

*Survey of causes and
economic consequences*



WINTER INJURIES ON GOLF GREENS in the Nordic countries

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Winter injuries on golf greens in the Nordic countries

- Survey of causes and economic consequences

A comprehensive survey conducted in 2015 showed that winter injuries have a large economic impact, especially in the form of lost revenue. Causes of winter injuries vary depending on geography and grass species utilized on the greens. This article summarizes the answers and gives brief comments to some unexpected results.

	DEN	FIN	ICE	NOR	SWE
Number of golf courses (approx.)	150	160	60	170	470
Number of respondents	77	24	40	80	125
Average number of respondents	45	19	25	59	102
Average response rate	30%	12%	42%	35%	22%

Table 1. Response number from golf courses in the Nordic countries

About the survey

There has long been a claim that winter injuries of grass are a significant economic burden for golf courses in the Nordic countries. Estimates, based on observations made by consultants, have been the most important references for this claim. In order to confirm this claim, NIBIO and NFG, with the support of STERF, conducted a net-based survey in 2015 regarding winter injury in the five Nordic countries; Denmark, Finland, Iceland, Norway and Sweden.

For the mapping of winter injuries and to assess their economic consequences in the Nordic countries an Easy Research survey (QuestBack, Oslo, Norway) was used. The survey was distributed to all golf courses through the national golf federations and greenkeeper association with instruc-

tions that the most competent person employed at the golf course should complete the survey. The answers were anonymous.

The survey was composed of 24 questions regarding the courses geographically placement, size and age, grass species, management and use of pesticides during the autumn of 2014, winter injuries 2014 – 15, economically important injuries on the course over the last 5 years (2010-2014) and economic consequences of winter injury.

This article reports these economic consequences independent of the number of golf greens.

Questions of management and injury are reported for an “average green” on the course. 346 people completed the survey, however not all respondents

answered all questions. A total of 325 respondents answered the questions regarding economic impact of winter injury. The number of answers per country and average response rate are presented in Table 1.

Finland had fewest respondents (12% of golf courses). Danish respondents answered fewest questions, possibly because winter damages are less common than in the other Nordic countries.

Extent of winter injuries

The majority of golf courses experienced significant winter injuries between 2010 and 2014. During these five years, the opening date of the course was delayed at least once on 65 % of the courses in Norway, 64 % of the courses in Sweden, 62 % of the courses in Denmark, 53 % of the courses in Finland and 32 % of the courses in Iceland (Table 2). From 2 % to 12 % of the courses responded that course opening date was delayed almost every year due to winter injuries.

Number of years (of 5) with delayed opening	DEN (37)	FIN (17)	ICE (22)	NOR (52)	SWE (97)	Average
	----- % -----					
0	38	47	68	35	36	45
1	16	12	18	40	33	24
2	24	12	0	12	19	13
3	14	18	5	10	9	11
4	3	6	5	4	0	3
5	5	6	5	0	2	4
SUM	100	100	100	100	100	100

Table 2. Number of years course opening was delayed as a result of winter injury in the period between 2010 and 2014. Number of responses in parentheses.



Photo: Agnar Kvalbein

Delayed course opening

Reestablishment of a golf green following winter damages is time consuming. Winter injuries also lead to delayed course opening. Two thirds of the courses delayed opening date by 1 – 2 weeks. The remaining respondents reported a delay of 3 – 8 weeks (Table 3).

Even if the course is opened, it can take a long time before the injuries are fully repaired. The course can have reduced playing quality over an extended period, as reported in Table 4.

A third of the respondents in all of the countries reported that on average it takes 1 – 4 weeks, a third reported that reestablishments take 5 – 6 weeks while the remaining respondents reported that 7 – 8 weeks were required before winter damages were fully repaired. The survey showed that winter injuries took the longest time to repair in Iceland and Norway.

	DEN (32)	FIN (17)	ICE (18)	NOR (54)	SWE (97)	Average
	----- % -----					
1-2 weeks	53	65	83	71	63	67
3-4 weeks	31	24	17	27	35	27
5-6 weeks	13	12	0	2	1	5
7-8 weeks	3	0	0	0	1	1
SUM	100	100	100	100	100	100

Table 3. On average the length of the delay of course opening due to winter injuries in the period 2010 – 2014. Number of responses in parentheses.

	DEN (33)	FIN (18)	ICE (22)	NOR (54)	SWE (97)	Average
	----- % -----					
1-2 weeks	12	6	0	6	4	5
3-4 weeks	30	39	23	11	31	27
5-6 weeks	27	33	32	35	34	32
7-8 weeks	18	17	14	20	21	18
> 8 weeks	12	6	32	28	10	18
SUM	100	100	100	100	100	100

Table 4. Time normally required to completely repair winter injuries. Number of responses in parentheses.



Photo: Agnar Kvalbein

Economic consequences

Winter injuries result in increased costs and loss of revenue. In a normal year 39% of the golf courses used less than 3000 € for labour, equipment, seed, fertilizer, weed control, etc. (Table 5).

Sweden and Norway reported the highest reestablishment costs: 2 % of Swedish courses and 8 % of Norwegian courses used more than 30 000 EUR to repair of playing areas.

The informants estimated the revenue losses in a year with considerable winter injuries. Almost 50 % of courses reported that the loss could be up to 6 000 EUR, 25% reported 6 000 to 12 000 EUR and 25 % had a revenue loss from 12 000 to 60 000 EUR or more, on average for all five countries. (Table 6).

Revenue losses exceeding 45 000 EUR were reported from 14 % of Norwegian, 9 % of Swedish, 6 % of Finish, 5 % of Icelandic and 3 % of Danish courses.

	DEN (35)	FIN (18)	ICE (22)	NOR (53)	SWE (95)	Average
euro (€)	----- % -----					
< 3 000	40	17	59	38	42	39
3 000 - 6 000	26	28	14	30	36	27
6 000 - 9 000	11	28	14	9	11	15
9 000 - 12 000	9	17	5	6	4	8
12 000 - 18 000	9	0	9	9	2	6
18 000 - 24 000	3	0	0	0	3	1
24 000 - 30 000	3	11	0	0	0	3
30 000 - 35 000	0	0	0	2	1	1
35 000 - 45 000	0	0	0	2	1	1
45 000 - 60 000	0	0	0	2	0	0
> 60 000	0	0	0	2	0	0
SUM	100	100	100	100	100	100

Table 5. Estimated costs of repair of winter injured greens and fairways (labour, equipment, seed, fertilizer etc.). Number of responses from each country in parentheses.

	DEN (32)	FIN (18)	ICE (20)	NOR (51)	SWE (93)	Average
euro (€)	----- % -----					
< 3 000	44	44	25	22	19	31
3 000 - 6 000	9	0	20	25	29	17
6 000 - 9 000	13	28	10	12	8	14
9 000 - 12 000	3	17	15	8	14	11
12 000 - 18 000	13	0	5	10	13	8
18 000 - 24 000	9	6	15	4	3	7
24 000 - 30 000	3	0	5	0	2	2
30 000 - 35 000	3	0	0	4	2	2
35 000 - 45 000	0	0	0	2	1	1
45 000 - 60 000	3	6	5	4	1	4
> 60 000	0	0	0	10	8	3
SUM	100	100	100	100	100	100

Table 6. Estimate of lost revenue due to winter injuries in a year with significant winter injuries. Number of responses from each country in parentheses.

What type of winter injury is most important?

The type of winter injuries varies between countries (Figure 1). Ice and water caused the majority of winter injuries in Norway, Finland and Iceland, 73 %, 67 % and 62 % respectively. Snow moulds were reported

by 89 % of Danish respondents to be the main cause of winter injuries. In Sweden there was an approximate 50 / 50 split between snow mould and ice/water as the causes of winter injuries. Low temperature or desiccation was

reported as the main cause of winter injury on greens on 5 % of Danish, 9 % of Swedish, 12 % of Norwegian, 11 % of Finnish and 24 % of Icelandic golf courses.

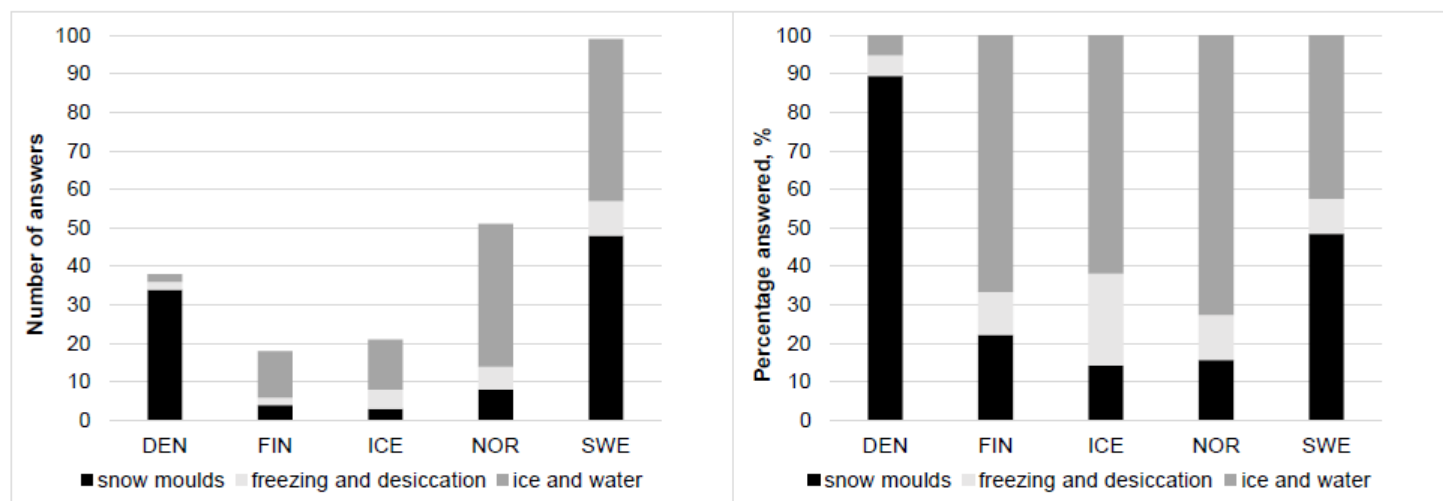


Figure 1. The most economically important causes of winter injury on greens in the five Nordic countries, based on the response of 227 golf courses. Actual numbers on the left and relative numbers on the right.

Grass species on Nordic greens

As grass species have very different winter survival abilities, the respondents were asked to specify which three grass species dominated a typical green on their golf course. Figure 2 shows the most common grass species. Red fescue (*Festuca rubra*) was much more common in Iceland than in the other Nordic countries. Only 4 of 19 courses in Icelandic respondents using browntop bent (*Agrostis capillaris*) as species number two or three. This makes Iceland most likely the country in the world with most pure red fescue greens. Creeping bent (*Agrostis stolonifera*) dominated only on 26 % of greens in the Nordic countries, but we assume that more greens were originally sown as pure creeping bent greens. In Finland there

were just as many greens with Velvet bent (*Agrostis canina*), but this number was uncertain due the low response (21 courses). The use of rough stalked meadow grass (*Poa trivialis*) was common in Sweden. Other than in Sweden, only two Danish courses reported this species in second or third place. The distribution between species was quite similar in Denmark, Finland, Norway and Sweden. Annual meadow grass was present on greens in all of the countries. This is more clear in the next figure.

By combining information regarding the three most dominating species we could identify the most common species combinations. Figure 3 shows that greens in Denmark were dominated with red fescue in combi-

nation with bent (61 %); followed by creeping bent greens (22 %) and pure red fescue greens (12 %). In Finland greens were dominated with creeping bent grass (39 %), while velvet bent was this country's specialty (22 % of greens). Red fescue with bent (17 % of greens) and pure red fescue (6 % of greens) were also found in Finland. In Iceland the most common species on greens was red fescue: either pure (73%, however 64 % of them are contaminated with annual meadow grass) or red fescue in combination with bent (21 % of greens). In Norway the ratio was almost 60/40 between greens sown with red fescue with or without bent (58 %) and greens sown with creeping bent (38 %). Greens in Sweden were dominated with creeping

bent (36 %), red fescue (20 %) and the country's specialty rough stalked meadow grass (20 % of greens). Figure 3 also shows that on average for all countries, annual meadow grass (*Poa annua*) (black or black dots) was among the three most dominating species on 70 % of greens. Respondents from Sweden and Finland reported more pure annual meadow

grass greens than respondents from the other countries. The majority of respondents reported that annual meadow grass represented a significant proportion of plant coverage, regardless if greens had been sown with red fescue, browntop bent or creeping bent. Perennial ryegrass was used to a certain degree in most countries, in particular Iceland. Like rough stalked

meadow grass, perennial ryegrass has poor winter survival, but both species are sometimes used to repair greens after winter injuries due to their quick establishment rates.

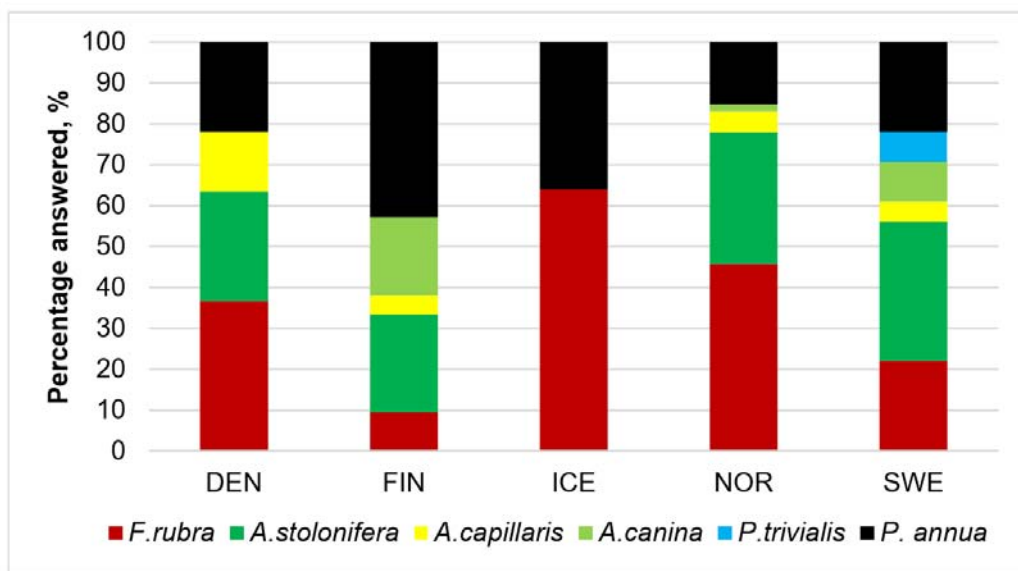


Figure 2. The most common grass species on golf greens in the Nordic countries. Number of courses in the different countries (from left to right) was 41/21/25/59/41.

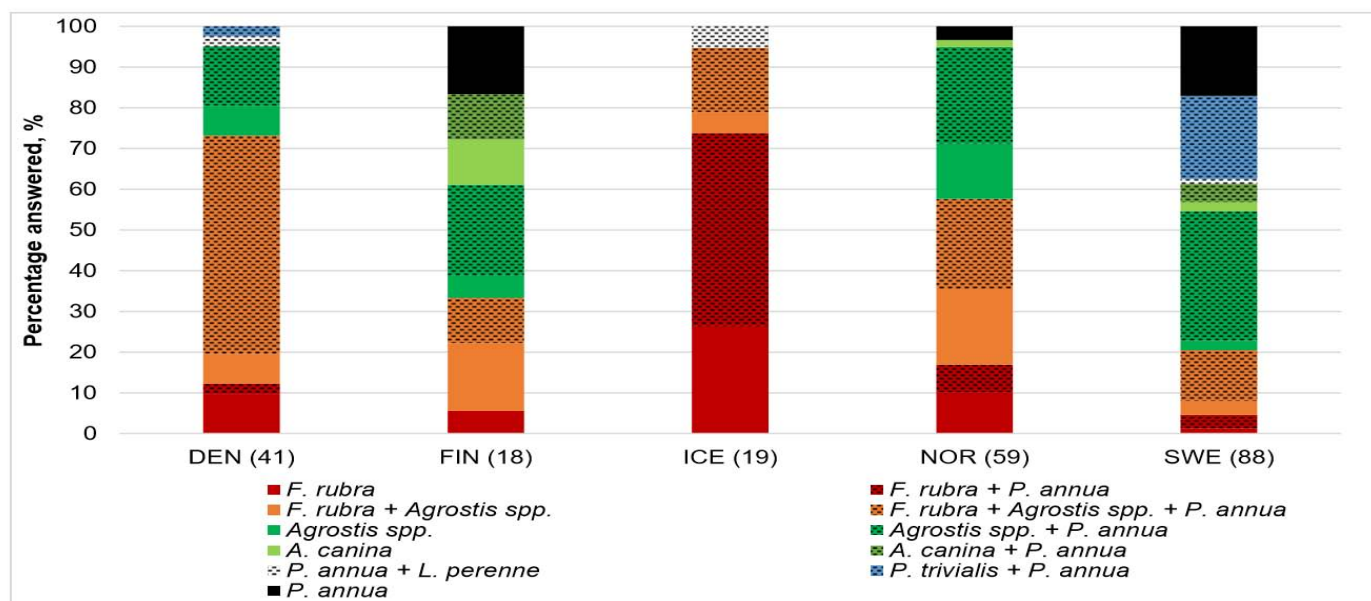


Figure 3. Percent distribution of grass species and species mixtures on golf greens in the Nordic countries. Number of responses from each country in parentheses, in total 225 answers.

Relationship between injury and grass species

The most important cause of winter injury, as assumed by the respondent, was reported in the survey. Alternatives were a) ice and water, b) low temperature and desiccation, or c) disease injury (snow mould). The relationship between the cause of winter injury and the most common grass species is shown in Figure 4. Annual meadow grass and creeping bent showed similar levels of damage due to snow mould and ice/water, whereas browntop bent was reported to have higher levels of snow mould damage. Red fescue was the species most susceptible to abiotic stress factors such as low temperature, desiccation, ice and water. This corresponds well with reports from the SCANGREEN trials.

If we look more closely at the answers (Table 7), we find that Denmark had a lot of snow mould damage and that these damages were surprisingly similar for all grass species. Strict regulations on the use of pesticides in Denmark can have influenced the results of this survey, as fungicides use may be prioritized for the most sensitive species. Abiotic injuries in Denmark were reported mainly in red fescue, and answers from Iceland confirm this. Data from the rest of the Nordic countries were more difficult to interpret. This may be a result of the fact that annual meadow grass can dominate areas on greens that are susceptible to ice and water, while bent and red fescue occur in higher areas of the green.

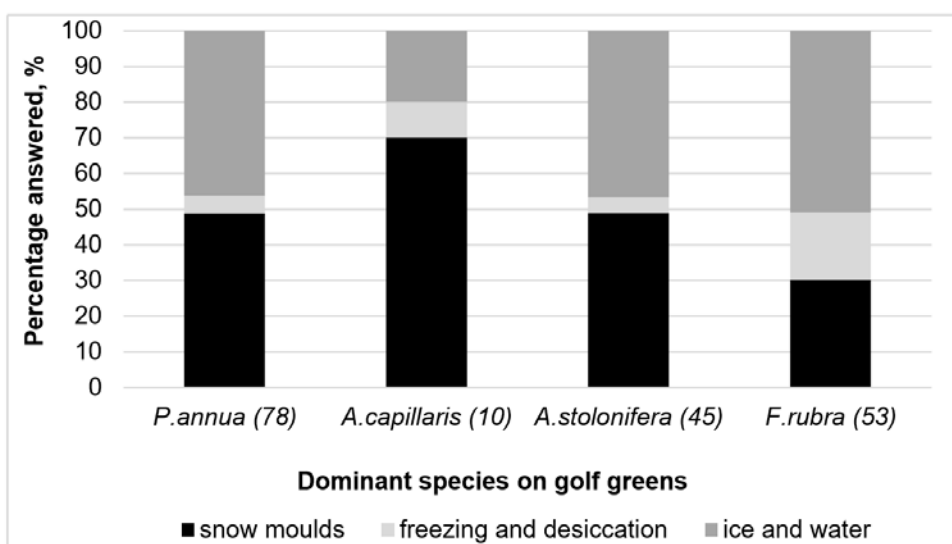


Figure 4. Economically most important causes of winter injury for the four most common grass species. Average for all countries. Number of responses from each country in parentheses, in total 186 answers.

		DEN (35)	FIN (16)	ICE (15)	NOR (48)	SWE (83)	Average
		----- % -----					
Snow mould damage	<i>P.annua</i>	23	13	0	0	34	14
	<i>A.capillaris</i>	17	0	0	2	0	4
	<i>A.stolonifera</i>	23	0	0	10	11	9
	<i>F.rubra</i>	26	6	7	4	4	9
	<i>P.trivialis</i>	0	0	0	0	0	0
	<i>A.canina</i>	0	6	0	0	1	1
Low temperature / dessication	<i>P.annua</i>	0	0	0	0	5	1
	<i>A.capillaris</i>	0	0	0	0	1	0
	<i>A.stolonifera</i>	0	6	0	2	0	2
	<i>F.rubra</i>	6	0	27	6	1	8
	<i>P.trivialis</i>	0	0	0	0	1	0
	<i>A.canina</i>	0	0	0	0	0	0
Ice and water	<i>P.annua</i>	0	19	20	17	27	16
	<i>A.capillaris</i>	0	6	0	2	0	2
	<i>A.stolonifera</i>	0	25	0	27	5	11
	<i>F.rubra</i>	6	6	47	27	5	18
	<i>P.trivialis</i>	0	0	0	0	2	0
	<i>A.canina</i>	0	13	0	2	4	4
SUM		100	100	100	100	100	100

Table 7. Economically important causes of winter injury the last 5 years, in relation to the most dominating grass species on the green. Number of responses per country in parentheses.

Other influencing factors

We related the answers to latitude, altitude, distance from the sea, age of the greens and green construction (soil and drainage).

Geography

Over 220 courses responded to the question regarding relationship between winter injuries and geographical location. There appeared to be a shift at 60° north. Snow mould injuries dominated south of this latitude, while

physical damages were the major causes of winter injuries farther north (Figure 5).

The majority of golf courses in the survey (71 %) were at an altitude of less than 100 m. Snow mould was that cause of 50 % of winter injuries at these locations, and only 23 % of winter injuries on courses over 300 m (Figure 6).

The distance from the sea was shown to have an impact on the type

of winter injury. An equal number of courses located less than 10 km from the coast reported that disease and ice damage were of equal importance. On the other hand, only 23 % of the courses located more than 50 km from the coast reported that disease was an important cause of winter injury.

The finding that snow mould injury was more important in the southern than in the northern parts of the Nordic countries may be surprising

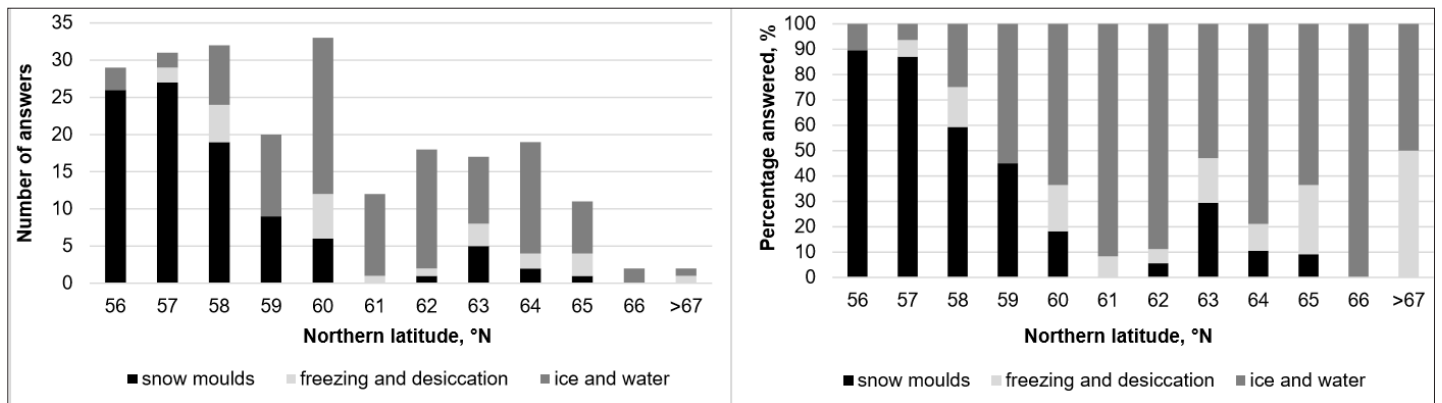


Figure 5. Winter injury in relation to latitude (all 5 countries), reported from 226 golf courses. Actual numbers on the left and relative numbers on the right.

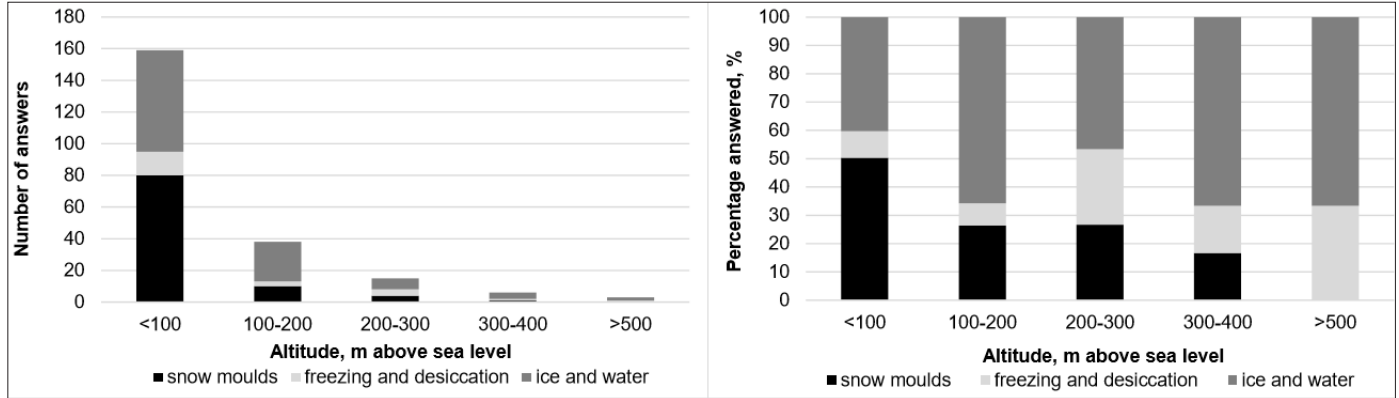


Figure 6. Winter injury in relation to altitude (all 5 countries), reported from 221 golf courses.

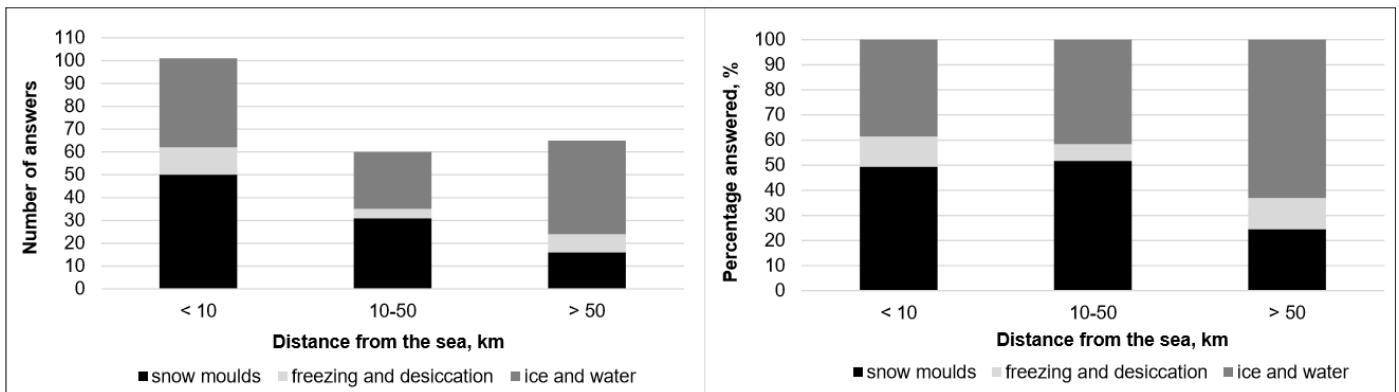


Figure 7. Winter injury vs. distance from the coast (all 5 countries), reported from 226 golf courses.

for those who associate snow moulds with stable snow cover. However, this can be explained by the fact that the most common low-temperature disease on golf courses in the Nordic countries does not require snow cover.

Our results also indicate that rain during winter can result in ice formation under the snow, and that this has a greater economic impact than snow moulds. Access to effective fungicides may also explain these results.

Age and construction of the greens

The majority of the 225 greens reported in the survey were newer than 30 years. There was a clear tendency of increased damage due to snow mould as the age of the green increased (Figure 8). This is most likely connected to the higher proportion of annual meadow grass on older greens.

The results of the survey indicate clear differences between the various green construction methods. Well drained soil greens were reported to

have the most disease injuries, while the poorly drained greens had more ice and water injuries. This result can support the claim that *Microdochium nivale* requires anaerobic conditions to develop. There was not less ice damage on well drained greens, possibly due to faster freezing in the autumn which increases the risk of ice build-up under rainy conditions.

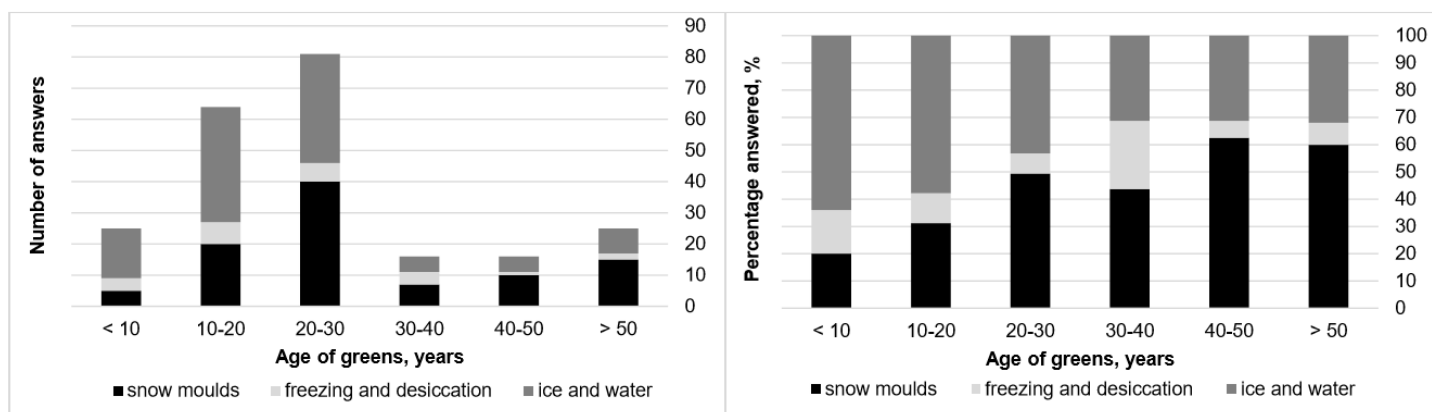


Figure 8. Winter injury in relation to the age of the green (all 5 countries), reported from 227 golf courses. Actual numbers on the left and relative numbers on the right.

Constructed and performs according to the USGA recommendations	Constructed with a draining gravel layer, but the sand does not drain well	Constructed with sand that does not hold water well (dry green)	Well drained soil	Poorly drained soil	Sand based green, like California type
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Enlarged bar graph texts for Figure 9.

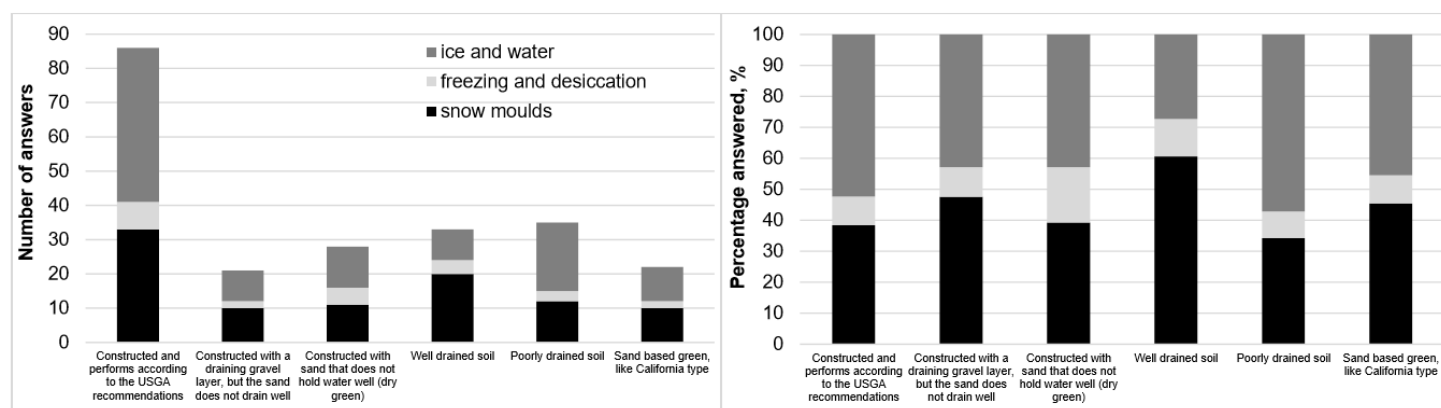


Figure 9. Winter injury in relation to green construction (all 5 countries), reported from 225 golf courses. Actual numbers on the left and relative numbers on the right.

Data that is not yet analyzed

The survey provided much data that has not yet been analyzed, including information regarding autumn fertilization practices, use of fungicides, snow and ice removal and several other management strategies. Winter injury observed in the spring of 2015 may be more fully explained by utilizing information regarding management during the autumn of 2014 and winter of 2015. Many people in the golf sector express the need for more research-based information from golf courses. We support this, but data analysis such as this is time consuming and require appropriate theoretical and practical competence. We hope that the remaining data can be analyzed and published.

An overview of the answers from each country are available here:

Denmark	http://web.easyresearch.se/APP/ReportLogin.aspx?R=3965771.78287421
Finland	http://web.easyresearch.se/APP/ReportLogin.aspx?R=3965772.46117874
Iceland	http://web.easyresearch.se/APP/ReportLogin.aspx?R=3965773.96683195
Norway	http://web.easyresearch.se/APP/ReportLogin.aspx?R=3965774.58979569
Sweden	http://web.easyresearch.se/APP/ReportLogin.aspx?R=3965775.83764265
Overview	http://web.easyresearch.se/APP/ReportLogin.aspx?R=3854636.69265494

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