Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 99 (2018) 193-214 EISSN 2392-2192

Preliminary studies toward an effective Macrolepidoptera monitoring system in the forests of the Narew National Park, North-east Poland - ultraviolet vs. actinic light Heath traps

João Matos da Costa

Narew National Park, Kurowo 10, 18-204 Kobylin Borzymy, Poland

E-mail address: joao.mcosta@npn.pl

ABSTRACT

To design a cost effective Macrolepidoptera monitoring system in the forests of the Narew National Park it is necessary to evaluate sampling methods. Light traps are one of most applied methods to survey moths and ultraviolet lamps are widely used. In this study I evaluate if the actinic light spectrum won't provide better results. In six nights in six forest stands, two Heath traps were placed simultaneously, one with ultraviolet light and another with actinic light. The ultraviolet traps captured 162 individuals of 51 species while the actinic light traps captured 294 individuals of 60 species. The ANOVA test found no significant differences in the allocation of species and individuals per family among areas captured by the actinic (F = 0,2894, df = 5, p = 0,92; F = 0,2568, df = 5, p = 0,93) or by the ultraviolet (F = 0,4515, df = 5, p = 0,81; F = 0,61, df = 5, p = 0,69) Heath traps. Nevertheless the Shannon and the Margalef measures of biodiversity disclosed that the actinic light provides a better image of the moth communities present in the research areas.

***Keywords*:** Narew National Park, Macrolepidoptera, monitoring, ultraviolet Heath traps, actinic Heath traps

(Received 26 April 2018; Accepted 11 May 2018; Date of Publication 11 May 2018)

1. INTRODUCTION

Forest covers approximately 45% of Europe continent surface being one of the most important terrestrial ecosystems (FAO 2010) and it has been regarded as one of the most species rich habitats, especially for arthropods (Stork 1988, Stork et al. 1997). Almost two-thirds of the known organisms in Planet Earth are Insects. Their abundance, due to their capacity of adaptation to different environmental conditions, is viewed as a good indicator of ecosystems biodiversity. Lepidoptera is one of the most species rich groups of insects. More than 157.000 species were described worldwide and near 3200 in Poland (Bogdanowicz and Chudzicka 2004, Van Nieukerken et al. 2011). Lepidoptera species play important roles in forests as they are herbivorous, pollinators and prey for birds and mammals (Holmes et al. 1979, Schowalter et al. 1986). Moths (Lepidoptera – Heterocera). Their important role in European forests (Schmitt 2003) has been widely used in ecological research studies (Buford et. al. 1999, Kitching et al. 2000, Hilt and Fiedler 2006, Beck and Chey 2007). Macrolepidopteran moths because of their popular appeal, easiness of collection and identification, have their ecologies and distributions well documented (Macek et al. 2007, Macek et al. 2008, Macek et al. 2012, Buszko and Masłowski 2012, Malkiewicz 2012, Bělín 2013).

Light traps are one of the most applied methods to survey moths once they are easily attracted to artificial lights (Taylor and French 1974, Fox et al. 2011, Infusino et al. 2017). It is known that moth catches are significantly influenced by the trap type and light source employed, and by the weather, the season and the moonlight conditions. A wide range of lamps and trap types for light trapping moths have been used and normally ultraviolet light Heath traps are those which are normally preferred (Robinson and Robinson 1950, Heath 1965, Aktinson 1980, Mizutani 1984, Preisser and Smith 1998, Butler et al. 1999, Summerville et al. 1999, Fayle et al. 2007, van Langevelde et al. 2011, Barghini and Souza de Medeiros 2012, Sayama et al. 2012, Choi 2013, Highland et al. 2013, Horváth 2013, Nowinszky et al. 2013, Somers-Yeates et al. 2013, An and Grunsven et al. 2014). This type of light is biased toward collecting phototactic species (Southwood and Henderson 2000) and so other studies reported that other light types could be as effective as UV (Fayle et al. 2007, Barghini and Souza de Medeiros 2012, Nowinszky et al. 2013).

The weather conditions and their effect on insect light trap catches have been studied (Williams 1940) and temperature and humidity are commonly registered throughout sampling studies (Mizutani 1984, Holoyoak et al. 1997, Butler et al. 1999, Highland et al. 2013).

Seasonal trends in moth communities have been studied, and it is known that at the end of their flight season (late august) their richness and abundance decrease (Beck and Linsenmair 2006, Sayama et al. 2012, Pickering and Staples 2016).

The phase of the moon has already been reported to affect the number of insects attracted to light (William 1936, Yela and Holyoak 1997) and recently, Pickering and Staples 2016 reported that the most efficient mean is to sample around each new moon for a total of 13 samples per year.

Biodiversity is one of the most important community attributes that determine its stability, productivity, trophic structure and migration (Krebs 2001). It is known that measuring biodiversity is not that easy as it might be expected, and the literature reveals a huge variety of indices. The most commonly used indices are based in species richness and evenness. Species richness is the total number of species of a sample while evenness expresses how evenly the individuals (abundance) are distributed over the different species. The statistical analysis of species distributions is hardly modulated by the changes in biodiversity not reflecting the weigh of evenness and species richness. It is known that in a community few species are very abundant, some have medium abundance, while others are represented only by few individuals (Magurran 1988, Gotelli and Colwell 2001). To evaluate the biodiversity the Margalef's and the Shannon indices are widely employed. The Margalef's species richness index measures the number of species present for a given number of individuals and so provides an instantly comprehensive expression of biodiversity. The Shannon heterogeneity index takes into account species richness and evenness and provides an alternative approach to the measurement of biodiversity (Peet 1974, Magurran 1988, Heip 1998).

One of the aims of this three years study is to design a cost-effective method to monitor Macrolepidoptera forest species of the Narew National Park (NPN). Test-trial experiences are necessary once the monitoring programs should ensure data of high quality through the use of broadly accessible methods (Beattie 1996, Basset et. al. 2004, Oliver and Huang 2006, Lovett et al. 2007, Rohr et. al. 2007, Malaque et al. 2009, Grunsven et al. 2014, Pickering et al. 2016). To achieve that objective, it is necessary to conduct an inventory of the forest Macrolepidoptera fauna as well as to study the ecology of its populations and their habitat preferences. Throughout this study two different light system Heath traps will be used to evaluate which one provides a better Macrolepidoptera inventory. Surveys will be conducted in 16 forest areas. In each forest stand throughout the period of study a humidity temperature sensor will be placed to evaluate how these factors influence moths' activity.

2. MATERIAL AND METHODS

This study is being conducted in the Narew National Park, North-East Poland, in the Podlaskie Voivodeship. The Park lies in the Upper Narew valley and occupies the marshy Narew valley between the cities of Suraż and Rzedziany. Marshlands and wasteland are the dominating ecosystems and cover about 90% of the Park area. In 2013, forests occupied 10% of the area of the Narew National Park (665 ha) and occur mainly on swampy habitats (83%). In the NPN, alder stands predominate, occupying over 84% of the forest area. In addition, there are also pine stands (8.5%) and small areas of birch, aspen, oak, spruce and maple. In 2017, the first year of this study, six areas were selected to conduct an inventory of the Macrolepidoptera fauna of the NPN forests. The area A (53') is a 43 years old alder forest with a diameter at breast height (DBH) of 18 cm and an average height of 18 m. The area B (coordinates) is a 40 years old alder forest with a DBH of 22 cm and an average height of 15 m. The area C (coordinates) is a 38 years old alder forest with a DBH of 18 cm and an average height of 14 m. The area D (coordinates) is a 35 years old pine forest with a DBH of 17 cm and an average height of 17 m. The area E (coordinates) is a 35 years old birch forest with a DBH of 17 cm and an average height of 14 m. The area F (coordinates) is a 25 years old pine forest with a DBH of 12 cm and an average height of 10,5 m. In the middle of each forest area a temperature and humidity sensor (HOBO Pro v2-U23) was placed from 28.08.2017 to 26.03.2018 tied to a tree at DBH. The Macrolepidoptera inventory was conducted simultaneously in each area for six nights (D1-28.08.17, D2-30.08.17, D3-14.09.17, D4-29.09.17, D5-16.10.17 and D6-19.10.17) in between the last quarter and the first quarter of the moon phases. In each area two Heath traps, one with an 8W ultraviolet (UV) light (Philips TL 8W BLB) and the other with an 15W actinic (ACT) lamp (Philips Actinic BL TLD 15W) positioned approximately 50 m apart. The ACT lamp used in this study, emits wavelengths between 320 - 400 nm plus a peak at 405 nm and another at 440 nm (Philips 2018). The UV lamp emits similar ultraviolet wavelengths, between 320 - 400 nm, and a small peak at 405 nm (Philips 2017), Figure 1.

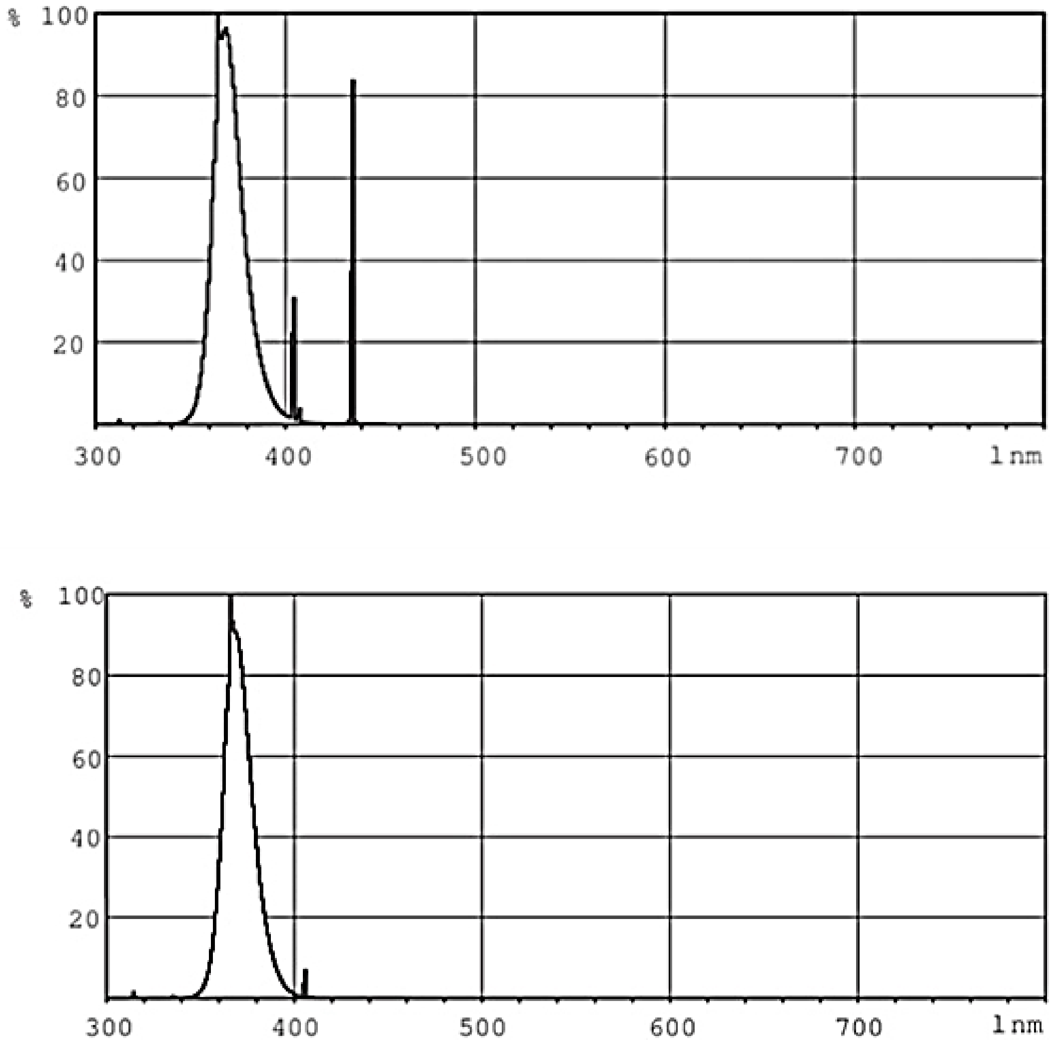

Figure 1. Light spectrum of ACT light (upper image) and of UV light (bottom image) (Philips 2017, Philips 2018) used in this study.

Both traps were powered by a 12V 7 Ah batteries. The traps were positioned at the ground level and operated from dusk to down. The collected fauna was euthanized using ethyl acetate as a killing agent inside the traps. All fauna was sorted and stored frozen. Macroleptidoptera specimens were identified after curation using wing pattern and stored in the NPN entomological collection. The Pearson's correlation coefficient (R) was used to measure the strength and direction of the relationship between two variables. To test if there were statistical significant differences among groups the analysis of variance test (ANOVA) was used with a 0,05 significant level of confidence ($p < 0,05$). To evaluate the biodiversity the Margalef's and the Shannon indices were used. The formulas used for the calculation of these indices were extracted from Magurran 1988 and are the followings:

$$H' = -\Sigma \, Pi \ln Pi \qquad DM = (S - l) / \ln N$$

where: the quantity Pi is the proportion of individuals found in the it species, S is the total number of species and N is the total number of individuals.

3. RESULTS

A total of 456 Macroleptidoptera individuals belonging to 6 families and 72 species were collected (appendix 1). The families Noctuidae, with 211 individuals of 38 species and Geometridae, with 142 individuals of 21 species, made up the majority of species (81,9%) and individuals (77,6%) of the total collected fauna. The number of individuals and species collected in each area is present in Table 1.

Table 1. Total number of species and individuals collected in each area.

	A	B	C	D	E	F
Species	18	28	19	29	25	37
Individuals	44	68	72	102	61	109

The ANOVA test found no significant differences in the distribution of species (F=0,412, df=5, p=0,84) or individuals (F=0,2992, df=5, p=0,91) per family among areas. The total number of species and individuals per family was highly correlated (R=0,9787, p=0,0006). The average values of temperature and humidity registered in each area (of all sampling days from 11AM to 10AM) are present in Table 2 and per day (an average of all areas) in Table 3.

Table 2. Average values of the temperature and humidity registered in each area of all sampling days from 11AM to 10AM.

	A	B	C	D	E	F
Temperature C	13,3	13,4	13,4	13,3	12,7	13,6
Humidity %	95	92,5	94	88,7	94,9	89,6

Table 3. Average values of temperature and humidity registered per sampling day (11AM-10Am) in all areas.

	D1	D2	D3	D4	D5	D6
Temperature C	13,40	15,46	13,64	13,76	13,68	9,86
Humidity %	92,08	82	91,82	90,5	98,22	96,9

The number of species (R=-0,903 p=0,013) and individuals (R=-0.880, p=0,02) captured during each night is negatively correlated with the average registered humidity. No significant differences in the humidity registered in all areas per sampling night (F=0,0427, df=5, p=0,99) were demonstrated (ANOVA). The average temperature registered per sampling night in all areas was not correlated with the number of species (R=0,6715, p=0,1446) or with the number of individuals (R=0,7461, p=0,0885) captured. No statistical differences between the average temperatures registered in each area in each sampling night (F=0,0006, df=5, p=1) were found. The total number of species and individuals collected per sampling night, in all areas, is present in Table 4.

Table 4. Number of species and individuals collected per day.

	D1	D2	D3	D4	D5	D6
Species	29	37	20	20	14	14
Individuals	96	118	82	65	52	43

According to the light type with which the moth fauna was captured, the ACT light trap captured 292 individuals of 60 species of all families. The UV light captured 163 individuals of 51 species of five families. The total number of species and individuals per family captured by the UV and ACT traps is highly correlated (R=0,9775, p=0,0007; R=0,9309, p=0,0069 respectively). No significant differences in the allocation of species or individuals per family among areas captured by the ACT (F=0,2894, df=5, p=0,92; F=0,2586, df=5, p=0,93) or by the UV (F=0,4515, df=5, p=0,81; F=0,61, df=5, p=0,69) traps were disclosed. The number of individuals and species captured per family, in each area with both light traps, is present in table 5 and 6 respectively.

The number of species, which were captured in both light type traps, is 39 (highlighted species in appendix 1). This species pool comprehends a total of 398 individuals, of which 148 individuals were captured in the UV traps and 250 individuals in the ACT traps. The UV light trap captured 14 individuals of 12 species, which were not captured in the ACT traps. The ACT traps captured 52 individuals of 21 species, which were not captured in UV traps. The value of the indices obtained through the use of species diversity measures, such as the Shannon diversity index (H') and the Margalef's richness index (DM) are present in Table 7.

Table 5. Number of individuals collected per area in both light type traps.

	A		B		C		D		E		F		Total	
	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT
Drepanidae	0	0	1	0	0	1	1	0	0	0	0	1	2	2
Erebidae	2	5	10	2	2	8	9	1	1	3	4	9	28	28
Geometridae	2	5	7	5	13	15	9	24	4	14	17	27	47	95
Hepialidae	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Lasiocampidae	0	9	2	9	2	11	0	1	0	4	0	3	4	37
Noctuidae	7	11	6	25	9	13	22	35	13	22	20	28	82	129
Total	12	32	26	42	24	48	41	61	18	43	41	68	162	294

Table 6. Number of species collected per area in both light type traps.

	A		B		C		D		E		F		Total	
	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT
Drepanidae	0	0	1	0	0	1	1	0	0	0	0	1	2	2
Erebidae	2	3	4	2	2	2	2	1	1	2	2	3	6	7
Geometridae	2	4	5	5	4	4	5	5	3	6	9	8	18	15
Hepialidae	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Lasiocampidae	0	1	1	1	1	1	0	1	0	1	0	1	1	1
Noctuidae	4	7	3	12	4	7	12	13	8	11	11	15	24	33
Total	8	16	14	20	11	15	20	20	12	20	22	28	51	60

Table 7. Values of the diversity measures, H' and DM, obtained with the number of species and individuals captured in each area in both light type traps (UV and ACT) as well as with their totality (Total).

Area	Shannon (H')			Margalef (DM)		
	UV	ACT	Total	UV	ACT	Total
A	1,91	2,47	2,57	2,82	4,33	4,49
B	2,37	2,61	2,97	3,99	5,08	6,16
C	2,03	2,35	2,43	3,15	3,62	4,21
D	2,78	2,42	2,85	5,12	4,62	6,05
E	2,40	2,84	3,04	3,81	5,05	5,84
F	2,95	2,95	3,20	5,65	6,40	7,67

The H' and the DM indices show that the ACT traps have higher results of biodiversity in almost all areas than the UV traps although two exceptions occur. The first is that in the area D, the UV traps show higher values of diversity than those obtained in ACT traps. The second one is that in the area F the H' index gives the same value of biodiversity for the UV and ACT traps.

4. DISCUSSION

Several similar studies have already shown that the Noctuidae and Geometridae are the dominant families recorded (Summerville et al. 1999, Ludwig 2000, Summerville et al. 2002, Summerville and Crist 2005, Schmidt and Roland 2006, Sayama et al. 2012, An and Choi 2013, Jonason el al. 2014) and that normally the number Noctuid species and individuals is higher, although Sayama et al. 2012 registered more Geometrids than Noctuids.

In agreement with my results, few studies have found no differences in the number of species among areas and the strong correlation between the abundance and species richness, normally equated with high diversity, has already been reported (Usher and Keiller 1998, Summerville et al. 2002, Summerville and Crist 2003, Shuey et al. 2012, Somers-Yeates et al. 2013, Horváth et al. 2016, Tikoga S. et al. 2017) but Horwath 2013 did not report this correlation. It is known that early and late season light trap catches are not as species rich or abundant as summer inventories due to the ecology of the species, so these results are not uncommon (Beck and Linsenmair 2006, Sayama et al. 2012, Pickering and Staples 2016).

The temperature registered during the six nights of this inventory was not correlated with the abundance nor with species richness captured, probably due to the fact that it was higher than the lower thresholds of the moth species captured, as it was registered in other studies (Marks 1977, Mizutani 1984, Dent and Pawar 1988, Mcgeachie 1989, Intachat et al. 2001. It is known that humidity affects moths' activity (Marks 1977, Dent and Pawar 1988) and the negative correlation between the abundance and species richness with the humidity was already registered (Persson 1976, Intachat et al. 2001, Bahareth 2006). The differences in the humidity registered in each forest stand are probably due to the vegetation type, proximity to the river channels and so if the area is flooded or not, factors known to affect moth diversity (Usher and Keiller 1998, Summerville and Crist 2003, Nowacki an Frąckiel 2010, Shuey et al. 2012, Horváth 2013, Highland et al. 2013, Horváth et al. 2016). It seems that the humidity did not exceed the thresholds of the moth fauna active in this period.

Most of the moth inventory studies have been conducted with UV lightning systems (Mizutani 1984, Thomas and Thomas 1994, Hammond and Miller 1998, Summerville et al. 2002, Summerville and Crist 2005, Schmidt and Roland 2006, Choi and An 2010, Truxa and Fielder 2012, Highland et al. 2013, Horváth 2013, Grunsven et al. 2014, Jaroš et al. 2014, Infusino et al. 2017) and few have been made with different light sources (Birkinshaw and Thomas 1999, Beck and Linsenmair 2006, deWaard et al. 2009, Nowacki and Frąckiel 2010, Ignatov et al. 2011, Shubhalaxmi et al. 2011, Tikoga et al. 2017). Ultraviolet light traps are widely used due to the fact that Lepidoptera species are strongly attracted to shorter wavelengths (Cowan and Gries 2009, van Langevelde et al. 2011, Somers-Yeates et al. 2013) although this method is appropriated for collecting phototactic species (Southwood and Henderson 2000). Studies, in which at the same time different light sources were used, show that the number of species is clearly higher when short wavelengths are used (van Langevelde et al. 2011, Somers-Yeates et al. 2013) but lower in UV when other lights are used (Fayle et al. 2007, Barghini and Souza de Medeiros 2012). Nowinszky et al. 2013 stated that according to their studies, normal light traps could be at most as successful as UV traps. Van Langevelde et al. 2011 captured more species in ACT light traps, due to their UV-part emission, when compared with light traps, which emit no UV wavelengths. Cowan and Gries 2010 found in their study that more individuals of the species *Plodia interpunctella* (Hubner, 1813) were attracted to lights with wavelengths between 400 - 475 nm than at higher lengths and that the 405 nm wavelength was the most effective. Moth species respond differently to the light spectrum emitted by the lamps (Briscoe and Chittka 2001, Johnsen et al. 2006) so the wider ACT light spectrum, possibly due to the blue light peak (440 nm) attracts more fauna as it was mentioned by Brehm G. 2017.

The species richness increases with the sample effort but no community consists of species of equal abundance and so the biodiversity indices seek to characterize the diversity of a sample by a single number (Magurran 1988). The values obtained in this study by the H' and by the DM indices show clear differences in the biodiversity of each area and the differences in between the UV, ACT traps and the total fauna captured. The values obtained by the ACT traps are clearly near with those obtained in total (UV+ACT). In the area D, where both indices show higher values of biodiversity obtained by the UV traps than those obtained in the ACT shows that the UV traps do not provide a proper picture of the existent community.

The UV traps captured three individuals of the *Pennithera firmata* (Hubner, 1822) while the ACT captured 18. The equal number of species captured, in the area D, by the UV and ACT traps, as well as the equal number of singletons, 12, (data not shown) could be explained by the fact that there is not enough understory vegetation in this *Pinus sylvestris* (Linnaeus, 1753) forest stand. The 50 meters that separate both traps it is possible not enough to avoid light interference and so the species are evenly attracted to both light traps. The cost efficiency of monitoring tools should affect the population as little as possible however they should obtain adequate numbers for analysis (Thomas and Thomas 1994).

A wider species abundance distribution of a given community provides a better picture of the relationship between species richness and evenness (Magurran 1988).

5. CONCLUSIONS

According to our results the meteorological conditions, humidity and temperature, registered in each area did not influence differently the activity of the moth fauna, nor differences in the abundance and the species richness captured were detected. In this late season inventory, the ACT light heath traps provide better results, higher abundance, species richness and biodiversity values. The moth fauna is better surveyed by the ACT traps than by the UV heath traps at the same environmental conditions.

Developing cost-effective monitoring techniques requires comparison between the efficiency of available sampling methods. The heath traps used in this study are cheap, approximately 100 euros. The ACT light seems to provide a better catch, a more effective survey of the moth fauna present in each forest stand.

It is necessary to continue this experiment throughout the all Macrolepidoptera flight season to test if the results of this study are reproducible, If so, the use of this ACT light to survey macromoths instead of UV light should be more widespread and selected for studies in our Park.

Aknowledgment

This results were obtained thanks to the financial support of the Polish State Forests' "Forest Fund" as part of the following research project: "*Inwentaryzacja oraz badanie ekologii populacji i preferencji siedliskowych fauny motyli nocnych z grupy Macrolepidoptera w różnych siedliskach leśnych Narwiańskiego Parku Narodowego*" which will conducted until the end of 2019.
I am very grateful to my colleague Iwona Laskowska for her help throughout the preparation of this project and to Justyna Bujonwska for its translation.

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APPENDIX

List of species collected in each research area (A, B, C, D, E and F) by both of light type traps. The highlighted rows represent the pool of species, which was captured by both light type traps (UV – ultraviolet, ACT – actinic). The species names were extracted from Jonko 2018.

	A		B		C		D		E		F	
	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT	UV	ACT
	n	n	n	n	n	n	n	n	n	n	n	n
Drepanidae												
Drepana curvatula (Borkhausen, 1790)							1					1
Ochropacha duplaris (Linnaeus, 1761)			1			1						
Erebidae												
Arctia caja (Linnaeus, 1758)		1										
Catocala electa (Vieweg, 1790)		1	1	1		3			1	1		
Catocala nupta (Linnaeus, 1767)	1											
Hypena proboscidalis (Linnaeus, 1758)	1	3	7		1	5	6			2	2	3
Hypena rostralis (Linnaeus, 1758)					1							
Katha depressa (Esper, 1787)												1

Lymantria (Lymantria) monacha (Linnaeus, 1758)							3	1			2	5
Scoliopteryx libatrix (Linnaeus, 1758)			1	1								
Spilosoma lubricipeda (Linnaeus, 1758)			1									
Geometridae												
Biston betularia (Linnaeus, 1758)											1	
Campaea margaritata (Linnaeus, 1761)							3	1				
Chloroclysta siterata (Hufnagel, 1767)								1			2	2
Colotois pennaria (Linnaeus, 1761)				2						5		5
Dysstroma truncata (Hufnagel, 1767)							1	1				
Ectropis crepuscularia (Denis & Schiffermüller, 1775)	1	2	1	1	1	2						
Ennomos alniaria (Linnaeus, 1758)											1	
Ennomos autumnaria (Werneburg, 1859)	2	1	3		8	10				1	3	
Ennomos fuscantaria (Haworth, 1809)							1					
Epione repandaria (Hufnagel, 1767)									1			
Epirrhoe alternata (Müller, 1764)		1			1	1					1	2

Epirrita autumnata (Borkhausen, 1794)				1			1	3	1	2		
Epirrita dilutata (Denis & Schiffermüller, 1775)			1		1						1	
Erannis defoliaria (Clerck, 1759)										1	1	
Eulithis testata (Linnaeus, 1761)									2	3		
Eustroma reticulata (Denis & Schiffermüller, 1775)			1									
Orthonama vittata (Borkhausen, 1794)			1			2						1
Pennithera firmata (Hübner, 1822)							3	18		2	4	14
Timandra comae (Schmidt, 1931)		1		1							3	1
Xanthorhoe designata (Hufnagel, 1767)												1
Xanthorhoe spadicearia (Denis & Schiffermüller, 1775)												1
Hepialidae												
Triodia sylvina (Linnaeus, 1761)		2										
Lasiocampidae												
Poecilocampa populi (Linnaeus, 1758)		9	2	9	2	11		1		4		3

Noctuidae												
Agrochola circellaris (Hufnagel, 1766)		1						2				
Agrochola lota (Clerck, 1759)			3		5	4			2		1	1
Agrochola macilenta (Hubner, 1809)								1				
Allophyes oxyacanthae (Linnaeus, 1758)				1			1		1		2	
Amphipyra berbera (Rungs, 1949)						1						
Amphipyra (Amphipyra) livida (Denis & Schiffermüller, 1775)								1				
Anchoscelis litura (Linnaeus, 1758)								1				
Asteroscopus sphinx (Hufnagel, 1766)									1			
Coenophila subrosea (Stephens, 1829)									2	1		
Conistra (Dasycampa) rubiginea (Denis & Schiffermüller, 1775)								6				2
Conistra (Conistra) vaccinii (Linnaeus, 1761)		1		4			3	10	3	4	4	6
Deltote (Protodeltote) pygarga (Hufnagel, 1766)								1				
Denticucullus pygmina (Haworth, 1809)							1		1	2	1	

Diachrysia stenochrysis (Warren, 1913)				1								
Diloba caeruleocephala (Linnaeus, 1758)				1					1			3
Eucarta virgo (Treitschke, 1835)												1
Euplexia lucipara (Linnaeus, 1758)							1					
Eupsilia transversa (Hufnagel, 1766)												1
Gortyna flavago (Denis & Schiffermüller, 1775)				1	1							
Hadena (Anepia) perplexa (Denis & Schiffermüller, 1775)										1		
Hydraecia micacea (Esper, 1789)	1	2		1						2	1	2
Lithophane (Lithophane) furcifera (Hufnagel, 1766)							1	1				
Macdunnoughia confusa (Stephens, 1850)				1							1	
Mniotype satura (Denis & Schiffermüller, 1775)							1				3	2
Mythimna (Hyphilare) l-album (Linnaeus, 1767)		1										
Noctua fimbriata (Schreber, 1759)												1
Noctua pronuba (Linnaeus, 1758)							1					

Phragmatiphila nexa (Hübner, 1808)		1	1	1		2						
Pterostoma palpina (Clerck, 1759)												1
Sedina buettneri (E. Hering, 1858)	1	2	2	4	2	1	1		2	1		
Staurophora celsia (Linnaeus, 1758)										1		1
Tholera cespitis (Denis & Schiffermüller, 1775)										2	1	1
Tholera decimalis (Poda, 1761)				2			1	2				1
Xanthia (Xanthia) togata (Esper, 1788)				1	1			1				
Xestia (Megasema) c-nigrum (Linnaeus, 1758)	4	3		7		2	4	4		4	3	4
Xestia (Xestia) sexstrigata (Haworth, 1809)	1			1		1				1	1	
Xestia (Xestia) xanthographa (Denis & Schiffermüller, 1775)						2	4	1		3	2	1
Xylena (Lithomoia) solidaginis (Hübner, 1803)							3	4				
Sub totlal	7	11	6	26	9	13	22	35	13	22	20	28
Total	44		68		72		102		61		109	