Population dynamics of eight-toothed spruce bark beetle (*Ips typographus* [L.]) in the area of National Nature Reserve Praděd in 1998–2001

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ABSTRACT: The paper deals with the study of bionomics and population dynamics of *Ips typographus* (L.) in the area of the Praděd National Nature Reserve (NNR). Data were collected on the basis of detected feeding marks, beetles caught in traps, and also according to the frequency of occurrence or increase in the number of standing dead trees killed by the bark beetle attack in localities where sanitation felling was not performed. Finally, evaluation of the present condition of forest stand and population dynamics of *Ips typographus* was carried out. The results showed that the stands currently occur in the stage of disintegration when the role of the bark beetle is irreplaceable. Based on the research findings, the management of the bark beetle was proposed that would enable to achieve so-called regulated disintegration of natural spruce forests in the area of the Praděd NNR.

Keywords: *Ips typographus* (L.); population dynamics; management of *Ips typographus*; NNR Praděd; regulated disintegration

Gradation of *Ips typographus* (L.) in mountain spruce stands is still an urgent problem. At the beginning of its invasion, the bark beetle prefers weakened spruce trees. The weakening of attacked spruce trees takes place due to synergetic effects of extreme climatic fluctuations, long-term acidification of soil and anthropogenic impacts, in particular air pollution load. The mechanism of damage to forest trees consists in both, the direct effect of pollutants on assimilatory organs and roots of plants, and indirect effects in the form of changes in soil properties.

The problem mentioned above has already been discussed for several years in the context of *Ips typographus* gradations in the Šumava National Park (Zatloukal 1998). There is a controversy whether to let natural forces establish the homeostatic balance resulting in a climax natural forest or to achieve this desirable objective by human support, i.e. silvicultural interventions. The same problem is whether to leave standing dead trees killed by the bark beetle attack in the area of the Praděd NNR.

Regarding the bark beetle attack in a specially protected area (SPA), the main problem is possible damage to standing trees representing a rare, irreplaceable gene resource. However, is it the only or the main reason for the declaration of protected areas? Although differentiated protection in SPA is laid down by legislation (Forest Act No. 289/1995, Act of the Nature and Landscape Conservation No. 114/1992), we do not encounter a more detailed definition of the object of protection, not even in areas with the highest degree of protection (National Nature Reserve, Nature Reserve, the 1st zone of National Park or Protected Landscape Area), which probably leads to many misunderstandings (Mrkva 1998). One of the main objectives of SPA is protection of the spontaneous course of natural processes with minimum anthropic impacts.

Concepts of the management of plant communities (care of plant communities) and particularly of forests in protected areas have developed for a long time. The concepts were subjeced to diverse opinions of experts and new ideas have been suggested recently. Although nobody doubts that also animals are a part of ecosystems, until recently (Mrkva 1998) nobody in the Czech Republic has raised the issue of problematic animal groups and how to modify their management in protected areas. Much more, nature protection dealt with traditional conservation problems of the protection of some threatened species or methods of their reintroduction, protection of their environment, etc. In the professional community of forest management of the Jeseníky area, an idea dominates that animals considered dangerous pests in forest protection should be controlled and killed in any case and thus even in protected areas. As mentioned above, one of the problematic groups of animals in mountain spruce ecosystems is insect pests, including the most important *Ips typographus*. If we ask a question concerning the natural role and function of cambiophagous insects in protected areas, we have to understand the organisms also as stressors which, along with many other ones (Mrkva 1994), affect plants and play an important role not only in the life of individuals of particular tree species but also in the development of their populations and communities. If we admit the effects of stressors in the case of communities of other tree species, we cannot change our attitude in the case of spruce and its natural ecosystems.

Generally, it is possible to say that cambiophagous insects and particularly *Ips typographus*, *Ips amitinus* (Eichhoff) and to a smaller extent also *Ips duplicatus* (Sahlberg) play an important role during the whole life of spruce stands because they are a significant tool of natural selection and one of many factors in the large regeneration cycle of forest development (Míchal 1992). Thanks to the diversity of genetically fixed properties of trees which are not capable to resist the synergetic effects of natural and anthropic stress factors, usually including also a cambiophagous insect, the formation of ecological valence of trees occurs resulting finally in evolution.

The natural development and shift in the generation time of *Ips typographus* are very important from the aspect of the gene resource protection, particularly for mountain spruce stands. The process of natural disintegration occurs in larger groups in mountain stands. Where the stage of spruce stand disintegration predominates, it is possible to expect the dominance of standing dead trees killed by the bark beetle attack (as many as 60%). The initial stage of disintegration is characterised by the presence of spruce seedlings and their natural selection. In the stands, natural seeding species such as *Sorbus* and *Salix* play an important and irreplaceable role. Their occurrences increase resistance to both abiotic and biotic stressors (Mrkva 1999).

The aim of this paper was to study bionomics and population dynamics of *Ips typographus* and *Ips amitinus* in the area of the Praděd NNR on the basis of the detection of feeding marks and number of beetles caught in the traps, and according to the frequency or increase in the number of standing dead trees killed by the bark beetle attack on studied plots where no sanitary measures were taken.

It was necessary to perform the following studies and measurements in analysed standing dead trees or trap trees in order:
- to record the species composition of bark beetles and/or to determine the participation of bark beetles in the disintegration of spruce stands,
- to describe climatic conditions (temperature, precipitation, Lang's rain factor) and health condition of stands as possible predisposition factors for the attack of trees. These factors may also affect the population dynamics of bark beetles. Based on the findings obtained, we try to formulate a proposal for the management of bark beetles which could help to achieve so-called regulated disintegration of natural spruce stands in the area of the Praděd NNR.

METHODS

Description of the area under study

The studied locality is situated in northern Moravia, Bruntál district, about 3 km NW of Karlova Studánka. The locality belongs to the competence of Forests of the Czech Republic Co., Hradec Králové. The locality lies in the area of Forest District Karlovice (Silesia), Ranger District Praděd (1,412 ha). The study is carried out in the 1st zone of the Jeseníky Protected Landscape Area (PLA) (74,400 ha), NNR Praděd (2,031.40 ha), part Bílá Opava (273.70 ha). The Praděd NNR was declared by the Ministry of Environment of the Czech Republic, Decree No. 6/1991 of 14 December 1990.

The area under study comprises a plot of 9.60 ha in total where a network of 94 marked trees was established. In 1996, an attack of bark beetles was observed on the trees, however, no sanitary measure (felling) was taken. The "bark beetle tree" was taken to mean a tree attacked by *Ips typographus* and/or *Ips amitinus* with evident entrance holes on the surface of the lower part of the stem. When peeling off the bark around bark beetles holes, distinct feeding marks were observed and needles in the upper part of the tree often showed to become brownish. The trees were singularly marked in order to follow the development of "bark beetle foci" in the area of NNR Praděd, part Bílá Opava.

Working procedures

The study of *Ips typographus* population dynamics was carried out from 1998 to 2001. Population dynamics of *Ips typographus* was studied by means of 40 traps of Theysohn type in the whole area of the Bílá Opava reserve, three of them being situated on the studied plot. Annual collection from the traps was carried out in ten-day intervals from May to September. Numbers of beetles were compared with the course of temperatures and precipitation in the period under study. Precipitation and temperatures obtained from the Železná Meteorological Station, Vidly, Bruntál District, were converted to corresponding altitudes by means of respective gradients.

Each year at the end of measurements, analyses of the total amount of *Ips typographus* were carried out by means of felling records in the Bílá Opava reserve. Throughout the studied area, the spread of *Ips typographus* was monitored in foci on trees around the previously marked trees (1996). Trees were selected by employees of Forests of the Czech Republic Co., Forest District Karlovice, Silesia. So-called "bark-beetle trees" were marked where no sanitation felling was carried out. Annually at the end of measurements, an analysis of the occurrence of *Ips typographus* and *Ips amitinus* on the attacked wood was performed. For this purpose, three windbreaks were always selected. On the stems, the number of entrance holes was calculated in the most densely attacked part on an area of 20 dm^2 of the continuous surface of bark. Further, a conversion to 1 dm^2 was carried out and the degree of the stem attack was determined.

RESULTS AND DISCUSSION

Temperatures and precipitation were compared between the target period 1998–2001 and the so-called normal period 1961–1990. When comparing precipitation and temperatures in the studied period, it is very important to note the decreased total of average monthly precipitation, which primarily affects the course of *Ips typographus* swarming and also the health condition of stands.

Only mean monthly temperatures were available which, however, sufficiently described favourable conditions for *Ips typographus* swarming. Temperatures ranged about a long-term normal in the interval +3 to –3°C (Figs. 1 to 4). The mean annual temperature for the normal period reached 2.6°C and the mean monthly temperature during the growing season amounted to 9.4°C. The total annual amount of precipitation for the normal period was 998.1 mm and in the growing season precipitation amounted to 570.3 mm.

In 1998 (Fig. 1), the mean annual temperature was 1.6°C and mean monthly temperature for the grow-

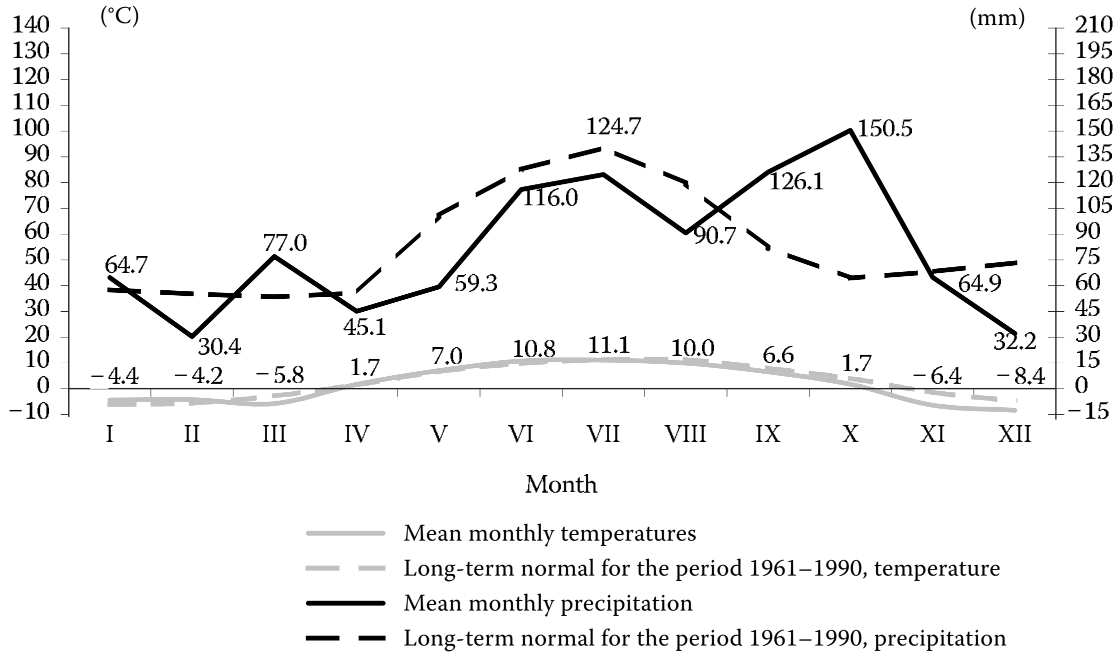

Fig. 1. Comparison of temperatures and precipitation in 1998

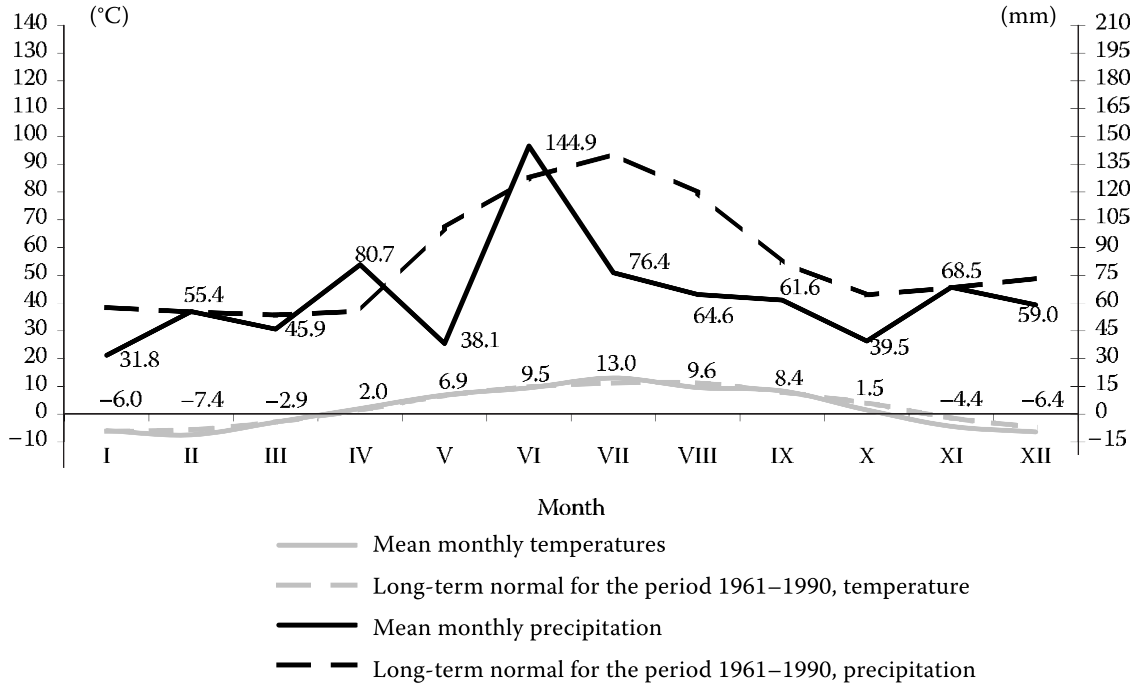

Fig. 2. Comparison of temperatures and precipitation in 1999

ing season 9.1°C. The total annual amount of precipitation was 981.6 mm and 516.8 mm fell within the growing season. After conversion, the mean monthly temperature for the growing season decreased below the long-term normal by 3% and mean monthly precipitation was lower by 10%.

A similar course of weather was also in 1999 (Fig. 2). The mean annual temperature was 2.0°C and mean monthly temperature for the growing season was 9.5°C. The total annual amount of precipitation was 766.4 mm and 385.6 mm fell in the growing season. After conversion, the mean monthly tem-

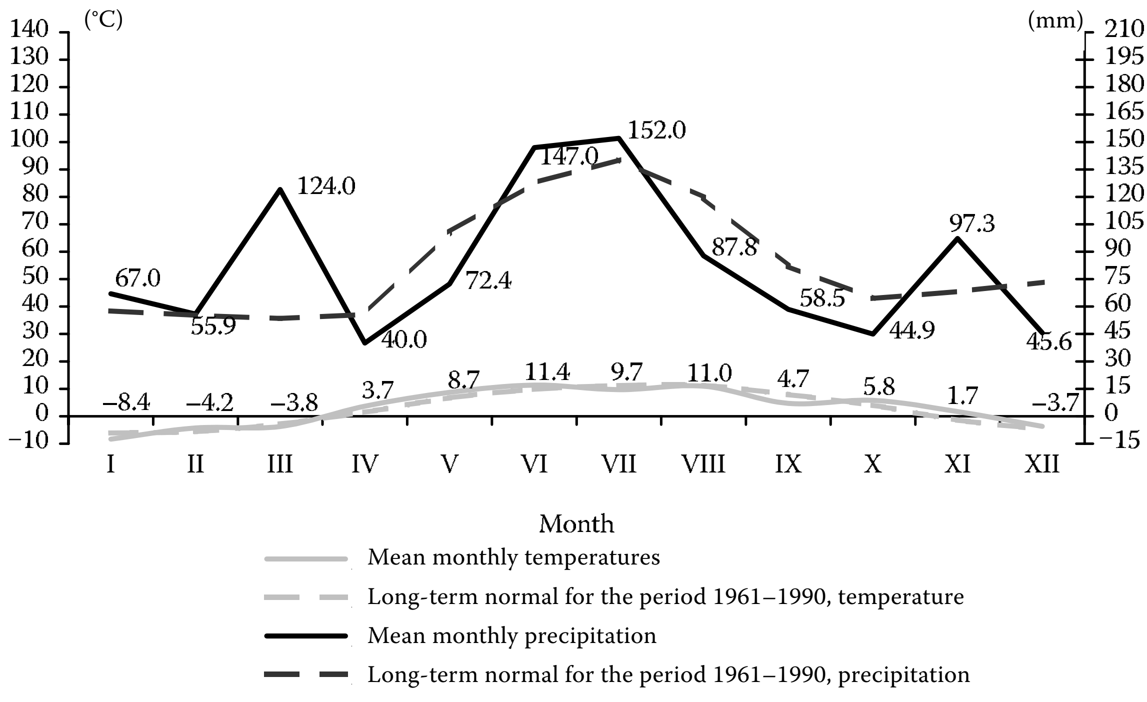

Fig. 3. Comparison of temperatures and precipitation in 2000

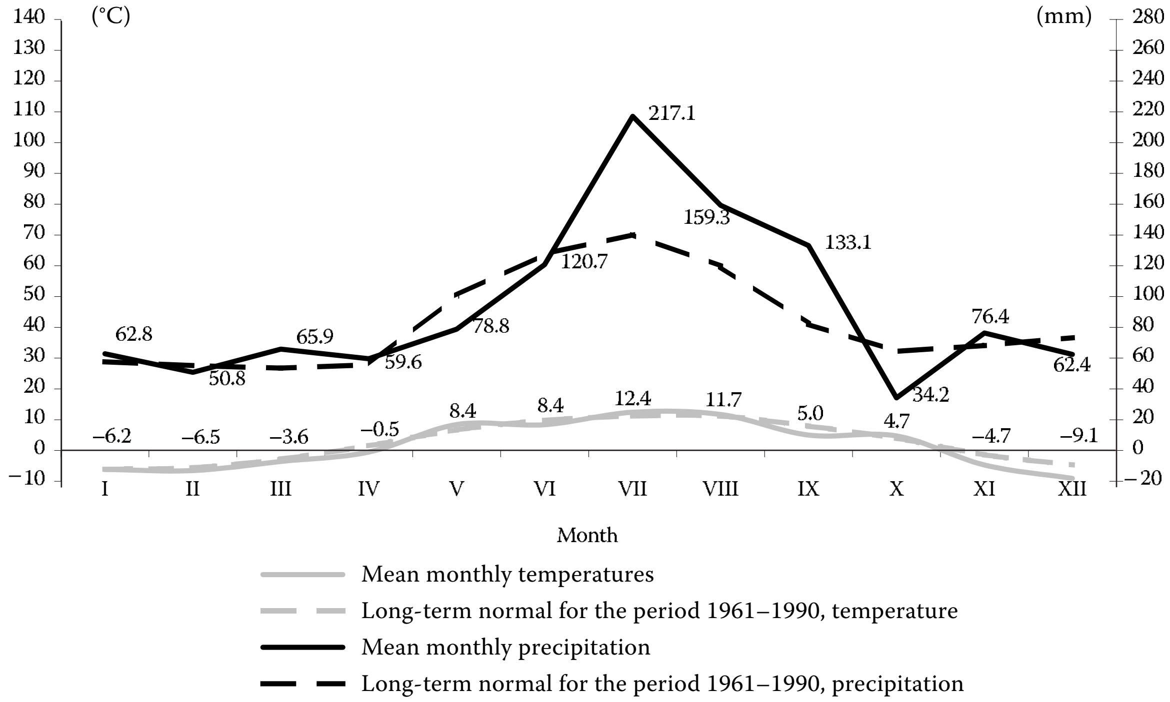

Fig. 4. Comparison of temperatures and precipitation in 2001

perature for the growing season increased above the long-term normal by 1% and mean monthly precipitation was lower by 32%.

In 2000 (Fig. 3), the mean annual temperature was 3.1°C and mean monthly temperature for the growing season was 9.1°C. The total annual amount of precipitation was 992.5 mm and 517.7 mm fell in the growing season. After conversion, the mean monthly temperature for the growing season decreased below the long-term normal by 3% and mean monthly precipitation was lower by 9% against the long-term precipitation normal for the growing season.

During 2001 (Fig. 4), the mean annual temperature was 1.7°C and mean monthly temperature for the growing season was 9.2°C. The total annual amount of precipitation was 1,121.1 mm and 709 mm fell in the growing season. After conversion, the mean monthly temperature for the growing season decreased below the long-term normal by 2% and mean monthly precipitation was higher by 24%.

After the additional evaluation of the studied area from the aspect of mesoclimate according to Lang's rain factor (Table 1), the area was classified as extremely humid, in spite of the generally decreased total precipitation against normal values.

Bionomics, generation cycle and evaluation of population dynamics of *Ips typographus* in the period under study

The survey of felling carried out in the area of NNR Praděd, part Bílá Opava (Table 2) shows the processing of standing and lying trees and wood infested by bark beetles in particular months since 1998. The most extensive disasters caused by bark beetle mass outbreaks occurred in 1998. In May 1998, a wind throw disaster was processed on the eastern boundary of the studied area. Owing to the time delay of processing the attacked wood, a mass outbreak of *Ips typographus* occurred. The maximum

Table 1. Determination of Lang's rain factor for the period 1998–2001

Year	Mean annual precipitation (mm)	Mean annual temperature (°C)	Lang's rain factor	According to Wiegner	Climatic region
1998	981.6	1.6	614	982	extremely humid
1999	766.4	2.0	383	766	extremely humid
2000	992.5	3.1	320	993	extremely humid
2001	1,121.1	1.7	659	1,121	extremely humid

Table 2. Development of the processing of wood from standing, lying and infested trees (m^3) in the area of NNR Praděd, part Bílá Opava, in the period 1998–2001

	Month												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1998					203.3	44.7	69.0		21.5				338.5
1999						56.1	35.4						91.5
2000							100.0	16.7					116.7
2001								89.6	10.2				99.8

number of beetles caught in traps placed in the studied area in that year was 4,000, which corresponds to the medium degree of infestation according to the ON 48 2711 standard. These ministerial standards are old norms, however, no new ones have been proposed until now.

In 1998, spring swarming of *Ips typographus* occurred already at the beginning of May when the mean monthly temperature reached 7°C (Fig. 5). The bark beetle occurring at the edges of a clear-cut and at places of initial regeneration began to swarm a little earlier than in the stand where tree crowns are more closed and a colder microclimate predominates. The swarming was, however, also earlier in parts of the stand with considerably open canopy where the stage of disintegration occurred. Low precipitation and relatively balanced temperatures (Fig. 1) created favourable conditions for its generation cycle.

A subsequent summer swarming occurred from June 15 when mean temperatures steadily increased reaching their maximum of 11.1°C in July. Relatively warm weather and descending trend of precipitation also created conditions for the summer gradation of *Ips typograpghus*. The summer degree of trapping can be considered to be medium similarly like in spring. Maximum trapping amounted to 1,500 bark beetles. The summer swarming was completed as early as at the end of August when a gradual fall in temperatures occurred and, at the same time, there was an increase in precipitation with the maximum value of 150.5 mm in October.

In 1999, *Ips typographus* left its wintering places and began to swarm similarly like in the previous year at the very beginning of May (Fig. 6). Mean temperatures in that month reached only 6.9°C but precipitation was 21 mm less than in the previous year. Lower precipitation totals and only negligible temperature differences compared to the long-term normal were the cause of the early beginning of spring warming. However, the low degree of trapping

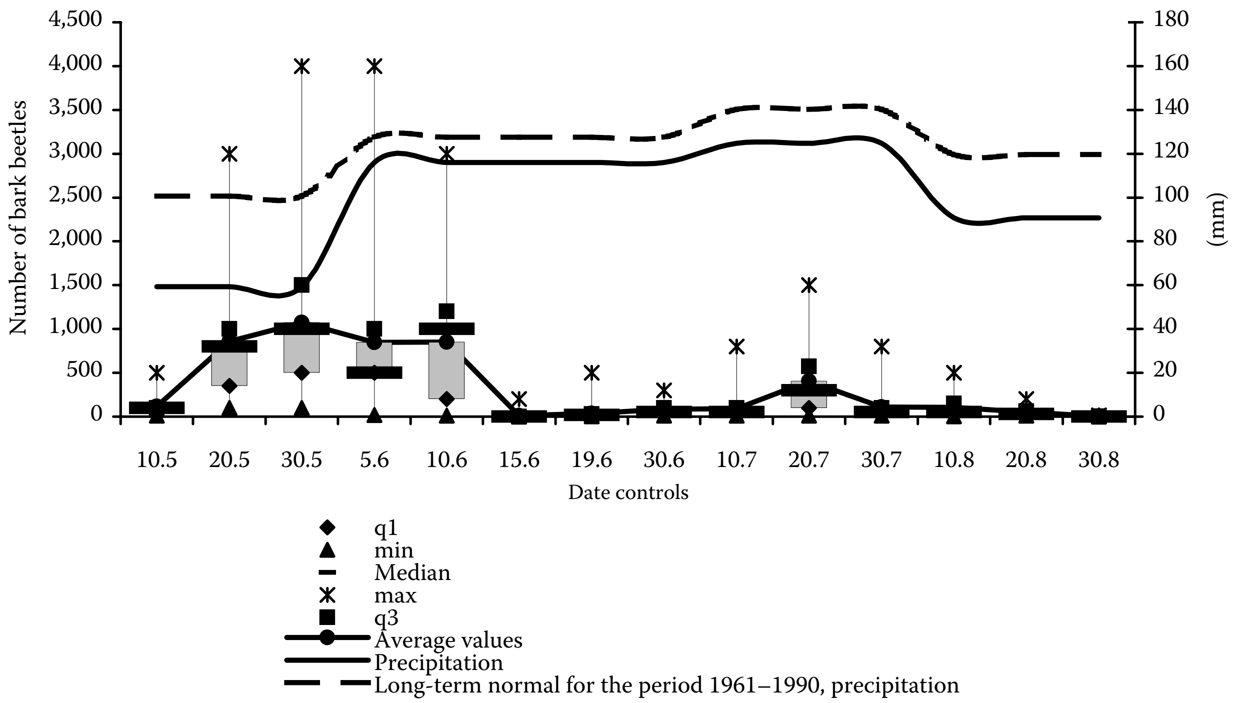

Fig. 5. Box and Whisker diagram – Comparison of numbers of bark beetles collected in traps with the course of precipitation in 1998

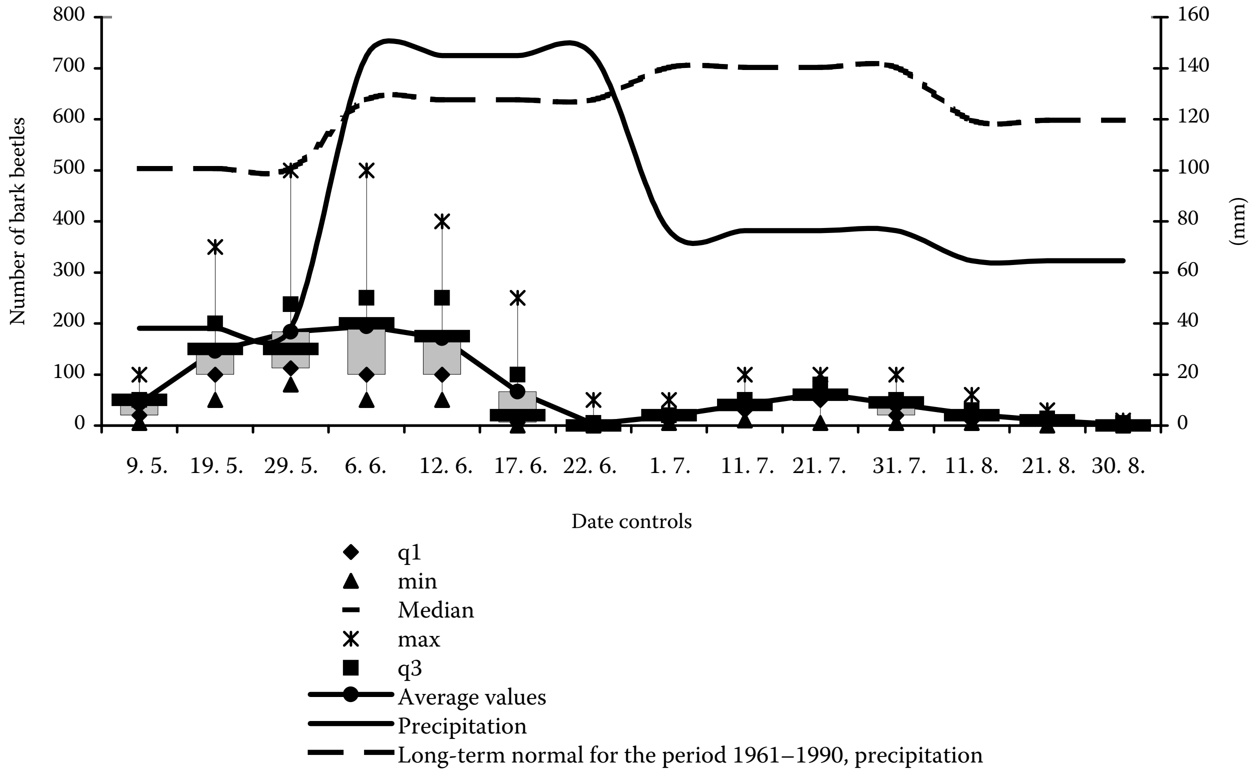

Fig. 6. Box and Whisker diagram – Comparison of numbers of bark beetles collected in traps with the course of precipitation in 1999

during spring swarming (500 bark beetles) was a consequence of the following increase in precipitation that reached its maximum 144.9 mm in June (Fig. 2). The beginning of summer swarming was June 22 when the increase in temperatures continued and, at the same time, precipitation decreased. Owing to the decreased number of swarming beetles in the spring season the conditions for increased gradation of the summer population of *Ips typographus* were not created and thus catching into traps was only low (100 bark beetles). The termination of summer swarming began at the end of August when temperatures and precipitation gradually decreased.

The beginning of spring swarming in 2000 came on May 16 when average monthly temperatures reached a value of 8.7°C (Fig. 7). Spring swarming in that year began a week later than in 1999. The time shift in leaving winter places and subsequent swarming, which was not identical throughout the studied area, can be explained by the higher precipitation total (even by 34 mm) compared to May 1999. Although temperatures exceeding a long-term normal generally create favourable conditions for the bark beetle swarming, in this case relatively high precipitation distributed within summer months with max. of 152 mm in July (Fig. 3) prevented the formation of larger population gradations. It also corresponded to the low number of beetles (150 bark beetles) caught in traps.

In 2001, swarming began as late as on 20 May at the mean monthly temperature of 8.4°C (Fig. 8). A repeated shift of the beginning of swarming occurred as a consequence of the higher amount of precipitation on average by 40 mm as compared with 1999. Similarly like in the previous year, there were favourable temperature conditions for the swarming of *Ips typographus*, however, high precipitation total with max. 217.1 mm in July (Fig. 4) precluded a higher reproduction. The degree of catching in traps was low again (120 bark beetles). At the end of August 2000 and 2001, an increase in the population values of *Ips typographus* occurred signalising the establishment of a sister generation.

Increase in the number of standing dead trees killed by the bark beetle attack on the plot under study

On the studied plot of 9.60 ha, distribution of bark beetle foci was monitored in the vicinity of 94 marked trees attacked by *Ips typographus*: trees with evident entrance holes in the lower part of the stem or trees with peeled off bark and evident gallery patterns of bark beetles or trees with brownish needles.

In the course of research, only a negligible spread of particular foci occurred. In 1999, only 4 new standing dead trees occurred at the maximum trapping

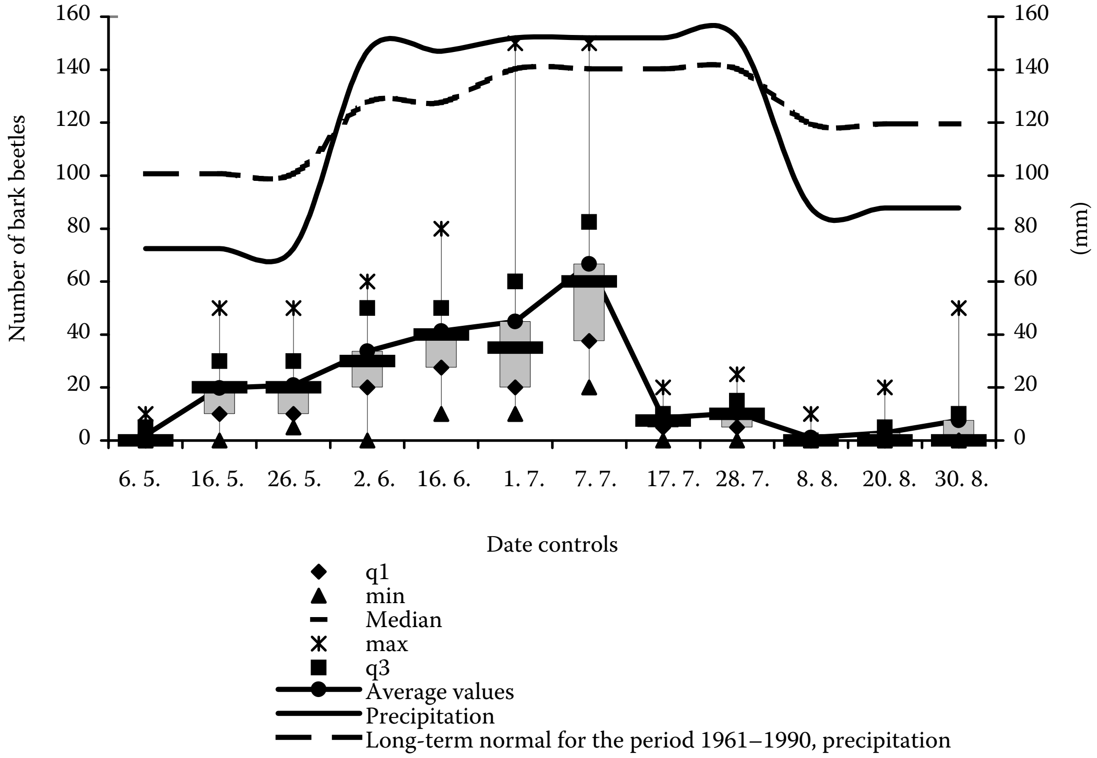

Fig. 7. Box and Whisker diagram – Comparison of numbers of bark beetles collected in traps with the course of precipitation in 2000

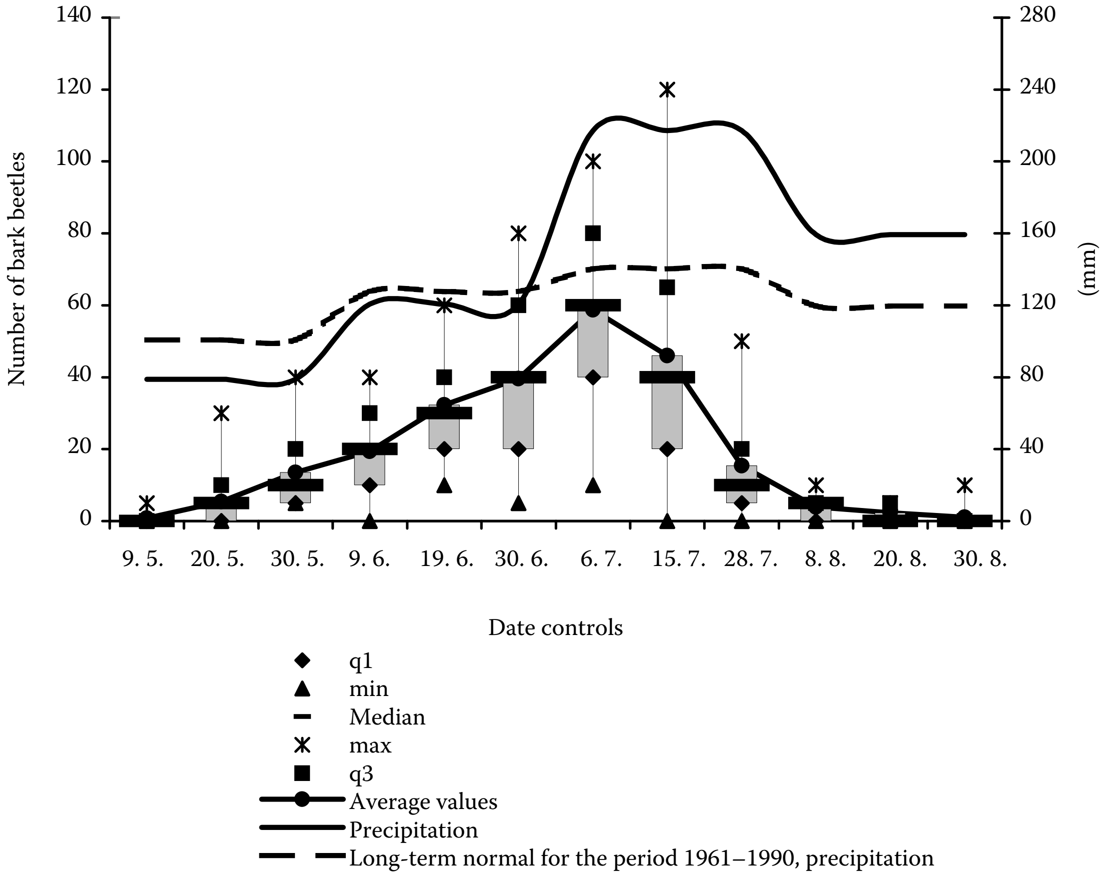

Fig. 8. Box and Whisker diagram – Comparison of numbers of bark beetles collected in traps with the course of precipitation in 2001

of 300 *Ips typographus* beetles in the nearest trap. In 2000, when 8 new standing dead trees appeared, only 60 beetles of *Ips typographus* were caught. The same number of swarming bark beetles was also caught in 2001 but the number of new standing dead trees increased to eleven.

Standing dead trees in the vicinity of marked trees originated due to the effect of *Ips typographus*. At its mass invasion the bark beetle attacks already weakened trees owing to the effect of predisposition factors, in this case above all decreased precipitation total and air pollution.

Composition of bark beetles and invasion density on attacked wood

In 1998–2001, an analysis of twelve lying stems was carried out in the studied area when the species composition of bark beetles was determined and, at the same time, the invasion density of *Ips typographus* and *Ips amitinus* was determined on the attacked stems. In the analysis of lying dead trees, the following species were detected in the basal parts of stems: *Xyloterus lineatus* (Olivier), *Hylurgops palliatus* (Gyllenhal) and *Dryocoetes autographus* (Ratzeburg). In the branches of the upper part of the crown, *Pityophthorus pityographus* (Ratzeburg) and to a lower degree also *Pityogenes chalcographus* (L.) were found.

When determining the invasion density on attacked stems, the occurrence of *Ips amitinus* was monitored in the crown part and of *Ips typographus* in the central part of the stem (Table 3). Through the analysis of invasion density, the high degree of attack (according to ON 48 2711 standard) by both bark beetles was found on stems only in 1998. In 1999, the heavy invasion of *Ips typographus* occurred again but of lower density than in the previous year and, at the same time, low to medium invasion of *Ips amitinus*. In the last two years of the research, only low to medium invasion of *Ips typographus* occurred and low invasion of *Ips amitinus* which was not present in some stems at all. Gallery patterns of *Ips typographus*, which was the most numerous in the investigated stems, amounted to the maximum density of 3 entrance holes per 1 dm^2 in 1998. *Ips amitinus* occurring on attacked stems to a lesser degree throughout the time of investigation reached its maximum invasion density also in 1998 (1.5 entrance holes per 1 dm^2).

The proposal of *Ips typographus* management in the area of NNR Praděd

If we want to manage mountain spruce forests in the area of NNR Praděd in a natural way or at least to preserve or create the natural structure of stands at their regeneration, we should also admit destruction activities of pathogens. Of course, this is valid only to such an extent that can be considered as natural. Therefore, it is relevant to use the term "regulated disintegration" for adequate management, i.e. controlled natural development and disintegration by means of pathogens. Clearly, its application cannot be adopted generally and used irrespective of the evaluation of local situation.

Within the management proposal for *Ips typographus* in the area of NNR Praděd, sanitation felling can be recommended only for new windfalls and windbreaks while "active trees attacked by bark beetles" and sterile standing dead trees should be preserved to their natural development. Possible sanitary measures are implemented by the barking of lying stems left on the spot. These stems can simultaneously be used as trap trees. Barking should be carried out in the stage when larvae or first pupae occurred under bark. As a part of the measures numerical and graphical records were proposed to be held by Forests of the Czech Republic Co. As a defensive mechanism against the bark beetle swarming, traps should be installed at endangered and other suitable places in numbers corresponding

Table 3. Invasion density of bark beetles on attacked wood in the period 1998–2001 (according to ON 48 2711)

Species	Statistical data	Number of entrance holes per 1 dm^2			
		1998	1999	2000	2001
Ips typographus (L.)	average value	2.75	1.75	0.58	0.58
	dispersion	0.25	0.25	0.14	0.14
	max.	3.00	2.00	0.75	0.75
	min.	2.50	1.50	0.50	0.50
Ips amitinus (E.)	average value	1.33	0.58	0.17	0.17
	dispersion	0.29	0.14	0.14	0.14
	max.	1.50	0.75	0.25	0.25
	min.	1.00	0.50	0.00	0.00

to the mass outbreak basis in spring and summer. In the stands in the area of the NNR, only new windfalls and windbreaks should be used as trap trees, otherwise it is necessary to place pheromone-baited traps in sufficient numbers (preferably combined or star-shaped ones, e.g. Theysohn type).

The removal of sterile dead trees by means of felling is excluded. With respect to the danger of damage to stands by SW and W winds, these dead trees slow down the movement of air, slightly shade the area being also functional for regeneration. Wood from wind disasters exceeding the rate of concentrated occurrence (= minimum number of 15 standing dead trees per 3 ares) of windfalls and windbreaks will be skidded cautiously, leaving at least 30% of the volume on the spot (Mrkva 1997). This will permit to ensure the sufficient amount of biomass for subsequent regeneration. The wood can suitably be used as trap trees. However, it has to be processed and barked or disposed in the forest before the emergence of a new generation of *Ips typographus*. Chemical treatment of standing and lying trees and wood infested by bark beetles including trap trees by means of biocides is banned according to the Czech law, § 26, section 3, letter a). It is proposed to intensify bark beetle control measures in neighbouring commercial stands.

An important condition to implement management measures mentioned above is the knowledge of weather factors and particularly precipitation, i.e. the conditions when no mass outbreak of *Ips typographus* and subsequent damage to neighbouring stands occurred in the course of research. In case drought episodes with a deviation of monthly precipitation totals from the long-term normal exceeding 32% (Fig. 2) occur in three successive months during the growing season, a meeting of the representatives of Forest District Karlovice (Silesia) and Jeseníky PLA Administration should be arranged. They should decide on a further procedure which part of the network of marked trees attacked by *Ips typographus* has to be checked.

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Populační dynamika lýkožrouta smrkového (*Ips typographus* [L.]) na území NPR Praděd v letech 1998–2001

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ABSTRAKT: Práce se zabývá sledováním bionomie a populační dynamiky lýkožrouta smrkového (*Ips typographus* [L.]) na území Národní přírodní rezervace Praděd. Vyhodnocování výsledků bylo provedeno na základě zjištěných požerků, brouků odchycených do lapačů, ale také podle četnosti výskytu či přírůstu počtu kůrovcových souší na vyznačených lokalitách, kde se neprováděla asanační opatření. Nakonec bylo provedeno vyhodnocení současného stavu porostu a populační dynamiky lýkožrouta smrkového. Ze zjištěných dat vyplynulo, že se současné porosty nacházejí ve stadiu rozpadu, kde má lýkožrout nezastupitelnou roli. Na základě získaných poznatků byl navržen management lýkožroutů, jímž lze dosáhnout tzv. regulovaného rozpadu přirozených smrčin na území Národní přírodní rezervace Praděd.

Klíčová slova: *Ips typographus* (L.); populační dynamika; management lýkožrouta smrkového; NPR Praděd; regulovaný rozpad

Práce sleduje populační dynamiku a bionomii druhu *Ips typographus* (L.) na území Národní přírodní rezervace Praděd. V NPR Praděd, v části Bílá Opava, se nachází studovaná plocha o rozloze 9,60 ha. Zde bylo v roce 1996 označeno 94 tzv. „kůrovcových stromů“, u kterých se neprováděla žádná asanační opatření. Za kůrovcové stromy byly považovány stromy napadené druhem *Ips typographus* a *Ips amitinus* (Eichhoff) se zřetelnými závrty v dolní části kmene, stromy s odlupující se borkou a zřetelnými požerky kůrovců nebo jedinci s rezivějícím jehličím. V okolí takto označených stromů bylo sledováno šíření lýkožroutů v ohniscích. V průběhu výzkumu docházelo pouze k nepatrnému rozšiřování kůrovcových ohnisek. V roce 1999 vznikly čtyři nové souše při maximálním odchytu 300 brouků druhu *Ips typographus* v nejblíže umístěném lapači. V roce 2000 vzniklo osm souší při maximálním odchytu 60 brouků a při stejném odchytu v roce 2001 vzniklo 11 nových souší.

Populační dynamika druhu *Ips typographus* byla sledována pomocí čtyřiceti lapačů typu Theysohn, z nichž tři byly na studované ploše. Zjištěné početní stavy byly dále porovnány s průběhem teplot a srážek ve sledovaném období. Z evidence těžebních zásahů je zřejmé zpracování větrné kalamity v roce 1998 (tab. 2), jejíž pozdní zpracování se projevilo i při jarním rojení lýkožroutů. Na základě pravidelných kontrol lapačů byl v roce 1998 zjištěn střední stupeň napadení (podle ON 48 2711) při maximálním odchytu 4 000 brouků (obr. 5). V následujících letech poklesl stupeň napadení na slabý při odchytu 500 brouků v roce 1999 (obr. 6), pouhých 150 brouků v roce 2000 (obr. 7) a 120 brouků v roce 2001 (obr. 8).

Podobných výsledků bylo dosaženo také analýzou hustoty náletu napadených kmenů, kdy byl v korunové části zkoumán *Ips amitinus* a ve střední části kmene *Ips typographus*. K tomuto účelu byly každý rok vybrány tři zlomy. Na těchto kmenech byl spočítán počet závrtů v nejhustěji napadené části, na ploše 20 dm^2 souvislého povrchu kůry. Pak byl proveden přepočet na 1 dm^2 a určen stupeň napadení kmene podle ON 48 2711. V roce 1998 byl zjištěn silný stupeň napadení oběma lýkožrouty při maximální hustotě 3 závrtů/dm^2 druhu *Ips typographus* a 1,5 závrtů/dm^2 druhu *Ips amitinus* (tab. 3). V následujícím roce byl zjištěn opět silný stupeň napadení druhem *Ips typographus* a pouze slabý až střední stupeň napadení druhem *Ips amitinus.* V posledních dvou letech proběhl pouze slabý až střední stupeň napadení druhem *Ips typographus* a pouze slabý stupeň napadení *Ips amitinus*, který na některých kmenech nebyl zastoupen vůbec. Při dalším rozboru ležících kmenů byl v bazální části nalezen druh *Xyloterus lineatus* (Olivier), *Hylurgops palliatus* (Gyllenhal) a *Dryocoetes autographus* (Ratzeburg). Dále na větvích v horní části koruny druh *Pityophthorus pityographus* (Ratzeburg) a v menší míře také *Pityogenes chalcographus* (L.).

Porovnáním průběhu teplot a srážek ve sledovaných letech s normálovým obdobím 1961–1990 byla zjištěna teplotní oscilace kolem dlouhodobého normálu v intervalu +3 °C až –3 °C (obr. 1–4). Průměrné měsíční teploty za vegetační období se v roce 1998 pohybovaly 3 % pod dlouhodobým normálem a průměrné měsíční srážky byly nižší o 10 %. V roce 1999 se zvýšila průměrná měsíční teplota za vegetační období o 1 % nad dlouhodobý normál, ale srážky byly nižší o 32 %. V roce 2000 klesly průměrné měsíční teploty za vegetační období o 3 % a průměrné měsíční srážky o 9 % pod dlouhodobý normál za vegetační období. V roce 2001 byly průměrné měsíční teploty za vegetační období proti dlouhodobému normálu nižší o 2 % a průměrné měsíční srážky byly vyšší o 24 %. Při doplňkovém hodnocení sledovaného území z hlediska mezoklimatu podle Langova dešťového faktoru (tab. 1) bylo území označeno za extrémně humidní (i přes všeobecně snížený srážkový úhrn vůči normálovým hodnotám).

Na základě zjištěných poznatků byl dále formulován návrh managementu lýkožrouta smrkového na území NPR Praděd. V něm se doporučuje asanace pouze čerstvých vývratů a zlomů, přičemž aktivní kůrovcové stromy a sterilní souše by měly být ponechány svému vývoji. Případná asanace je možná odkorněním ležících kmenů, které se ponechají na místě. Ty je možné využít současně jako lapáky v počtu odpovídajícímu kalamitnímu základu. Lapáky se v potřebném počtu doplní feromonovými lapači (nejlépe sdružené nebo hvězdicovité, např. typu Theysohn). Likvidace sterilních souší těžbou je vyloučena. Tyto souše s ohledem na nebezpečí ohrožení porostů jihozápadním a západním větrem snižují pohyb vzduchu, mírně stíní plochu jako celek a jsou funkční i hydricky pro obnovu v zástinu. Vyklidit a odvézt je možné pouze dřevní hmotu z větrné kalamity převyšující míru soustředěného výskytu (což je nejméně 15 souší na ploše 3 arů) s ponecháním minimálně 30 % objemu na místě (Mrkva 1997) na zajištění dostatečného množství biomasy pro následnou obnovu pod porostem. Dřevní hmota se může vhodně využít jako stromové lapáky. Chemická asanace kůrovcového dříví včetně lapáků pomocí biocidů je podle § 26 odst. 3 písm. a) zákona zakázána. V okolních hospodářských porostech je navrženo zintenzivnit protikůrovcová opatření.

Důležitým předpokladem pro realizaci navrženého managementu je znalost průběhu počasí a zejména srážek, za kterých nedošlo během výzkumu ke kalamitnímu přemnožení lýkožrouta a k následným škodám na okolních porostech. V případě výskytu epizody sucha s odchylkou měsíčních srážkových úhrnů od dlouhodobého normálu větší než 32 % (obr. 2) ve třech po sobě jdoucích měsících během vegetace by se mělo vyvolat jednání mezi zástupci LS Karlovice ve Slezsku a Správou CHKO Jeseníky. Na tomto jednání by se mělo rozhodnout o dalším postupu, jehož součástí by měla být i kontrola sítě označených, lýkožroutem napadených stromů.

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