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COMPARISON OF PHEROMONE TRAPS

For monitoring of the European spruce bark beetle

Juraj Galko, Bjørn Økland, Christo Nikolov & Andrej Kunca

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Summary:
Six trap models were compared with respect to their ability to capture European spruce bark beetles and technical details in handling and use. All trap models proved to be efficient and gave high captures of beetles during operation for one summer season (2013). Ranking the trap models in descending order of total capture of beetles gave this list: Lindgren trap, Theysohn, prototype-P, Ecotrap, BEKA, and prototype-K. However, there was much variation in trapping results between localities for all trap models, and the estimated means did in most cases not differ significantly between models. The estimated mean capture of the Lindgren trap was significantly higher than for prototype-K and BEKA, but their confidence intervals were wide and they were close to being insignificantly different. The retail price of the traps vary from about 10 € (Ecotrap) to 50-55 € (Lindgren), while prices are not available for the two prototypes, which are not in regular production. Advantages and disadvantages concerning weight, size, robustness, draining of rain water, ease of handling and mounting are commented on in the discussion, and technical details of the traps are presented in a separate appendix (6).

Sammendrag:
Seks fellemodeller ble sammenlignet med hensyn til deres evne til å fange granbarkbiller og tekniske detaljer i håndtering og bruk av fellene. Alle fellemodellene viste seg å være effektive og ga høye fangster av biller i løpet av en sommersesong (2013). Rangering av fellemodellene etter total fangst av biller ga denne synkende rekkefølgen: Lindgren, Theysohn, prototype-P, Ecotrap, BEKA og prototype-K. For hver fellemodell var det imidlertid stor variasjon i fangstene mellom lokaliteter, og gjennomsnittlig fangst var i de fleste tilfeller ikke signifikant forskjellig mellom fellemodellene. Gjennomsnittlig fangst for Lindgren-fellen var signifikant høyere enn for prototype-K og BEKA, men konfidensintervallene var vide og forskjellene var bare marginalt forskjellige. Utsalgsprisen til de ulike fellemodellene varierer fra ca. 10 € (Ecotrap) til 50-55 € (Lindgren), mens det ikke foreligger noen pris for de to prototypene som ikke er i regulær produksjon. Fordeler og ulemper med hensyn til vekt, størrelse, robusthet, drenering av regnvann, enkel håndtering og montering er kommentert i diskusjonen, og tekniske detaljer for de ulike fellene er presentert i et eget appendiks (6).

Ansvarlig signatur
Jeg innestår for at denne rapporten er i samsvar med oppdragsavtalen og Skog og landskaps kvalitetssystem for oppdragsrapporter.

Dan Hamilton

……
Adm.dir./Avdelingsdirektør

Commissioned report 09/2013
from Skog og landskap

COMPARISON OF PHEROMONE TRAPS

For monitoring of the European spruce bark beetle

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Cover photo: The pheromone traps Ecotrap (top left), Lindgren – LFT (top right), Prototype-P (bottom left), and Theysohn (bottom right). All trap photos on front page and Fig. 1: Juraj Galko

PREFACE

The populations of the European spruce bark beetle beetle (*Ips typographus* L.) (Coleoptera: Curculionidae, Scolytinae) has been monitored in Norway annually since 1979. The reports from the monitoring serve a tool for foresters and forestry authorities in their planning and management. Knowledge about trapability and characteristics of the different pheromone traps are important to the operation of the monitoring program, especially if the program is forced to change to another trap model in the future. The comparison of traps reported here was performed in collaboration between the Norwegian Forest and Landscape Institute and the Landscape Institute and National Forest Centre (under the Forest Research Institute Zvolen - Forest Protection Service in Slovakia), with financial support from the County Governors of Hedmark, Nordland, Sør-Trøndelag and Telemark. The Slovakian authors designed and implemented the experiments, and did parts of data processing and appendices, while the Norwegian author did the statistical tests and finalized the report writing. The report is written in English to make it accessible to all authors, but the summary is also available in Norwegian.

FORORD

Bestandene av granbarkbillen (*Ips typographus* L.) (Coleoptera: Curculionidae, Scolytinae) har vært overvåket i Norge årlig siden 1979. Rapportene fra overvåkingen er et verktøy for skogbrukere og skogbruksmyndigheter i deres planlegging og forvaltning. Kunnskap om fangbarhet og egenskaper ved de ulike feromonfellene er viktig for driften av overvåkingsprogrammet, særlig når programmet kan bli nødt til å skifte til en annen fellemodell i fremtiden. Fellesammenligningen er utført som et samarbeid mellom Norsk institutt for skog og landskap og National Forest Centre (under Forest Research Institute Zvolen – Forest Protection Service i Slovakia), med økonomisk støtte fra Fylkesmennene i Hedmark, Nordland, Sør-Trøndelag og Telemark. De slovakiske forfatterne har stått for design og gjennomføring av eksperimentet, samt deler av databehandlingen og appendikser, mens den norske forfatteren gjorde statistiske tester og sluttførte rapportskrivingen. Rapporten er skrevet på engelsk for å gjøre den tilgjengelig for alle forfatterne, men sammendraget finnes også på norsk.

SUMMARY

Six trap models were compared with respect to their ability to capture European spruce bark beetles and technical details in handling and use. All trap models proved to be efficient and gave high captures of beetles during operation for one summer season (2013). Ranking the trap models in descending order of total capture of beetles gave this list: Lindgren trap, Theysohn, prototype-P, Ecotrap, BEKA, and prototype-K. However, there was much variation in trapping results between localities for all trap models, and the estimated means did in most cases not differ significantly between models. The estimated mean capture of the Lindgren trap was significantly higher than for prototype-K and BEKA, but their confidence intervals were wide and they were close to being insignificantly different. The retail price of the traps vary from about 10 € (Ecotrap) to 50-55 € (Lindgren), while prices are not available for the two prototypes, which are not in regular production. Advantages and disadvantages concerning weight, size, robustness, draining of rain water, ease of handling and mounting are commented on in the discussion, and technical details of the traps are presented in a separate appendix (6).

SAMMENDRAG

Seks fellemodeller ble sammenlignet med hensyn til deres evne til å fange granbarkbiller og tekniske detaljer i håndtering og bruk av fellene. Alle fellemodellene viste seg å være effektive og ga høye fangster av biller i løpet av en sommersesong (2013). Rangering av fellemodellene etter total fangst av biller ga denne synkende rekkefølgen: Lindgren, Theysohn, prototype-P, Ecotrap, BEKA og prototype-K. For hver fellemodell var det imidlertid stor variasjon i fangstene mellom lokaliteter, og gjennomsnittlig fangst var i de fleste tilfeller ikke signifikant forskjellig mellom fellemodellene. Gjennomsnittlig fangst for Lindgren-fellen var signifikant høyere enn for prototype-K og BEKA, men konfidensintervallene var vide og forskjellene var bare marginalt forskjellige. Utsalgsprisen til de ulike fellemodellene varierer fra ca. 10 € (Ecotrap) til 50-55 € (Lindgren), mens det ikke foreligger noen pris for de to prototypene som ikke er i regulær produksjon. Fordeler og ulemper med hensyn til vekt, størrelse, robusthet, drenering av regnvann, enkel håndtering og montering er kommentert i diskusjonen, og tekniske detaljer for de ulike fellene er presentert i et eget appendiks (6).

Key words: *Ips typographus*, pheromone traps, monitoring

Nøkkelord: granbarkbiller, feromonfeller, overvåking

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1. INTRODUCTION

Pheromone traps is the most common method for monitoring bark beetle population density and distribution. In Europe, traps are widely used for monitoring of the European spruce bark beetle (*Ips typographus*, L.). For continuous monitoring schemes, it is important that the trapping methods are consistent and comparable over time. The optimal solution would be to have continuous access to trapping equipment with identical trapability all the time. However, trap models are from time to time changed or go out of production. For example, the monitoring scheme of the European spruce bark beetle in Norway is currently using the BEKA trap, but may in the future have to change to a different model if the production of the BEKA trap is stopped. If or when a new trap model has to be implemented, it is crucial to know the relative trapability (i.e. how efficiently beetles are trapped) of existing and new trap models. In this way, it may possible to choose a new trap model with the best trapability. But trapping data may be even more important for calibrating the trapability of existing and new trap models during the transition period.

In this report we summarize the results from a comparison of six trap models, including some of the most commonly used traps models for monitoring this bark beetle species in Europe. One of the trap models is BEKA, and two of the models are prototypes that still are under development. In addition to comparing trapability, we present practical information on the different traps, such as ease of handling, size, durability etc. The field testing was conducted in the Tatra National Park in summer 2013.

2. METHODS

The trapping experiment was carried out in the period May - September 2013 in the Tatra National Park (TANAP) in the district of Tatranská Javorina, where the population density of the European spruce bark beetle has stayed at an epidemic level for several years. The experiment was conducted at ten different sites (Appendix 1). Each site was located on a clear-cut area within continuous spruce forest. Six pheromone traps (one of each model) were installed at each of the ten sites; in total 60 traps (Fig. 1).

Figure 1. One of the research sites with infested spruce stands in the background

Some places in the text, the names of the six trap models are shortened with the following labels**:**

- **T** – model Theysohn, resp. Ridex
- **E** – model Ecotrap
- **L** – Lindgren funnel trap
- **P** – trap prototype (the big funnel trap)
- **B** – BEKA trap (self-supporting funnel trap)
- **K** – cross trap prototype (made of black foil)

Traps were placed randomly in two parallel rows (Appendix 2) and their positions were not changed during the experiment. Traps were spaced approximately 20 meters apart.

Traps were installed and baited on 10.05.2013. All traps were baited with the same lure type; IT-Ecolure Tubus Mega (Fytofarm s.r.o.) manufactured 03.04.2013. IT-Ecolure Tubus Mega lures last the whole season, and were not changed during the experiment. The pheromone traps were emptied every week (altogether 20 weeks × 60 traps = 1200 samples) (Appendix 3). Samples were stored in Zip-Loc bags below 0°C in the laboratories of the Forest Protection Service (FPS) in Banská Štiavnica. At the end of the experiment, the pheromone trap catches were dried, cleaned, and the individuals of the European spruce bark beetle were determined and counted. Since the present report is only about one species, the European spruce bark beetle is in many cases simplified as “beetles” in the text.

To prevent any biases we checked the following trap components every week along with the trap emptying:
- bottom part (sieve) of collecting jar
- seal around the collecting jar
- trap poles, if they were properly installed and standing.

All trap models (except BEKA, which is self-supporting) were mounted on metal poles, which were developed at FPS. The poles are easy to handle, flexible and suitable for all trap models. The poles were painted with protective anti-corrosion coating.

The result data were analyzed with ANOVA and plotted using the software R (R Development Core Team 2012).

3. RESULTS

In total, 574 000 imagoes of the European spruce bark beetle were captured. There was a significant change in the total trap captures of beetles throughout the season, both for each trap model, and in total for beetles across all trap models (Appendix 4).

Since the sum of beetles for the whole season is the most used statistics in the monitoring of the European spruce bark beetle in Norway, we used the seasonal sums of beetles in the comparison between trap models.

The total sum of beetles per trap model in the whole season ranged from 85 327 to 107 523 (Table 1). The largest total capture was found in Lindgren traps and the smallest in the prototype-K trap. The beetle captures also tended to differ between sites. Mean beetle capture per trap model and research site are presented in Appendix 5.

Table 1. Total number of European spruce bark beetles caught in each trap model in ranked descending order Lindgren trap (L)*, Theysohn* (T)*, the prototype P* (P)*, Ecotrap* (E)*, BEKA* (B)*, and the prototype K* (K).

	L	**T**	**P**	**E**	**B**	**K**	**Sum**
Individuals	107 523	99 921	97 318	96 568	87 483	85 327	574 140

The mean number of beetles per trap also differed between trap models, and their means (Figure 2) follow the the same descending order of traps as for the total sum of beetles (Table 1). Highest mean values were observed for the Lindgren trap, followed by Theysohn, the prototype-P, Ecotrap, BEKA, and the prototype-K. However, when analyzing the variance between the trap models, the difference between trap models is not statistically significant (Table 2).

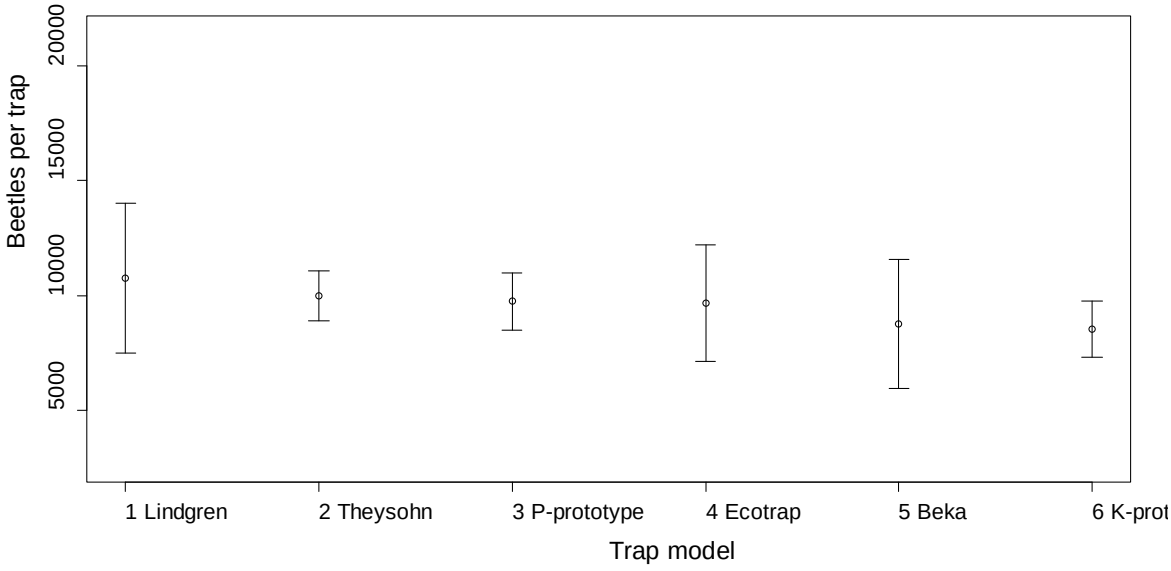


Figure 2. Mean number of beetles per trap for each trap model in ranked descending order and including +/-95% confidence intervals

We see from Figure 2 that the mean catch per trap showed considerable variation for all trap models. In most cases, none of the estimated means are beyond the wide confidence intervals of the other trap models, indicating that their mean trap captures are not different (Figure 2). The only exceptions is that the Lindgren trap is significantly higher than the confidence range of prototype-K, and that the prototype-K is significantly lower than the confidence range of Theysohn.

Table 2. Analysis of variance (ANOVA) between trap models. The mean beetle captures for the whole season are compared using the per trap models as factor

	Df	Sum of squares	Mean of squares	F value	Pr(>F)
Trap model	5	933581	186716	0.5289	0.7534
Residuals	54	19064503	353046		

4. DISCUSSION

According to our results, all trap models showed high trapability of European spruce bark beetles. Their trap captures could hardly be distinguished as significantly different. The estimated mean trap capture of the Lindgren trap was significantly higher than the estimated means for the K-prototype, but their confidence intervals were wide and they were only marginally different. Thus, our results suggest that trapability is not a decisive factor for choosing one trap model over the other among the trap models included in the present comparison.

The trap comparison was performed under somewhat different conditions than those of the Norwegian monitoring scheme of the European spruce bark beetles. Firstly, the study area is warmer and the European spruce bark beetles complete two generations per year instead of one asin Norway. Secondly, the traps in the experiment were baited with IT-Ecolure Tubus Mega pheromone lures (Fytofarm) instead of Ipslure (Kjemikonsult), which is used by the monitoring scheme in Norway. However, the comparison was based on the total trap capture over the whole season, and the same type of lures was applied in all of the traps tested. Thus, the test was designed to reveal possible differences between trap models, and the results of similarity or differences between trap models are probably applicable under Norwegian conditions as well.

While the trap models cannot be clearly distinguished by differences in trapability, the price and practical details of the trap models differ considerably (Appendix 6). The two cheapest traps models are Ecotrap (9,6 €) and Theysohn (15-18 €). The crossed barrier plates of Ecotrap enables this model to capture beetles from most directions, and the weight is low (1.3 kg). The transparent collecting jar makes it easy to do quick estimations of the amount of trapped beetles without emptying the jar (Appendix 6). On the other hand, rainwater is poorly drained from the jar, and the trap materials tend to become fragile within a few years of use. The big collecting jar of Theysohn is an

advantage, and this robust trap model is easy to install. Due to its flat shape, only two sides are exposed to trapping, and the large trap requires much space during transport and storing (Appendix 6).

The two most expensive traps models are Lindgren LFT (50-55 €) and BEKA (50-52 €). Lindgren had the highest estimated mean trap capture, but the difference was marginal compared to the trap model with lowest capture, prototype-K. The Lindgren trap is small, easy to mount, and requires little space during storing and transport. On the other hand, it has poor draining of rainwater from the collecting jar. BEKA has a big collecting jar, and the trap is self-supporting. It may be problem that the mounted trap is close to the ground, especially when the vegetation is high and can cover the trap. The trap consists of many parts, and it is relatively complicated to mount and empty.

The two prototypes are not given a price in Appendix 6, since they are not yet in regular production and cannot be purchased. Prototype-P has a big collecting jar, and draining of rain water from the collecting jar works well. Even though the weight of this model is the highest among the tested models, it is space-saving during storing and transport. Also Prototype-K has a big collecting jar and sufficient draining of rain water. The weight of Prototype-K is lower than for Prototype-P due to the use of foil instead of solid plastic in the barrier panes. Since the large trap panes consists of flexible foil, this trap model is easy to pack up and transport, and the trap foil is robust.

More technical details of the trap models are presented in Appendix 6.

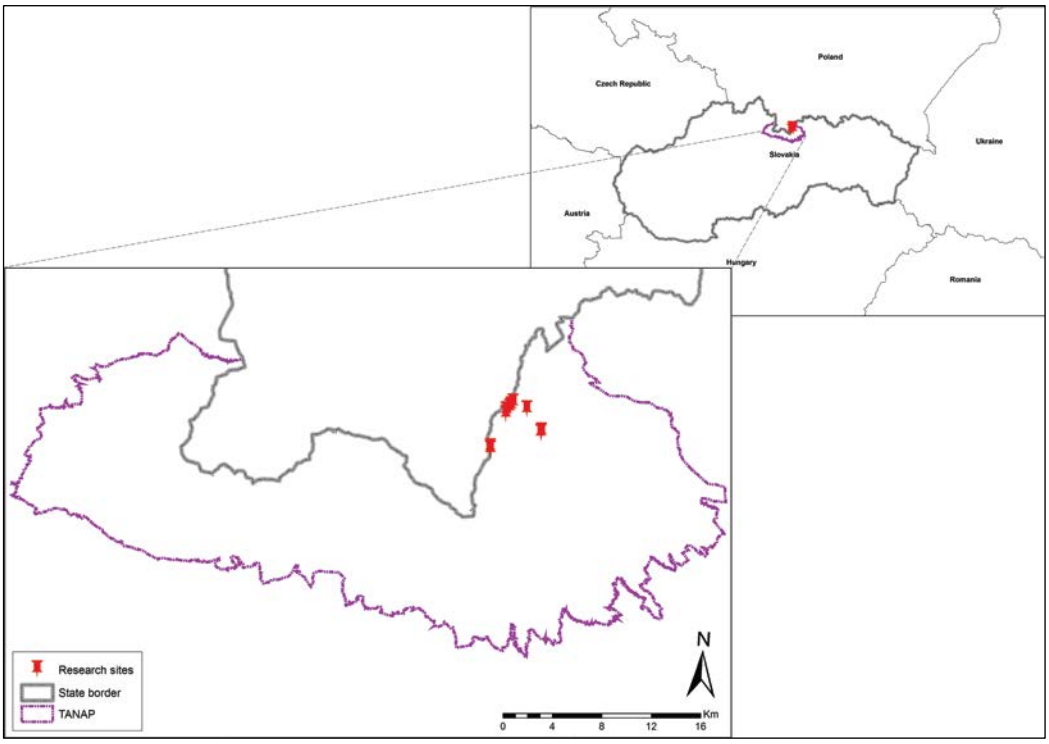
5. REFERENCES

Galko, J., Vakula, J., Gubka, A., Rell, S., Nikolov, C., 2012. Catches of the European spruce bark beetle in different types of pheromone traps in Tatranská Javorina – preliminary results 2012. V. Windstorm Research 2012.

R Development Core Team 2012. R: A Language and Environment for Statistical Computing. The R Foundation for Statistical Computing, Vienna, Austria. www.r-project.org

6. APPENDICES

Appendix 1. Location of study area (Tatra National Park, Tatranská Javorina)



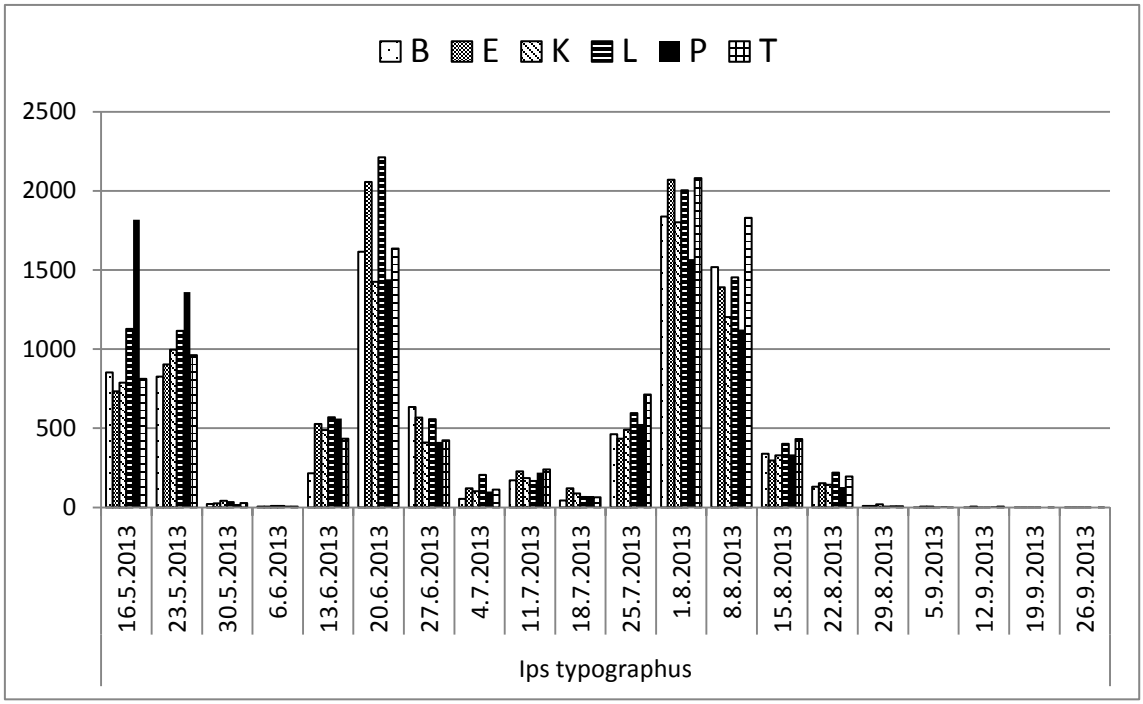
Appendix 2. Design of randomly spacing of traps at research sites (labels of trap models are explained in the text of the method section)

Site	Trap position 80-100 m ⟷
1	P T E K L B
2	P K E L T B
3	E B L K P T
4	E K T B P L
5	K P L B T E
6	B P L T K E
7	T K B L E P
8	B L K P E T
9	E K B P T L
10	P L T E K B

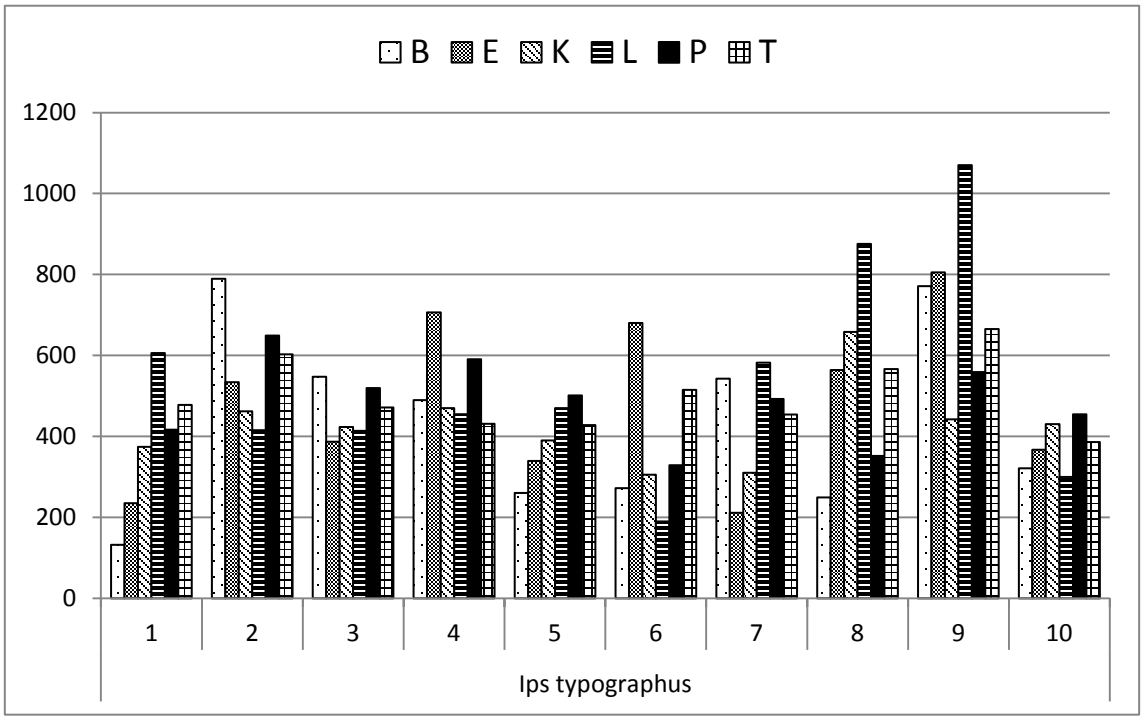
Appendix 3. Dates of emptying traps

Date	Trapping period
9 May	Trap installation
16 May	**1**
23 May	**2**
30 May	**3**
6 June	**4**
13 June	**5**
20 June	**6**
27 June	**7**
4 July	**8**
11 July	**9**
18 July	**10**
25 July	**11**
1 August	**12**
8 August	**13**
15 August	**14**
22 August	**15**
29 August	**16**
5 September	**17**
12 September	**18**
19. September	**19**
26 September	**20**

Appendix 4. Mean captures of the European spruce bark beetle per trap model and trapping period throughout the summer 2013



Appendix 5. Mean captures of the European spruce bark beetle per trap model and site (1-10), for the whole trapping period combined



Appendix 6. Technical details about the pheromone trap models

	Theysohn	Ecotrap	Lindgren trap (12 unit)	Prototype - P	BEKA	Prototype - K
Name and type of trap						
Producer	**Ridex s.r.o.** Nádražní 151 793 26 Vrbno pod Pradědem Czech Republic www.ridex.cz	**Fytofarm s.r.o.** Areál ÚMB SAV Dúbravská cesta 21 845 08 Bratislava 45 Slovakia www.fytofarm.sk	**Contech Inc.** **(PheroTech Inc.)** 115-19 Dallas Rd Victoria, British Columbia Canada www.pherotech.com		**NoveFella** Kajsalilla AS 7500 Stjørdal Norway www.kajsalilla.no	
Use	EU	EU	US, Canada, (EU)	Slovakia	Skandinavien	Slovakia
Shape	slot-panel	cross barriers	funnel	funnel	funnel	cross barriers
Dimensions (cm)	50x60x14	36x36x85	30x115 (12 funnels)	46x145 (12 funnels)	21x119 (10 funnels)	50x50x115
Weight (kg)	1.8	1.3	1.3	2.5	1.8	2.1
Trap surface area (dm^2)	40.5	45.4	39.6	95.3	56.2	134
Volume of collecting jar (l)	1.5	0.5	0.65 - dry option 0.45 - wet option	1.5	1.3	1.4
The maximum possible number of captured beetles (1ml/40pc)	60 000	20 000	26 000 – dry option 18 000 – wet option	60 000	52 000	56 000
Detail of collecting jar						
The area of the bottom of collecting jar (dm^2)	2.70	0.15	0.79	1.13	1.27	1.13
Drain off the water from collecting jar	3 small holes	sieve	1 small hole	sieve	central hole in collecting jar	sieve
Height jar bottom to ground (cm) with pole 195-200 cm	120 - 125	85 - 100	60 - 65	35 - 45	0 - 5	67
Lowest height of trap area (cm) with pole 195-200 cm	130 - 135	135 - 140	80 - 85	65 - 70	35 - 40	115
Appoximate time of installation (min.)	1 - 2	2	1 - 2	1 - 2	4 - 6	4 - 5
Roof area (dm^2)	6.9	7.3	7.1	16.6	-	-
The number of trap parts	3	5 + selection sieve	14 + funnel holders (3 on 1 funnel)	14 + 3 wires	25	4
Variant	trio (star)	trio	4, 8, 12, 16 funnels	-	no	-
Possibility of wet trapping	no	no	yes	no	no	no
Selection	yes	yes	no	no (yes with selection sieve)	partialy	no (yes with selection sieve)
The need of pole	yes	yes	yes	yes	no	yes
Detail of uninstalled trap						
Effeciency according to Galko et al. 2012	100 %	101 %	141 %	129 % (10 funnels)	tested in 2013	tested in 2013
Price (no tax included)	15-18 €	9.58 €	50-55 €	-	50-52 €	-
Pros	- big collecting jar - easy installation - the area of the bottom of collecting jar - selection - service life	- weight - cross shape - selection - price - transparent collecting jar = quick estimation of trapped beetles	- most effective - manipulation - space saving	- effective - big collecting jar - good drain off of water from jar	- does not need pole - big collecting jar - partial selection	- the largest trap area - big jar - drain off - space saving - cross shape - life service = foil (10 years warranty)
Cons	- flat shape – only two sides are deployed in trapping - storing (need of space)	- small area of the bottom of collecting jar - poor drain off of rainwater from jar - installation - short service life – after few years of use the material becomes fragile	- poor drain off of rainwater from jar - no selection - price	- weight - no selection - storing (need of space)	- trap area close to the ground (weed) - number of parts – installation time - difficulties with trap emtying (complicated) - price	- weight