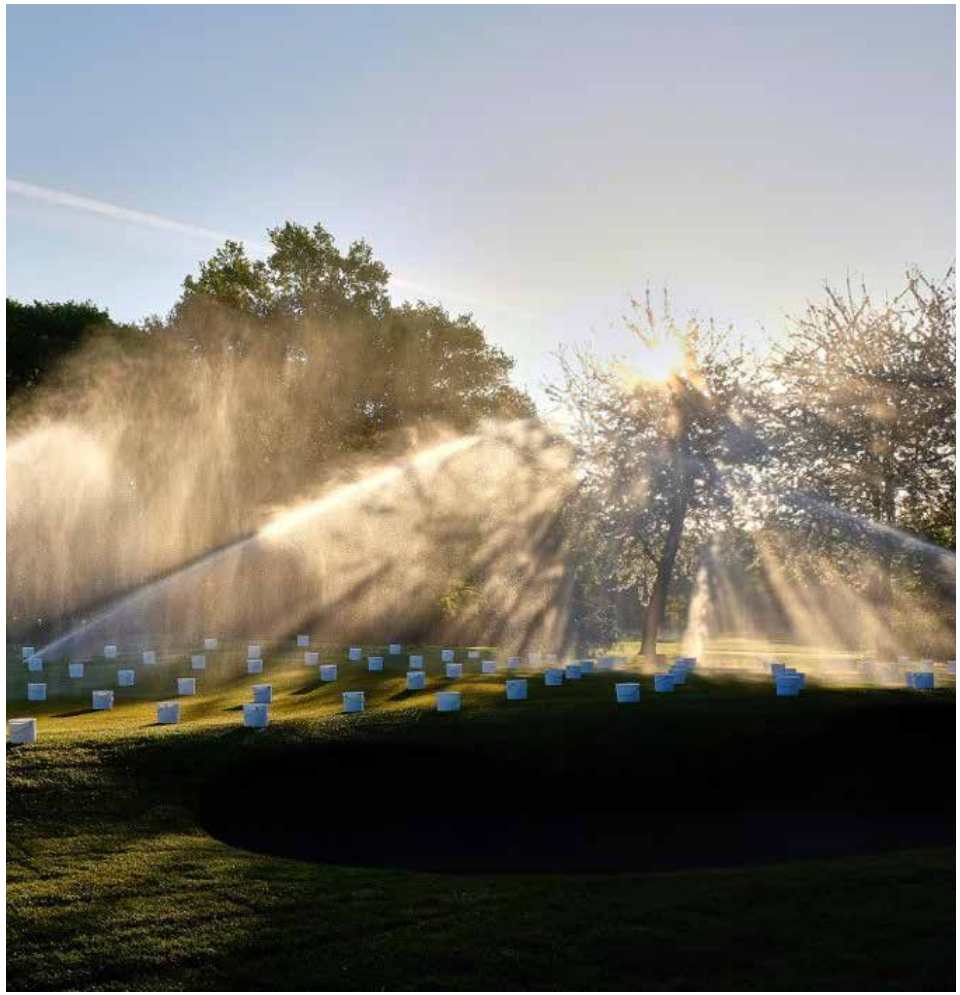
RESEARCH AND DEVELOPMENT YEARBOOK 2024

RESEARCH AND DEVELOPMENT YEARBOOK 2024. STERF. SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION

CLIMATE – COMPETENCE – CAPITAL - COOPERATION!



These four alliterated words represent the lion´s share of STERF activities in the year 2024.

It started with a hybrid attack aimed at the IT company hosting STERF's website. The consequences of the Russian "hackers" attack was that all data, reports, pictures and designs were erased, and we were forced to build up a totally new website, with hard work and a lot of money. The positive thing is that when you now log in to www.sterf.org, you will reach a much more user friendly and functional site!

The **climate** now induces widespread change in the atmosphere, oceans, cryo- and biosphere. Climate change is already affecting all regions across the globe, with many severe impacts and related damages to nature and humans. The years 2023 and 2024 are two consecutive "warmest years" in the history of mother earth and, as I have pointed out frequently, this is catastrophic for golf and other turf sports that use land and nature as their sports arena. The old scientific findings, management strategies, good practice, etc. are no longer valid, creating a need for a restart supported by robust applied science.

To be able to manage and build resilient and sustainable golf facilities, we need new **competence** and knowledge. Because of this need, in 2024, the STERF board worked intensely to create four new international and trans-disciplinary R&D programs, including:

- Winter stress and integrated pest management
- Use of Natural Resources in Golf Course Management
- Multifunctional golf courses and ecosystem services – Landscape perspective
- New technologies for a sustainable future

In the coming calls, STERF will support R&D based on these programmes. The activities of STERF are intended to lead to improvements in the quality of golf courses, as well as economic and environmental gains for the industry and society as a whole (all programmes are available at www.sterf.org).

As science today requires a great deal of **capital** and the golf sector underfinances development work, in late 2023, STERF

took the initiative and approached USGA and the R&A to explore the interest in joint financing of research projects with global significance. Even in the first meeting, we saw a mutual understanding of the need for increased research efforts and financial undertakings. At present, the three partners (STERF, USGA and the R&A) have invested SEK eight million for a three year period. We also hope that this unique initiative will inspire other important stakeholders to support the open research we so badly need.

To be able to manage international projects, we also needed a **cooperation** infrastructure, so we set up the following goals for the Initiative

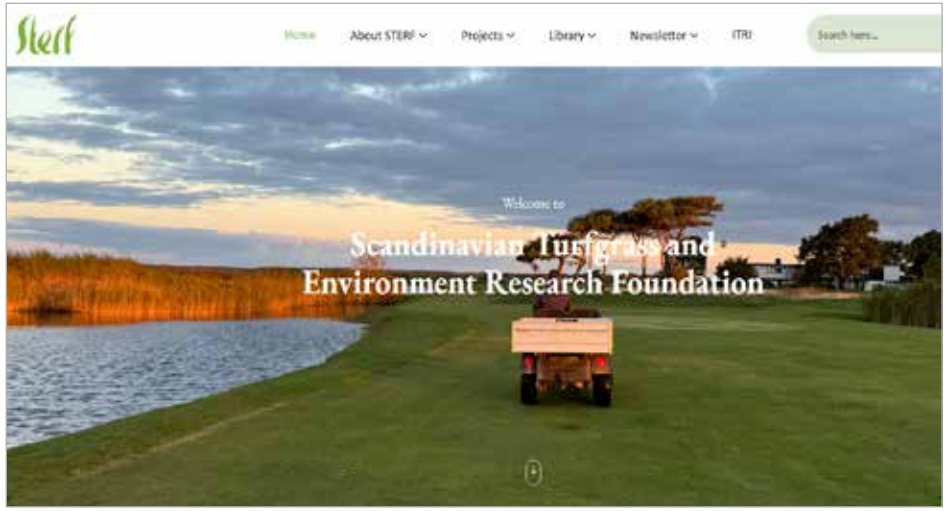
1. Agree on the most important global research topics for turfgrass management.
2. Solicit and select research proposals to advance these topics.
3. Start globally cooperative and applicable projects with international research teams.
4. Model global research cooperation and learn from the initiative for even better future efforts.

In May 2024, the International Turfgrass Research Initiative was launched, a presentation of the initiative can be found on www.sterf.org . Based on our first research priorities, Integrated Pest Management, Water Conservation, Biodiversity and Landscape Perspective, and Climate (Carbon Balance), we invited scientists to submit pre-proposals. In 2024, the initiative received 25 pre-proposals which have been reviewed by a review committee. Based on recommendations from the review committee, we have decided to invite 9 principal investigators to submit full proposals. The deadline for full proposals is February 26th, 2025, and final decisions on the funding of the projects will be taken in April 2025.

Through this cooperative effort by STERF, USGA and the R&A to fund globally relevant research that will advance scientific knowledge and turfgrass management, we hope to inspire other stakeholders to invest in a resilient and sustainable future.
Even in the darkest hour, there is light around the corner!

Bruno Hedlund
STERF Chairman

IMPORTANT EVENTS IN 2024



NEW WEBSITE STERF.ORG

STERF was one of many organizations exposed to the Russian hacker attacks in Sweden and Finland in late January 2024. It took some time to understand the consequences of STERF losing their website, including the backups, and having to find a way to move on. The work of rebuilding the website included finding a new technical supplier and filling the website with both news and ten years of lost material. The new website has been up and running for six months, and all fact sheets, articles and handbooks are now published in all Nordic languages. Information about STERF´s completed and ongoing projects is also available at the website, and more information will be added continuously. It was extensive work to gather all lost project information, articles, fact sheets, handbooks, etc. but now the job is done, and the website is better than ever. Visit us at sterf.org!

TWO NEW PROJECTS

FAIRWATER II

In August 2024, The R&A's program 'Golf Course 2030' and the North German Greenkeeper Association generously granted a follow up of the project FAIR WATER I, which was funded by STERF and the German Golf Federation in 2022. The new project, designated FAIR WATER II, is a joint STERF and R&A project. The project has two subprojects (Work Packages, WPs), the first of which implements newly acquired knowledge from FAIR WATER I in large scale demo trials on golf courses in Finland, Norway, Denmank and Germany. The WP aims for more drought tolerant fairways by combining scarification, to reduce thatch organic matter, and/or deep aeration, to promote root development in the fall, with the application of selected soil surfactants during the following growing season. The demo trials will also be actively used for field days, the first of which to be hosted by Hirsala GC, Finland and St. Diony's GC, Germany, in June and September 2025, respectively.

In the second WP of FAIR WATER II, STERF and the R&A will, for the first time, engage in research into irrigation water quality. A number of GCs in coastal Sweden and Finland want to explore the potentials and risks of using either brackish water from the Baltic sea (average salt content 0.7% vs. 3.5% in ocean water) or recycled water from local sources for fairway irrigation. Seven Swedish GCs were visited and soil and water samples were taken in October 2024; this will be followed by new sampling and monitoring of turfgrass quality in 2025 and 2026. Read more about the project on page 20.

ADORE

Despite rising turf maintenance challenges related to climate change, fungicide and pesticide restrictions and cost inflation, turf maintenance is mostly a manual and non-optimized process. The greenkeeper takes daily decisions on a maintenance scheme, including mowing height, irrigation, and fertilization based on weather forecasts and the current state of soil and turf, targeting optimized metrics for sustainability, playability and cost. Decisions are made individually based on experience and without a decision support system that could leverage historical data. The lack of a prediction tool hampers the greenkeeper greatly. To address this, the ADORE project explored a digital, data-driven approach powered by Artificial Intelligence (AI) to identify sustainable and playability-

optimized turf maintenance strategies across the vast array of possible configuration combinations. Could AI and time-series modeling be effective without significant investments in data measurement hardware or the need for large volumes of data? While AI has shown proof-of-concept success on courses equipped with soil sensors and local weather systems, the challenge was to assess its applicability for the average Scandinavian golf club, where data collection is limited to records of maintenance actions, occasional soil analysis, and open-source weather APIs. Read more about the project on page 26.

INTERNATIONAL TURFGRASS RESEARCH INITIATIVE – Call for proposals 2024

Development and sustainability were the theme of the 14th International Turfgrass Research Conference (ITRC 2022) hosted by STERF in Copenhagen, Denmark in July 2022. Global challenges and challenges within the turfgrass industry related to the sustainable development goals set out in Agenda 2030 were the focus of many presentations and were discussed by delegates. STERF feels that investing in turfgrass research would be the most appropriate legacy from ITRC 2022, and the STERF board have decided to reserve future funds to support global turfgrass research. Therefore, STERF, together with the R&A, and USGA have created the International Turfgrass Research Initiative to develop research projects with global significance.

Research priorities

Sustainable agronomy is the most prevalent area of interest, and because of increasing pesticide regulations, warm, dry weather, and a drought and irrigation ban in many parts of the world, all agreed that integrated pest management and water conservation would likely be important foci of the initiative. Biodiversity research in turfgrass management globally is essential to foster an ecological balance by understanding and preserving diverse ecosystems within turfgrass landscapes. It promotes resilient turfgrass systems by supporting beneficial organisms that contribute to natural pest control, soil health, and overall ecosystem stability. A better understanding of the carbon balance in turfgrass management globally is crucial for understanding the impact of turfgrass on greenhouse gas emissions and carbon sequestration. The following specific topics have been suggested so far:

- Integrated pest/turfgrass management
- Water conservation
- Biodiversity and landscape perspective
- Climate (Carbon balance)

In 2024, ITRI circulate a two-phase Request for Proposals. Projects that advance the research priorities mentioned above are evaluated and funded through a two-step process, beginning with pre-proposals. Pre-proposals were due August 15th 2024, and ITRI received 25 interesting project ideas.

Based on the proposal review committee´s recommendations, the steering committee has invited nine principal investigators to submit full proposals. The final decision regarding projects for funding will be made during the spring 2025. For more information see page 12.

INTERNATIONAL RESEARCH COLLABORATION - study tour to Madison, USA

To meet the huge challenges the golf sector must face in the future, we must increase investment in research and development and continue to work together to solve global problems. Therefore, STERF´s goal is to increase important international research collaboration. In June 2024, STERF, represented by two board members Maria Strandberg and Bruno Hedlund, was invited to the University of Wisconsin, Madison to participate in the NCERA-221 meeting.

NCERA-221 is a group of turfgrass research and extension professionals that work together to improve the sustainability of turfgrass management in the North Central Region of the United States, which shares turfgrass management challenges with the Nordic countries due to climate similarities. The NCERA group's annual meeting was held in June 2024 and was hosted by the University of Wisconsin, in Madison, Wisconsin. The meeting featured research updates, collaborative project discussions, and site visits to the O.J. Noer Turfgrass Research Facility for a tour of the University of Wisconsin research plots. Presentations included updates on organic turf management, winter turf survival, soil test calibration, and sustainable pest management. Maria Strandberg and Bruno Hedlund provided an organizational update and participated in discussions on international turf research initiatives. Future research directions for the NCERA-221 group emphasized no-input lawn systems, water conservation, and biodiversity-enhancing strategies, including clover and bee lawns. The meeting was very important for STERF and resulted in many ideas for potential joint projects between STERF and NCERA-221 members.

STERF STRATEGIC WORK AND NEW RESEARCH PROGRAMMES

STERF´s board has decided to update its strategic work and revise all existing STERF research programmes and develop new programmes for the 2025-2034 period. This work is based on: (1) Future challenges and trends; (2) Input from Nordic golf clubs on future needs; and (3) Inventory and analysis of the availability of new and complementary strong scientific environments. Future challenges and trends have been discussed and identified alongside international golf organisations, researchers, authorities, and the Nordic golf sector. Input from Nordic golf clubs on future needs and an inventory and analysis of the availability of new and complementary strong scientific environments need to be completed.

In 2024, STERF board members, together with researchers at Nordic universities, have worked on and created four new research programmes. The programmes will be launched early in 2025. The programmes focus on and cover the following research areas of high priority:

- Winter stress and integrated pest management
- The sustainable use of natural resources in golf course management
- Multifunctional golf courses and ecosystem services – Landscape perspectives
- New technologies for a sustainable future

In 2025, the new programmes will be followed up by a questionnaire to all Nordic golf clubs with the aim of gaining input on the most important gaps in knowledge and the research questions needing to be prioritized.

ABOUT STERF

SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION, STERF

STERF is an independent research foundation that supports existing and future R&D efforts and delivers 'ready-to-use' research results that benefit the golf and turfgrass sector. STERF was set up in 2006 by the golf federations in Sweden, Denmark, Norway, Finland and Iceland and the Nordic Greenkeepers' Associations. Research funded by STERF is carried out at universities or research institutes (or equivalent), where the majority of relevant research capacity is concentrated. STERF helps to strengthen research capacity by encouraging and supporting networks and collaborating actively with key international organisations in the field of turfgrass management. STERF also arranges innovation workshops to help identify the golf and turfgrass industry´s future research needs in which researchers and industry representatives contribute to the planning process. STERF receives funding from participating golf associations, complemented by funding from other sources.

STERF's vision is to be the leading international centre of expertise in sustainable golf course management.

To achieve this vision, STERF focuses on:

- Making the turfgrass industry in the Nordic countries a role model of responsibility for sustainable societal development, i.e. in the production of managed turfgrass areas of a high standard while ensuring the sustainable use of natural resources, contributing to functioning ecosystems, and providing recreation areas that are open to the public and to outdoor activities.

- Ensuring that Nordic turfgrass research and development focuses on internationally important areas where concerted research and industrial efforts are required. These include the pressures generated by government demands for greater environmental regulation, increasing pressure on natural resources (notably water, energy and land), the emerging role of turf management in supporting

ecosystem services and enhancing biodiversity, the continued need to promote integrated pest management, and the looming challenges posed by a changing climate and the urgent need to adapt. Activities within the focus areas must contribute to the fulfilment of eight of the 17 sustainable development goals (SDGs) set in the United Nations Agenda 2030.

- Establishing successful international research and development collaboration, including research facilities and expertise from all five Nordic countries. STERF will continue to initiate inter-disciplinary and multi-disciplinary research and support collaboration in Europe, Canada and USA, involving researchers and stakeholders interested in land used for managed turfgrass areas.

- Developing and expanding the STERF industrial scientific partner programme by collaborating with leading international companies within the sector to further strengthen the strategy of research and development integration from producer to end-user.

- Taking a lead in making research results and new knowledge easily accessible to end-users and providing support to implement changes, a prerequisite for achieving progress in the sustainable management of golf courses and other turfgrass areas.

STERF´s activities must contribute to the fulfilment of eight of the 17 SDGs set out in Agenda 2030. STERF has divided these into six categories:

1. Sustainable use of natural resources and chemicals (SDGs 6, 11, 12, 14, 15).
2. Ecosystem services and enhanced biodiversity (SDGs 14,15).
3. Adapting to a changing climate and minimising factors affecting climate change (SDG 13).
4. Sustainable cities and communities (SDG 11).
5. Healthy lives and well-being for people of all ages (SDG 3).
6. Partnership for sustainable development and for new regulations (SDG 17).

These categories and goals are closely related to the golf and turfgrass industry´s everyday challenges and to STERF's programmes, projects and dissemination efforts.

BACKGROUND

Managed turfgrass areas, such as golf courses, sports fields, landscaped amenity areas and public parks, together act as an important social, environmental and economic resource for both urban and rural communities. These areas serve a multifunctional purpose by offering valuable open spaces for recreation, helping to improve the health and quality of life for individuals and, when designed and managed appropriately, enhancing biodiversity and supporting regulatory targets for environmental protection. Conversely, where turfgrass management practices are inadequate or inappropriate, their services to society are reduced and their impacts on the natural environment can be damaging and costly.

The future challenges for turfgrass and golf course management are many and diverse. They include increasing demands on natural resources (notably land use, water resources and energy) driven by economic development and population growth, coupled with government demands for greater environmental protection, which are creating conflicts at the interface between land management (including turfgrass) and the environment. The situation is particularly acute in peri-urban areas, where the majority of managed turfgrass facilities are concentrated. Population growth, migration and climate change will exacerbate the current situation by increasing competition for resources between individual sectors, including agriculture, urban development, tourism and the environment.

Many golf courses, sports facilities and stadiums are under economic pressure due to economic recession in many parts of the world. In many countries, there has also been a decrease in the number of registered golf players. It is common for golf courses to base their financial stability on a constant inflow of members, rather than a static membership. However, they are now facing the challenge of balancing this approach against the new reality of fewer members and new conditions in a more variable and competitive market.

The key to success in future golf course and turfgrass management will be to increase resource use efficiency, reduce maintenance costs and minimise environmental impact. In this context, the protection and enhancement of ecosystem services will need to be fully integrated into the planning, design, construction and management of all golf and turfgrass facilities.

Nordic Golf Federations have approximately 1.1 million members, playing golf on more than 1,100 courses that occupy a total area of more than 70,000 hectares. Any societal activity as significant as golf must take responsibility for building knowledge through research and development (R&D). There are several important reasons why Nordic R&D is necessary. In Central Scandinavia, Oslo, Stockholm and Helsinki lie at the same latitude as the southern tip of Greenland (~60^{o}N). This creates a unique climate resulting from a combination of factors such as light, temperature and precipitation during the playing season and particularly during the winter season. The Nordic climate creates conditions for plant growth and the construction and management of golf courses, sports fields etc. that are not found anywhere else in the world.

R&D will continue to be a necessary and strategically important investment for the golf sector in achieving economically and environmentally sustainable golf facilities of a high standard and in establishing the credibility of golf as an environmentally friendly sport. Golf facilities that are already using new knowledge are achieving cost savings through more efficient management strategies while also enhancing their golf courses, raising the profile of their golf facility and improving the environment.

The financial resources allocated to R&D in each country are very limited, and the number of scientists actively working within each priority R&D area is also quite limited compared with agricultural and forestry research. The financial resources and efforts of these researchers should therefore be coordinated through STERF, to optimise R&D within the golf and turfgrass sector.

RESEARCH OBJECTIVES AND R&D PROGRAMMES

STRATEGIC RESEARCH OBJECTIVES

The golf and turfgrass industry, like other land-based industries, must take responsibility for sustainable societal development, i.e., it must produce golf courses and other turfgrass areas of a high standard while also ensuring the sustainable use of natural resources and contributing to functioning ecosystems.

The aim of STERF is to support R&D that can help the golf industry to fulfil these ambitions. The activities of STERF are intended to lead to improvements in the quality of golf courses, as well as supporting economic and environmental gains for the industry and society as a whole.

The strategic objectives for STERF-funded R&D activities are that:

- The design, construction, management and administration of golf courses provide optimal conditions for playing quality, utilisation of the course and management inputs.

- The design, construction, management and administration of golf courses are economically and environmentally sustainable, for example, with respect to plant nutrient requirements, water and energy use, drainage and the control of weeds and plant diseases.

- Golf courses contribute to the production of biological diversity, the conservation of natural and cultural envi¬ronments, and the retention and expansion of ecosystem services, and to improving the conditions for high quality of life and health, for example, through providing a broa¬der active outdoor life, experiences of nature and better climate adaptation in the everyday landscape.

R&D PROGRAMMES

It is evident that the golf and turfgrass industry faces a number of local and international challenges, all of which will need concerted and collective solutions underpinned by robust applied science. To meet the challenges facing the sector, STERF has created four international and transdisciplinary R&D programmes:

- Integrated pest management
- Sustainable water management
- Turfgrass winter stress management
- Multifunctional use of golf facilities and ecosystem services.

Progress in these programme areas will collectively lead to improvements in the quality of managed turfgrass areas, as well as economic and environmental gains for the industry. The key objectives of the programmes are to coordinate the design and running of R&D activities and to ensure effective dissemination of outputs (new knowledge) through channels and formats which are easily accessible to end-users. STERF will play a key role in expanding the programmes to an international level.

Integrated pest management

New regulations at a national and international level relating to the turfgrass industry are becoming more demanding. An example of this is the EU Green Deal and the proposed Sustainable Use of Pesticides Regulation, which includes strategies for integrated pest management (IPM) and reductions in pesticide use. STERF, together with the Nordic park and golf sector, universities, research institutions, and authorities, will take responsibility for ensuring that R&D activities important for IPM and pesticide reduction are coordinated and executed, and that new knowledge is delivered.

Sustainable water management

Water is essential for securing the future of the turf industry and the livelihoods of many rural communities that depend upon it. Working with the industry and leading research institutes, STERF's goal is to provide science-based information to practitioners and stakeholders on integrated water management in turf. This will improve management practices relating to both irrigation and drainage systems, help protect environmental water quality, and support the industry in adapting to the effects of future changes in rainfall and climate variability on water resources.

Turfgrass winter stress management

Winter damage is the foremost reason for dead grass, reducing the aesthetic and functional value of turf. UN-IPCC climate scenarios predict that, due to high precipitation and unstable temperatures, ice and water damage will become the major cause of winter damage in the future. This is a complex but high-priority area for STERF, as an estimated 70% of Nordic golf courses suffer from winter damage each year, with associated average annual costs per golf course of €35 000-40 000. STERF will take responsibility for developing strategic expertise and new knowledge to avoid and manage such damage.

Multifunctional use of golf facilities and ecosystem services

Multifunctional golf courses can contribute to increased biological diversity, the conservation of na¬tural and cultural environments, and the retention and expansion of ecosystem services. They can also help to improve people's health and quality of life by providing facilities for active outdoor recreation and outdoor teaching. Through STERF´s R&D programme within multifunctional facilities, the societal benefits of golf can be improved, and the Nordic area can become a model region for multifunctional golf courses and collaborations between different interests in society. Four central research and development areas have been identified: (1) The everyday landscape and peri-urban nature; (2) Nature and culture; (3) Dialogue and cooperation; and (4) Business promotion.

INTERNATIONAL TURFGRASS RESEARCH INITIATIVE

A COOPERATIVE EFFORT BY STERF, THE R&A, AND USGA

The challenges for the future of the golf and the larger turfgrass industry are many and varied. Climate change is transforming abiotic stress patterns, pest life cycles, and basic turfgrass selection and management. Strong restrictions on the use of chemicals and fertilizers and increasing pressure on natural resources (notably water, energy and land) are expected. Development is accelerating the loss of ecosystem services and biodiversity. All this calls for more research and innovation for a sustaina¬ble future. Development and sustainability were the theme of the 14th International Turfgrass Research Conference (ITRC 2022) hosted by STERF in Copenhagen, Denmark in July 2022. Global challenges and challenges within the turfgrass industry related to the sustainable development goals set out in Agenda 2030 were the focus of many presentations and were discussed by delegates. STERF feels that investing in turfgrass research would be the most appropriate legacy from ITRC 2022, and the STERF board have decided to reserve future funds to support global turfgrass research. Therefore, STERF, together with the R&A and USGA, have created the International Turfgrass Research Initiative to develop research projects with global significance.

Aims of the International Turfgrass Research Initiative

1. To agree on the most important global research topics for turfgrass management.
2. To solicit and select research proposals to advance these topics through a competitive request for proposals (RFP).
3. To begin two to three globally cooperative and applicable projects with international research teams.
4. To model global research cooperation and learn from the initiative for even greater future efforts.

Research Priorities

Sustainable agronomy is the most prevalent area of interest. In light of increasing pesticide regulations, warmer weather patterns, and more frequent droughts and irrigation restrictions in many parts of the world, all parties agreed that integrated pest management (IPM) and water conservation are important foci for the initia¬tive. Another important focus is biodiversity research in turfgrass management, which is essential to foster an eco¬logical balance by understanding and preserving diverse ecosystems within turfgrass and golf course landscapes. A better understanding of the carbon balance in turfgrass management globally is crucial for understanding the impact of turfgrass on greenhouse gas emissions and net carbon sequestration. The following specific topics have been agreed and prioritized:

- Integrated pest/turfgrass management
- Water conservation
- Biodiversity and landscape perspective
- Climate (carbon balance)

Committees

The initiative has two important committees. First, the steering committee is comprised of representatives from the funding organizations (STERF, USGA and the R&A) that plan and execute the initiative, appropriately representing the interests of the organizations funding the initiative. The steering committee has nominated, selected, and is overseeing the work of 10 to 12 people to serve on the proposal review committee. The review committee will include eight to 10 scientists and two to four industry practitioners.

Call for proposals 2024

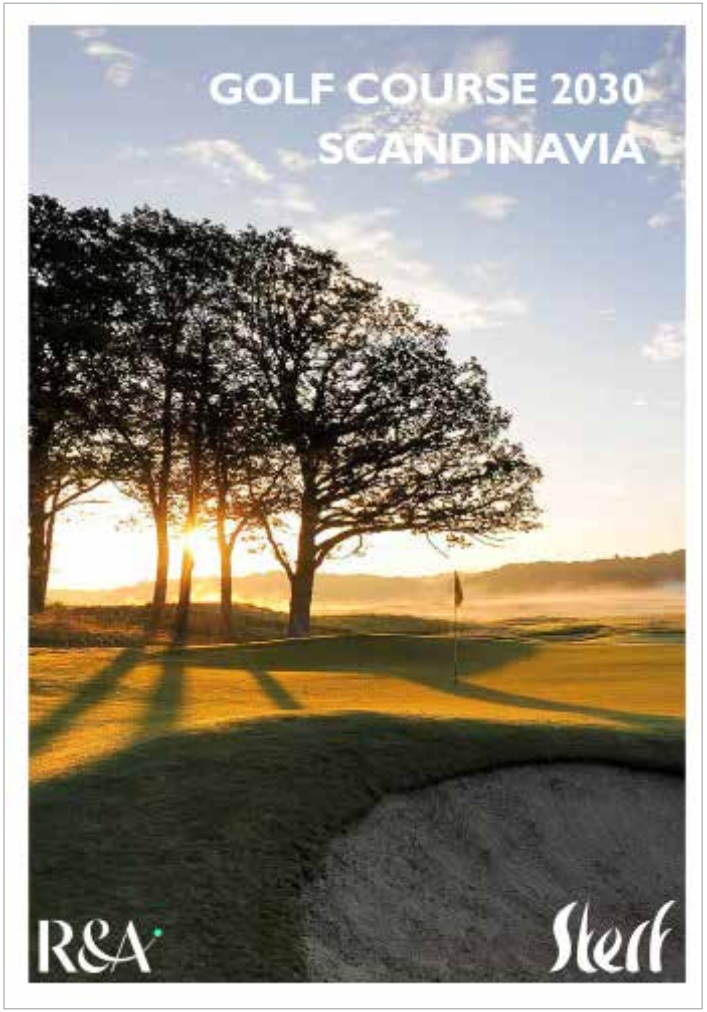
STERF, the R&A and USGA have together reserved approximately € 250,000 per year for three years for research projects with global significance. Collaboration and joint projects between international research organizations are an important aim of the initiative and a requirement for project funding. We also recognize that industrial engagement and support is a critical component of research.

In 2024, we circulate a two-phase Request for Proposals. Projects that advance the research priorities mentioned above are evaluated and funded through a two-step process, beginning with pre-proposals. Pre-proposals were due August 15th 2024, and we received 25 interesting project ideas. Based on the proposal review committee´s recommendations, the steering committee has invited nine principal investigators to submit full proposals. The final decision regarding projects for funding will be made in the spring of 2025.

International Turfgrass Research Initiative

A Cooperative Effort by STERF, The R&A, and USGA

GOLF COURSE 2030 SCANDINAVIA



To achieve the maximum future impact from the turfgrass sector´s sustainability work, it is of the utmost importance to establish international, interdisciplinary collaboration where all stakeholders make efforts to cooperate and align their resources and efforts using the United Nations 2030 Agenda for Sustainable Development, with its 17 sustai-nable development goals (SDGs) as a steering document.

The R&A Golf Course 2030, established by the Royal & Ancient (R&A) in 2018, is a significant initiative to support and stimulate golf industry stakeholders to agree on a roadmap that secures optimal golf course conditions and playability for current and future generations. The roadmap is also intended to highlight the potential for golf courses to be designed and managed to promote critical ecosystem services, and to restore and enhance biodiversity in ecologically simplified lands¬capes.

Golf Course 2030 focuses on broad themes of sustainable golf course management. As part of the R&A Golf Course 2030 initiative, STERF has created Golf Course 2030 Scandinavia. This collaboration between STERF and the R&A focuses on ready-to-use research as an important tool to help prevent negative impacts on the planet and aims to develop new knowledge that is neces¬sary to change the mindsets and attitudes of people world¬wide.

Three joint R&A and STERF projects within the Golf Course 2030 programme:

- The IPM-project "*Integrated management of important turfgrass diseases and insect pests on European golf courses*" was completed in 2023. Research results and new knowledge have been presented in scientific publications and as practical advice and recommendations provided in demonstration videos, fact sheets, popular scientific articles and presentations at seminars and workshops (for example, at the symposium '*Sustainable golf course management Integrated turf management*' held in Sigtuna in September by STERF and R&A).
- The ongoing "*GOLF LANDSCAPES: Biodiversity and multifunctionality of golf landscapes*", was started in 2023 and is progressing well. See page 24.
- In 2024, a third joint project started, named FAIRWATER II, focusing on maintenance strategies for more drought tolerant fairways and on irrigation water quality. See page 22.

Furesø GC

SCANGREEN: TURFGRASS SPECIES AND VARIETIES FOR INTEGRATED PEST MANAGEMENT OF SCANDINAVIAN PUTTING GREENS, 2023-26

PROJECT PERIOD: JANUARY 2023 - MARCH 2027

FUNDING (kSEK)

	2023	2024	2025	2026	Total
STERF	529	669	635	510[1]	2343
Companies [2]	160			160	320
Smørum GC (in kind)	40	7	7	7	61
Reykjavik GC/Golf Union of Iceland (in kind)	7	15	15	15	52
Danish Golf Union (in kind)	25	25	25	25	100
Total	761	716	682	717	2876

1) Reserved, not granted;
2) Barenbrug (The Netherlands), DLF (Denmark), Landmark Seeds Company and Mountain View Seeds (Oregon, USA).

PRINCIPAL INVESTIGATOR / CONTACT PERSON

Karin J. Hesselsøe NIBIO Landvik, N-4886 Grimstad, Norway, Tel: + 47 413 96 851
E-mail: karin.hesselsoe@nibio.no

CO-APPLICANTS

Pia Heltoft Thomsen, NIBIO-Apelsvoll, Norway.
Bjarni Hannesson, Reykjavik Golf Club, Iceland.
Per Rasmussen, Smørum Golf Club, Denmark.
Eric Watkins and **Andrew Hollmann,** University of Minnesota, USA*
*This collaboration includes a complete test site at University of Minnesota funded by US-project WinterTurf.

PROJECT OBJECTIVES

- To screen in the field and clarify which varieties of Agrostis, Festuca, Poa and Lolium are the most winter-hardy, most stress tolerant and most disease resistant on putting greens at four experimental sites representing the two major climatic zones in the Nordic countries.
- To create meeting places for discussions between plant breeders, seed companies and greenkeepers in order to encourage variety awareness, integrated pest management and continued effort in turfgrass breeding for northern environments.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2024

5th June: International field day at Smørum GC, Denmark (Greenkeepers from Germany, the Netherlands and Sweden, approx. 30 participants).
April-October: Several visits at Smørum from DLF.
4th & 18th June: Project managers visit UMN, Minnesota and Reykjavik GC, Iceland test sites.
27th June: Visit from Danish greenkeepers at Smørum GK (Demo Day at the course)
June-August: Several visits at Reykjavik from individual greenkeepers.
July/August: Visits at Apelsvoll from Strand and Floratine.
4th September: National field day at Smørum GC, Denmark (approx. 50 participants).
19th September: Students from greenkeepers college Sandmoseskolen in Denmark visit NIBIO-Landvik.
November: Visit at Smørum from a smaller group of greenkeepers.
December: Visit at Smørum from students from the greenkeepers college Roskilde.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2025

This project is a continuation of the SCANGREEN variety testing that has been going on for more than 20 years. Varieties are assessed on sand-based greens at NIBIO-Landvik, Norway and Smørum GC, Denmark in the southern zone and at NIBIO-Apelsvoll, Norway and Reykjavik GC, Iceland in the northern zone. The project includes an additional test site at UMN, Minnesota, USA, which is funded by the WINTER-TURF-project. 2024 was the second year in the on-going test round, in which greens were established in 2023. SCANGREEN 2023-2026 comprises 7 species (Chewings and slender creeping fescue, colonial and creeping bentgrass, perennial ryegrass, Kentucky bluegrass and smaller cats tail) with 20 new varieties for comparison with the references. Mixtures of fescue and bentgrass are also tested. Experimental plots are evaluated monthly and varieties ranked for turf quality, winter tolerance, diseases and the invasion of moss and annual bluegrass. The

Photo 1: *The experimental green at Apelsvoll after snow was melted mid April. Only the row with colonial bentgrass had any green grass. Photo: Pia Heltoft.*

Photo 2: *Reseeding of plots at Apelsvoll in late June. Photo: Pia Heltoft.*

test sites are used for field days, and results will be communicated at www.sterf.org, www.scanturf.org and in greenkeeper magazines.

Winter survival was fine in the southern zone (Smørum and Landvik) and at UMN, with only a small number of plots to be reseeded. At Smørum, big differences in the coverage of diseases were seen from February-April. Challenges with in establishment of some of the plots of Kentucky bluegrass were still an issue at this site, and some plots were reseeded more than once in May. At Landvik, a 30 cm thick layer of snow had covered the experiment since early January but had melted by the end of February, and none of the plots had to be reseeded. At UMN, three plots of fescue were reseeded.

In the northern zone (Apelsvoll and Reykjavik), more winter damage was seen as expected. At Apelsvoll, the green was free from snow in mid April, but all plots except the row with colonial bentgrass were brown (Photo 1).

From May, most plots started to green-up, but at the end of June, all varieties of creeping bentgrass and Kentucky bluegrass, plus some varieties of red fescue (most of the slender creeping fescue), were reseeded (Photo 2).

At Reykjavik, the green was ice-covered from February-March and remained brownish through April. On 10th May, only the perennial ryegrasses were still brown and dead, and they were reseeded in early June. Leaf spot infection (Drechslera poae) was observed in Kentucky bluegrass in early August due to the low temperatures in July (the average temperature in Reykjavik in July was 11 ^{o}C).

At Landvik, some disease observed in perennial ryegrass was later diagnosed to be take-all-patch.

FAIRWAYS4FUTURE: MANAGING HIGH QUALITY GOLF COURSE FAIRWAYS AND SEMI ROUGHS WITHOUT HERBICIDES AND LESS EMISSION OF GREENHOUSE GASES

PROJECT PERIOD: MARCH 2023 - DECEMBER 2026

FUNDING (kSEK)

	2023	2024	2025	2026	Total
STERF	413	329	234	109	1085
Husqvarna (cash)	413	329	343	0	1085
Husqvarna (in kind)	0	1558	12	0	1570
Golf courses (in kind)	0	49	49	0	98
Total	826	2264	638	109	3837

PRINCIPAL INVESTIGATOR / CONTACT PERSON
Karin Juul Hesselsøe, NIBIO Landvik, N-4886 Grimstad, Norway
Tel: + 47 413 96 851 E-mail: karin.hesselsoe@nibio.no

CO-APPLICANTS AND COLLABORATORS
Anne Friederike Borchert and **Trygve S. Aamlid,** NIBIO Landvik Norway
Daniel Hahn, Independent Turfgrass Agronomist
Wolfgang Prämaßing, Hochschule Osnabrück, Germany
Golf courses (course managers):
St. Eurach and Haus Bey, Germany.
Brøndby GC (**Gediminas Rudokas**) and Grenå GC (**Lasse Nielsen**), Denmark.
Hirsala GC (**Janne Lehto**), Finland.
Hills GC (**Christofer Andersson**), Sweden.
Sandnes GC (**Atle R. Hansen**), Norway.

PROJECT OBJECTIVES
- To elucidate the long-term effects of robotic mowing on the physical condition of soil on golf course fairways.
- To investigate how the combination of mowing system (robotic vs. traditional), mowing height and fertilizer rate affects the level of individual weed species and other aspects of turfgrass quality on fairways and semi-roughs.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2024
19th, 22nd March & 11th April: Teams meetings for project-core group. Presentations by project manager.
5th-6th September: Hirsala GC, Finnish Greenkeepers Association hosted a "Robotic Workshop", and one of the areas visited during the education days was the F4F trial area. About 30 people took part in the seminar.
19 September: NIBIO-Landvik, class of students from greenkeepers college Sandmoseskolen in Denmark visiting the experimental area.
31 October: Sandmoseskolen, Denmark, presentation on sustainable golf course management incl. the F4F-project, Karin J. Hesselsøe.
April and October: Brøndby, visits at experimental area from project manager.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2025
WP1: To evaluate the long-term impact of robotic mowing on the physical properties of soil, fairways on golf courses in the ROBO-GOLF project (2020-23) were further examined. In 2023, two fairways at Sandnes (Norway) were analysed and in August 2024, fairways at Grenå, Denmark were examined. Undisturbed soil cylinders (Photo 1) were taken, and infiltration rates and soil compaction were measured (Photo 2). Preliminary results show that there was a clear tendency towards lower soil compaction with robotic mowing. The results of WP1 will be disseminated in a scientific NIBIO-report in February 2025.

Photo 1. *Undisturbed soil cylinders taken out.*

Photo 2*. Measuring soil compaction.*

Photo 3. *Robotic mowing at Landvik.*

WP2: At NIBIO Landvik, Norway the experimental area was seeded in spring 2024. After grow-in, the installation of a Ceora 546 EPOS robotic mower was carried out on 7th August (Photo 3). From spring 2025, traditional rotary mowing will be compared with systematic robotic mowing at two mowing heights to investigate turfgrass quality and the encroachment of white clover on semi-roughs. Plugs of fairway-type white clover (*Trifolium repens*) were planted into the experimental area in mid-August 2024.

WP3: The same robotic mowers as in WP2 will be programmed to mow at different fairway mowing heights at three nitrogen fertilizer levels (0, 60, and 120 kg/ha/yr) from spring 2025. Plugs of white clover, daisies (*Bellis perennis*), dandelion (*Taraxacum officinale*), and yarrow (*Achillea millefolium*) were planted into subplots to study the combined effect of different mowing heights and fertilizer levels on the encroachment of broadleaved weed species.

WP4: Demonstration trials were established and Ceora EPOS robotic mowers were installed at four golf courses in spring and summer 2024 (Hirsala, Finland; Brøndby, Denmark; Haus Bey and St. Eurach, Germany). Robotic and traditional mown fairways and semi-roughs were compared for turfgrass quality and coverage of broadleaved weeds.

On the fairways, the fertilizer levels were split into two: 'Common practice' (100%) and reduced (50%). Preliminary results from some of the courses show a tendency towards increased turfgrass quality with robotic mowing compared to traditional mowing in plots with fertilizer levels as 'Common practice' (100%). At St. Eurach, the benefit was visually clear in the semi-rough after one season of robotic mowing. Compared to the traditional rotary mower, the robotic mower left no clippings and created clear definition at the edges.

FAIR-WATER I: TOWARDS BETTER DROUGHT RESISTANCE AND REDUCED WATER CONSUMPTION ON GOLF COURSE FAIRWAYS

PROJECT PERIOD: JANUARY 2023 - DECEMBER 2026

FUNDING (kSEK)

	2023	2024	2025	2026	Total
STERF	567	572	408	172	1719
Other sources	629	491	150	0	1270
Total	1196	1063	558	172	2989

PRINCIPAL INVESTIGATOR / CONTACT PERSON
Trygve S. Aamlid, NIBIO Department for Urban Greening and Vegetation Ecology, Turfgrass Research Group, Landvik, N-4886 Grimstad, Tel: + 47 90 52 83 78.
E-mail: trygve.aamlid@nibio.no

CO-APPLICANTS AND COLLABORATORS
Anne F. Borchert, **Karin Juul Hesselsøe**, **Trond Pettersen, Paula Lawicka** and **Iris Eik**, NIBIO, Norway
Peter Edman, Swedish Golf Federation
Wolfgang Prämaßing, Osnabruck University of Applied Sciences, Germany
Thomas Fischer, iNova Green, Germany
Bernd Leinauer, New Mexico State University

PROJECT OBJECTIVES
The principal objective of this proposal is to develop management strategies for resilient GC fairways that retain acceptable quality with no or strongly reduced consumption of potable irrigation water. This includes the following goals:

1. Identify the most drought resistant cultivars of the turfgrass species/subspecies commonly seeded on fairways in Northern Europe, including mixtures of these species.
2. Screen seven soil surfactants for their potential to prevent drought stress, reduce water consumption and enhance recovery after drought.
3. Validate through field trials in Norway and Germany the two most drought tolerant blends/mixtures (from goal 1) and the two best performing surfactants (from goal 2) to optimize fairway quality under drought conditions.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2024
14th June Visit to turfgrass experiments at Landvik by NIBIOs new CEO, Ivar H. Kristiansen
6 th Aug. Results from WP1 and WP2 presented in digital meeting for project reference group.
19 th Aug. 'Forsker på grønne plener med mindre behov for vanning'. NIBIO Nyheter. https://www.nibio.no/nyheter/forsker-pa-gronne-plener-med-mindre-behov-for-vanning?locationfilter=true
5 Sep. Presentation for Sara Kahri, Assistant Pro with PGA Finland. Teams.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2025
Over the last decade, the scarcity of potable water for irrigation has become a greater issue in northern Europe. In the three work packages (WPs) of this project, we study methods to reduce irrigation while retaining turfgrass quality on golf course fairways.

In WP1, we evaluate 42 varieties of 10 turfgrass species for drought tolerance and recovery in sandy soil under a rain shelter at NIBIO Landvik, Norway. The first drought period was implemented from 30th April to 25th June 2024, followed by a 3-week recovery period. Turfgrass coverage was determined through digital images of each plot twice a week and analyzed using https://turfanalyzer.com. The main findings from 2024 were: (1) tall fescue was least affected by drought, followed by perennial ryegrass and sheep fescue; (2) tetraploid varieties of perennial ryegrass were more drought tolerant than diploid varieties; (3) slender creeping red fescue was more drought tolerant than Chewings fescue and strong creeping red fescue. The trial will be repeated in 2025.

In WP2, we continued testing seven soil surfactants for their ability to retain turfgrass quality and coverage on a fairway seeded in sandy soil under a rain shelter. The surfactants were applied in early spring before imposing drought from 15th May to 10th July. Individual plots were irrigated with 8 mm of water only when turfgrass coverage fell below 70%, as determined from digital images. Control treatments included a negative control (no surfactant but the same criterion for irrigation) and a positive control irrigated to field capacity three times a week. Unlike in 2023, significant differences were detected in the last three weeks of the drought period. Plots treated with H2PRO had better coverage and less consumption of irrigation water; plots treated with Qualibra had the higher turfgrass quality; and plots treated with ProWet Evolve had higher soil moisture contents than the negative control treatment.

In WP3, two supposedly drought resistant seed mixtures were composed based on WP1, and new trials were seeded in a split-plot design in sandy soils at NIBIO Landvik, Norway and Osnabrück University, Germany in August 2024. One mixture was primarily based on slender creeping red fescue, sheep fescue and hard fescue, the other on tall fescue and tetraploid perennial ryegrass. A standard 'Nordic' seed mixture of Kentucky bluegrass and Chewings fescue was included as a control. In 2025, the most promising surfactants from WP2 will be tested on subplots in these trials to find the optimal combination of seed mixture and surfactant for better drought resistance.

FAIR-WATER II: TOWARDS BETTER DROUGHT RESISTANCE AND REDUCED WATER CONSUMPTION ON GOLF COURSE FAIRWAYS

PROJECT PERIOD: SEPTEMBER 2024 - DECEMBER 2026

FUNDING (kSEK)

	2024	2025	2026	Total
STERF	0	0	0	0
R&A	242	403	403	1048
Other sources	143	277	285	705
Total	385	680	688	1753

PRINCIPAL INVESTIGATOR / CONTACT PERSON
Trygve S. Aamlid, NIBIO Department for Urban Greening and Vegetation Ecology, Turfgrass Research Group, Landvik, N-4886 Grimstad, Tel: + 47 90 52 83 78.
E-mail: trygve.aamlid@nibio.no

CO-APPLICANTS
Michael Bekken, NIBIO, Norway.
Peter Edman, Swedish Golf Federation.
Thomas Fischer, North German Greenkeeper Association.

PROJECT OBJECTIVES
Principal objective: To develop management strategies for resilient GC fairways that retain acceptable turfgrass quality with no or highly reduced consumption of potable irrigation water.

Specific goals for FAIR WATER II:
- Validate through a large-scale demo trial the combined effect of mechanical treatments to stimulate root development and the application of surfactants (WP1)
- Review literature, collect data from ten Swedish GCs and conduct two large-scale demo trials comparing brackish water from the Baltic Sea or effluent water from sewage cleaning plants with potable water for fairway irrigation (WP2)

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2024
As the project started in September 2024, only a few results have been available for dissemination so far. A technical report from WP 2 was submitted to the International Turfgrass Society Research Journal in December 2024 and will be presented at the 15th International Turfgrass Research Conference in Japan in July 2025. A popular article presenting both WPs will be submitted to www.sterf.org and Nordic and German greenkeeper magazines in January 2025.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2025
FAIR WATER II (FW II) is a continuation and extension of FAIR WATER (FW I). The project comprises two work packages (WPs)

In WP1, methods to enhance fairway drought resistance are compared in large scale demo trials at Hirsala GC (Finland), Kalundborg GC (Denmark), Romerike GC (Norway), and St. Dionys GC (Germany). The trials are carried out on fairways that have a history of drying out during the summer. The soil texture is 81% silt at Romerike and 82-94% sand at the three other sites. Fairways are split into 3x3 sections with the following treatments in factorial combination:

Factor 1: Mechanical treatments in the fall of 2024 and 2025 to remove thatch and enhance root development.
A. Untreated control
B. Scarification to a 2 cm depth[1]
C. Scarification to a 2 cm depth[1] + aerification to a 20 cm dept

1) At Hirsala, the only sand-capped fairway in the project, scarification was replaced by hollow tine coring at a 5 cm depth followed by core removal and topdressing.

Mechanical treatment at St.Dionys GC.

Factor 2: Monthly application of soil surfactants in the summer of 2025 and 2026.
1. Untreated control
2. Product 1 to be selected[2] based on FW I, WP2
3. Product 2 to be selected[2] based on FW I, WP2

2) The final selection will be made in February 2025.

The WP started with mechanical treatments in September 2024. Initial analyses showed 25-50 mm thatch layers with 9, 20, 20 and 29% organic matter in the top 3 cm at Hirsala, Romerike, Kalundborg and St.Dionys GC, respectively. At the end of the growing season, mechanical treatments had reduced soil penetrometer resistance by up top 10%. It is hoped that this will result in deeper roots, reduced hydrophobicity and more drought-resistant turf in 2025.

In WP2, Ljunghusen, Falsterbo, Flommen, Ronneby, Emmaboda, Västervik and Loftahammar GCs on the Baltic coast of Sweden, all using lower quality irrigation water, were visited in October 2024. Greenkeepers were interviewed and soil and water samples taken for salinity analysis. Four of the seven GCs experienced salinity stress regularly, primarily in a 6-8 week period in July and August. The soil and water samples taken in October 2024 did not exceed salinity thresholds for cool season turfgrasses. In 2025, water samples will be taken at the start, middle, and end of the summer period, the time at which salinity stress is highest.

GOLF LANDSCAPES: BIODIVERSITY AND MULTIFUNCTIONALITY OF GOLF LANDSCAPES

PROJECT PERIOD: FEBRUARY 2023 - DECEMBER 2025

FUNDING (kSEK)

	2023	2024	2025	Total
STERF	300	300	300	900
R&A	225	225	225	675
NIBIO	0	100	100	200
Total	525	625	625	1775

PRINCIPAL INVESTIGATOR / CONTACT PERSON

Hans Martin Hanslin, The Norwegian Institute of Bioeconomy Research (NIBIO), Postboks 115, NO-1431 Ås, Norway. hans.martin.hanslin@nibio.no

CO-APPLICANTS AND COLLABORATORS

Trygve Aamlid, NIBIO, Dept of Urban Greening and Vegetation Ecology, Norway
Wendy Fjellstad, NIBIO, Dept. of Landscape Monitoring, Norway
Johannes Kollmann, NIBIO and Technical University Munich, Germany
Tommy Lennartsson, Swedish Biodiversity Centre, SLU, Sweden
Christopher Marston, UK Centre for Ecology & Hydrology, UK.

PROJECT OBJECTIVES

- Main objective: provide knowledge of how golf courses can be designed and managed to improve their contributions to biodiversity and multifunctionality on a landscape scale.
- Identify approaches to assess and document existing qualities and biodiversity potential, prioritise approaches, and recommend methods to monitor development based on GC potential and landscape context.
- Provide simple indicators of GC contributions to landscape functions to be used in design and management, such as connectivity, species pool, and structural and habitat diversity.
- Provide methods to estimate multifunctionality for the courses and landscapes.
- Prescribe principles of design to improve biodiversity and ecological functioning, both in the quality of GC habitats for biodiversity and their contributions to biodiversity in the wider landscape, while retaining playability and quality of the game.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2024

4th November Golf landscapes workshop with designer. Teams meeting.
17th December Follow-up meeting with STERF and the R&A. Teams meeting.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2025

Golf courses (GCs) are often established in highly fragmented and at least partly degraded landscapes, resulting in positive effects on biodiversity and ecosystem functions. However, there are few studies on the ecological effects within and beyond GCs.

The project carries out landscape ecological analysis of 40 courses along urbanization gradients in Munich (Germany), Manchester (UK), Stockholm (Sweden), Copenhagen (Denmark) and Oslo (Norway). In 2024, we completed habitat mapping using GIS, breeding bird surveys, and vegetation surveys. For birds, we used a standardised approach to estimate the occurrence of pairs of breeding birds through early morning observations in a number of fixed locations per course. This gives information on species composition and density. For the vegetation survey, we used standardised transect walks partitioned by land use type (rough, lawn, forest etc.), with the number of

species being recorded to estimate vascular plant species richness. The field botanists had a joint field-day in early May 2024 in Munich to calibrate survey methods.

Landscape analyses are based on high resolution satellite imagery for all five target cities, covering the selected golf courses plus a 1-km buffer and the surrounding areas. Imagery was acquired from multiple satellites, all at a 2-m spatial resolution and acquiring imagery in four spectral bands (green, blue, red and near infra-red). This information is used to estimate landscape indicators for biodiversity, such as the size and shape of landscape elements, edge effects, landscape diversity, and landscape heterogeneity based on land cover types. A case study on the use of drone data to characterise golf courses at a higher level of spatial detail is in progress at the Dunscar GC, UK.

Landscape analyses and analyses of bird and vegetation data will be completed in the first half of 2025 and prepared for publication and dissemination. To better understand motivations and bottlenecks in addressing biodiversity in course design and management, we hosted a workshop in early December 2024 with part of the reference group and professional golf course designers. This is useful to the consortium as it allows for target dissemination.

In sum, the project will provide knowledge of how GCs can be designed and managed to improve their contributions to biodiversity and ecological functions on a landscape scale, while also giving the context dependence of each GC. The main findings of the project will be disseminated to the golf industry as a combination of guidelines, workshops and webinars.

Golf Landscapes Fieldday at Eichenenried GC, Munich.

ARTIFICIAL INTELLIGENCE POWERED GOLF TURF MAINTENANCE (ADORE)

PROJECT PERIOD: JANUARY 2024 - MARCH 2025

FUNDING (kSEK)

		2024	2025	Total
STERF		225	25	250
Other sources		107		107
Total		357	25	357

PRINCIPAL INVESTIGATOR / CONTACT PERSON

Claes Holmström, Nordic AI Technology AB Husarviksgatan 16, 115 47 Stockholm, Sweden. Phone +46 70 247 87 44 claes.holmstrom@gmail.com

CO-APPLICANTS AND COLLABORATORS

Felix Rios, Mathematics of Data and AI department at KTH, Stockholm
Viktor Österberg, Nordic AI Technology AB/Ferritico AB

PROJECT OBJECTIVES

Evaluate the potential for AI not only to simulate turf conditions but also to generate optimized maintenance prescriptions that balance turf quality, sustainability, and cost.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2024

The project is not yet finalized and dissemination has not started. During the project, collaboration and knowledge transfer has been done with domain experts in the project's reference group. Following the initial data analysis and a software design workshop with the reference group, a set of AI models was defined for each course. Preliminary models were developed to simulate variables such as nutrition and organic matter levels, as well as playing quality metrics like stimp and bobble. The reference group also guided the bundling of target variables where possible, allowing the team to reduce the number of models by grouping variables with similar causal relationships.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2025

Turf optimization is inherently complex and multivariate, relying on multiple interdependent factors, including maintenance practices and environmental conditions. Consequently, optimizing turf maintenance through traditional methods such as domain expertise and physical experiments alone proves to be impractical. To address this, the ADORE project explored a digital, data-driven approach powered by Artificial Intelligence (AI) to identify sustainable and playability-optimized turf maintenance strategies across the vast array of possible configuration combinations.
In the project, AI time series modeling was employed to simulate future turf conditions, focusing on both playability and stress metrics, based on current turf state, maintenance practices, and environmental data. Given the high resource demands and cost of continuous data collection, the project aimed to answer two integrated research questions: (i) what types of data are essential?, and (ii) what volume of data is necessary to produce accurate predictions and assess the viability of AI-generated turf maintenance strategies?

A key focus was to determine whether AI and time-series modeling could be affective without significant investment in data measurement hardware or the need for large volumes of data. While AI has shown proof-of-concept success on courses equipped with soil sensors and local weather systems, the challenge was to assess its applicability for the average Scandinavian golf club, where data collection is limited to records of maintenance actions, occasional soil analysis, and open-source weather APIs.

The ADORE project concluded that current state-of-the-art AI time series models struggle to deliver accurate predictions when relying on sparse, manually collected data and non-local weather information. Both playability and stress metrics were evaluated, with even basic target variables such as STIMP, which is strongly influenced by factors like mowing height and frequency, showing reduced accuracy.

COMPLETED PROJECTS

The projects listed below were funded by STERF during the period 1999-2024. More information about the projects can be found on the STERF website www.sterf.org

1. The effects of soil organic matter, content, and quality on soil biological activity and turfgrass root development in sand dominated golf greens. Karin Blombäck, Swedish University of Agricultural Sciences (1999–2001)

2. Nitrogen utilisation efficiency in different golf green constructions of Creeping Bentgrass golf greens. Karin Blombäck, Swedish University of Agricultural Sciences (2001-2004).

3. Effects of demand-driven fertilisation on growth, appearance and nitrogen use efficiency of turfgrass. Tom Ericsson, Swedish University of Agricultural Sciences (2003-2004).

4. Leaching of fungicides from golf greens: Quantification and risk assessment. Nicholas Jarvis, Swedish University of Agricultural Sciences (2004-2005).

5. Benefits and environmental risks of fungicide use on Scandinavian golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2004-2005).

6. Evaluation of *Agrostis* and *Festuca* varieties for use on Scandinavian golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2004- 2007).

7. Environmental management programmes for golf facilities - a case study in the Stockholm golf district. Mårten Wallberg, Swedish Society of Nature Conservation, Stockholm (2005-2007)

8. Evaluation of Agrostis and Festuca varieties (Nordisk sortguide). Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2007).

9. Evaluation of biodiversity and nature conservation on golf courses in Scandinavia. Bente Mortensen, GreenProject (2006-2007).

10. Effects of organic amendments and surfactants on hydro-phobicity and fungicide leaching from ageing golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2006-2007).

11. The role of golf course management in the support of wetland-associated organisms in greater metropolitan Stockholm. Johan Colding, Beijer Institute of Ecological Economics, Royal Swedish Academy of Science (2006-2008).

12. Ageing of a sand-based rootzone. Karin Blombäck, Swedish University of Agricultural Sciences (2006-2008).

13. Turfgrass demonstration trials in Dalarna. Erik Svärd, Swedish Golf Federation (2006-2008).

14. Improved strategy for control of *Microdochium nivale* on golf courses. Anne Marte Tronsmo, Department of Plant and Environmental Sciences, Norwegian University of Life Sciences (2006-2008).

15. The influence of golf on nature and environment – analyses and evaluation of the environmental performance in Scandinavia. Bente Mortensen, GreenProject (2006-2008).

16. Evaluation of the plant growth regulator trinexapac-ethyl (Primo MAXX®) on Nordic golf courses. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2007-2009).

17. Development, evaluation and implementation of playing quality parameters in a continuous golf course evaluation concept – user survey. Anne Mette Dahl Jensen, Forest & Landscape, University of Copenhagen (2007-2009).

18. Prediction of turf growth as a function of light and temperature under Nordic conditions. Karin Blombäck, Swedish University of Agricultural Science (2007-2009)

19. Re-establishment of green turfgrass after winter damage, spring 2009. Agnar Kvalbein, Norwegian Greenkeepers' Association (2008-2009).

20. Impact of mowing height and late autumn fertilisation on winter survival of golf greens in the Nordic countries. Agnar Kvalbein, Norwegian Greenkeepers' Association (2008 -2010)

21. Multifunctional golf course with unique natural and cultural values. Carina Wettemark, Kristianstads Vattenrike Biosphere Reserve, Kristianstads kommun (2008 – 2010)

22. Evaluation of turfgrass varieties for use on Scandinavian golf greens, 2007-2010. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2007-2010)

23. Demonstration trials with winter cover protection. Boel Sandström, Swedish Golf Federation (2007-2010)

24. Breeding of winterhardy turgrass varieties for central and northern Scandinavia. Petter Marum, Graminor AS, Bjørke Research Station (2007-2010)

25. VELVET GREEN: Winter hardiness and management of velvet bentgrass (*Agrostis canina*) on putting greens in northern environments. T. Espevig, Norwegian Institute for Agricultural and Environmental Research (2007-2011)

26. Fertiliser strategies for golf turf: Implications for physiology-driven fertilization. Tom Ericsson, Department of Urban and Rural Development. Swedish University of Agricultural Sciences. (2007- 2011)

27. Nordic cooperation between authorities and non-governmental organisations for creating multifunctional golf courses and healthy ecosystems. Maria Strandberg, Scandinavian Turfgrass and Environment Research FoundationJanuary (2010–2011)

28. The Nordic Turfgrass Guide 2012 and Variety Lists. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2011-2013)

29. Optimal maintenance for hardening and early spring growth of green turfgrass. Karin Blombäck, Department of Soil and Environment, Swedish University of Agricultural Sciences (2006-2013)

30. Development of methods for non-pesticide weed control on golf fairways. Anne Mette Dahl Jensen, Forest & Landscape, University of Copenhagen-LIFE (2008-2013)

31. Preservation of cultural landscapes and cultural heritage elements on golf courses. Ole R. Sandberg, Department of Landscape Architecture and Spatial Planning, Norwegian University of Life Sciences (2009-2013)

32. Interactive map with navigation to learn and understand environmental work and impacts at a golf course. Magnus Enell, Enell Sustainable Business AB (2011-2013)

33. Integrated pest management - communication project within the park and golf sector. Maria Strandberg, Scandinavian Turfgrass and Environment Research Foundation (2011-2013)

34. Evaporative demands and deficit irrigation on sand-based golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2008-2014)

Sölvesborgs GC

35. Large-scale demonstration trials: Silvery thread moss on greens. Mikael Frisk, Swedish Golf Federation (2011-2014)

36. SCANGREEN: Turfgrass species and varieties for integrated pest management of Scandinavian putting greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2011-2015)

37. Increasing rates of the current and a new formulation of Primo MAXX® for plant growth regulation on greens and fairways. Ingunn M. Vågen, Norwegian Institute for Agricultural and Environmental Research (2013-2015)

38. Effects of mowing height, N-rate and P-rate/ mycorrhiza on quality and competition against annual meadowgrass on putting greens with red fescue as predominant species. Tatsiana Espevig, Norwegian Institute for Agriculture and Environmental Research (2011-2015)

39. Validation of the GreenCast prediction model for microdochium patch on golf greens in the Nordic region. Tatsiana Espevig, Norwegian Institute for Agricultural and Environmental Research (2012-2015)

40. Testing of alternative plant production products for the control of *Microdochium nivale* and other diseases on golf greens.Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2011-2015)

41. Better turfgrass survival in a changing winter climate Tatsiana Espevig, Norwegian Institute for Agriculture and Environmental Research (2011-2015)

42. A comparison of the soil surfactant Qualibra and Revolution on creeping bentgrass greens varying in water availability. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2014-2015)

43. GreenCast validation of anthracnose (*Colletotrichum graminicola)* on golf greens in the Nordic region. Tatsiana Espevig, Norwegian Institute for Agricultural and Environmental Research (2014-2015)

44. FESCUE-GREEN: Best management of red fescue (Festuca rubra) golf greens for high sustainability and playability. Trygve Aamlid, NIBIO (2011-2016)

45. Overseeding of Fairways - A strategy for finer turf with less broad-leaved weeds and Poa annua. Anne-Mette Dahl Jensen, University of Copenhagen (2011-2016)

46. Identification and risk assessment for dollar spot on Scandinavian golf courses. Tanja Espevig, NIBIO (2014-2016)

47. Experience mapping and multifunctional golf course development - enhanced possibilities of increased and more varied use of golf courses. Ole Hjorth Caspersen, University of Copenhagen (2011-2016)

48. Multifunctionality in golf courses – effects of different management practices on the ecosystem services carbon sequestration and biodiversity. Thomas Kätterer and Jörgen Wissman, SLU (2014-2016)

49. Optimal application of nitrogen and sulfur in autumn for better winter survival. Agnar Kvalbein, NIBIO (2014-2017)

50. Successful reestablishment of golf greens following winter damages. Wendy Waalen, NIBIO (2014-2017)
51. Fairy rings and thatch collapse, Tatsiana Espevig, NIBIO (2016-2017)

52. Evaluation of the soil surfactant Qualibra on sand-based putting greens. Trygve S. Aamlid, NIBIO (2015-2016)

53. Evaluation of Aquatrols experimental biostimulant formulations on fine turfgrass subjected to wear, drought (nutrient) and winter stress. Agnar Kvalbein, NIBIO (2015-2016)

54. Sustainable fairway management. Trygve S. Aamlid, NIBIO (2014-2016)

55. Evaluation of fungicides for Nordic golf courses. Trygve S. Aamlid (2016-2017)

56. Evaluation of a phosphite pigment, alone and in combination with fungicides, for control of turfgrass winter diseases on green and fairway. Trygve S. Aamlid, (2016-2017)

57. Optimal application of nitrogen and sulphur in autumn for better winter survival of perennial grasses – with emphasis on turf. Bert Sandell, NIBIO, (2014-2017)

58. Dandelion management at Värpinge golf course Håkan Rasmusson, Värpinge golf course (2014-2018)

59. Engineering better irrigation in turf - Quantifying impacts of application uniformity on turf quality in golf. – Jerry Knox, Cranfield University (2014-2019)

60. Effect of fertiliser type, silicon and copper on turf quality and Microdochium infection on Poa annua putting greens. Tanja Espevig, NIBIO (2016-2019)

61. Effect of irrigation, fertiliser type and soil amendment on turf quality and organic matter accumulation/thatch control on creeping bentgrass greens. Bert Sandell, NIBIO (2017-2019)

62. Testing the effect of AlgeaGreen® on winter stress tolerance. Bert Sandell, NIBIO (2016-2019)

63. Selection and management of bentgrass cultivars for genetic and induced resistance to microdochium patch and pink snow mould. Trygve Aamlid, NIBIO (2014-2019)

64. Practical re-establishment of golf greens following winter damage – a field study. Carl-Johan Lönnberg, Swedish Golf Federation (2017-2019)

65. Winter damage to golf greens in the Nordic countries: Survey of causes and economic consequences (part II). Tatsiana Espevig, NIBIO (2017-2019)

66. Golf clubs as landscape players – Establishment of collaboration networks in the landscape for enhanced contribution to the 2030 Agenda on sustainable development. Anders Esselin, Man & Nature (2017-2019)

67. SCANGREEN: Turfgrass species, varieties and seed blends and mixtures for integrated pest management of Scandinavian putting greens, Trygve Aamlid, NIBIO (2015-2020)

68. Risks for surface runoff and leaching of fungicides from golf greens varying in rootzone composition and amount of thatch, Trygve Aamlid, NIBIO (2016-2020)

69. Invite the starling to help the greenkeeper, Henning Heldbjerg, DOF Birdlife Denmark (2018-2020)

70. Go outdoors and use the Golf area in a pedagogical way – creativity, learning and health in the unlimited classroom, Anders Szczepanski, Linköping University/ Spetsa (2017-2020)

71. From dense swards to biodiverse roughs. Hans Martin Hanslin, NIBIO, (2017-2020)

72. Risk assessment, management and control of dollar spot caused by *Clarireedia* spp. on Scandinavian golf courses. Tatsiana Espevig, NIBIO, (2017-2020)

73. SUSPHOS: Sustainable phosphorus (P) fertilization on golf courses. Trygve S. Aamlid, NIBIO, (2017-2022)

74. SCANGREEN: Turfgrass species and varieties for integrated pest management of Scandinavian putting greens, P. Heltoft and K. J. Hesselsøe, NIBIO (2019-2022)

75. ICE-BREAKER: Reducing the agronomic and economic impact of ice damage on golf courses and other grasslands, Trygve S. Aamlid, NIBIO (2020-2024)

76. Carbon Par: Estimating carbon status of land used by Icelandic golf Courses, Edwin Roald, Carbon Par ehf. (2020-2024)

77. ROBO-GOLF: Robotic mowers for better turf quality, reduced fertiliser cost and less use of fossil energy on golf course fairways and semi-roughs, T. S. Aamlid and K. J. Hesselsøe, NIBIO (2020-2024)

78. Integrated management of important turfgrass diseases and insect pests on European golf Courses, T. Espevig, NIBIO (2020-2024)

79. Practical measures to increase biodiversity on golf Courses, Peter Edman, Swedish Golf Federation (2020-2024)

STERF KEY INDICATORS 2006 - 2024

Year	Funding (kSEK)		Applications		Ongoing projects	Scientific publications		Popular publi-cations	Presen-tations at seminars, webinars, conferences	Handbooks, Fact sheets, videos Programmes	Subscribers to STERF newsletters		
	STERF	Match-funding	Received	Approved for funding									
2006	1 500		17	7	12	7		23	46				
2007	4 900		1	1	13	3		12	26	1			
2008	4 500		22	6	18	11		29	42	2			
2009	5 500		1	1	15	16		20	49	1			
2010	3 000		16	9	13	7		29	46	1			
2011	3 700				19	4		32	50	25			
						Peer-reviewed papers	**Publications and reports**				**English**	**Swedish**	**Finnish**
2012	3 400				18	9	12	24	98	25			
2013	4 100				14	2	11	36	71	11			
2014	6 300		19	8	22	13	18	33	84	12			
2015	4 400				17	6	7	23	77	9			
2016	4 100		15		19	14	6	25	86	126			
2017	4 700	3 682		7	18	10	3	50	92	16	893	1 233	
2018	3 300	4 711	3	1	15	10	7	48	114	19	898	1 238	
2019	2 412	4 129	17	6	7	2	4	49	122	5	1 303	1 271	
2020	2 900	5 952			9	7	1	88	85	13	1 374	1 293	
2021	2 900	5 467			7	5	8	57	103	26	1 452	1 397	
2022	1 321	4 224	9	4	6	6	5	44	106	35	1 465	1 428	250
2023	2 600	5 414	1	1	11	2	13	60	118	30	1 465	1 428	250
2024	2 345	3 291	27*	2	6	2	7	42	87	24	718	1 614	125

These key indicators are based on information in annual project reports. STERF issues an open call for proposals approximately every three years. If there are specific reasons, a project application in between the open call for proposals may be approved for funding by the STERF board. *) Proposals submitted through ITRI are not yet decided for funding

FINANCIAL SUMMARY

INCOME STATEMENT		
	01/01/2023 12/31/2023	**01/01/2024 12/31/2024**
Revenue		
Net revenue	4 217 367	4 171 712
	4 217 367	4 171 712
Expenses		
Other external expenses	-106 251	-103 452
	4 111 116	**4 068 260**
Income from financial items		
Interest	325 996	365 134
Surplus	**4 437 112**	**4 433 394**

BALANCE SHEET	**2023**	**2024**
Other receivable	0	0
Cash and bank balances	**10 732 549**	**12 048 893**
Total assets	**10 732 549**	**12 048 893**
Liabilities and equity		
Equity		
Restricted reserves	262 719	262 719
Non restricted reserves	10 469 830	11 669 174
Total equity	**10 732 549**	**11 931 893**
Current liabilities		
Other current liabilities	0	117 000
Total current liabilities	**0**	**117 000**
Total liabilities and equity	**10 732 549**	**12 048 893**

LIST OF PUBLICATIONS 2024

PAPERS IN INTERNATIONAL PEER REVIEWED JOURNALS / CONFERENCE PROCEEDINGS

Aamlid, T.S., A.F. Borchert, K.J. Hesselsøe, I. Eik, T. Pettersen & P. Lawicka 2024. Drought resistance of cool-season grasses for fairways. European Journal of Turfgrass Science 55(4): 77-80.

Chen, Y., Pettersen, T. & Aamlid, T.S. (2024): Turfgrass quality, growth rates, and annual bluegrass contamination as affected by seasonal fertilizer distribution on red fescue putting greens. International Turfgrass Society Research Journal. https://onlinelibrary.wiley.com/doi/10.1002/its2.174

Hesselsøe, K. J., Borchert, A.F., Pettersen, T. & Aamlid, T.S. (2024): Transitioning from traditional to robotic mowing affects turfgrass quality and broadleaf weeds on golf course fairways. International Turfgrass Society Research Journal. https://onlinelibrary.wiley.com/DOI: 10.1002/its2.157

OTHER PUBLICATIONS IN ENGLISH AND GERMAN

Aamlid, T.S., A.F. Borchert, K.J. Hesselsøe, I. Eik, T. Pettersen & P. Lawicka 2024. Drought resistance of cool-season grasses for fairways. STERF Popular Scientific Article, October 2024. https://sterf.org/wp-content/uploads/2024/11/FAIRWATER-Drought-resistance-of-cool-season-grasses-for-fairways.pdf

Dalmannsdottir, S. & T.S. Aamlid 2024. Spring stresses - the difficult transition into a new growing season STERF fact sheet, updated version November 2024. https://sterf.org/wp-content/uploads/2024/11/Spring-stress-_The-difficult-transition-into-a-new-growing-season-2024.pdf

Hahn, A. 2024 Local and landscape factors influence bird diversity on urban golf courses: a case study in Munich. Bachelor thesis, Technic al University Munich.

Hesselsøe, K.J., A.F. Borchert, T. Pettersen & T.S. Aamlid 2024. How tolerant are different turfgrass species and varieties to ice encasement? STERF Popular Scientific Articles, July 2024. https://sterf.org/wp-content/uploads/2024/07/How-tolerant-are-different-grass-species-to-ice-encasement.pdf

Hesselsøe, K.J. & T.S. Aamlid 2024. Grass species and varieties for severe winter climates. STERF fact sheet, updated version March 2024. https://sterf.org/wp-content/uploads/2024/07/Grass-species-and-varieties-for-severe-winter-climates-2024-1.pdf

Hesselsøe, K. J., A. F. Borchert, & T. S. Aamlid, (2024): 'Kleine mähroboter auf dem Golfplatz: Erfahrungen von Greenkeepern, Golfern und Forschern in Skandinavien. Rasen,Turf,Gazon, nr. 1, p. 12-15.

Hesselsøe, K. J., Borchert, A. F. & Aamlid, T. S (2024): 'Use of robotic mowers on golf courses', STERF Fact sheet, https://www.sterf.org/wp-content/uploads/2024/04/Factsheet-Use-of-robotic-mowers-on-golf-courses.pdf

Hesselsøe, K. J., Borchert, A. F., Pettersen, T., Beisland, A., Sundsdal, K., Moen, V. S., Lysøe, E., Skogen, M., Frisk, C. A., Espevig, T., Spring, C., Ferguson, M., Clark, M., Hargreaves, L., Nilsson, M., Prämaßing, W., Borrink, L., Hunt, D. R., Siebert, J., Städler, A., Lebedin, Y., Maygurova, V., Antropova, A., Gagkaeva, T., Usoltseva, M., Entwistle, K., Braitmaier, S., Guerrero, C., Hokkanen, I. M., & Hokkanen, H. (2024) Golf Course 2030. Integrated management of turfgrass diseases and pests. Study on European golf courses. The R&A and STERF. 58 s. . https://sterf.org/wp-content/uploads/2024/07/IntegratedManagementofTurfgrassDiseases-k.pdf

Koch, C. 2024 The influence of structural conditions and landscape factors on plant diversity on urban golf courses: a case study in Munich. Bachelor thesis, Technical University Munich.

Melbye, P., T.S. Aamlid, K.J. Hesselsøe, W. Waalen, S. Dalmannsdottir, P. Heltoft, M. Almvik, C.J. Lönnberg, H. Blusi, M. DaCosta, E. Watkins, T. Espevig & A F. Borchert 2024. ICE-BREAKER: Reducing the agronomic and economic impact of ice damage on golf courses and other grasslands. Final report to STERF. 18 pp.

Strandberg, M. 2024. STERF yearbook 2023. P 49. https://sterf.org/library/annual-reports/

Strandberg, M. 2024. STERF Vuosikirja 2023. P 49. https://sterf.org/library/annual-reports/

Strandberg. M. 2024. Sustainable Golf Courses - Integrated Turf Management A Golf Course 2030 and STERF Symposium, September 18-19. International Turfgrass Society Newsletter 02/2024 p 10. https://turfsociety.com/wp-content/uploads/2024/02/2024-01-itsnd.pdf

Strandberg, M., Kemp, J. & Thompson, C. 2024. International Turfgrass Research Initiative - A Cooperative Effort by STERF, The R&A, and USGA 2024 Request for Proposals - project period 2026-2028. International Turfgrass Society Newsletter 03/2024 P 5. https://turfsociety.com/wp-content/uploads/2024/06/2024-05-itsnd.pdf

EXTENSION PAPERS OR REPORTS IN NORDIC LANGUAGES

Aamlid, T.S., A.F. Borchert, K.J. Hesselsøe, I. Eik, T. Pettersen & P. Lawicka 2024. Hvilke græsarter klarer sig bedst under tørke? STERF Popular Scientific Article. October 2024. https://sterf.org/wp-content/uploads/2024/11/Hvilke-graesarter-klarer-sig-bedst-under-torke-d.pdf

Aamlid, T.S., A.F. Borchert, K.J. Hesselsøe, I. Eik, T. Pettersen & P. Lawicka 2024. Hvilke græsarter klarer sig bedst under tørke? Greenkeeperen 38(2): 56-60.

Aamlid, T.S., A.F. Borchert, K.J. Hesselsøe, I. Eik, T. Pettersen & P. Lawicka 2024.Nye resultater fra STERF-prosjekt FAIR WATER: Hvilke gressarter er sterkest mot tørke? Gressforum 2024(4): 17-22.

Aamlid, T.S., A.F. Borchert, K.J. Hesselsøe, I. Eik, T. Pettersen & P. Lawicka 2024.Hvilke gressarter er sterkest mot tørke? STERF Popular Scientific Article. October 2024.https://sterf.org/wp-content/uploads/2024/11/FAIRWATER-Hvilke-gressarter-er-sterkest-mot-torke-n.pdf

Bekken, M. & T.S. Aamlid 2024. Etablering av krypkvein på tunrappgreen etter simulert vinterskade. Gressforum 2024(2): 14-16.

Bekken, M., T.S. Aamlid & H. Blusi 2024. Etablering av krypven på tidigare vitgrëgreen. Greenbladet 41(3): 60-61.

Björn, T. 2024. Golfbanan som utomhusklassrum – nu sprider sig projektet över Sverige. Greenbladet nr 1. P 38-39.

Björn, T. 2024. Golfen nav i satsning på A6 friluftsområde. Greenbladet nr 2. P 32-33.

Björn, T. 2024. Golfbanan som utomhusklassrum Stärker rekrytering och kommunkontakter. Greenbladet nr 3. P 40-41

Björn, T. 2024. Skola i ny miljö med golfträning. Greenbladet nr 4. P 38

Björn, T. 2024. Ordförande stolt över STERFs framgång. Greenbladet nr 4. P 32-33

Björn, T. 2024. Uteklassrummet ökar ungas intresse för golf. Greenbladet nr 5. P 44-45.

Björn. T. 2024. Femteklassare lär sig matte och allemansrätt på Haninge Golfklubb. https://www.youtube.com/watch?v=nXhE3RBftPo

Björn. T. 2024. STERF´s chairman on status and challenges. Video, KlubbTV STERF. https://www.klubbtv.nu/#parts/709433

Björn. T. 2024 Golf clubs collaborate to implement new knowledge. Video, KlubbTV STERF. https://www.klubbtv.nu/#parts/709025

Björn. T. 2024. Club managers ask for more research. Video, KlubbTV STERF. https://www.klubbtv.nu/#parts/709023

Björn. T. 2024. The Golf course as an outdoor classroom, English. Video, KlubbTV STERF. https://www.klubbtv.nu/#parts/655244

Dalmannsdottir, S. & T.S. Aamlid 2024. Vårskader – den vanskelige overgangen til ny vekstsesong. STERF faktablad, revidert utgave november 2024. 5s. https://sterf.org/wp-content/uploads/2024/11/Varskader_Den-vanskelige-overgangen-til-ny-vekstsesong-2024.pdf

Dalmannsdottir, S. & T.S. Aamlid 2024. Vårskador – den svåra övergången till en ny växtsäsong. STERF faktablad, reviderad utgåva november 2024. https://sterf.org/wp-content/uploads/2024/11/VARSKADOR-Den-svara-overgangen-till-en-ny-vaxtsasong.pdf

Dalmannsdottir, S. & T.S. Aamlid 2024. Kevätstressit - Vaikea siirtymä uuteen kasvukauteen. Päivitys 2024. https://sterf.org/wp-content/uploads/2024/12/Kevatstressit-2024-v21.pdf

Edman, P. 2024. Projekt i Halland redovisas i handbok. Greenbladet n2 4. P 39

Edman, P. 2024. Skötselhandbok för Biologisk Mångfald på golfbanor. Handbok PP34. https://sterf.org/wp-content/uploads/2024/09/Skotselhandbok-Biologisk-Mngfald-webb.pdf

Edman, P. 2024. Plejehåndbog for Biodiversitet på Golfbaner. Handbok PP34. https://sterf.org/wp-content/uploads/2025/01/Plejehandbog-for-Biodiversitet-pa-Golfbaner-dansk.pdf

Espevig, T., Sundsdal, K., Moen, V. S., Lysøe, E., Skogen, M., Usoltseva, M., Entwistle, K., Braitmaier, S., Guerrero, C. (2024) Mindst to arter af dollar spot forårsager angreb på golfbaner i Europa. Greenkeeperen 2:38-40.

Espevig, T., Sundsdal, K., Moen, V. S., Lysøe, E., Skogen, M., Usoltseva, M., Entwistle, K., Braitmaier, S., Guerrero, C. (2024) Myntflekk: sopparter som forårsaker sykdommen i Europa. Gressforum 4:11-13.

Espevig, T., Sundsdal, K., Moen, V. S., Lysøe, E., Skogen, M., Usoltseva, M., Entwistle, K., Braitmaier, S., Guerrero, C., Edman, P. (2024) Svampar som orsakar dollarspot i Europa. Greenbladet 5:46-47.

Hesselsøe, K. J., Hornslien, J., Lawicka, P., Hannesson, B., Petersen, T. K. & Normann, K. (2024): SCANGREEN 2023-2026: En ny runde med sortsafprøvning på greens er godt igang. STERF website November 2024 (version in Danish)https://sterf.org/wp-content/uploads/2024/11/En-ny-runde-med-sortsafprovning-pa-greens-er-godt-igang-d.pdf

Hesselsøe, K. J., Hornslien, J., Hannesson, B., Petersen, T. K. & Normann, K. (2024): SCANGREEN 2023-2026. STERF website, November 2024, (version in Norwegian) https://sterf.org/wp-content/uploads/2024/11/SCANGREEN-2023-26-no.pdf

Hesselsøe, K. J., Hornslien, Hannesson, B., Petersen, T. K. & Normann, K. (2024): SCANGREEN 2023-2026. Greenkeeperen nr. 2, p. 52-54.

Hesselsøe, K. J., Hornslien, J., Hannesson, B., Petersen, T. K. & Normann, K. (2024): SCANGREEN 2023-2026. Gressforum, s. 39-42.

Hesselsøe, K. J., Hornslien, J., Hannesson, B., Petersen, T. K. & Normann, K. (2024): Nya grässorter testade. Greenbladet nr. 5, p. 46-47.

Hesselsøe, K.J., A.F. Borchert, T. Pettersen, T.S. Aamlid & H. Blusi 2024. Gräsarters och -sorters tolerans mot isinkapsling. Greenbladet 41(4): 60-62.

Hesselsøe, K.J., A.F. Borchert, T. Pettersen, T.S. Aamlid & H. Blusi 2024. Hur toleranta är olika gräsarter och sorter mot isinkapsling? STERF Popular Scientific Articles, August 2024. https://sterf.org/wp-content/uploads/2024/07/Hur-toleranta-ar-olika-grasarter-och-sorter-mot-isinkapsling-svensk.pdf

Hesselsøe, K.J., A.F. Borchert, T. Pettersen & T.S. Aamlid 2024. Hvor mye isdekke (anoxia) tåler ulike gressarter? Gressforum 2024(3): 15-17.

Hesselsøe, K.J., A.F. Borchert, T. Pettersen & T.S. Aamlid 2024. Hvor mye isdekke (anoxia) tåler ulike gressarter? STERF Popular Scientific Articles, August 2024. https://sterf.org/wp-content/uploads/2024/07/Hvor-mye-isdekke-taler-ulike-gressarter-norsk.pdf

Hesselsøe, K. J. & A.F. Borchert (2024): 'Robotklip på golfbaner - høj kvalitet, men hvad med miljø og energiregnskab? Greenkeeperen nr. 1, side 26-28.

Hesselsøe, K. J., Borchert, A. F. & Aamlid, T. S (2024): 'Robo-Golf-projektet - slutsummering av erfarenheter och resultat'. Greenbladet nr. 1, side 34-37

Hesselsøe, K. J., Borchert, A. F. & Aamlid, T. S (2024): 'Anvendelse af robotklippere på golfbaner', STERF Faktablad https://www.sterf.org/wp-content/uploads/2024/05/Factsheet-Anvendelse-af-robotklippere-pa-golfbaner.pdf

Hesselsøe, K. J., Borchert, A. F. & Aamlid, T. S (2024): ‘Robottileikkureiden käyttö golfkentillä’, STERF Fact sheet (in Finnish), https://sterf.org/wpcontent/uploads/2025/01/Robottileikkureiden-kaytto-1.pdf

Lönnberg, C.J. 2024. Så klarar krypven låga temperaturer. Greenbladet 41(4): 54-58.

Lönnberg, C.J. & H. Blusi 2024. Slutseminarium om ICE-BREAKER. Greenbladet 41(1) 50.

Strandberg, M. 2024. Nödvändig kunskap kräver internationellt samarbete. Greenbladet nr 2. P 34.

Strandberg, M. 2024. STERF inleder samarbete med USGA och R&A. Greenbladet nr 3. P 39.

Strandberg, M. 2024. Åtta miljoner delas ut. Greenbladet nr 5. P 53

Vallda GC

LAYOUT: KARIN SCHMIDT. **LINGUISTIC REVISION:** WILL COWLEY **COVER PHOTO:** C. GÓMEZ ARMAYONES, NIBIO.

ADDRESS P.O. BOX 11016, SE-100 61 STOCKHOLM, SWEDEN **PHONE** +46 8 622 15 27 **E-MAIL** MARIA.STRANDBERG@GOLF.SE **INTERNET** WWW.STERF.ORG