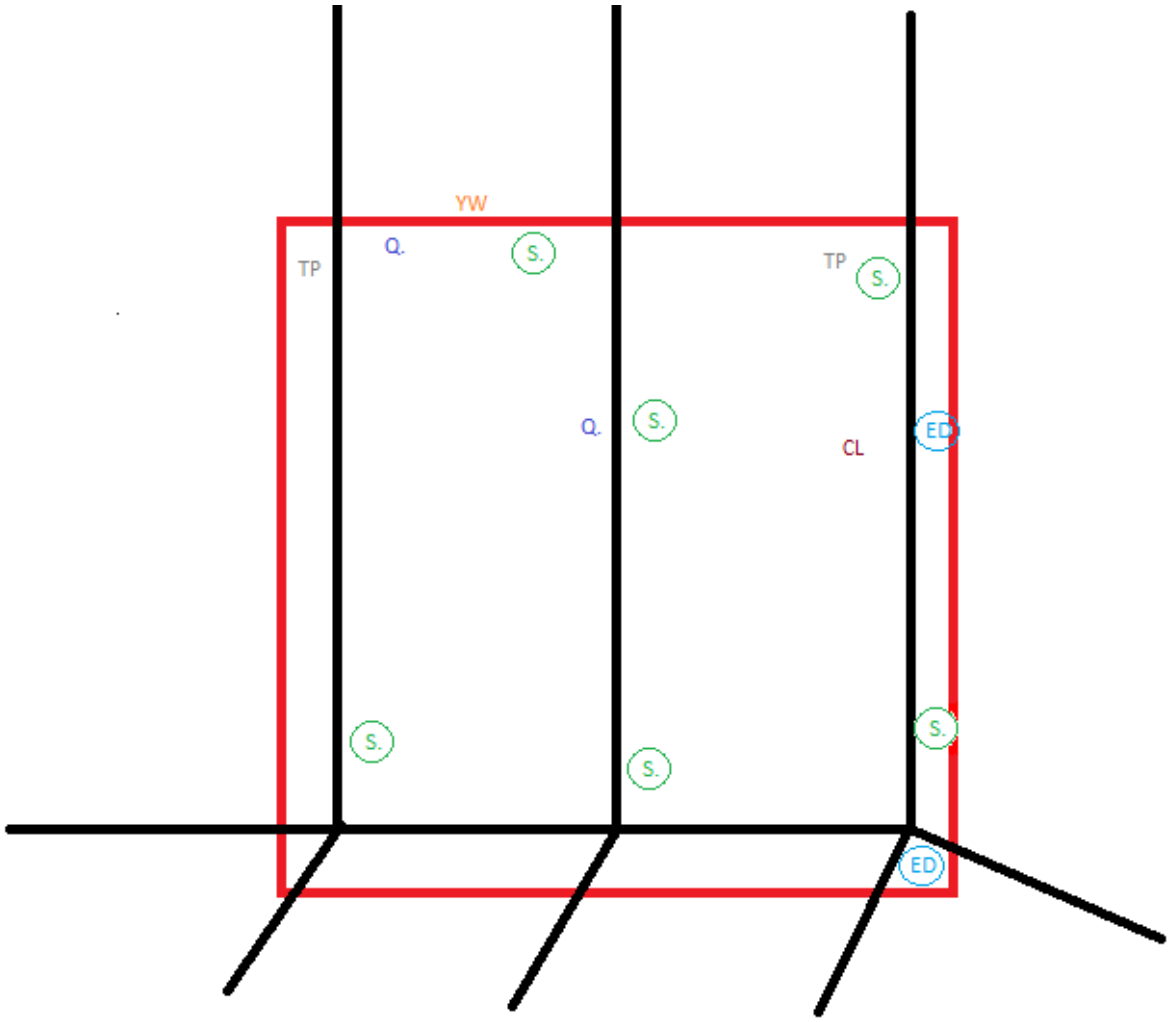
= possible territory

= confirmed territory

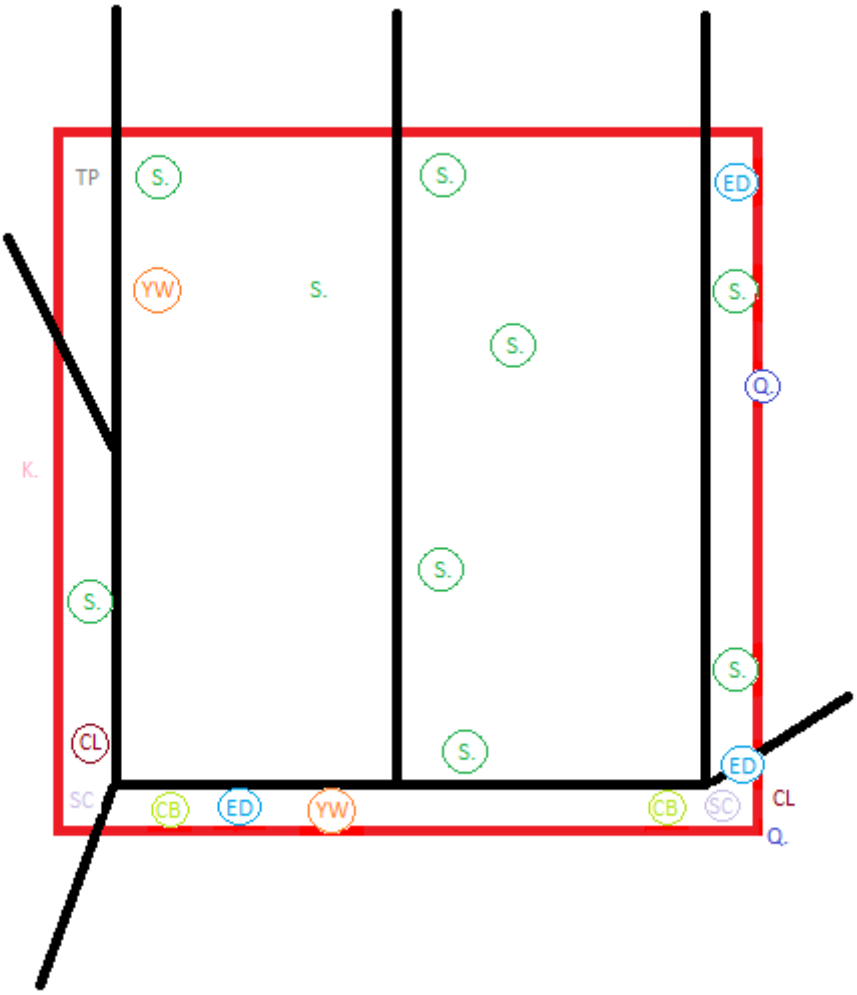
= Survey square boundary

= Access track (survey route)

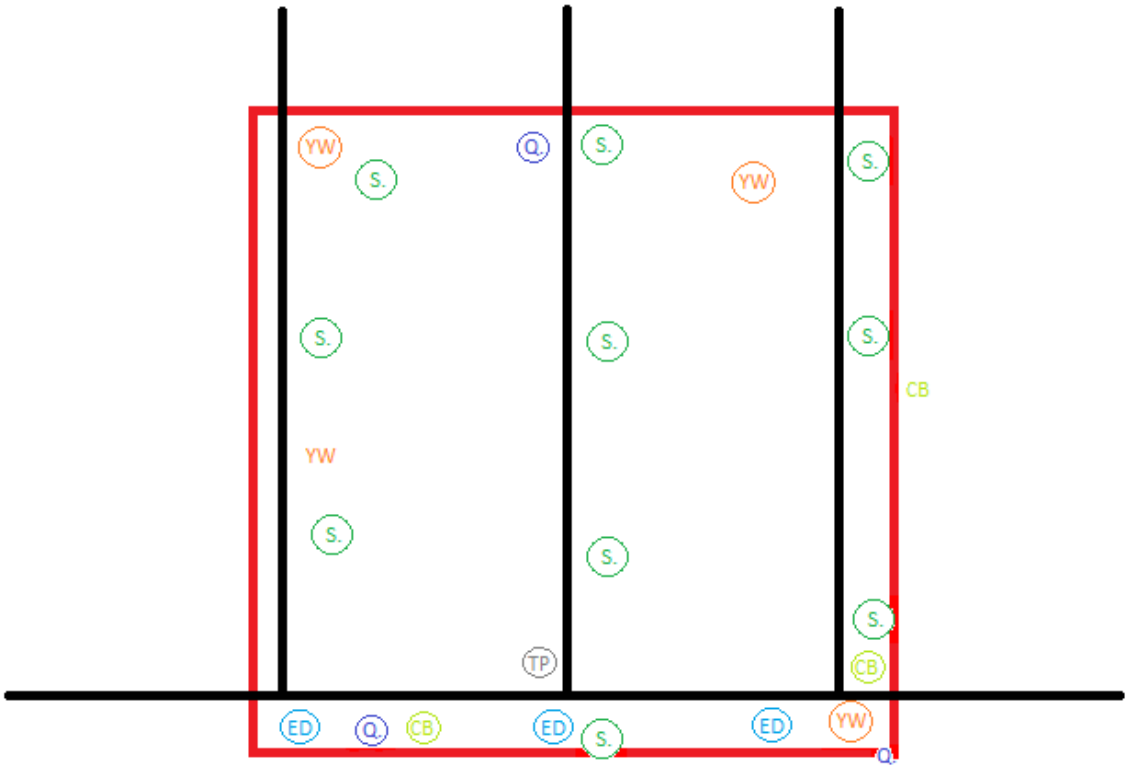
Breeding square 1



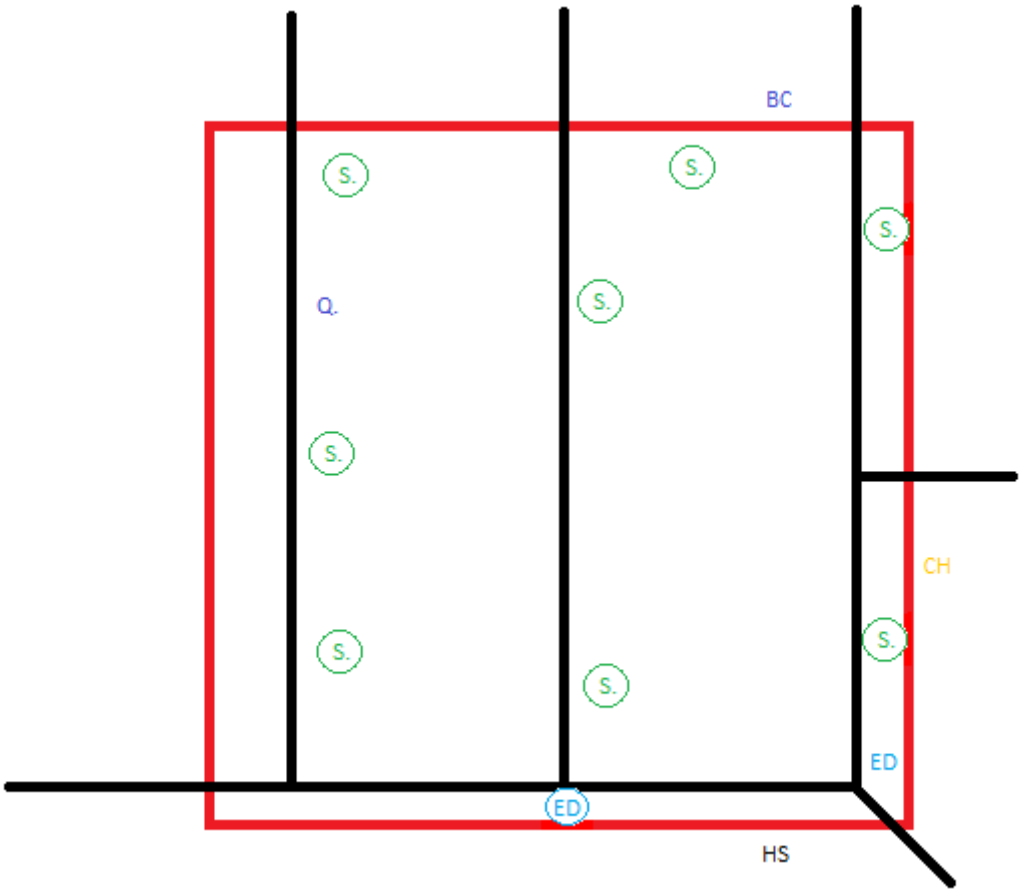
Breeding Square 2



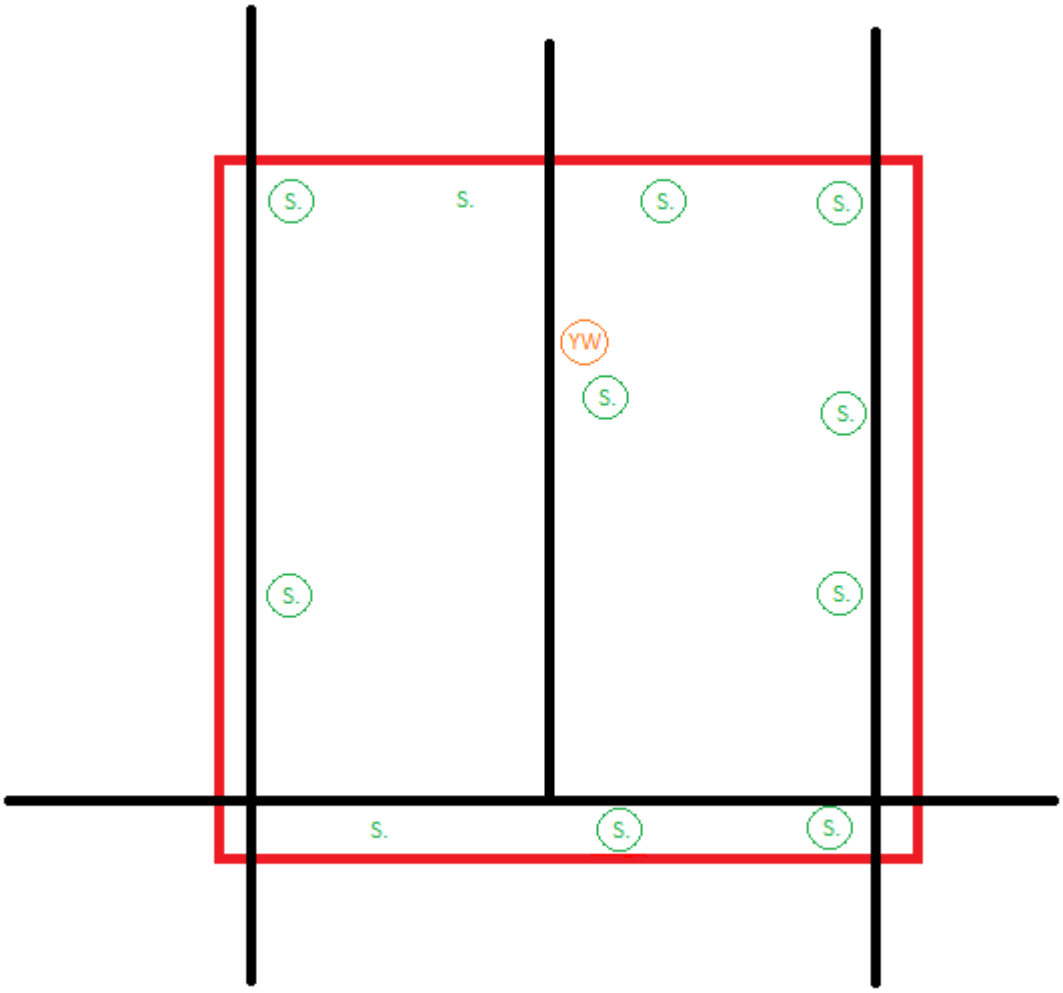
Breeding square 3



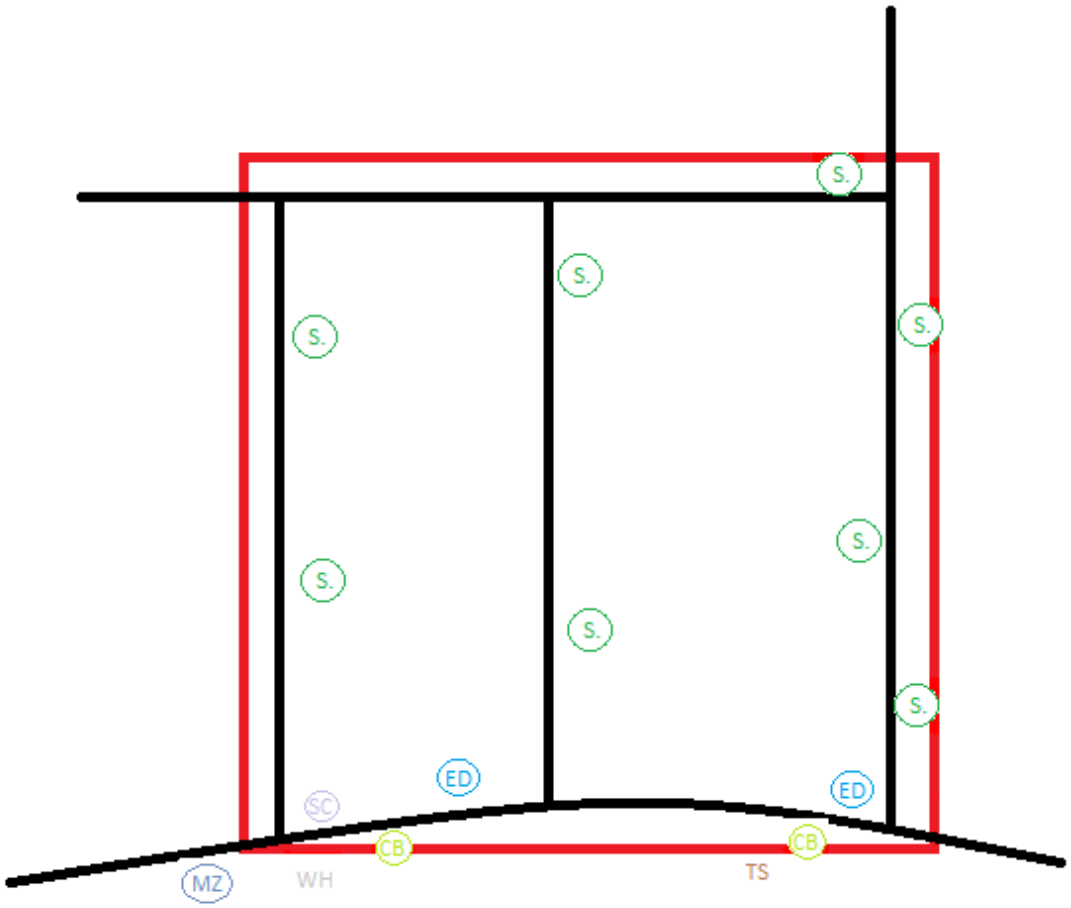
Breeding square 4



Breeding square 5



Breeding square 6



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