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Quality of Valuable Habitats

Designed to cover changes in the quality of valuable habitats, the Z11 indicator now presents initial results regarding mires. While mires do not qualify as biodiversity hotspots—indeed, they harbor a relatively small number of animal and plants species—, mire-dwelling organisms typically rely on this type of habitat, i.e. they do not occur anywhere else. In addition to being rare to begin with, many mire-dwellers are already redlisted. Mires themselves are fairly rare elements of the landscape and, as such, in need of protection.

Between 1997 and 2006, mires in Switzerland went through a substantial decrease in quality. Roughly one quarter turned into considerably drier, more nutrient-rich ecosystems during this period. Moreover, approximately one fifth incurred a significant loss in peat content. In almost one third of all Swiss mires, the share of woody plants increased greatly. Due to these developments, mires gradually lose their characteristic features. Roughly 15% of all mires sustained a noticeable loss in mire nature.

The overall surface area of raised bogs and fens was minimally reduced by roughly 1%. However, surface shares among mire types have shifted: raised bogs shrank by 10%, peat-forming fens decreased by 6%, and non-peat-forming fens increased by 9%.

Despite their success, regenerative measures are few and far between and therefore unable to offset losses in quality.

Contents

Changes in mire quality nationwide

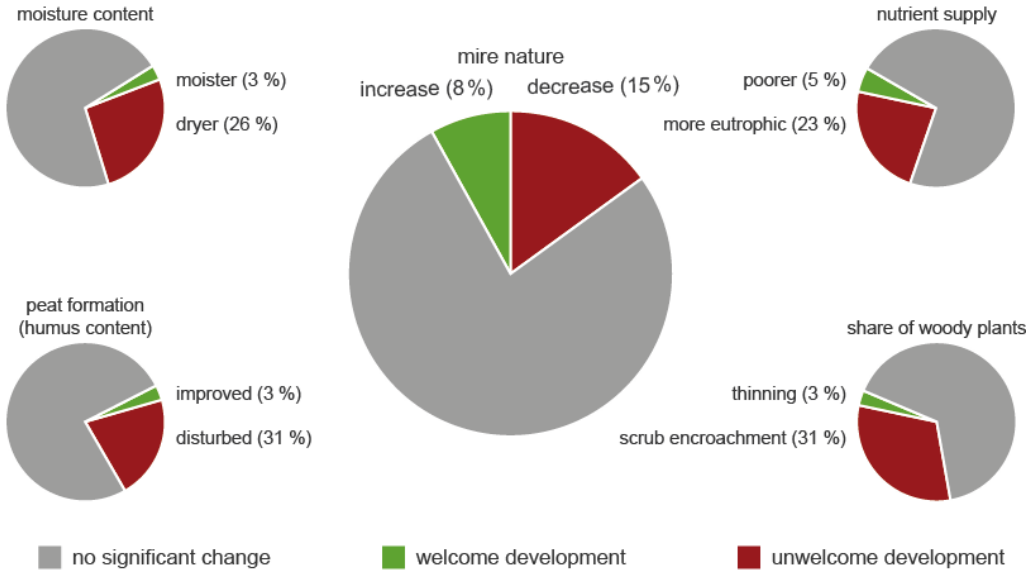
Changes observed considering various characteristics

In the period under observation, i.e. between the initial survey of 1997/2001 and the second survey of 2002/2006, raised bogs and fens of national importance declined in quality:

- As measured by the share and the degree of vegetative cover claimed by typical mire species, 15% of mires underwent a distinctive loss in mire nature.
- More than 25% of mires became considerably drier.
- Just under 25% of mires registered a distinctive increase in nutrient supply.
- Almost 33% of mires harbor substantially higher numbers of woody plants.
- Almost 33% of mires had the humus content of their soils distinctly diminished.

Fig. 1: Changes in mire quality

Initial survey 1997/2001; second survey 2002/06. An individual mire is considered to have undergone significant changes if net changes affect at least 10% of its surface and these changes can be evidenced with an error probability of less than 10%.

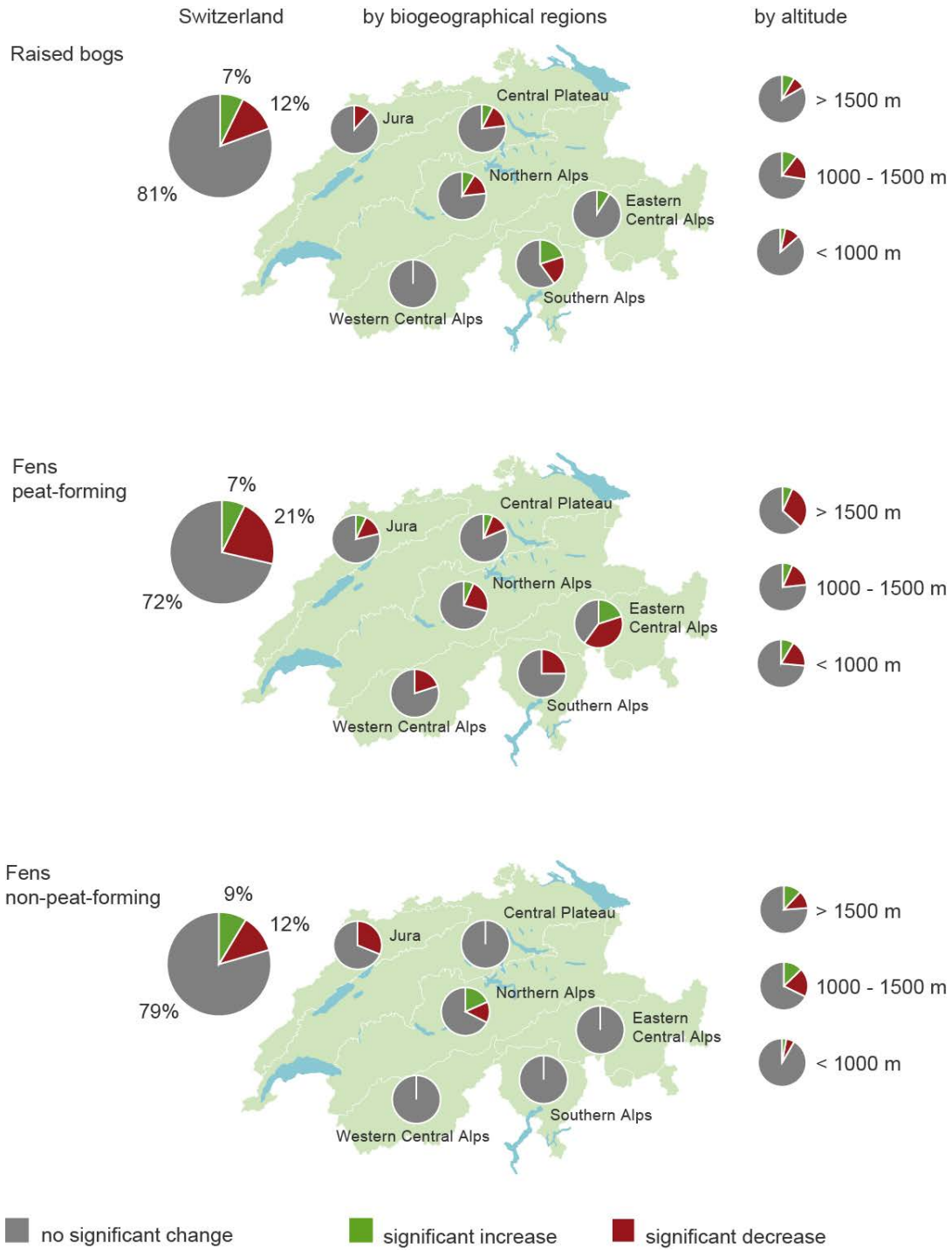


Development in Switzerland and in the regions

Changes in mire nature

Changes in the nature of mires in Switzerland and its regions measured by the so-called mire index. The mire index reflects the share of typical mire species in the vegetation as well as their degrees of species cover. An increasing mire index equals an increase in mire nature. Period under observation: 1997/2001 until 2002/2006.

Fig. 2: Changes in mire nature (increase = positive)



Interpretation example

During the period under observation, four fifths of Switzerland's raised bogs did not undergo any significant change. The mire index of raised bogs sustaining a significant change has mostly been decreasing.

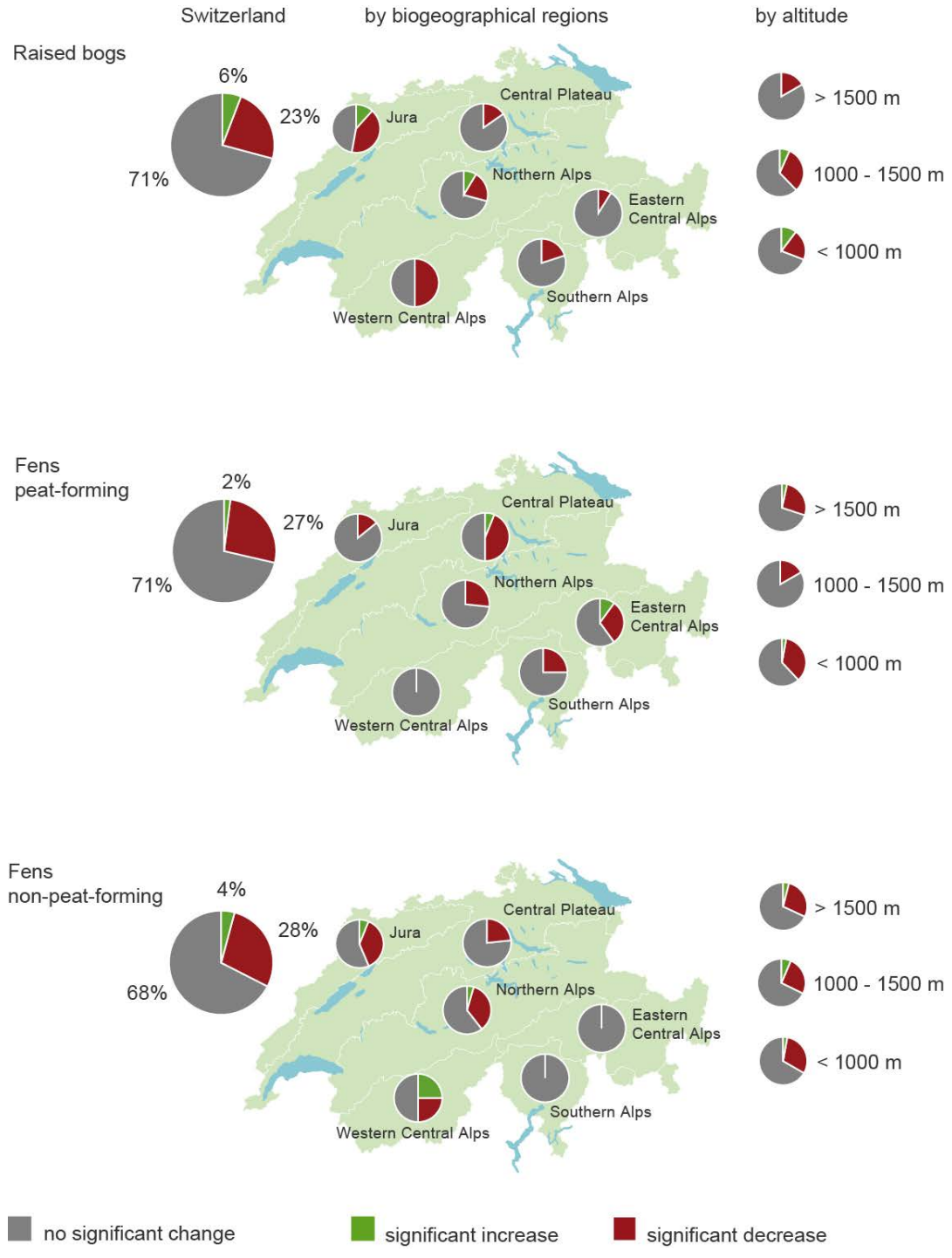
Comments

- Even though the sites concerned continue to be considered mires, these changes are alarming, since more mires are losing in mire nature than gaining it.
- On the whole, the ratio of sites characterized by increasing mire nature to sites characterized by decreasing mire nature is neutral or negative. Exceptions to this rule are provided by raised bogs in the Eastern Central Alps and non-peat-forming fens in the Northern Alps. Comparatively speaking, the least degree of change is observed in non-peat-forming fens.

Changes in moisture content

Changes in the moisture content of mires in Switzerland and its regions, measured by moisture value. The drier a mire, the lower its moisture value. Period under observation: 1997/2001 until 2002/2006.

Fig. 3: Changes in moisture content (increase = positive)



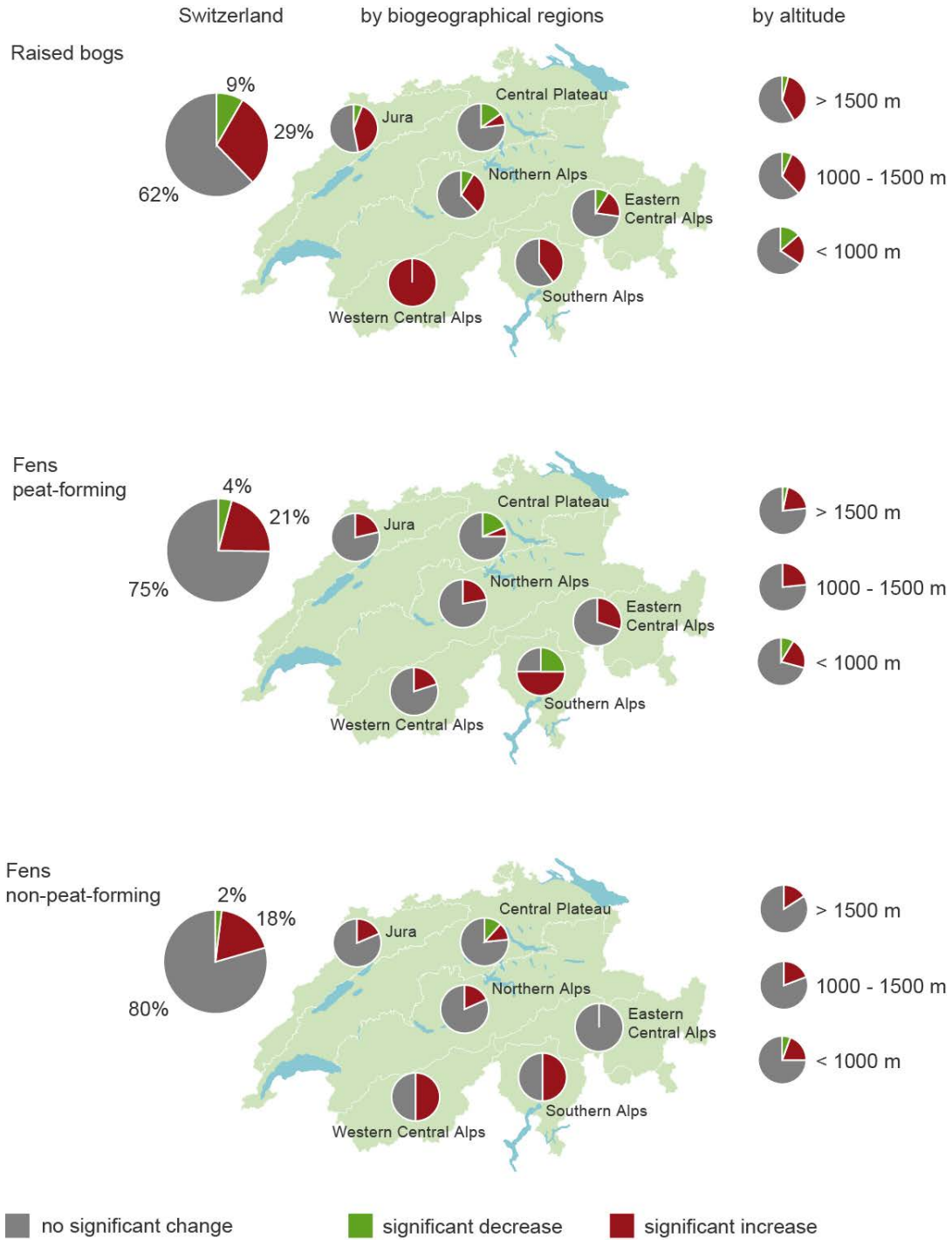
Comments

- Constant moisture due to a surplus of water is a central feature of mires. When they start to dry up, their mineralization rate rises and, as a result, so does their nutrient content. In addition, the probability of scrub encroachment increases.
- Roughly one third of Switzerland's mires registered a significant change in their water balance. In general, they have become drier. Only isolated raised bogs have become moister, a development in which regenerative measures are likely to have played their part.
- Regional developments, while varied, follow the overall trend towards drier mires. Peat-forming fens on the Central Plateau and non-peat-forming fens in the Jura and in the Northern Alps are affected by the most marked trend towards desiccation.

Changes in nutrient supply

Changes in the nutrient supply of mires in Switzerland and its regions. Period under observation: 1997/2001 until 2002/2006.

Fig. 4: Changes in nutrient supply (increase = negative)



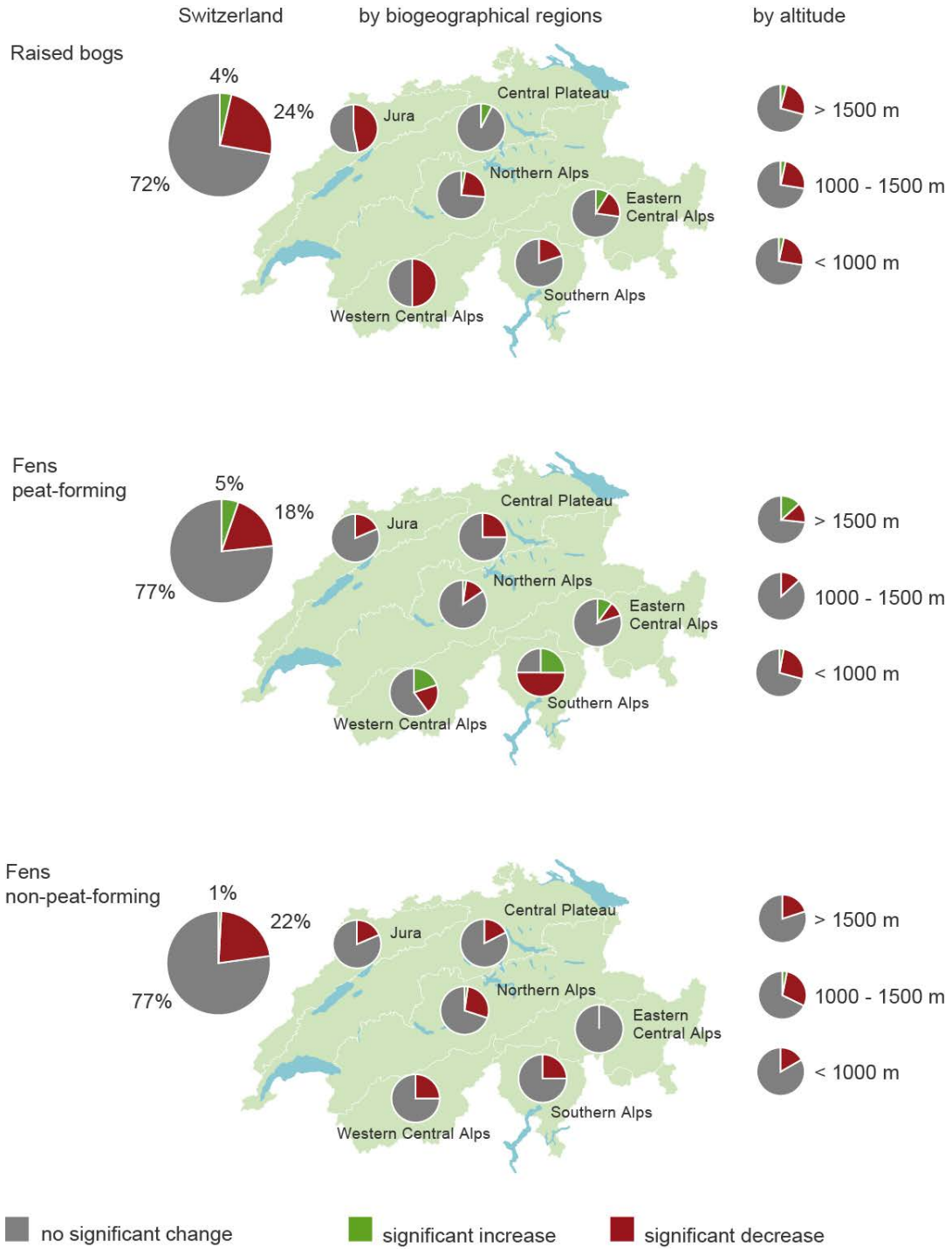
Comments

- Nutrient deficiency is relative. Mires in general are considered to be nutrient-deficient, with raised bogs being extremely poor in nutrients.
- Communities typical of raised bogs and peat-forming fens are adapted to nutrient deficiencies in their environment. Any increase in nutrient entry has a negative impact on such types of vegetation, since typical mire plants will be crowded out by other, faster growing species. Hence, mire nutrient supply is not supposed to increase.
- Mire nutrients originate from various sources. Direct airborne nutrient entries mostly consist of nitrogen oxides and ammonia, with the former mainly produced by motorized traffic and the latter by agriculture. However, nutrients also enter mires by way of—usually illegal—fertilization. In addition, nutrients are absorbed from neighboring agricultural land or inflowing water. Mires also increase their nutrient supply as a result of organic materials releasing nutrients due to desiccation and mineralization.
- Alarmingly, nutrient supply has increased in all three mire types!
- Mire nutrient supply has grown at all altitudes, with high-altitude raised bogs apparently most markedly affected by this development.
- For exact reasons unknown, the only region to feature a narrow overall majority of positive changes is the Central Plateau.

Changes in humus content

Changes in the humus content of mires in Switzerland and its regions, measured by humus value. Period under observation: 1997/2001 until 2002/2006.

Fig. 5: Changes in humus content (increase = positive)



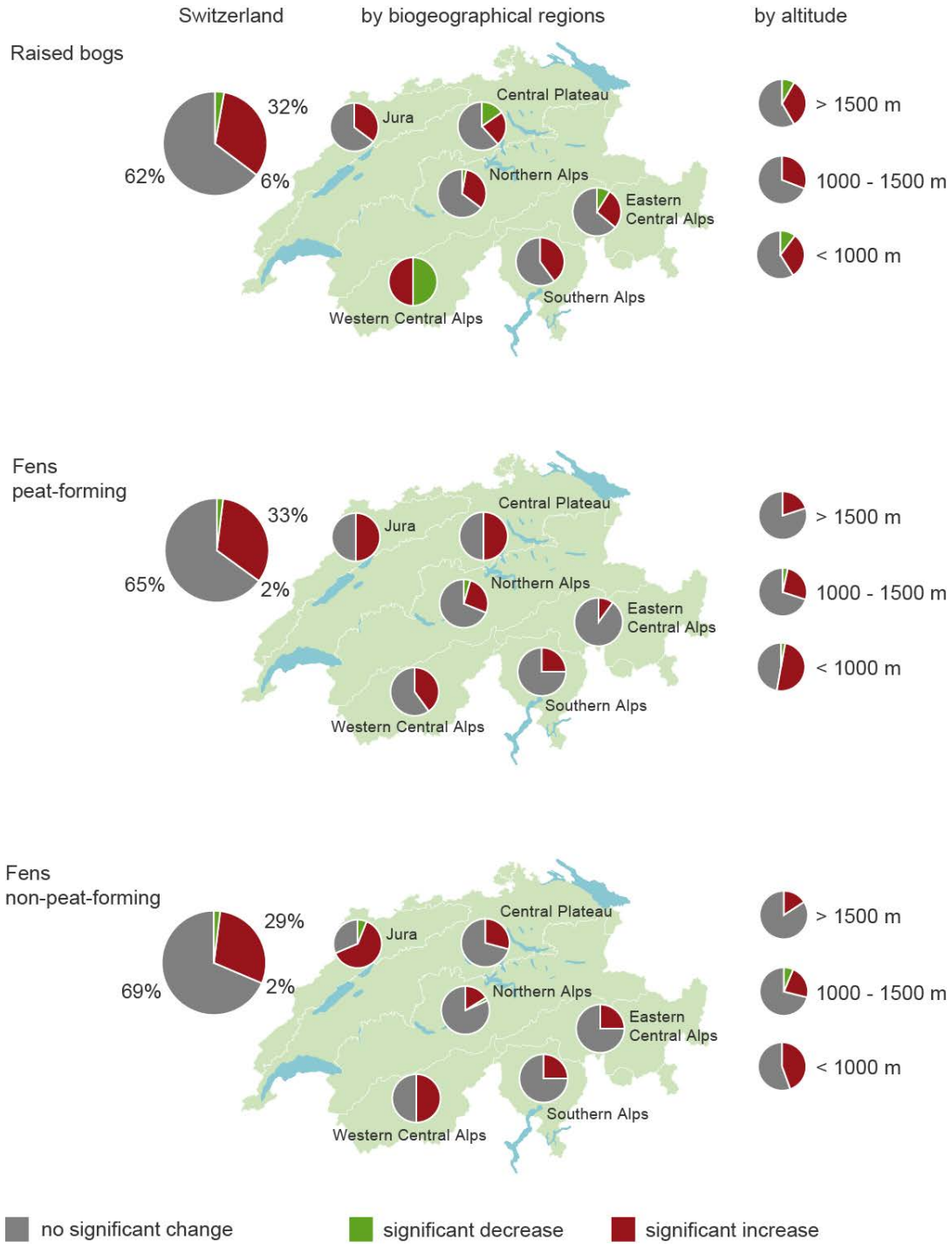
Comments

- A mire's humus value indicates the amount of organic substances found in its soil.
- Mire soils are characterized by high contents in organic substance. When there is more organic substance being stored than decomposed, the resultant peat strata may reach immense thicknesses over time, creating carbon sinks.
- For peat strata to form, it takes a surplus of water generating an oxygen-deficient, reducing environment. Draining mires causes them to desiccate, which introduces oxygen into the soil, accelerating the decomposition of organic material. As a result, mires turn into carbon sources.
- The humus value has dropped significantly in roughly one fifth of Switzerland's mires, above all affecting raised bogs—a disturbing development indeed.
- Developments in the regions are rather uniform, with humus content decreasing almost everywhere and concerning all three mire types. There are a few exceptions, e.g. raised bogs on the Central Plateau, but these cannot offset the negative overall trend.

Changes in the share of woody plants

Changes in the share of woody plants in mires in Switzerland and its regions. Period under observation: 1997/2001 until 2002/2006.

Fig. 6: Changes in the share of woody plants (increase = negative)



Comments

- Composed mostly of birch, alder, or Scots pine, fen woodlands, while being peat-forming fens, are not covered by any Federal Mire Inventory, since they are considered to be part of Switzerland's forestland. Hence, they are primarily governed by the Federal Law on Forests rather than the Federal Law on the Protection of Nature and Cultural Heritage.
- Isolated trees or shrubs, typically of stunted growth, are a normal mire component. However, a closed shrub or tree layer will displace the light-loving mire vegetation. In raised bogs, an increase of woody plants is usually caused by disturbances of the water balance. Fens undergo scrub or forest encroachment due to a combination of insufficient land use (when they are no longer mowed or grazed) and desiccation.
- From a nature conservation point of view, scrub or forest encroachment of mires is always an unwelcome development, as it turns near-natural open country into forest, causing the typical mire vegetation to disappear.
- The share of woody plants is increasing in almost a third of all mires.
- The large number of raised bogs affected by an increasing share of woody plants reflects disturbances in the water balance.
- Scrub and forest encroachment of fens, particularly lowland fens, is likely to be the result of insufficient land use, with the process being accelerated by desiccation.
- There are no major regional differences. In lowland fens, scrub encroachment tends to progress faster than in highland fens. This development does not seem to affect raised bogs to the same extent.

Surface area losses and gains of all three mire types

Tab. 1: Surface area losses and gains in sampling areas. Gains and losses were extrapolated to Switzerland's overall mire area. Period under observation: 1997/2001 until 2002/2006.

Vegetation units	Sampled area in ha, initial survey	Sampled area in ha, second survey	Gains/losses in ha	Gains/losses in %	Extrapolation to Switzerland's overall mire area
Raised bogs	63.9	59.0	-4.9	-7.7	-10.0% ± 2.3 % (-150 ha)
Fens peat-forming	44.7	42.4	-2.3	-5.1	-6.1% ± 1% (-510 ha)
Fens non-peat-forming	44.9	49.7	+4.8	+10.7	+9.3% ± 1.4% (+540 ha)
Nonmires	34.3	36.7	+2.4	+7.0	+5.1% ± 1.9% (+120 ha)

Interpretation example

Sampling the “raised bogs” vegetation unit yielded 63.9 hectares in the initial survey and 59.0 hectares in the second survey, corresponding to a loss of 4.9 hectares or 7.7%. Hence, extrapolated to Switzerland’s overall raised bog area, the surveys registered a 10.0% loss with a 95% confidence interval of ±2.3%.

Source

All information is based on the results of the Swiss Mire Monitoring Program by the Swiss Federal Institute for Forest, Snow and Landscape Research WSL as commissioned by the FOEN. For more information, please refer to Klaus, G. (ed.): *Zustand und Entwicklung der Moore in der Schweiz. Ergebnisse der Erfolgskontrolle Moorschutz*. Status: June 2007. Federal Office for the Environment, 97 p. (not available in English). For BDM purposes, data applying to Switzerland’s six biogeographical regions were recalculated by Meinrad Küchler of the WSL.

Status

Data 2007. The Z11 indicator will be updated after the end of the Swiss Mire Monitoring Program’s next surveying period and/or complemented once additional Federal Habitat Inventories have produced monitoring results.

Significance for biodiversity

Mires are isolated patch habitats, but they are not biodiversity hotspots, i.e. sites featuring a particularly high number of species. As a matter of fact, mires—above all raised bogs—are rather poor in species, even though they enclose markedly differing types of vegetation. With their water level permanently high, mires are wet and, apart from calcareous small sedge fens, very acid and nutrient-deficient. Furthermore, despite their increased occurrence in certain regions, mires are rare. After an estimated 90% of all mires have disappeared to this day, they now amount to a mere 0.54% of Switzerland's overall expanse.

Raised bogs and fens of national importance harbor roughly one fourth of all endangered vascular plant species in Switzerland. Each vegetation type offers a habitat for its own range of specific species, which makes mires irreplaceable. Particularly high numbers of endangered plant species grow in so-called hollows, shallow basins typical of intact raised bogs. Almost 10% of plant species to be found in hollows are on Switzerland's Red List of endangered ferns and flowering plants.

Aside from specialized plants, especially various peat mosses and lichens occurring only in these habitats, mires are also home to specialized fungi and animals. A large number of dragonfly species, for example, cannot exist without hollows, rills (drainage channels) and bog ponds. If these structures were to disappear, so would such specialized species, as they have no alternative habitat to escape to. The same goes for butterfly species whose caterpillars feed exclusively on mire plants.

Moreover, mires—particularly peat bogs—are biodiversity archives. Not only pollen, but also large remains of plants and animals will be conserved by this acid and water-saturated environment for ten thousands of years. Whenever peat bogs dry up, the peat is mineralized, irreversibly destroying the archives it contains.

Last but not least, mires are important elements of the landscape and as such of biodiversity, albeit on an ecosystem level.

Definition

Changes in average quality features of individual habitat types registered in Federal Inventories subject to the Federal Law on the Protection of Nature and Cultural Heritage

Operational definitions are listed under "Surveying methods".

Surveying methods

Surveying covers a representative sample consisting of 102 1-km^2 sampling areas, each containing at least one raised bog or fen site of national importance, with all size categories, mire types, altitudinal zones, and natural areas adequately represented. Sites are registered by means of infrared aerial photos, which are then used to delimit homogeneous standard surfaces based on colors and patterns. Sized between 100 and 200 square meters, these standard surfaces are field monitored for vascular plants and mosses as well as their degrees of species cover. Combining aerial photo interpretation and field data makes it possible to establish site vegetation maps. Surveys are assigned to certain vegetation types.

Site quality is determined using the following ecologic indicator values of identified plant species:

- moisture value,
- nutrient value,
- humus value,
- light value,
- share of woody plants.

For details, please refer to Klaus (2007) and the literature listed in that publication.

In order to detect changes, we compared initial surveys to second surveys, assessing indicator value changes against targets set by nature conservation policies. An individual mire is considered to have undergone significant changes if net changes affect at least 10% of its surface and these changes can be evidenced with an error probability of less than 10%.

As a matter of principle, the following changes are rated to be favorable developments: waterlogging (increasing moisture value), growing poorness (decreasing nutrient value), peat formation (increasing humus value), thinning (decreasing share of woody plants), and intensification of mire nature (increasing mire index, i.e. increasing diversity and dominance of mire species).

Further information

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Additional sources of information

http://www.bafu.admin.ch/org/index.html?lang=en (FOEN website)

http://www.wsl.ch/index_EN?-C=& (WSL website)

This information is based on the German-language document 1260_Z11_Basisdaten_2015_v1.docx dated April 22, 2015.

Annex

Table 1

Mire index

			Number of surveyed sites	Significant increase	Significant decrease	No significant change	Overall result
Raised bogs	**Mire index**	Switzerland	82	6	10	66	-0.05
		Jura	17	0	2	15	-0.12
		Central Plateau	13	1	2	10	-0.08
		Northern Alps	34	3	5	26	-0.06
		Western Central Alps	2	0	0	2	0.00
		Eastern Central Alps	11	1	0	10	0.09
		Southern Alps	5	1	1	3	0.00
		<1000 m	29	1	3	25	-0.07
		1000-1500 m	29	3	5	21	-0.07
		>1500 m	24	2	2	20	0.00
Fens, peat-forming	**Mire index**	Switzerland	94	7	20	67	-0.14
		Jura	14	1	2	11	-0.07
		Central Plateau	16	1	2	13	-0.06
		Northern Alps	45	3	10	32	-0.16
		Western Central Alps	5	0	1	4	-0.20
		Eastern Central Alps	10	2	4	4	-0.20
		Southern Alps	4	0	1	3	-0.25
		<1000 m	34	3	6	25	-0.09
		1000-1500 m	30	2	5	23	-0.10
		>1500 m	30	2	9	19	-0.23
Fens, non-peat-forming	**Mire index**	Switzerland	92	8	11	73	-0.03
		Jura	16	0	5	11	-0.31
		Central Plateau	17	0	0	17	0.00
		Northern Alps	43	8	6	29	0.05
		Western Central Alps	4	0	0	4	0.00
		Eastern Central Alps	8	0	0	8	0.00
		Southern Alps	4	0	0	4	0.00
		<1000 m	36	1	2	33	-0.03
		1000-1500 m	31	4	6	21	-0.06
		>1500 m	25	3	3	19	0.00

Interpretation example

In 8 out of 92 surveyed non-peat-forming fens in Switzerland, the mire index increased significantly, while it decreased significantly in 11, remaining unchanged in 73. Overall, the survey resulted in a relative change of -0.03, which corresponds to a decrease of 3%.

Table 2

Moisture value

			Number of surveyed sites	Significant increase	Significant decrease	No significant change	Overall result
Raised bogs	**Moisture value**	Switzerland	82	5	19	58	-0.17
		Jura	17	2	7	8	-0.29
		Central Plateau	13	0	2	11	-0.15
		Northern Alps	34	3	7	24	-0.12
		Western Central Alps	2	0	1	1	-0.50
		Eastern Central Alps	11	0	1	10	-0.09
		Southern Alps	5	0	1	4	-0.20
		<1000 m	29	3	6	20	-0.10
		1000-1500 m	29	2	9	18	-0.24
		>1500 m	24	0	4	20	-0.17
Fens, peat-forming	**Moisture value**	Switzerland	94	2	25	67	-0.24
		Jura	14	0	2	12	-0.14
		Central Plateau	16	1	7	8	-0.38
		Northern Alps	45	0	12	33	-0.27
		Western Central Alps	5	0	0	5	0.00
		Eastern Central Alps	10	1	3	6	-0.20
		Southern Alps	4	0	1	3	-0.25
		<1000 m	34	1	12	21	-0.32
		1000-1500 m	30	0	5	25	-0.17
		>1500 m	30	1	8	21	-0.23
Fens, non-peat-forming	**Moisture value**	Switzerland	92	4	26	62	-0.24
		Jura	16	1	6	9	-0.31
		Central Plateau	17	0	4	13	-0.24
		Northern Alps	43	2	15	26	-0.30
		Western Central Alps	4	1	1	2	0.00
		Eastern Central Alps	8	0	0	8	0.00
		Southern Alps	4	0	0	4	0.00
		<1000 m	36	1	11	24	-0.28
		1000-1500 m	31	2	8	21	-0.19
		>1500 m	25	1	7	17	-0.24

Table 3

Nutrient value

			Number of surveyed sites	Significant increase	Significant decrease	No significant change	Overall result
Raised bogs	**Nutrient value**	Switzerland	82	24	7	51	0.21
		Jura	17	7	1	9	0.35
		Central Plateau	13	1	2	10	-0.08
		Northern Alps	34	10	3	21	0.21
		Western Central Alps	2	2	0	0	1.00
		Eastern Central Alps	11	2	1	8	0.09
		Southern Alps	5	2	0	3	0.40
		<1000 m	29	6	4	19	0.07
		1000-1500 m	29	9	2	18	0.24
		>1500 m	24	9	1	14	0.33
Fens, peat-forming	**Nutrient value**	Switzerland	94	20	4	70	0.17
		Jura	14	3	0	11	0.21
		Central Plateau	16	1	3	12	-0.13
		Northern Alps	45	10	0	35	0.22
		Western Central Alps	5	1	0	4	0.20
		Eastern Central Alps	10	3	0	7	0.30
		Southern Alps	4	2	1	1	0.25
		<1000 m	34	7	3	24	0.12
		1000-1500 m	30	7	0	23	0.23
		>1500 m	30	6	1	23	0.17
Fens, non-peat-forming	**Nutrient value**	Switzerland	92	17	2	73	0.16
		Jura	16	3	0	13	0.19
		Central Plateau	17	2	2	13	0.00
		Northern Alps	43	8	0	35	0.19
		Western Central Alps	4	2	0	2	0.50
		Eastern Central Alps	8	0	0	8	0.00
		Southern Alps	4	2	0	2	0.50
		<1000 m	36	7	2	27	0.14
		1000-1500 m	31	6	0	25	0.19
		>1500 m	25	4	0	21	0.16

Table 4

Humus value

			Number of surveyed sites	Significant increase	Significant decrease	No significant change	Overall result
Raised bogs	**Humus value**	Switzerland	82	3	20	59	-0.21
		Jura	17	0	8	9	-0.47
		Central Plateau	13	1	0	12	0.08
		Northern Alps	34	1	8	25	-0.21
		Western Central Alps	2	0	1	1	-0.50
		Eastern Central Alps	11	1	2	8	-0.09
		Southern Alps	5	0	1	4	-0.20
		<1000 m	29	1	7	21	-0.21
		1000-1500 m	29	1	7	21	-0.21
		>1500 m	24	1	6	17	-0.21
Fens, peat-forming	**Humus value**	Switzerland	94	5	17	72	-0.13
		Jura	14	1	3	10	-0.14
		Central Plateau	16	0	4	12	-0.25
		Northern Alps	45	1	6	38	-0.11
		Western Central Alps	5	1	1	3	0.00
		Eastern Central Alps	10	1	1	8	0.00
		Southern Alps	4	1	2	1	-0.25
		<1000 m	34	1	9	24	-0.24
		1000-1500 m	30	0	4	26	-0.13
		>1500 m	30	4	4	22	0.00
Fens, non-peat-forming	**Humus value**	Switzerland	92	1	20	71	-0.21
		Jura	16	0	3	13	-0.19
		Central Plateau	17	0	3	14	-0.18
		Northern Alps	43	1	12	30	-0.26
		Western Central Alps	4	0	1	3	-0.25
		Eastern Central Alps	8	0	0	8	0.00
		Southern Alps	4	0	1	3	-0.25
		<1000 m	36	0	6	30	-0.17
		1000-1500 m	31	1	9	21	-0.26
		>1500 m	25	0	5	20	-0.20

Table 5

Share of woody plants

			Number of surveyed sites	Significant increase	Significant decrease	No significant change	Overall result
Raised bogs	**Share of woody plants**	Switzerland	82	26	5	51	0.26
		Jura	17	6	0	11	0.35
		Central Plateau	13	3	2	8	0.08
		Northern Alps	34	11	1	22	0.29
		Western Central Alps	2	1	1	0	0.00
		Eastern Central Alps	11	3	1	7	0.18
		Southern Alps	5	2	0	3	0.40
		<1000 m	29	9	3	17	0.21
		1000-1500 m	29	9	0	20	0.31
		>1500 m	24	8	2	14	0.25
Fens, peat-forming	**Share of woody plants**	Switzerland	94	31	2	61	0.31
		Jura	14	7	0	7	0.50
		Central Plateau	16	8	0	8	0.50
		Northern Alps	45	12	2	31	0.22
		Western Central Alps	5	2	0	3	0.40
		Eastern Central Alps	10	1	0	9	0.10
		Southern Alps	4	1	0	3	0.25
		<1000 m	34	17	1	16	0.47
		1000-1500 m	30	8	1	21	0.23
		>1500 m	30	6	0	24	0.20
Fens, non-peat-forming	**Share of woody plants**	Switzerland	92	27	2	63	0.27
		Jura	16	10	1	5	0.56
		Central Plateau	17	5	0	12	0.29
		Northern Alps	43	7	1	35	0.14
		Western Central Alps	4	2	0	2	0.50
		Eastern Central Alps	8	2	0	6	0.25
		Southern Alps	4	1	0	3	0.25
		<1000 m	36	16	0	20	0.44
		1000-1500 m	31	7	2	22	0.16
		>1500 m	25	4	0	21	0.16