

NATURE OF THE GAME.

SUSTAINABLE GOLF REVIEW | EDITION 1, 2026

A global insights report from The R&A and GEO Sustainable Golf Foundation

GEO Foundation for Sustainable Golf

GOLF, PEOPLE AND PLANET

Golf has a great deal to be proud of. For hundreds of years, the sport has provided life-enhancing recreation to hundreds of millions of people in local communities around the world, while creating, maintaining and protecting green spaces that provide direct and indirect benefits to nature, golfers and the wider public.



Now, with needs and expectations for environmental and social responsibility higher than ever, and in recognition of the clear risks and opportunities that the global sustainability movement presents to golf, it is important to strengthen our commitments and efforts. In that spirit, this report seeks to bring greater clarity to the relationship between golf and sustainability.

It aims to strengthen our collective understanding of the priority issues, the challenges ahead and the new opportunities emerging for the sport. It provides new data and evidence to support clearer, credible and more confident communication, both within the game and beyond it. Most importantly, it is intended to encourage more consistent and purposeful action across the sport.

This is about safeguarding golf's future and building resilience. It is also about ensuring golf fulfils its clear potential to contribute positively on an increasingly pressured planet: to play an even greater part in restoring nature, conserving resources, addressing climate change and strengthening communities around the world.

Feedback and ideas

We would be delighted to hear your thoughts – comments, feedback, ideas for future editions, and also your own leadership stories.

Please email
sustainablegolfreview@sustainable.golf

Insights for a sustainable future

This review collates comprehensively researched data, evidence, and stories as insights into sustainability and golf, exploring the sport's impact, value, opportunities, and challenges in the context of a changing climate and broader global sustainability trends.

It also highlights how different parts of the golf industry are contributing to a sustainable future - for the sport, as well as the landscapes and communities it is part of.

The Review is a collaborative project between the R&A and GEO Sustainable Golf Foundation and forms part of both organisations' work to accelerate sustainability across golf. **Edition 1, 2026**

Acknowledgements

The Review has been researched and developed by a core team of people from The R&A and GEO Sustainable Golf Foundation. Team members from each organisation have also contributed information and perspectives. A wider network of stakeholders across golf, sport and sustainability have provided insights into key issues, as well as their own initiatives.

We are grateful to all those who have contributed to date. Without a collaborative effort, it would not have been possible to compile such a range of information, which provides a comprehensive (if not fully exhaustive) insight into golf and sustainability.

Authors and editorial

Rony Epelbaum, Jonathan Smith, Dr Robbie Fitzpatrick and John Kemp.

Sustainable Golf specialists

R&A - Daniel Lightfoot; Richard Windows;
GEO – Sam Thomas; Tyler Annan; Guy Stirling
Others....??????????

Other golf industry stakeholders and individuals are listed in Annex 1.

Disclaimer.

The organisations and authors waive all and any responsibility and liability in relation to the information provider or acted upon.

Distributed under Creative Commons License

This license enables re-users to copy and distribute the material in any medium or format in unadapted form only, for non-commercial purposes only, and only so long as attribution is given to the creator.

BY: Credit must be given to the creator.
NC: Only non-commercial uses of the work are permitted.
ND: No derivatives or adaptations of the work are permitted.

SHARE, LEARN ACT AND TELL

The primary purpose of this report is to raise broad awareness and understanding of golf's relationship with the environment and communities. However, awareness is only the starting point. This report is also designed to help you and other people across golf take action.

To do something that improves your performance. To elevate your profile. To inspire others. To show, in practical and visible ways, how you can contribute to nature, resources, climate and communities through golf.

No single action needs to solve everything. But every positive step matters - one change at your facility, one new partnership, one better story, one more efficient practice or one stronger commitment can encourage others and help build the cumulative positive impact of golf globally.

So, please consider these and other practical next steps. Choose one thing. Share it. Learn from it. Build on it. Then try another!

SHARE

Please forward this document on to others, post on your social media and help raise more awareness and understanding of the issues.

Access social media assets



LEARN

Find out more by visiting some of these key international resources for further information, ideas and supportive resources.

- Resources here.
- Resources here.
- Resources here.
- Resources here.
- Resources here.
- Resources here.
- Resources here.



ACT

Take a practical action, in your organisation, at your facility, tournament, in your lifestyle. Then take another.... Build the cumulative positive impact of golf globally.

- Action here.
- Action here.
- Action here.
- Action here.
- Action here.
- Action here.



TELL

Join a growing community of people and organisations across golf that are telling credible stories of innovation and positive social and environmental impact through golf

Access knowledge centre



CONTENTS

PART 1

THE SUSTAINABILITY LANDSCAPE



A sustainable golf course or golf-related activity operates within environmental limits, helps restore nature, strengthens local communities and contributes positively to the wellbeing of both people and planet.[1]

Modern golf now manages over

3.5 MILLION HECTARES

of green space globally, an area equivalent in size to Belgium.[13] It is the largest land-based sport, with more than 112 million adults and juniors participating across all formats in R&A-affiliated markets outside the USA and Mexico, and growing.[14]

POINT OF IMPACT: GLOBAL CONTEXT, HISTORY AND STEWARDSHIP

Historical Origins and Natural Sustainability

Golf traces its origins to the 14th and 15th centuries in Europe, with early ball-and-stick games evolving into the sport we know today.[1]

By the 16th century, the game had taken root in Scotland, where courses were laid out on coastal lands with sandy soils.[1]

These sites, combined with Scotland's cool climate and hardy native turfgrasses, provided ideal conditions that naturally required minimal upkeep. Sheep grazed the land, keeping the grass trimmed, while sand dunes, wind-shaped landforms, and wind-blown topdressing introduced natural hazards and added playing interest.[2] [3]



As such, in its earliest form, golf was a landscape-led game. Its character came from working with nature: firm ground, native grasses, natural hazards, changing weather and the challenge of adjusting play to the land.[4] [5] [6]

Global Expansion and Environmental Impact

As golf expanded globally in the 19th century, the sport adapted to new climates and diverse geographies. Turfgrasses native to northern Europe were introduced to areas without similar varieties, requiring increased resource inputs - such as water, fertilisers and pesticides - to maintain playable conditions.[7] [8]

While technological advances improved consistency in playing surfaces, they also heightened turfgrass stress, increased susceptibility to pests and raised expectations for course conditioning. Across many parts of the world, modern golf became more technically managed, placing greater emphasis on irrigation, machinery, energy use, turfgrass science and skilled course management.[7] [9] [10] [11]



112 MILLION

adults and juniors participating across all formats in R&A-affiliated markets outside the USA and Mexico, and growing.[14]

Golf's growth, on and off the course, over the last century has been exponential, with over 38,000 courses across more than 200 countries and hundreds of new golf courses currently under development globally.[12]

Modern golf now manages over 3.5 million hectares of green space globally, an area equivalent in size to Belgium.[13] It is the largest land-based sport, with more than 112 million adults and juniors participating across all formats in R&A-affiliated markets outside the USA and Mexico, and growing.[14]

Modern Scale and Stewardship

Golf is no longer only a game shaped by local landscapes; it is a global network of managed green spaces, skilled professionals, businesses, communities, events, players and governing bodies. Few sports have such a direct relationship with land, water, nature, climate and place.[15] [16] [17]

Golf's next chapter is therefore about continuing to connect scale with stewardship. The same qualities that shaped the game's origins — adaptation, landscape fit, resourcefulness and respect for natural conditions - are ever more central to its future.[18]

As the world responds to climate change,[19] biodiversity loss,[20] resource pressure and growing expectations for social responsibility,[21] golf has an opportunity to show how sport can evolve with purpose: protecting the places it depends on, strengthening the communities it serves and contributing to a more sustainable future.[22]

Sustainability Impact

This is golf's point of impact.

Sustainability has become one of the defining global movements of our time. Pressure on natural systems, climate stability, land, water, energy and other resources is reshaping expectations of governments, businesses, communities and the public.[19] [20] At the same time, there is growing recognition that environmental, social and economic wellbeing are deeply connected.[21]

For golf, this matters because the game depends directly on many of the things now under greatest pressure and closest scrutiny: land, water, climate resilience, biodiversity, local support, public confidence and long-term economic viability.[18] [22]



The question is therefore not only how golf manages its own footprint, but whether the sport can use its scale, influence and landscapes to contribute positively beyond the boundaries of the course.

- Where and how will golf be played?
- How will the sport be regarded by governments, communities, investors and wider society?
- Will golf be supported as a valued network of green spaces, community assets and sustainable businesses, or challenged as competition for land and resources intensifies?
- Ultimately, will golf be seen as part of the problem, or part of the solution?

These questions frame the rest of this review. They lead directly to the risks and rewards facing the sport, the framework needed to organise action, and how golf can play a bigger part in wider sustainable development.

References:

1. Williamson, J. (2018). Born on the Links: A Concise History of Golf. Rowman & Littlefield.
2. Arthur, J., & Isaac, S. (2014). Practical Greenkeeping (3rd ed.). R&A Group Services Limited.
3. MacKenzie, A. (1995). The Spirit of St Andrews. Sleeping Bear Press.
4. Colt, H. S., & Alison, C. H. (1920). Some Essays on Golf-Course Architecture. Country Life.
5. Hunter, R. (1926). The Links. Charles Scribner's Sons.
6. Course: The Art of Golf Architecture. Lyons & Burford. Retrieved from https://www.doakgolf.com/product/the-anatomy-of-a-golf-course/
7. Millington, B., & Wilson, B. (2016). The Greening of Golf: Sport, Globalization and the Environment. Manchester University Press.
8. Wheeler, K., & Nauright, J. (2006). "A global perspective on the environmental impact of golf." Sport in Society, 9(3), 427–443. Retrieved from https://doi.org/10.1080/17430430600673449
9. Bartlett, M. D., & James, I. T. (2011). "A model of greenhouse gas emissions from the management of turf on two golf courses." Science of the Total Environment, 409(23), 5137–5147. Retrieved from https://doi.org/10.1016/j.scitotenv.2011.07.054
10. Tidåker, P., Wesström, T., & Kätterer, T. (2017). "Energy use and greenhouse gas emissions from turf management of two Swedish golf courses." Urban Forestry & Urban Greening, 21, 80–87. Retrieved from https://doi.org/10.1016/j.ufug.2016.11.009
11. Bekken, M. A. H., Soldat, D. J., & Frank, K. W. (2022). "Estimated energy use and greenhouse gas emissions associated with golf course turfgrass maintenance in the northern USA." International Turfgrass Society Research Journal, 14(1), 58–75. Retrieved from https://doi.org/10.1002/its2.61
12. The R&A & National Golf Foundation. (2021). Golf Around the World: Fourth Edition. The R&A and National Golf Foundation. Retrieved from https://assets-us-01.kc-usercontent.com/c42c7bf4-dca7-00ea-4f2e-373223f80f76/50ff4344-b576-4e2e-a9e2-8411712954ac/2021%20Golf%20Around%20The%20World%20Fourth%20Edition.pdf
13. The R&A. (2019). Golf Course 2030: Sustainable Golf Course Management. The R&A. Retrieved from https://www.randa.org/sustainability/golf-course-management
14. The R&A. (2026). "Junior golf growth helps drive sustained increase in global participation." The R&A, 4 June 2026. Retrieved from https://www.randa.org/en/articles/junior-golf-growth-helps-drive-sustained-increase-in-global-participation
15. Lonsdorf, E. V., Nootenboom, C. W., Janke, B., & Horgan, B. P. (2021). "Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area." Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
16. Colding, J., & Folke, C. (2009). "The role of golf courses in biodiversity conservation and ecosystem management." Ecosystems, 12, 191–206. Retrieved from https://doi.org/10.1007/s10021-008-9217-1
17. Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., Grant, L., & Mutrie, N. (2017). "The relationships between golf and health: A scoping review." British Journal of Sports Medicine, 51(1), 12–19. Retrieved from https://doi.org/10.1136/bjsports-2016-096625
18. Isaac, S. (2022). "Golf Course 2030: Implementing UN Sustainable Development Goals to identify industry and research needs for greater resiliency in golf course playability." International Turfgrass Society Research Journal, 14(1), 36–39. Retrieved from https://doi.org/10.1002/its2.38
19. Intergovernmental Panel on Climate Change. (2023). Climate Change 2023: Synthesis Report — Summary for Policymakers. IPCC. Retrieved from https://www.ipcc.ch/report/ar6/syr/
20. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services. IPBES. Retrieved from https://doi.org/10.5281/zenodo.3553579
21. United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. United Nations General Assembly. Retrieved from https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/2030_agenda_for_sustainable_development_web.pdf
22. Fitzpatrick, R. D. J., White, R., & Matthews, I. M. (2022). "Seeking green grass: Strong sustainability for golf and turfgrass." International Turfgrass Society Research Journal, 14(1), 23–30. Retrieved from https://doi.org/10.1002/its2.22



RISKS AND REWARDS

The global sustainability movement presents clear risks and opportunities for the future success of golf businesses and the wider sport. As expectations for environmental and social responsibility continue to grow, golf's relationship with **land, water, nature, climate and communities** will increasingly shape how the sport is planned, permitted, funded, managed and perceived.

The question is not whether sustainability will affect golf, but whether golf is prepared to respond with the clarity, confidence and leadership needed to secure its future and strengthen its contribution.

These risks and rewards are closely connected. A facility that manages water efficiently, restores nature, reduces emissions and strengthens community relationships is also likely to be more resilient, more trusted and better prepared for future regulation, resource pressures and climate impacts.

Equally, a facility that fails to adapt may face rising costs, greater scrutiny, weaker public support and reduced room for manoeuvre.

Sustainability is therefore a strategic issue for the sport's future, with exciting opportunities to demonstrate leadership and show that golf can safeguard the places it depends on, strengthen the communities it serves and contribute positively to a more sustainable future.





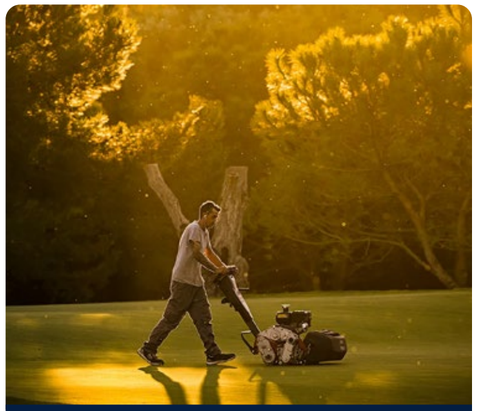
PLANNING, PERMITTING AND LAND

Rewards and opportunities

Golf is prioritised as part of economic development, urban greenspace protection, agricultural diversification, coastal zone protection, biodiversity conservation and sustainable urban water management.

Risks and challenges

New developments and course expansions are restricted. Existing courses are lost where they lack sufficient protection, or where land is increasingly prioritised for food, housing, business, industry, energy, nature recovery and wider public access.



REGULATION, RESOURCES AND COSTS

Rewards and opportunities

Golf facilities become highly efficient and increasingly self-sufficient in energy and water. They can also secure access to vital natural resources and materials, while minimising operational costs, liabilities and exposure to future restrictions.

Risks and challenges

Golf facilities become highly vulnerable to resource restrictions, price increases and supply pressures, particularly for energy, water and other key materials. Clubs and businesses also struggle to raise sufficient capital for technology transitions or resilience upgrades.



IMAGE AND REPUTATION

Rewards and opportunities

Golf becomes better known, more highly regarded and more widely supported for its commitments and value to nature, climate and communities. The sport is also recognised as part of the solution: a network of green spaces, community assets, sustainable businesses and places for healthy outdoor recreation.

Risks and challenges

Golf suffers from negative publicity, scrutiny and activism. The sport is portrayed as part of the problem rather than part of the solution, affecting public support, planning confidence, community relationships and private investment.

SUSTAINABLE GOLF FRAMEWORK

Key themes and focus areas for environmental responsibility and social value.

A sustainable golf course or golf-related activity operates within environmental limits, helps restore nature, strengthens local communities and contributes positively to the wellbeing of both people and planet.[1]

This aligns with the broader definition of sustainable development, as defined by the Brundtland Commission: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".[2]



In practical terms, sustainability in golf involves adopting agronomic practices tailored to local climatic conditions while also promoting and protecting native biodiversity.[3] It encompasses the management of natural resources, such as water and energy, alongside responsible chemical use and soil health practices that support long-term ecological viability.[3]

Sustainability also encompasses the operational impacts of golf facilities, such as reducing carbon emissions, managing supply chain impacts and optimising resource efficiency.[4] Equally important is recognising the multifunctional role of golf courses as green spaces that can support public health, recreation, flood mitigation, conservation and wider community value.[5]

Golf courses often play an important economic and social role in their communities, offering employment opportunities, tourism revenue and accessible recreational spaces that contribute to community cohesion and individual wellbeing.[6]

The Sustainable Golf Framework brings these responsibilities together under four connected themes.

Together, these themes provide the organising structure for this review. They also reflect the practical reality of sustainable golf: the future of the sport depends on how well land, water, energy, nature, climate, people, business and play are managed together.

NATURE

Management of land, landscape and ecological value.

Focus areas:

- Habitats and biodiversity
- Turfgrass management
- Pollution prevention

RESOURCES

Efficient use of natural resources.

Focus areas:

- Water stewardship
- Energy efficiency
- Circular use of materials



CLIMATE

Reducing emissions, storing carbon and adapting to changing conditions.

Focus areas:

- Emissions reduction
- Carbon sequestration
- Climate adaptation

COMMUNITIES

Benefiting people through golf, employment, recreation, communication and partnerships.

Focus areas:

- Health and wellbeing
- Education and outreach
- Communication and inspiration

PLAYING A BIGGER PART – CONTRIBUTIONS TO GLOBAL GOALS

The Sustainable Golf Framework is directly aligned with the United Nations Sustainable Development Goals (SDGs), which provide a shared global framework for sustainable development.

As a game, an industry and a land user, golf has connections across all of the SDGs: from the way courses are designed and managed, to how facilities and tournaments operate, to how the sport itself supports people, places and communities.

Golf can contribute to all 17 goals in some way, but certain goals are particularly relevant to the sport. These provide a useful lens for understanding where golf can have the most meaningful impact, and how the sport can make a positive global contribution to a more sustainable future.



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

Golf can contribute to local livelihoods through employment, enterprise, tourism, supply chains, community investment and charitable activity, particularly where facilities and events create inclusive local economic value.

2 ZERO HUNGER

Golf can support more sustainable food systems through responsible sourcing, reduced food waste, local procurement, community growing initiatives and the use of golf facilities and events to promote better food practices.

3 GOOD HEALTH AND WELL-BEING

Golf offers healthy, lifelong outdoor recreation, with proven benefits for the physical and mental wellbeing of millions of participants worldwide.

4 QUALITY EDUCATION

Golf facilities and tournaments can be incubators for apprenticeships, workplace education and collaborative projects across a wide range of disciplines. Creative initiatives in and around golf can also engage people in volunteering and lifelong learning.

5 GENDER EQUALITY

Golf can continue to become a more inclusive sport and sector, empowering women and girls as participants, leaders, professionals, employees, volunteers and decision-makers.

6 CLEAN WATER AND SANITATION

Working in collaboration with others in watersheds, golf has a positive role to play in prioritising water conservation and ensuring runoff to natural watercourses is free from polluting chemicals and other harmful substances.

Read more on next page →

Playing a bigger part – Contributing to global goals continued



7 AFFORDABLE AND CLEAN ENERGY

Golf can play a visible role in the transition from fossil fuels to cleaner and greener renewable sources. Facilities can showcase the business and social value of electrification, renewables and emerging local energy networks.

8 DECENT WORK AND ECONOMIC GROWTH

Golf can play an important role in jobs, careers and professional development, particularly in rural economies. In some countries, and especially in tourism destinations, golf represents significant inward investment and contribution to local and national economies.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Golf can support innovation in sustainable design, irrigation, turfgrass science, renewable energy, low-emission machinery, data, construction, materials and event infrastructure.

10 REDUCED INEQUALITIES

Golf can help reduce inequalities through inclusive participation, charitable activity, local employment, skills development, volunteering, accessible community programmes and targeted support for under-represented or disadvantaged groups.

11 SUSTAINABLE CITIES AND COMMUNITIES

Well-utilised golf courses and facilities can provide and protect green space, improve air and water quality in urban areas, and act as hubs for volunteering, community activity and social connection.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Golf must demonstrate that it can contribute to the sustainable production and consumption of water, materials and other increasingly scarce resources. This is one of the sport's greatest challenges and opportunities.

13 CLIMATE ACTION

By reducing emissions, tackling climate adaptation and supporting ecosystem services at a local level, golf courses are in a position to make a strong, visible contribution to climate action.

14 LIFE BELOW WATER

Many of golf's highest-profile courses are set in coastal environments, where they can contribute by working with local conservation organisations to support coastal protection and the sustainable use of oceans and marine resources.

15 LIFE ON LAND

Few sports occupy and manage such large areas of green space. Courses can be ecologically rich and restorative environments that connect with other habitats, support biodiversity and become part of wider green infrastructure.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Golf can support stronger institutions through good governance, ethical business practices, safeguarding, transparency, responsible leadership and respectful engagement with communities, regulators and stakeholders.



17 PARTNERSHIPS FOR THE GOALS

Golf can be a high-profile example of sector-wide collaboration for wider social and environmental benefit. Respectful stakeholder engagement and strong partnerships across the sport are essential for maximising golf's impact.

PART 2

PRIORITIES IN FOCUS



Topic 1: Land Use and Ecosystem Services

A global network of living landscapes

Golf courses span around 3.5 million hectares globally, making the sport one of the world's largest networks of managed green space. Responsibly planned and managed, these landscapes can do far more than host play: providing recreation, skilled employment, wildlife refuges, heat reduction, water management, outdoor learning and stronger connections between people, nature and place.

Page 13



Topic 2: Nature and Biodiversity

Room for nature to recover

With 50%–70% of many courses sitting beyond the main playing surfaces, golf has a major opportunity to support wildlife habitats, native vegetation and ecological connectivity. In urban and modified landscapes, courses can become important refuges for nature while also delivering wider benefits for players, communities and the environment.

Page 18



Topic 3: Sustainable Agronomy

Better playing conditions, with lower impact

Sustainable agronomy shows how great playing conditions and environmental responsibility can work in harmony. Through efficient water use, healthier soils, integrated pest management and lower-impact course care, golf can reduce its footprint while enhancing the ecological, aesthetic and functional value of the course.

Page 23





Topic 4: Water Stewardship

A shared resource for the long term

While golf can be a notable local water user, the sport's water story is evolving. Courses are reducing demand, using reclaimed water, adopting drought-tolerant grasses and embracing smarter irrigation systems to support secure, responsible water management for the long-term benefit of the game and the environment.

Page 28



Topic 5: Climate Action

Climate-ready courses and communities

Golf courses in urban areas can serve as valuable green infrastructure, helping to reduce heat, manage stormwater, store carbon and support healthier local environments. By lowering emissions and strengthening climate-ready landscapes, golf can play a visible role in responding to climate change.

Page 33



Topic 6: People and Communities

Healthier, more connected lives

A landmark study found that golfers had a 40% lower mortality rate than non-golfers, corresponding to around five years' longer life expectancy. With more than 100 million people now participating globally, golf has a powerful platform to promote healthier lifestyles, social connection, nature connectedness and meaningful community value.

Page 38

TOPIC 1

LAND USE AND ECOSYSTEM SERVICES

Golf courses span around 3.5 million hectares globally,[1] with many functioning as managed green infrastructure,[2] creating opportunities for recreation, urban cooling,[3] water management,[4] outdoor learning and wider ecosystem services that benefit players and communities.[4 5]

***Key Term: MULTIFUNCTIONALITY**

Multifunctionality is the use of golf course land and buildings to deliver benefits beyond the game itself. Alongside providing places to play, golf facilities can support wildlife, protect water and landscapes, strengthen climate resilience, and provide spaces for recreation, learning, events and wider community use.

68%

The share of the world's population projected to live in urban areas by 2050, increasing the need for well-planned green infrastructure in and around towns and cities.[7]

600M

In some urban contexts, the cooling influence of golf course green space can extend beyond course boundaries by up to 600 metres.[9]

Global Context

Land is one of the world's most pressured resources. Agriculture, urban growth, infrastructure and resource extraction have reshaped natural landscapes, placing increasing pressure on soils, water systems, climate resilience, biodiversity and access to green space.[6 7]

These pressures make land use one of the defining sustainability challenges of our time. The priority is not only to protect remaining natural ecosystems, but also to manage and restore already modified landscapes in ways that reduce impact, provide ecosystem services and support wellbeing for all.[6 8]

For golf, this means looking beyond the playing surfaces alone. Roughs, woodland, wetlands, water bodies, boundaries, built facilities and out-of-play areas are all part of how courses can support more resilient, **multifunctional*** and productive land use.[2 4 5]

Golf's Contribution to the UN Sustainable Development Goals

"Promote sustainable land use and halt land degradation, including desertification, drought and floods, striving to achieve a land degradation-neutral world."



SDG 15 - Life on Land, target 15.5.

References

1. The R&A. (2019). Golf Course 2030: Sustainable Golf Course Management. The R&A. Retrieved from https://www.randa.org/sustainability/golf-course-management
2. Nguyen, L. D. (2022). Golf courses as urban green infrastructures: A systematic review. Land, 11(1), 94. Retrieved from https://doi.org/10.3390/land11010094
3. Nguyen, T. T., Eslick, H., Barber, P., Harper, R., & Dell, B. (2022). Cooling effects of urban vegetation: The role of golf courses. Remote Sensing, 14(17), 4351. Retrieved from https://doi.org/10.3390/rs14174351
4. Lonsdorf, E. V., Nootenboom, C. W., Janke, B., & Horgan, B. P. (2021). Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area. Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
5. STERF. (2024). Handbook: Multifunctional Potential of Golf Courses. Scandinavian Turfgrass and Environment Research Foundation. Retrieved from https://sterf.org/wp-content/uploads/2024/07/Handbook-Multifunctional-potential.pdf
6. IPBES. (2019). Global Assessment Report on Biodiversity and Ecosystem Services: Summary for Policymakers. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from https://doi.org/10.5281/zenodo.3553579
7. United Nations Department of Economic and Social Affairs. (2018). 68% of the world population projected to live in urban areas by 2050, says UN. Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html
8. Elmqvist, T., Setälä, H., Handel, S. N., van der Ploeg, S., Aronson, J., Blignaut, J. N., Gómez-Baggethun, E., Nowak, D. J., Kronenberg, J., & de Groot, R. (2015). Benefits of restoring ecosystem services in urban areas. Current Opinion in Environmental Sustainability, 14, 101–108. Retrieved from https://doi.org/10.1016/j.cosust.2015.05.001
9. United States Golf Association. (2024). The Environmental Benefits of Golf Courses. USGA Green Section Record, 62(6). Retrieved from https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-06/the-environmental-benefits-of-golf-courses.html

Research finding Industry insight

HIGHLIGHTS:

PRODUCTIVE USE OF GOLF LAND



WIDER LANDSCAPES

Golf courses should be understood as wider landscapes, with their value depending on how well the whole site is planned, managed and connected to local environmental and community needs.[1] [2]

Around half or more of a course can sit outside the most intensively managed playing surfaces,[6] [7] creating space for landscape features, green infrastructure and wider ecosystem-service value.[2] [8]



MULTIFUNCTIONAL GOLF FACILITIES

can combine play with **recreation**, **conservation** and **community engagement**, improving land-use efficiency and wider social value in urban and peri-urban settings.[9]

Golf's land-use case is stronger where course landscapes restore or add ecosystem-service value to modified settings, and weaker where development replaces higher-value natural habitat or reduces biodiversity.[11] [12] [13]

Because golf generates revenue from access to and experience of a managed landscape, the sport can support green-space stewardship and ecosystem-service value, provided ecological value, access and resource impacts are actively managed.[10] [11]



URBAN GREEN INFRASTRUCTURE

Golf courses can function as urban green infrastructure because many sites combine managed turf, trees, water features, semi-natural areas and other landscape elements within a single landholding.[3] [4] [5]



Research finding Industry insight



HIGHLIGHTS:

ECOSYSTEM SERVICES AND CLIMATE RESILIENCE

Golf course landscapes can provide ecosystem services such as stormwater nutrient retention, pollinator support and urban cooling through their mix of trees, vegetation, soils, water bodies and connected green space.[5]

THE COOLING INFLUENCE OF GOLF COURSE GREEN SPACE

can extend beyond course boundaries, with effects reported up to **600 metres** in some urban settings.[18]



Turfgrass systems can provide environmental benefits including soil protection, water infiltration, temperature moderation, recreation and landscape function, although the scale of benefit depends on site design and management.[14 15 16]

Ecosystem-service assessment can help golf courses identify and compare environmental benefits and trade-offs, including those linked to turf, vegetation, water, nutrient retention, pollination, cooling and management intensity.[5 11 19]

COOLING

In urban settings, golf course vegetation can help reduce land surface temperatures, with cooling shaped by tree cover, water bodies, vegetation structure and landscape connectivity.[5 17]



HIGHLIGHTS:

ACCESS, WELLBEING AND COMMUNITY VALUE

Access to green space, including golf courses, is associated with a range of health and wellbeing benefits, such as physical activity, stress reduction and mental restoration.[20]

In addition to providing places to play, responsibly managed courses can conserve natural and cultural features, provide outdoor learning opportunities and offer wider recreational value where public access or community programming is available.[2 21 22]

References

1. The R&A. (2019). Golf Course 2030: Sustainable Golf Course Management. The R&A. Retrieved from https://www.randa.org/sustainability/golf-course-management
2. Dahl Jensen, A.-M. (2016). A Practical Guide for Assessing Your Golf Course's Multifunctional Potential. Scandinavian Turfgrass and Environment Research Foundation. Retrieved from https://researchprofiles.ku.dk/da/publications/a-practical-guide-for-assessing-your-golf-courses-multifunctional/
3. Nguyen, L. D. (2022). Golf courses as urban green infrastructures: A systematic review. Land, 11(1), 94. Retrieved from https://doi.org/10.3390/land11010094
4. Nguyen, T. T., Barber, P., Harper, R., Linh, T. V. K., & Dell, B. (2020). Vegetation trends associated with urban development: The role of golf courses. PLOS ONE, 15(2), e0228090. Retrieved from https://doi.org/10.1371/journal.pone.0228090
5. Lonsdorf, E. V., Nootenboom, C. W., Janke, B., & Horgan, B. P. (2021). Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area. Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
6. Australian Golf Industry Council. (2020). Golf: Benefits to the Environment. Retrieved from https://static.golf.com.au/clubs/1000/uploads/resources/attach__5__golf__benefits__to__the__environment__2020__final__june20.pdf
7. Athorn, M. (2022). Working with golf courses to create greenspaces for nature. The RSPB Community. Retrieved from https://community.rspb.org.uk/ourwork/b/actionfornature/posts/working-with-golf-courses-to-create-greenspaces-for-nature
8. Scandinavian Turfgrass and Environment Research Foundation. (2025). Multifunctional Golf Courses and Ecosystem Services: Research and Development Programme. STERF. Retrieved from https://sterf.org/wp-content/uploads/2025/03/RD-programme-Multifunctional-golf-courses-and-ecosystem-services.pdf
9. Dahl Jensen, A.-M., Caspersen, O. H., Jensen, F. S., & Strandberg, M. (2017). Multifunctional golf facilities as a resource of important ecosystem services in a changing urban environment: Nordic case studies. International Turfgrass Society Research Journal, 13, 236–239. Retrieved from https://doi.org/10.2134/itsrj2016.05.0424
10. Fitzpatrick, R. D. J., White, R., & Matthews, I. M. (2022). Seeking green grass: Strong sustainability for golf and turfgrass. International Turfgrass Society Research Journal, 14(1), 23–30. Retrieved from https://doi.org/10.1002/its2.22
11. Petrosillo, I., Valente, D., Pasimeni, M. R., Aretano, R., Semeraro, T., & Zurlini, G. (2019). Can a golf course support biodiversity and ecosystem services? The landscape context matters. Landscape Ecology, 34, 2213–2228. Retrieved from https://doi.org/10.1007/s10980-019-00885-w
12. Elmqvist, T., Setälä, H., Handel, S. N., van der Ploeg, S., Aronson, J., Blignaut, J. N., Gómez-Baggethun, E., Nowak, D. J., Kronenberg, J., & de Groot, R. (2015). Benefits of restoring ecosystem services in urban areas. Current Opinion in Environmental Sustainability, 14, 101–108. Retrieved from https://doi.org/10.1016/j.cosust.2015.05.001
13. Burgin, S., & Wotherspoon, D. (2009). The potential for golf courses to support restoration of biodiversity for biobanking offsets. Urban Ecosystems, 12, 145–155. Retrieved from https://doi.org/10.1007/s11252-008-0076-5
14. Beard, J. B., & Green, R. L. (1994). The role of turfgrasses in environmental protection and their benefits to humans. Journal of Environmental Quality, 23(3), 452–460. Retrieved from https://doi.org/10.2134/jeq1994.00472425002300030007x
15. Braun, R. C., Mandal, P., Nwachukwu, E., & Stanton, A. (2024). The role of turfgrasses in environmental protection and their benefits to humans: Thirty years later. Crop Science, 64, 2909–2944. Retrieved from https://doi.org/10.1002/csc2.21383
16. Stier, J. C., Steinke, K., Ervin, E. H., Higginson, F. R., McMaugh, P. E., Horgan, B. P., & Bonos, S. A. (2013). Turfgrass benefits and issues. In J. C. Stier, B. P. Horgan, & S. A. Bonos (Eds.), Turfgrass: Biology, Use, and Management, Agronomy Monograph 56, 105–145. ASA, CSSA and SSSA. Retrieved from https://doi.org/10.2134/agronmonogr56.c3
17. Nguyen, T. T., Eslick, H., Barber, P., Harper, R., & Dell, B. (2022). Cooling effects of urban vegetation: The role of golf courses. Remote Sensing, 14(17), 4351. Retrieved from https://doi.org/10.3390/rs14174351
18. United States Golf Association. (2024). The Environmental Benefits of Golf Courses. USGA Green Section Record, 62(6). Retrieved from https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-06/the-environmental-benefits-of-golf-courses.html
19. Dai, Z., Puyang, X., & Han, L. (2016). Using assessment of net ecosystem services to promote sustainability of golf course in China. Ecological Indicators, 63, 165–171. Retrieved from https://doi.org/10.1016/j.ecolind.2015.11.056
20. Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environmental Research, 166, 628–637. Retrieved from https://doi.org/10.1016/j.envres.2018.06.030
21. World Health Organization Regional Office for Europe. (2016). Urban Green Spaces and Health. WHO Regional Office for Europe. Retrieved from https://www.who.int/europe/publications/i/item/WHO-EURO-2016-3352-43111-60341
22. Sport and Recreation Alliance. (2019). The Value of Community Sport and Recreation Facilities. Retrieved from https://www.sportandrecreation.org.uk/policy/research-publications

CASE STUDY:

SEVEN GOLF COURSES FOR NATURE RESTORATION PROGRAMME

Fife Golf Trust, Scotland



The project aimed to enhance, create and connect habitats across the 544ha landholding to maximise biodiversity potential on the courses and create rich, multi-functional spaces for wildlife and people.



Between August 2023 and March 2025, Fife Golf Trust delivered a landscape-scale nature restoration programme across its seven municipal golf courses. We have a longstanding aspiration to do something significant for biodiversity, and the ambitious project was made possible with support from Scottish Government's Nature Restoration Fund, managed by NatureScot.

Outputs totalling 28ha included:

- Planting 8.7ha native woodland, copses and treelines
- Bringing 17.28ha grassland into meadow management
- Planting 1,070m native mixed hedgerows
- Creating five wetland mosaics and two wetland scrapes amounting to c. 2.03ha
- Establishing three new ponds and enhancing one pond amounting to c. 450m²
- Naturalising 3,560m² linear freshwater habitat including ditches and small watercourses
- Developing seven bee banks
- Removing 2,000m redundant fencing to improve permeability to wildlife
- Installing five barn owl boxes, two tawny owl boxes and 28 bat boxes.

CASE STUDY:

COURSE DEVELOPMENT AND LANDSCAPE RESTORATION

La Réserve Golf Links, Mauritius



La Réserve Golf Links in Mauritius was created on 104 hectares of former sugarcane monocrop, where depleted soils and erosion had reduced land quality and increased landslide risk. Through wider landscape development, much of the site has been transformed into a thriving mosaic of native plants, including over 3,700m² of wetlands and 6 hectares of open water. This has strengthened soils, reduced erosion risk, boosted biodiversity and attracted native fauna back to the area, creating a richer place for animals, plants and golfers.

Much of the site has been transformed into a thriving mosaic of native plants, including over 3,700m² of wetlands and 6 hectares of open water.



CASE STUDY:

WINNERS FOREST: A REGENERATIVE FORESTRY INITIATIVE

Loimijoki Golf, Finland

In partnership with Metsä Group, Loimijoki Golf launched Winners' Forest, where each competition winner is rewarded with a tree seedling of their choice. Planted according to regenerative forestry principles, the mixed-species forest will grow over time, with tree owners recognised on site and on a Club House map. The project aims to raise awareness of nature conservation and forest biodiversity, while giving players a direct way to contribute to shared natural heritage.



CASE STUDY:

NEW GREENWAY ENHANCES HABITAT CONNECTIVITY

Golf Club Lugano, Switzerland

Golf Club Lugano introduced a greenway spanning the entire golf course to the estuary of the Magliasina River. In collaboration with the Ticino Cantonal Authorities, new riverbank habitats were created to protect salamanders and other endangered native species. Informational boards explain the habitats along the river, while school visits with surrounding municipalities and online educational PDFs help share knowledge with children, golfers and the wider community.

TOPIC 2

NATURE AND BIODIVERSITY

Out-of-play areas can make up 50%–70% of total course land,[1] creating important opportunities for wildlife habitat,[2] biodiversity value,[3] ecological connectivity[4] and richer nature experiences for players and surrounding communities.[5] [6]



An estimated

1 MILLION SPECIES

are threatened with extinction globally.[7]

Around

10% – 15%

of UK golf courses are thought to support habitats important to species of conservation concern.[10]

***Key Term: NATURE RECOVERY**

Nature recovery is the process of helping landscapes become richer, healthier and more resilient over time. This can include protecting existing habitats, restoring degraded areas, creating new space for native plants and wildlife, and managing out-of-play areas to improve ecological connectivity and enable biodiversity to return and thrive.

Global Context

Humanity's increasing demand for resources such as land, water, food and shelter is placing growing pressure on the natural world. Changes in land and sea use, climate change, pollution, invasive species and habitat loss and fragmentation are all contributing to a decline in wildlife and the ecosystems that support life.[7]

Since 1970, monitored vertebrate wildlife populations have declined by an average of 73%, highlighting the scale and urgency of global biodiversity loss.[8] These trends are a reminder that **nature recovery*** is not only a conservation issue, but central to resilient landscapes, healthy communities and a sustainable future.

Protecting, restoring and reconnecting habitats is therefore one of the defining environmental priorities of our time.[9] For golf, a sport rooted in land, landscape and the natural character of place, this creates an important opportunity to support wildlife and habitat recovery across the thousands of carefully managed green spaces where the game is played.

Golf's Contribution to the UN Sustainable Development Goals

"Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species."



SDG 15 -
Life on Land, target 15.5.

References

1. Australian Golf Industry Council. (2020). Golf: Benefits to the Environment. Retrieved from https://static.golf.com.au/clubs/1000/uploads/resources/attach__5__golf__benefits__to__the__environment__2020__final__june20.pdf
2. Tanner, R. A., & Gange, A. C. (2005). Effects of golf courses on local biodiversity. Landscape and Urban Planning, 71(2–4), 137–146. Retrieved from https://doi.org/10.1016/j.landurbplan.2004.02.004
3. Colding, J., & Folke, C. (2009). The role of golf courses in biodiversity conservation and ecosystem management. Ecosystems, 12, 191–206. Retrieved from https://doi.org/10.1007/s10021-008-9217-1
4. Nguyen, L. D., Tran, C. T., Wanger, T. C., & Nguyen, D. N. (2020). Golf courses as stepping-stone habitats for wildlife conservation in urban landscapes. Land, 9(11), 419. Retrieved from https://doi.org/10.3390/land9110419
5. Perkins, C. (2010). The performance of golf: Landscape, place, and practice in North West England. Journal of Sport and Social Issues, 34(3), 312–338. Retrieved from https://doi.org/10.1177/0193723510377316
6. Fouillouze, A., Lacoeuilhe, A., & Truong, M.-X. A. (2023). A step towards a greener green? Investigating golfers' relationships with nature and attitudes about biodiversity conservation in golf courses. Journal of Outdoor Recreation and Tourism, 43, 100659. Retrieved from https://doi.org/10.1016/j.jort.2023.100659
7. IPBES. (2019). Global Assessment Report on Biodiversity and Ecosystem Services: Summary for Policymakers. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from https://doi.org/10.5281/zenodo.3553579
8. WWF/ZSL. (2024). Living Planet Report 2024: A System in Peril. World Wide Fund for Nature and Zoological Society of London. Retrieved from https://www.wwf.org.uk/sites/default/files/2024-10/living-planet-report-2024.pdf
9. Convention on Biological Diversity. (2022). Kunming-Montreal Global Biodiversity Framework. Retrieved from https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222
10. The R&A. (2024). Golf and Nature: A Study of UK Golf Courses — Year 2 Summary. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/8978719b-03ce-4071-b656-67fe9e8b0f06/R%26A%20Golf%20and%20Nature%20Summary%20%28Year%202%29.pdf

Research finding Industry insight



64%

A review of published evidence found that golf courses had higher ecological value than comparison land uses in 64% of assessed cases, with the strongest relative value where courses were compared with urban or agriculturally modified landscapes rather than natural or protected areas.[1]

75,000 HECTARES

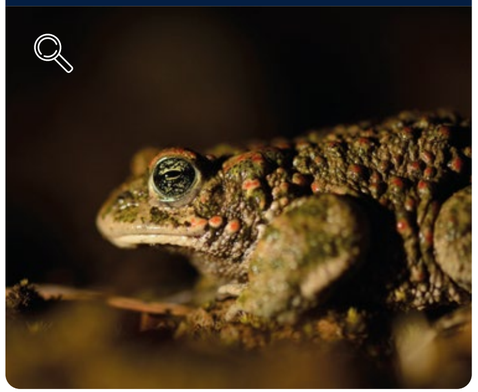
On average, around 60% of a UK golf course is thought to consist of natural or semi-natural habitat outside the areas managed for play, including woodland, wetland, heathland and dune grassland. This adds up to approximately 75,000 hectares, an area larger than Exmoor National Park.[2]

Natural and semi-natural areas on golf courses can include meadows, woodland, water features, sandy areas and rough grassland,[5 6 7] creating varied habitat conditions that can support a wider range of species.[8]

50% – 70%

Out-of-play areas can make up 50%–70% of total course land, creating important opportunities for wildlife habitat, native vegetation and ecological connectivity when managed with nature in mind.[2]

Golf courses can help maintain vegetation cover in urban landscapes,[16] support habitat connectivity and stepping-stone habitats,[17] and contribute to wider green infrastructure, local biodiversity networks and ecosystem-service value where managed appropriately.[1 18]



The diversity of trees, shrubs, understory vegetation, remnant habitat, surrounding landscape context and other structural features strongly influences the range of species a golf course can support.[8 13 14 15]



Naturalised roughs and lower-intensity habitat areas can increase plant species diversity, alter grassland structure and support invertebrate and natural-enemy communities, improving ecological value in non-playing parts of the course.[8 9 10 11 12]

10% – 15%

Around 10%–15% of UK golf courses are thought to support habitats important to species of conservation concern.[3] Some courses also contain nationally or internationally important habitats, demonstrating their potential value for biodiversity when managed in ways that support both nature and golf.[4]

Research finding Industry insight



HIGHLIGHTS: SPECIES

Studies show that golf courses can support species of conservation interest, particularly where habitats are retained within urban, agricultural or otherwise intensively managed landscapes.[1 5 6 14]

Studies have found higher bird and insect diversity on some golf course habitats than surrounding agricultural land,[6] while golf course wetlands have been shown to support wetland fauna in urban landscapes.[19]



HIGHLIGHTS: GUIDANCE AND MANAGEMENT CONTEXT

Golf courses are most likely to support biodiversity where habitats are retained or restored within urban, agricultural or otherwise modified landscapes.[1 22] Conversion of forests or semi-natural landscapes can reduce ecological value and risk the loss of sensitive, rare or specialised species.[1 23]

Biodiversity value can be reduced when semi-natural habitats are converted to intensively managed grassland, when habitat connectivity is lost, or when chemical use is not carefully managed.[3 21]

X2 BREEDING ACTIVITY

An Australian study found that golf courses supported almost twice as much bird-breeding activity as was recorded in residential and small park areas.[20]



HIGHLIGHTS: SOCIAL VALUE, PLAYER EXPERIENCE AND STEWARDSHIP

Nature-rich course landscapes can add visual interest, strategic variety and a stronger sense of place,[24] while also supporting greater awareness of biodiversity and conservation.[25]

Golfers with a stronger connection to nature and positive views of ecological management are more likely to support biodiversity activity on golf courses,[25 26] with research showing that people's attitudes and actions also shape biodiversity outcomes.[27]

References

1. Colding, J., & Folke, C. (2009). "The role of golf courses in biodiversity conservation and ecosystem management." Ecosystems, 12, 191–206. Retrieved from https://doi.org/10.1007/s10021-008-9217-1
2. Athorn, M. (2022). "Working with golf courses to create greenspaces for nature." The RSPB Community. Retrieved from https://community.rspb.org.uk/ourwork/b/actionfornature/posts/working-with-golf-courses-to-create-greenspaces-or-nature
3. The R&A. (2024). Golf and Nature: A Study of UK Golf Courses — Year 2 Summary. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/8978719b-03ce-4071-b656-67fe9e8b0f06/R%26A%20Golf%20and%20Nature%20Summary%20%28Year%202%29.pdf
4. The R&A. (2023). Golf and Nature: A Study of UK Golf Courses — Year 1 Summary. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/06e6c060-21f6-4d6d-92c3-25b0948af545/R%26A%20Golf%20and%20Nature%20Summary%20%28Year%201%29.pdf
5. Hodgkison, S. C., Hero, J.-M., & Warnken, J. (2007). "The conservation value of suburban golf courses in a rapidly urbanising region of Australia." Landscape and Urban Planning, 79(3–4), 323–337. Retrieved from https://doi.org/10.1016/j.landurbplan.2006.03.009
6. Tanner, R. A., & Gange, A. C. (2005). "Effects of golf courses on local biodiversity." Landscape and Urban Planning, 71(2–4), 137–146. Retrieved from https://doi.org/10.1016/j.landurbplan.2004.02.004
7. Green, B. H., & Marshall, I. C. (1987). "An assessment of the role of golf courses in Kent, England, in protecting wildlife and landscape." Landscape and Urban Planning, 14, 143–154. Retrieved from https://doi.org/10.1016/0169-2046(87)90019-3
8. Nooten, S. S., Schultheiss, P., Wright, J., Macdonald, C., Singh, B. K., Cook, J. M., & Power, S. A. (2018). "What shapes plant and animal diversity on urban golf courses?" Urban Ecosystems, 21, 565–576. Retrieved from https://doi.org/10.1007/s11252-017-0728-4
9. Pornaro, C., Macolino, S., De Luca, A., Sallenave, R., & Leinauer, B. (2018). "Plant species diversity of naturalized roughs as affected by conversion strategies." Agronomy Journal, 110(5), 1709–1717. Retrieved from https://doi.org/10.2134/agronj2017.11.0666
10. Saarikivi, J., Idström, L., Venn, S., Niemelä, J., & Kotze, D. J. (2010). "Carabid beetle assemblages associated with urban golf courses in the greater Helsinki area." European Journal of Entomology, 107(4), 553–561. Retrieved from https://doi.org/10.14411/eje.2010.064
11. Hejduk, S., Bitomský, M., Pornaro, C., & Macolino, S. (2020). "Establishment of a hemiparasite Rhinanthus alectorolophus and its density-dependent suppressing effect on a grass: A case study from golf roughs." Agronomy Journal, 112(5), 3619–3628. Retrieved from https://doi.org/10.1002/agj2.20300
12. Dobbs, E. K., & Potter, D. A. (2016). "Naturalized habitat on golf courses: source or sink for natural enemies and conservation biological control?" Urban Ecosystems, 19, 899–914. Retrieved from https://doi.org/10.1007/s11252-015-0521-1
13. McKinney, M. L. (2002). "Urbanization, biodiversity, and conservation." BioScience, 52(10), 883–890. Retrieved from https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2
14. Drake, E., Vonhof, M., & Maslo, B. (2023). "Bat use of golf courses depends on the surrounding landscape context." Urban Ecosystems, 26, 1469–1482. Retrieved from https://doi.org/10.1007/s11252-023-01397-x
15. Doll, S., & Duinker, P. N. (2020). "Characterization and justification of trees on an inner-city golf course in Halifax, Canada: An investigation into the ecological integrity of institutional greenspace." Forests, 11(1), 96. Retrieved from https://doi.org/10.3390/f11010096
16. Nguyen, T. T., Barber, P., Harper, R., Linh, T. V. K., & Dell, B. (2020). "Vegetation trends associated with urban development: The role of golf courses." PLOS ONE, 15(2), e0228090. Retrieved from https://doi.org/10.1371/journal.pone.0228090
17. Nguyen, L. D., Tran, C. T., Wanger, T. C., & Nguyen, D. N. (2020). "Golf courses as stepping-stone habitats for wildlife conservation in urban landscapes." Land, 9(11), 419. Retrieved from https://doi.org/10.3390/land9110419
18. Lonsdorf, E. V., Nootenboom, C., Janke, B., & Horgan, B. P. (2021). "Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area." Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
19. Colding, J., Lundberg, J., Lundberg, S., & Andersson, E. (2009). "Golf courses and wetland fauna." Ecological Applications, 19(6), 1481–1491. Retrieved from https://doi.org/10.1890/07-2092.1
20. Australian Golf Industry Council. (2020). Golf: Benefits to the Environment. Retrieved from https://static.golf.com.au/clubs/1000/uploads/resources/attach__5__golf__benefits__to__the__environment__2020__final__june20.pdf
21. United States Golf Association. (2024). "The Environmental Benefits of Golf Courses." USGA Green Section Record, 62(6). Retrieved from https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-06/the-environmental-benefits-of-golf-courses.html
22. Burgin, S., & Wotherspoon, D. (2009). "The potential for golf courses to support restoration of biodiversity for biobanking offsets." Urban Ecosystems, 12, 145–155. Retrieved from https://doi.org/10.1007/s11252-008-0076-5
23. Saarikivi, J., Tähtinen, S., Malmberg, S., & Kotze, D. J. (2015). "Converting land into golf courses - effects on ground beetles." Insect Conservation and Diversity, 8(3), 247–251. Retrieved from https://doi.org/10.1111/icad.12103
24. Perkins, C. (2010). "The performance of golf: Landscape, place, and practice in North West England." Journal of Sport and Social Issues, 34(3), 312–338. Retrieved from https://doi.org/10.1177/0193723510377316
25. Fouillouze, A., Lacoeuilhe, A., & Truong, M.-X. A. (2023). "A step towards a greener green? Investigating golfers' relationships with nature and attitudes about biodiversity conservation in golf courses." Journal of Outdoor Recreation and Tourism, 43, 100659. Retrieved from https://doi.org/10.1016/j.jort.2023.100659
26. Whitburn, J., Linklater, W. L., & Abrahamse, W. (2020). "Meta-analysis of human connection to nature and proenvironmental behavior." Conservation Biology, 34(1), 180–193. Retrieved from https://doi.org/10.1111/cobi.13381
27. Hammond, R. A., & Hudson, M. D. (2007). "Environmental management of UK golf courses for biodiversity: attitudes and actions." Landscape and Urban Planning, 83(2–3), 127–136. Retrieved from https://doi.org/10.1016/j.landurbplan.2007.03.004

CASE STUDY:

GOLF COURSE'S ROLE IN MOOR FROG CONSERVATION

Tammer-Golf ry, Finland



Conserving the Moor frog (Rana arvalis) on our golf course offers numerous benefits, including enhancing biodiversity and maintaining ecosystem health.



In recent years, Tammer-Golf has been under supervision due to the construction of a new tram line and nearby subdivision. We have proactively surveyed our grounds for valuable species, including the Moor frog, which has been found in nearly all of our water hazards. We are committed to protecting these frogs, which are safeguarded under the EU Nature Directive.

By creating and maintaining suitable habitats, such as ponds and wetlands, we not only support the Moor frog but also promote wider wildlife diversity on the course. As urban development and climate change threaten amphibian populations, our active conservation measures are essential for helping ensure the Moor frog's survival.

Conserving the Moor frog (Rana arvalis) on our golf course offers numerous benefits, including enhancing biodiversity and maintaining ecosystem health. As a key predator of insects, the Moor frog helps regulate populations and can reduce the need for physical interventions. Its presence also serves as an indicator of environmental health, making it valuable for monitoring ecosystem conditions.

CASE STUDY:

SHARING NATURAL SURROUNDINGS WITH GOLFERS AND GUESTS

Troia Golf Club, Portugal



The natural habitats surrounding the maintained turf at Troia Golf, including pine forests, dunes and freshwater lakes, support a rich diversity of wild flora and fauna. Identified species include forest birds, aquatic species, green frogs, reptiles and bats. The dune flora is dominated by stone pine and maritime pine, with an understory of juniper, mastic tree (Pistacia lentiscus) and Portuguese crowberry (Corema album) that we seek to preserve and improve.

The value of these habitats is communicated to golfers and the wider community through an information panel at the clubhouse.



CASE STUDY:

PHASED LANDSCAPE AND ECOLOGICAL MANAGEMENT PLAN

The Wisley, England

The Wisley is seeking to improve the biodiversity value of the site through more directed management of out-of-play areas, increased native planting and the gradual phasing out of some exotic species. Through a Landscape Ecological Management Plan and clearer communication around managing for both biodiversity and golf, proposed changes will be phased in over five years to help members and visitors understand and welcome the approach. The plan covers gorse management, fringing rough creation, heather restoration, woodland management, hedgerow creation and wildflower grassland management.



CASE STUDY:

BUG HOTELS ARE NOW OPEN FOR BUSINESS

Mimosa Plus Golf Course, Philippines

As part of Mimosa Plus Golf's sustainability objectives, the team created bug hotels to enhance biodiversity and foster teamwork. Materials were sourced from the course grounds, with the hotels crafted from upcycled off-cuts from recent renovations. The project supports biodiversity enhancement, natural pest control, pollination and education. Following golfer interest, information and QR codes were installed at each site. The team is now developing the initiative with seasonal nesting materials, bird feeders, water stations and subterranean habitats.

TOPIC 3

SUSTAINABLE AGRONOMY

Sustainable agronomy shows how high-quality playing conditions and environmental responsibility can work in harmony. Through integrated turf and pest management, evidence-led course conditioning and more efficient use of water, nutrients and plant protection products, golf courses can reduce the pressure of intensive maintenance while strengthening turf health, playability and long-term resilience.[1] [2] [3]

0.34%

Golf course plant protection product use has been reported at around 0.34% of the combined golf and agriculture total in Ireland, illustrating the relatively small scale of golf use compared with agriculture while reinforcing the need for responsible, well-regulated application.[6]



Key Term: SUSTAINABLE AGRONOMY

A commitment to reducing environmental impact while enhancing the ecological, aesthetic and functional value of courses. By embracing practices like efficient water use and integrated pest management, golf can make an important contribution to sustainable land stewardship.

Key Term: INTEGRATED TURF MANAGEMENT

A whole-course approach to managing turfgrass health, playing quality and environmental pressure. ITM aims to reduce stress, disease, pest and weed problems through sustainable and best-practice greenkeeping, while responding to climate, regulatory and resource constraints.

Key Term: INTEGRATED PEST MANAGEMENT

The prevention, monitoring and management of diseases, pests and weeds using available information, tools and methods, so that plant protection products are used only where targeted, justified and responsible.

Global Context

The golf industry continues to operate in a challenging environmental context, shaped by the impacts of climate change, resource constraints and an increasingly dynamic political and legislative landscape. These factors are driving significant shifts in how golf courses are managed, with many facilities and greenkeepers already moving towards more preventative, resilient and lower-input approaches.[1] [2] [3]

Golf courses face many of the same pressures as other managed plant systems. Turf needs to remain healthy, resilient and playable, while soil, water, nutrients, pests, diseases and weeds must be managed responsibly. As with agriculture, the challenge is to reconcile productive land management with environmental protection: maintaining performance while reducing unnecessary inputs, protecting natural resources and adapting to changing climatic and regulatory conditions.[4]

For golf, this is both a technical challenge and a significant opportunity. Better agronomic decision-making can help facilities move away from reactive management towards systems based on prevention, monitoring, turf resilience, targeted intervention and continuous improvement.[1] [2] [3] [4] [5]

Golf's Contribution to the UN Sustainable Development Goals

"Promote sustainable agricultural practices, ensure resilient production systems, maintain ecosystems, enhance soil quality, conserve water and protect biodiversity."



SDG 15 - Life on Land, target 15.5.

References

1. The R&A & Sports Turf Research Institute. (2021). Integrated Turf Management of Parkland Greens in GB&I: Best Practice Handbook. Golf Course 2030. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/82de5a48-639d-4543-a17e-b8a8d076f0bd/ITM%20of%20Parkland%20Greens.pdf
2. Isaac, S. (2022). Golf Course 2030: Implementing UN sustainable development goals to identify industry and research needs for greater resiliency in golf course playability. International Turfgrass Society Research Journal, 14(1), 36–39. Retrieved from https://doi.org/10.1002/its2.38
3. Woodham, P. (2024). Pesticide use for Plant Protection in golf — what will the future hold? The R&A. Retrieved from https://www.randa.org/articles/pesticide-use-for-plant-protection-in-golf-what-will-the-future-hold
4. Strandberg, M., Blombäck, K., Dahl Jensen, A. M., & Knox, J. W. (2012). Priorities for sustainable turfgrass management: A research and industry perspective. Acta Agriculturae Scandinavica, Section B – Soil & Plant Science, 62(Suppl. 1), 3–9. Retrieved from https://doi.org/10.1080/09064710.2012.682163
5. Scandinavian Turfgrass and Environment Research Foundation. (2024). The IPM-GOLF project 2020–23: Integrated management of important turfgrass diseases and insect pests on European golf courses. STERF. Retrieved from https://sterf.org/wp-content/uploads/2024/09/IPM-GOLF-20-23-english.pdf
6. Irish Golfer. (2024). Tackling the chemical misconception in golf. Irish Golfer Magazine, 2 June. Retrieved from https://irishgolfer.ie/latest-golf-news/2024/06/02/tackling-the-chemical-misconception-in-golf/

Research finding Industry insight



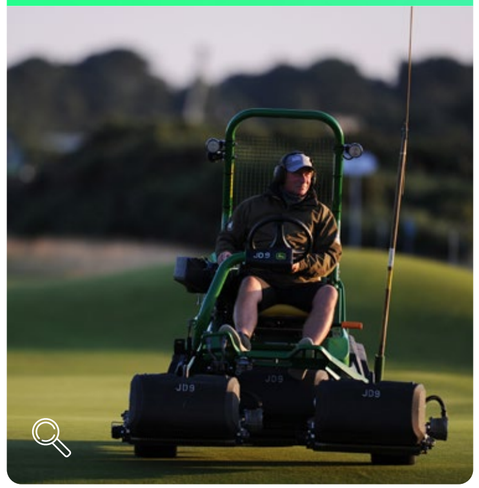
HIGHLIGHTS:

PLAYING QUALITY AND RESILIENT TURF

41% TO 56% LESS FERTILISER AND PESTICIDE

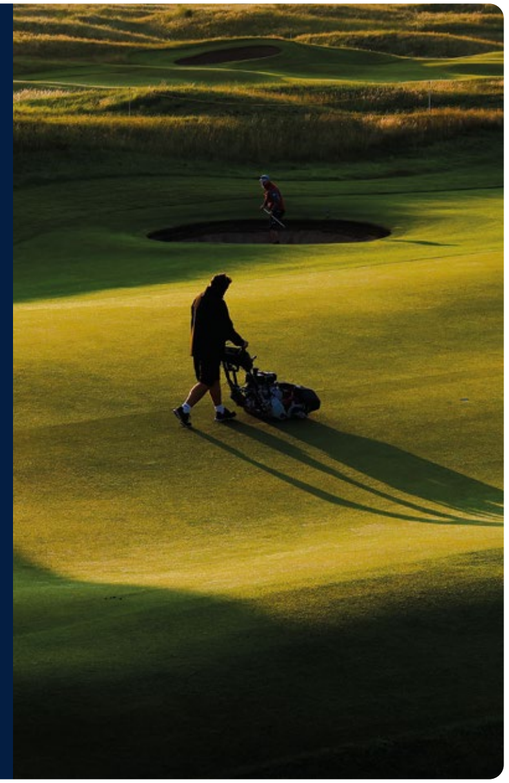
Trials found that newer fine fescues maintained good turf quality using 41% to 56% less fertiliser and pesticide than commonly used cool-season grasses.[1]

A field trial found that mowing and rolling each significantly increased ball roll distance, showing that putting speed can be influenced without relying solely on lower mowing heights.[4]



€14 MILLION

Winter damage was estimated to cause at least €14 million in repair costs and lost revenue across Nordic golf courses, demonstrating the value of investing in preventative agronomy and climate resilience.[6]





Locally suitable grasses and realistic expectations for colour and presentation can provide consistent playing surfaces with fewer resources.[3] [5]

SUITABLE GRASS SELECTION

Suitable grass selection, combined with well-planned mowing, irrigation, nutrition and pest management, can maintain playing quality while reducing resource use and emissions.[2] [3]



Suitable grasses, effective drainage, careful autumn preparation and regular monitoring can improve turf survival and speed recovery following winter damage.[7]

Research finding Industry insight



HIGHLIGHTS:

NUTRIENTS, SOILS AND PRECISION MANAGEMENT

Soil testing, moisture monitoring, weather data and mapping can guide more precise decisions about the timing, location and quantity of management inputs.[9] [10] [11]

TOTAL NITROGEN, PHOSPHORUS AND POTASSIUM APPLICATIONS ON U.S. GOLF COURSES DECLINED BY 41%, 59% AND 54% RESPECTIVELY BETWEEN 2006 AND 2021.[8]

FERTILISER USE

Around half of nutrient applications recorded in a major U.S. survey used calibrated equipment, highlighting a practical opportunity to improve the accuracy and efficiency of fertiliser use.[9]

SENSORS

Sensors can identify changes in turf condition before they become clearly visible, supporting earlier and more targeted management.[10]

Regular measurement of soil organic matter can help courses support soil health while maintaining the firmness, drainage and consistency required for play.[13]



Turfgrass soils can store carbon for several decades, although the amount and rate depend on soil type, previous land use, turf age and management.[12] [13]



HIGHLIGHTS:

INTEGRATED PEST MANAGEMENT AND RISK REDUCTION

Facilities with greater maintenance resources were more likely to have written pest-management plans and safer pesticide-handling facilities, demonstrating the value of investing in staff, planning and infrastructure.[14]

93%

In 2021, 93% of surveyed U.S. golf facilities monitored weather and scouted for pests as part of their management approach.[14]

44% TO 63%

The proportion of surveyed U.S. golf facilities with written pest-management plans increased from 44% to 63% between 2015 and 2021.[14]

Pesticide risk varies considerably between countries because it is shaped by the products used, application rates, treated areas, local conditions and regulation.[15]

References

1. Braun, R. C., Watkins, E., Hollman, A. B., & Patton, A. J. (2023). "Assessing the fertilizer and pesticide input needs of cool-season turfgrass species." Crop Science, 63(5), 3079–3095. Retrieved from https://doi.org/10.1002/csc2.21046
2. Braun, R. C., Straw, C. M., Soldat, D. J., Bekken, M. A. H., Patton, A. J., Lonsdorf, E. V., & Horgan, B. P. (2023). "Strategies for reducing inputs and emissions in turfgrass systems." Crop, Forage & Turfgrass Management, 9(1), e20218. Retrieved from https://doi.org/10.1002/cft2.20218
3. Strandberg, M., Blombäck, K., Dahl Jensen, A. M., & Knox, J. W. (2012). "Priorities for sustainable turfgrass management: A research and industry perspective." Acta Agriculturae Scandinavica, Section B—Soil & Plant Science, 62(sup1), 3–9. Retrieved from https://doi.org/10.1080/09064710.2012.682163
4. Woodham, P. (n.d.). Immediate Effects on Ball Roll Distance of Mowing and Rolling Treatments on a Golf Green. STRI. Retrieved from https://strigroup.com/wp-content/uploads/2022/08/The-Effects-on-Ball-Speed-of-Mowing-and-Rolling-Treatments-on-a-Golf-Green.pdf
5. Brown, S., & Fry, J. (2022). "Golf course condition and playability beyond the greens." International Turfgrass Society Research Journal, 14(1), 40–46. Retrieved from https://doi.org/10.1002/its2.73
6. Kvalbein, A., Waalen, W. M., Bjørnstad, L., Aamlid, T. S., & Espevig, T. (2017). "Winter injuries on golf greens in the Nordic countries: Survey of causes and economic consequences." International Turfgrass Society Research Journal, 13(1), 604–609. Retrieved from https://doi.org/10.2134/itsrj2016.09.0826
7. Scandinavian Turfgrass and Environment Research Foundation. (2025). Turfgrass Winter Stress Management Handbook. Retrieved from https://sterf.org/wp-content/uploads/2026/01/Turfgrass-winter-stress-management-handbook-_updated-2025.pdf
8. Shaddox, T. W., Unruh, J. B., Johnson, M. E., Brown, C. D., & Stacey, G. (2023). "Nutrient use and management practices on United States golf courses." HortTechnology, 33(1), 79–97. Retrieved from https://doi.org/10.21273/HORTTECH05118-22
9. Golf Course Superintendents Association of America. (2022). 2022 Nutrient Use and Management Practices on U.S. Golf Courses: Golf Course Environmental Profile, Phase III, Volume II. Retrieved from https://www.gcsaa.org/docs/default-source/environment/22__nutrient__report__web.pdf?sfvrsn=952fcd3e__0
10. Carlson, M. G., Gaussoin, R. E., & Puntel, L. A. (2022). "A review of precision management for golf course turfgrass." Crop, Forage & Turfgrass Management, 8(2), e20183. Retrieved from https://doi.org/10.1002/cft2.20183
11. Scandinavian Turfgrass and Environment Research Foundation. (2025). Research and Development Programme: New Technologies for a Sustainable Future. Retrieved from https://sterf.org/wp-content/uploads/2025/03/RD-programme-New-technologies.pdf
12. Phillips, C. L., Wang, R., Mattox, C., Trammell, T. L. E., Young, J., & Kowalewski, A. (2023). "High soil carbon sequestration rates persist several decades in turfgrass systems: A meta-analysis." Science of the Total Environment, 858, 159974. Retrieved from https://doi.org/10.1016/j.scitotenv.2022.159974
13. Braun, R. C., Mandal, P., Nwachukwu, E., & Stanton, A. (2024). "The role of turfgrasses in environmental protection and their benefits to humans: Thirty years later." Crop Science, 64, 2909–2944. Retrieved from https://doi.org/10.1002/csc2.21383
14. Shaddox, T. W., Unruh, J. B., Johnson, M. E., Brown, C. D., & Stacey, G. (2023). "Survey of pest management practices on US golf courses." HortTechnology, 33(2), 152–156. Retrieved from https://doi.org/10.21273/HORTTECH05117-22
15. Bekken, M. A. H., Soldat, D. J., Koch, P. L., Schimenti, C. S., Rossi, F. S., Aamlid, T. S., Hesselsøe, K. J., Petersen, T. K., Stæhr, C. M., Unruh, J. B., Kowalewski, A. R., & Spring, C. (2023). "Analyzing golf course pesticide risk across the US and Europe: The importance of regulatory environment." Science of the Total Environment, 874, 162498. Retrieved from https://doi.org/10.1016/j.scitotenv.2023.162498

CASE STUDY:

A STRATEGY TO ACCELERATE THE SUSTAINABILITY OF TURF MANAGEMENT

Golf De Rigenée, Belgium



To reduce disease susceptibility, we strategically modified the course, including cutting and replanting over 100 trees around greens to improve air circulation.





Since 2018, regulations in Wallonia have imposed limitations on the use of fungicides and herbicides for turf management. Despite adapting to these restrictions, the impact has been significant, requiring a 20% increase in maintenance efforts. Turf disease outbreaks further impact the club's reputation and economic standing.

In response, we have developed a strategy grounded in a deeper understanding of nature, emphasising four key pillars: course layout optimisation, data monitoring, prevention analytics, and additional maintenance.

To reduce disease susceptibility, we strategically modified the course, including cutting and replanting over 100 trees around greens to improve air circulation. Through collaboration with a Software As A Service (SAAS) entrepreneur, specifically MAYA, we monitor crucial ground and turf indicators, correlating them with weather data and disease occurrences specific to our location.

Leveraging analytics, we crafted a decision algorithm to proactively initiate prevention activities. This has led to a significant increase (+20%) in course maintenance workload, necessitating appropriate adjustments in recruitment.

While addressing this unique challenge, we have capitalised on the opportunity to introduce more sustainable turf management initiatives. For example, leveraging data monitoring enables us to enhance water management efficiency.

CASE STUDY:

SIGNIFICANT FERTILISER REDUCTION THROUGH SOIL TESTING

Golfklúbbur Mosfellsbæjar, Iceland



We saw a dramatic reduction in fertiliser use after implementing the Minimum Levels for Sustainable Nutrition (MLSN) soil test interpretation guidelines. Upon initial testing across all surfaces, it became apparent that the soil already contained ample amounts of most essential nutrients. This realisation allowed the superintendent team to shift its focus, confirming that Nitrogen (N) was the primary nutrient needed to maintain the club's high-quality turf standards. Since adopting this approach, we have significantly optimised nutrient applications, targeting only what the turfgrass needs and eliminating unnecessary inputs.



CASE STUDY:

SIMPLIFYING TURF MANAGEMENT FOR GREATER SUSTAINABILITY

Blue Devil Golf Club, Canada

On our executive course, a single, slightly higher mowing height is used across all maintained turf. This simplifies operations, reduces machinery adjustments and fuel use, and allows turf to develop deeper roots. The result is healthier grass that is more resilient to drought, requires less irrigation and is better able to resist disease, insects and weeds. By combining efficient maintenance with stronger turf, the approach reduces resource use while supporting high-quality playing conditions.



CASE STUDY:

REDUCING CHEMICAL INPUTS THROUGH PRECISION SPOT SPRAYING

Golfclub Zeewolde, Netherlands

In response to requirements to reduce chemical inputs, the club introduced precision spot-spraying technology. Cameras identify weeds using an extensive image database, activating nozzles only when a target plant is detected. This applies just a few drops of herbicide directly to individual weeds while avoiding surrounding turf, significantly reducing use compared with blanket spraying. The system has effectively controlled fairway weeds and inspired other golf courses to adopt similar technology.

TOPIC 4

WATER STEWARDSHIP

Golf courses can play an important role in local water stewardship, particularly where ponds, wetlands, soils and drainage systems are designed to store water,[1] slow runoff,[2] support water quality,[3] strengthen catchment resilience and enhance the wider landscape.[4]

Key Term: RAINWATER HARVESTING

The use of reservoirs and other water storage structures to collect, store and reuse rainfall for irrigation, runoff control and wider water resilience.



31%

U.S. research found that projected irrigation water applied to golf courses declined by 29% between 2005 and 2020[11] and by around 31% between 2005 and 2024, reflecting fewer irrigated acres and more efficient water management.[12]

90%

Closed-loop washdown and reedbed systems can treat and reuse machinery wash water, reducing water requirements by up to around 90%.[13]

Global Context

Freshwater is one of the world's most important and most pressured resources. Population growth, economic development and more resource-intensive consumption have driven a major increase in freshwater use since 1900, placing pressure on rivers, aquifers, wetlands and the communities and ecosystems that depend on them.[5]

Climate change is adding to that pressure, increasing the frequency and severity of drought, heat and water scarcity in many regions.[6] As a visible land-based sport, golf can face scrutiny where water is scarce, particularly when course irrigation is seen to compete with wider human or environmental needs.[7] [8]

This makes water stewardship one of the defining sustainability priorities for golf. The opportunity is to reduce demand, protect water quality, diversify supply, improve storage and reuse, and show how carefully managed courses can support play, nature, communities and catchments in a water-stressed world.[8] [9] [10]

References

1. Hauschel, B. (2018). Stormwater Management Benefits Golf Course and Community. USGA Green Section Best Management Practices Case Study. Retrieved from https://www.usga.org/content/usga/home-page/course-care/water-resource-center/bmp-case-studies/2018/stormwater-management-benefits-golf-course-and-community.html
2. Beard, J. B., & Green, R. L. (1994). The role of turfgrasses in environmental protection and their benefits to humans. Journal of Environmental Quality, 23(3), 452–460. Retrieved from https://doi.org/10.2134/jeq1994.00472425002300030007x
3. Kohler, E. A., Poole, V. L., Reicher, Z. J., & Turco, R. F. (2004). Nutrient, metal, and pesticide removal during storm and nonstorm events by a constructed wetland on an urban golf course. Ecological Engineering, 23(4–5), 285–298. Retrieved from https://doi.org/10.1016/j.ecoleng.2004.11.002
4. Lonsdorf, E. V., Nootenboom, C., Janke, B., & Horgan, B. P. (2021). Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area. Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
5. Ritchie, H., & Roser, M. (2024). Water Use and Stress. Our World in Data. Retrieved from https://ourworldindata.org/water-use-stress
6. IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Summary for Policymakers. Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/report/ar6/wg2/
7. Serba, D. D., Hejl, R. W., Burayu, W., Umeda, K., Bushman, B. S., & Williams, C. F. (2022). Pertinent water-saving management strategies for sustainable turfgrass in the desert U.S. Southwest. Sustainability, 14(19), 12722. Retrieved from https://doi.org/10.3390/su141912722
8. The R&A. (2025). Sustainable Water Management. Golf Course 2030 / Sustainable Golf Water Solutions. Retrieved from https://www.randa.org/sustainable-golf/water/solutions
9. STERF. (2024). Handbook: Multifunctional Potential of Golf Courses. Scandinavian Turfgrass and Environment Research Foundation. Retrieved from https://sterf.org/wp-content/uploads/2024/07/Handbook-Multifunctional-potential.pdf
10. United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. Sustainable Development Goal 6, targets 6.4 and 6.6. Retrieved from https://digitallibrary.un.org/record/1654217
11. Shaddox, T. W., Unruh, J. B., Johnson, M. E., Brown, C. D., & Stacey, G. (2022). Water use and management practices on U.S. golf courses. Crop, Forage & Turfgrass Management, 8, e20182. Retrieved from https://doi.org/10.1002/cft2.20182
12. Shaddox, T. W., Unruh, J. B., Tapp, J., Brown, C. D., Stacey, G., & Fuger, E. (2025). Survey of water use and management practices on U.S. golf courses from 2005 to 2024. HortTechnology, 35(5), 848–857. Retrieved from https://doi.org/10.21273/HORTTECH05716-25
13. The R&A. (n.d.). Closed Loop Reedbed and Washdown Facilities. Sustainable Golf Water Solutions. Retrieved from https://www.randa.org/sustainable-golf/water/solutions/29

Research finding Industry insight



HIGHLIGHTS:

EFFICIENT USE AND RESILIENT SUPPLY

IMPROVE IRRIGATION EFFICIENCY

Water-use surveys and turfgrass research show that ET-based scheduling, soil moisture monitoring, irrigation audits, hand watering and drier turf management are among the practices used by golf courses to improve irrigation efficiency and reduce unnecessary water application.[9] [10] [11] [12]

90%

Closed-loop washdown and reedbed systems can recycle machinery wash water for reuse, reducing annual washdown water requirements by up to around 90%.[17]

PRECISE IRRIGATION PLANNING

Applied turfgrass research and emerging technologies, including UAV video image analysis, can support more precise irrigation planning and improve understanding of how water, fertiliser and pesticide management affect golf course sustainability.[13] [14]

U.S. survey research found that projected irrigation water applied to golf courses declined by 29% between 2005 and 2020[10] and by around 31% between 2005 and 2024,[11] reflecting fewer irrigated acres and improved water management.[10] [11]



Drought-tolerant grasses, healthy root zones and responsible management practices can improve resilience where water availability is constrained.[12]



Rainwater harvesting, storage and reuse can help diversify supply and reduce pressure on potable water where they form part of an integrated site water management plan.[15]



Reclaimed water or treated effluent can provide an alternative irrigation source where health, environmental and operational risks are assessed and managed.[16]

0.5%

In the United States, golf course water use has been estimated at around 0.5% of total daily U.S. water use, helping place golf water use in context while reinforcing the need for continued efficiency.[4]

Research finding Industry insight

Turfgrass systems can support water infiltration, runoff reduction, surface-water protection and groundwater recharge through dense vegetation, thatch, roots and soil structure.[1] [2]



HIGHLIGHTS: HYDROLOGY, STORAGE AND WATER QUALITY



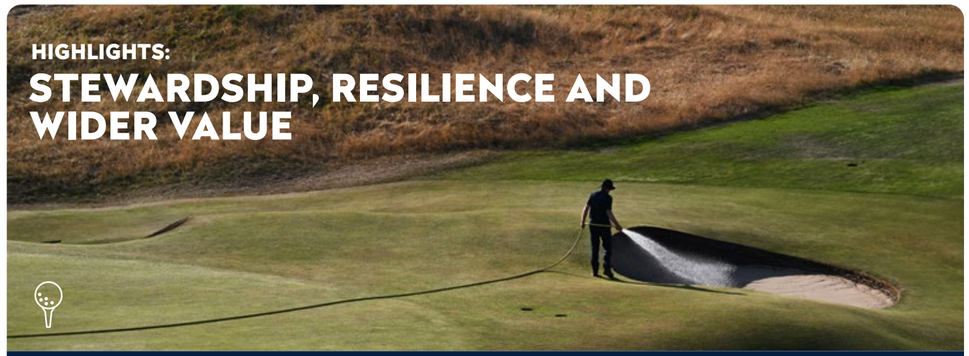
By maintaining permeable green space, soils, ponds, wetlands and drainage features, golf courses can help manage stormwater, reduce runoff and support local water cycles where this is built into course design and management.[4] [5] [6]

Vegetated buffer zones around ponds, streams and drainage channels can help protect aquatic ecosystems by intercepting runoff and reducing pesticide, fertiliser and sediment movement before they reach water bodies.[5]

Case-study evidence shows that, where golf courses work with local authorities, water managers and community partners, course landscapes can help deliver stormwater storage, runoff control, flood-risk reduction and water-quality benefits beyond the course boundary.[6] [7] [8]

CONSTRUCTED WETLAND

A constructed wetland on an urban golf course was shown to remove nutrients, metals and pesticides during storm and non-storm events, demonstrating the water-quality role that well-designed treatment wetlands can play.[3]

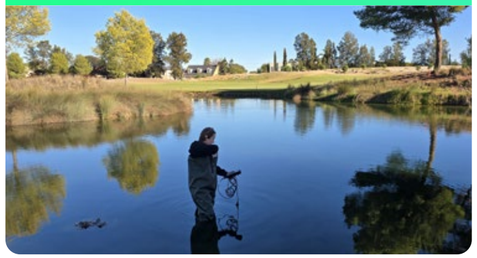


HIGHLIGHTS: STEWARDSHIP, RESILIENCE AND WIDER VALUE

The strongest water strategies combine demand reduction, diverse supply sources, storage, efficient irrigation, drainage, water-quality protection and monitoring, rather than relying on any single intervention.[5] [7] [8] [15]

WATER-STRESSED SETTINGS

In water-stressed settings, responsible golf water use depends on reducing demand, diversifying supply and ensuring that water supports playing quality, habitat, landscape resilience and wider community value.[7] [8] [12] [15]



References

1. Beard, J. B., & Green, R. L. (1994). "The role of turfgrasses in environmental protection and their benefits to humans." Journal of Environmental Quality, 23(3), 452–460. Retrieved from https://doi.org/10.2134/jeq1994.00472425002300030007x
2. Braun, R. C., Mandal, P., Nwachukwu, E., & Stanton, A. (2024). "The role of turfgrasses in environmental protection and their benefits to humans: Thirty years later." Crop Science, 64, 2909–2944. Retrieved from https://doi.org/10.1002/csc2.21383
3. Kohler, E. A., Poole, V. L., Reicher, Z. J., & Turco, R. F. (2004). "Nutrient, metal, and pesticide removal during storm and nonstorm events by a constructed wetland on an urban golf course." Ecological Engineering, 23(4–5), 285–298. Retrieved from https://doi.org/10.1016/j.ecoleng.2004.11.002
4. United States Golf Association. (2024). "The Environmental Benefits of Golf Courses." USGA Green Section Record, 62(6). Retrieved from https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-06/the-environmental-benefits-of-golf-courses.html
5. LandStudies, Inc., & Pennsylvania Environmental Council. (2009). Golf Course Water Resources Handbook of Best Management Practices. Pennsylvania Department of Environmental Protection. Retrieved from https://pecpa.org/wp-content/uploads/2022/04/Golf-Course-Water-Resources-Handbook-of-Best-Management-Practices.pdf
6. Hauschel, B. (2018). Stormwater Management Benefits Golf Course and Community. USGA Green Section Best Management Practices Case Study. Retrieved from https://www.usga.org/content/usga/home-page/course-care/water-resource-center/bmp-case-studies/2018/stormwater-management-benefits-golf-course-and-community.html
7. American Society of Golf Course Architects Foundation. (2016). Golf & Water: Case Studies in Water Stewardship. Retrieved from https://asgca.org/images/stories/publications/Water_Golf_All_Pages2_lores.pdf
8. American Society of Golf Course Architects Foundation. (2018). Golf & Water, Volume II: Case Studies in Water Stewardship. Retrieved from https://asgca.org/wp-content/uploads/2018/02/Water_Golf_Vol-II_LR.pdf
9. Gelernter, W. D., Stowell, L. J., Johnson, M. E., Brown, C. D., & Beditz, J. F. (2015). "Documenting trends in water use and conservation practices on U.S. golf courses." Crop, Forage & Turfgrass Management, 1, 1–10. Retrieved from https://doi.org/10.2134/cftm2015.0149
10. Shaddox, T. W., Unruh, J. B., Johnson, M. E., Brown, C. D., & Stacey, G. (2022). "Water use and management practices on U.S. golf courses." Crop, Forage & Turfgrass Management, 8, e20182. Retrieved from https://doi.org/10.1002/cft2.20182
11. Shaddox, T. W., Unruh, J. B., Tapp, J., Brown, C. D., Stacey, G., & Fuger, E. (2025). "Survey of water use and management practices on U.S. golf courses from 2005 to 2024." HortTechnology, 35(5), 848–857. Retrieved from https://doi.org/10.21273/HORTTECH05716-25
12. Serba, D. D., Hejl, R. W., Burayu, W., Umeda, K., Bushman, B. S., & Williams, C. F. (2022). "Pertinent water-saving management strategies for sustainable turfgrass in the desert U.S. Southwest." Sustainability, 14(19), 12722. Retrieved from https://doi.org/10.3390/su141912722
13. Perea-Moreno, A.-J., Aguilera-Ureña, M.-J., Meroño-De Larriva, J.-E., & Manzano-Agugliaro, F. (2016). "Assessment of the potential of UAV video image analysis for planning irrigation needs of golf courses." Water, 8(12), 584. Retrieved from https://doi.org/10.3390/w8120584
14. Thompson, C. S., Kridel, D. J., & Kenna, M. P. (2022). "Economic and sustainability benefits of the United States Golf Association's investment in water, fertilizer, and pesticide management research." International Turfgrass Society Research Journal, 14, 47–57. Retrieved from https://doi.org/10.1002/its2.91
15. The R&A. (n.d.). Golf Water Solutions. Sustainable Golf / Golf Course 2030 Water. Retrieved from https://www.randa.org/sustainable-golf/water/solutions
16. Salgot, M., Priestley, G. K., & Folch, M. (2012). "Golf course irrigation with reclaimed water in the Mediterranean: A risk management matter." Water, 4(2), 389–429. Retrieved from https://doi.org/10.3390/w4020389
17. The R&A. (n.d.). Closed Loop Reedbed and Washdown Facilities. Sustainable Golf Water Solutions. Retrieved from https://www.randa.org/sustainable-golf/water/solutions/29

CASE STUDY:

NEW SPRINKLERS, IRRIGATION LAKE AND POLICIES HAVE LED TO 44% RECYCLED WATER

Le Golf National, France



The installation of new sprinklers has improved application by 26%, allowing water to be distributed more uniformly with fewer wet and dry spots.



Our new irrigation system does not water out-of-play areas, removing 16 hectares from irrigation and delivering a 20% reduction in the total irrigated area. A new water reservoir with a capacity of 11,800m³ was also constructed in 2016, allowing water collected from across the course to be recycled through the irrigation lake.

Greater efficiency has been achieved through individual sprinkler control, hand-watering valves where needed, and separate control of the inner and outer areas of greens. The installation of new sprinklers has improved application by 26%, allowing water to be distributed more uniformly with fewer wet and dry spots. Organic surfactants are also used to improve soil moisture retention and help make more effective use of the water applied.

Together, these measures save approximately 50,000m³ of water each year. Around 150 kilometres of drainage trenches have been excavated across the course, directing an estimated 60% of the water falling on the site into the irrigation lake for reuse. Average annual irrigation water consumption is approximately 220,000m³, of which 56% comes from groundwater and 44% is recycled through the reservoirs and drainage system.

CASE STUDY:

OPTIMISING IRRIGATION THROUGH SOIL MOISTURE MONITORING

Abama Golf, Spain



We have installed soil moisture sensors across key playing areas to provide real-time information on root-zone conditions. This enables the greenkeeping team to target irrigation according to actual turf needs, reducing unnecessary water use while maintaining high-quality playing conditions. In a region where water is scarce, the technology supports more efficient irrigation scheduling, healthier turf and the long-term resilience of the course.

In a region where water is scarce, the technology supports more efficient irrigation scheduling, healthier turf and the long-term resilience of the course.



CASE STUDY:

NEW IRRIGATION LAKE FOR GREYWATER AND RECYCLED RAINWATER

Minthis Golf Club, Cyprus

We irrigate entirely with recycled rainwater and greywater supplied by Paphos. Its upgraded irrigation lake has doubled in capacity to 3,800 cubic metres, providing sufficient storage for year-round course maintenance. Leakage recovery, overflow controls and an improved pumping system further strengthen efficiency and playing quality. Local stone and drought-tolerant planting also integrate the lake into the landscape and create opportunities for wildlife.



CASE STUDY:

CLOSED-LOOP WASHING AREA ASSISTS IN THE SUSTAINABLE MANAGEMENT OF WATER

Wylihof Golf Club, Switzerland

We have created a dedicated sprayer-washing area that reduces the risk of contaminants entering the environment. Wash water passes through a sludge collector, oil separator and copper filter before entering a covered retention basin containing humus and barley straw. This natural filtration system absorbs the water and supports the breakdown of residues, helping the club manage wash water and potentially harmful substances responsibly.

TOPIC 5

CLIMATE ACTION

Golf courses can be visible climate assets, combining lower-carbon operations,[1] [2] carbon-storing soils, trees and vegetation,[3] [4] and green infrastructure that can cool urban areas, manage water and strengthen landscape resilience for the game, nature and surrounding communities.[5] [6] [7]

CARBON IN THE COURSE

The R&A has supported research to measure how golf course landscapes store and release carbon, including carbon balance work, soil sampling protocols and course case studies developed through Golf Course 2030 projects.[10]

600M

In some urban contexts, the cooling influence of golf course green space has been reported to extend beyond course boundaries by up to 600 metres.[11]

Key Term:
CARBON SEQUESTRATION

The process by which carbon dioxide is captured from the atmosphere and stored in soils, turfgrass, trees and other vegetation. In golf landscapes, carbon storage can be supported by healthy soils, established turfgrass, trees, woodland, naturalised areas and lower-disturbance management. [1] [2] [3] [4] [9]

Global Context

Climate change is one of the defining challenges of this century. Human activity has increased the concentration of greenhouse gases in the atmosphere, warming the climate system and driving changes in temperature, rainfall, sea levels, ice cover and the frequency of extreme weather events.[8]

These changes are already affecting people, ecosystems and economies around the world. Heat, drought, flooding, coastal erosion and more volatile weather patterns are placing growing pressure on water resources, food systems, infrastructure, biodiversity and human health.[8]

Responding to climate change requires both rapid emissions reduction and practical adaptation to the impacts already emerging.[8] For golf, this means reducing emissions from course maintenance, energy use, materials, travel and events,[1] [2] [9] while also preparing courses and facilities for hotter, wetter, drier and more unpredictable conditions.[7]

Climate action should be treated not only as a response to risk but also as a way to strengthen the game's long-term resilience.

Lower-carbon operations, climate-ready landscapes, healthier soils, better water management, shade, cooling and habitat protection can all help golf adapt to a changing climate while delivering wider value for nature and communities.[5] [6] [7]

References

1. Bekken, M. A. H., Soldat, D. J., & Frank, K. W. (2022). Estimated energy use and greenhouse gas emissions associated with golf course turfgrass maintenance in the northern USA. International Turfgrass Society Research Journal, 14(1), 58–75. Retrieved from https://doi.org/10.1002/its2.61
2. Bartlett, M. D., & James, I. T. (2011). A model of greenhouse gas emissions from the management of turf on two golf courses. Science of the Total Environment, 409(23), 5137–5147. Retrieved from https://doi.org/10.1016/j.scitotenv.2011.07.054
3. Qian, Y., & Follett, R. F. (2002). Assessing soil carbon sequestration in turfgrass systems using long-term soil testing data. Agronomy Journal, 94(4), 930–935. Retrieved from https://doi.org/10.2134/agronj2002.9300
4. Doll, S., & Duinker, P. N. (2020). Characterization and justification of trees on an inner-city golf course in Halifax, Canada: An investigation into the ecological integrity of institutional greenspace. Forests, 11(1), 96. Retrieved from https://doi.org/10.3390/f11010096
5. Nguyen, T. T., Eslick, H., Barber, P., Harper, R., & Dell, B. (2022). Cooling effects of urban vegetation: The role of golf courses. Remote Sensing, 14(17), 4351. Retrieved from https://doi.org/10.3390/rs14174351
6. Lonsdorf, E. V., Nootenboom, C. W., Janke, B., & Horgan, B. P. (2021). Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area. Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
7. Isaac, S. (2022). Golf Course 2030: Implementing UN sustainable development goals to identify industry and research needs for greater resiliency in golf course playability. International Turfgrass Society Research Journal, 14(1), 36–39. Retrieved from https://doi.org/10.1002/its2.38
8. IPCC. (2023). Climate Change 2023: AR6 Synthesis Report. Summary for Policymakers. Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/report/ar6/syr/
9. Wilby, R. L., Orr, M., Depledge, D., Giulianotti, R., Havenith, G., Kenyon, J. A., Matthews, T. K. R., Mears, S. A., Mullan, D. J., & Taylor, L. (2023). The impacts of sport emissions on climate: Measurement, mitigation, and making a difference. Annals of the New York Academy of Sciences, 1519(1), 20–33. Retrieved from https://doi.org/10.1111/nyas.14925
10. The R&A. (2025). The Climate Impact of Golf Courses. Golf Course 2030, Version 2. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/97ed7a38-a664-4441-ae79-186ed1441621/Climate%20Impact%20of%20Golf%20Courses%20Version%202.pdf
11. United States Golf Association. (2024). The Environmental Benefits of Golf Courses. USGA Green Section Record, 62(6). Retrieved from https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-06/the-environmental-benefits-of-golf-courses.html

Research finding Industry insight



HIGHLIGHTS:

COOLING, ADAPTATION AND CLIMATE RESILIENCE

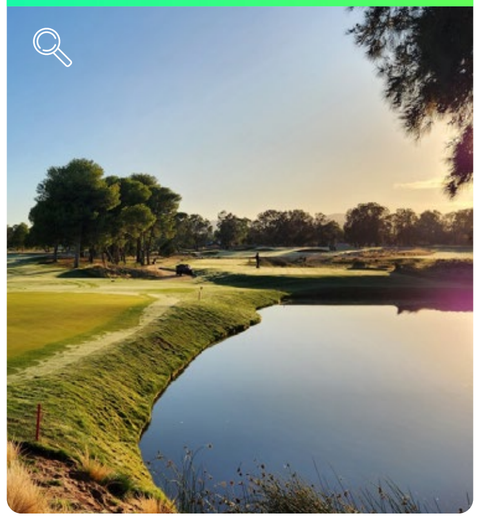
CLIMATE-RELEVANT ECOSYSTEM SERVICES

Golf course landscapes can deliver multiple climate-relevant ecosystem services, including urban cooling, stormwater nutrient retention and pollinator support through trees, vegetation, soils, water bodies and connected green space.[4 5]



Urban golf courses can deliver measurable cooling benefits, with research in Perth, Australia showing lower land surface temperatures than most surrounding urban land uses.[1]

Former golf course landscapes can contribute to flood mitigation when restored or managed to provide flood storage and reconnect water movement across the site.[6]



WIDER URBAN GREEN INFRASTRUCTURE

Urban green space can help reduce heat-related health risks,[3] giving golf landscapes potential public health relevance when they form part of wider urban green infrastructure.[1 4]

The interrelated challenges of climate change, resource constraints and regulation are key issues that will shape the future of resilient golf course design, condition and playability.[7]



600 METRES

The cooling influence of golf course green space can extend beyond course boundaries, with effects reported up to 600 metres from the course edge in some urban settings.[2]

Climate resilience needs to be designed locally, with course adaptation shaped by climate risks, water availability, resource pressures, regulation, turf conditions and playing expectations.[8]

Research finding Industry insight



HIGHLIGHTS:

CARBON STORAGE AND CARBON BALANCE

Trees, woodland and other vegetation can enhance carbon storage and ecological value across golf landscapes when well planned, established and managed.[14] [18]

The climate value of turfgrass carbon storage is shaped by management inputs, including energy, fuel, fertiliser, machinery, irrigation and materials used to maintain playing surfaces.[10] [14] [15] [16] [17]



Turfgrass soils can store carbon, particularly where turf is established over time and soil management supports long-term accumulation of organic carbon.[9] [10] [11] [12] [13]

CARBON BALANCE RESEARCH

Carbon balance research is developing a clearer understanding of how golf course landscapes store and release carbon, with soil sampling protocols and case studies developed from Golf Course 2030 projects.[19] [20] [21]



HIGHLIGHTS:

EMISSIONS, MATERIALS AND MAINTENANCE

Golf course maintenance has a measurable carbon footprint, with emissions shaped by course type, managed area, climate, machinery, energy sources, fertiliser use and maintenance intensity.[15] [16] [17]

IMPORTANT EMISSIONS SOURCES

Fuel, electricity, nitrogen fertiliser, machinery and material inputs can be important emissions sources in course maintenance, highlighting the value of efficient machinery, lower-input turf systems, careful nutrient management and reduced reliance on high-impact materials.[15] [16] [17]



Reducing or naturalising lower-value intensively maintained areas can reduce input pressure and create space for naturalised roughs, grass bunkers, woodland, wetlands and other lower-input landscape features.[22] [23]

SPORT-SECTOR RESEARCH SHOWS THAT CLIMATE STRATEGIES NEED TO LOOK BEYOND DIRECT SITE OPERATIONS, WITH PARTICIPANT TRAVEL, FACILITIES, PURCHASED GOODS AND EVENT ACTIVITY ALL RELEVANT TO CREDIBLE EMISSIONS MEASUREMENT AND REDUCTION.[24] [25]

References

1. Nguyen, T. T., Eslick, H., Barber, P., Harper, R., & Dell, B. (2022). "Cooling Effects of Urban Vegetation: The Role of Golf Courses." Remote Sensing, 14(17), 4351. Retrieved from https://doi.org/10.3390/rs14174351
2. United States Golf Association. (2024). "The Environmental Benefits of Golf Courses." USGA Green Section Record, 62(6). Retrieved from https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-06/the-environmental-benefits-of-golf-courses.html
3. Nazish, A., Abbas, K., & Sattar, E. (2024). "Health impact of urban green spaces: a systematic review of heat-related morbidity and mortality." BMJ Open, 14, e081632. Retrieved from https://doi.org/10.1136/bmjopen-2023-081632
4. Lonsdorf, E. V., Nootenboom, C. W., Janke, B., & Horgan, B. P. (2021). "Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis–St. Paul metro area." Landscape and Urban Planning, 208, 104022. Retrieved from https://doi.org/10.1016/j.landurbplan.2020.104022
5. Petrosillo, I., Valente, D., Pasimeni, M. R., Aretano, R., Semeraro, T., & Zurlini, G. (2019). "Can a golf course support biodiversity and ecosystem services? The landscape context matters." Landscape Ecology, 34, 2213–2228. Retrieved from https://doi.org/10.1007/s10980-019-00885-w
6. Ritter, J. (2023). "Assessing the Potential Flood Mitigation Services of a Former Golf Course with a Focus on Flood Storage." IntechOpen. Retrieved from https://doi.org/10.5772/intechopen.113107
7. Isaac, S. (2022). "Golf Course 2030: Implementing UN sustainable development goals to identify industry and research needs for greater resiliency in golf course playability." International Turfgrass Society Research Journal, 14(1), 36–39. Retrieved from https://doi.org/10.1002/its2.38
8. The R&A. (2020). Golf Course 2030: Great Britain and Ireland. The R&A. Retrieved from https://www.randa.org/what-is-gc2030
9. Qian, Y., & Follett, R. F. (2002). "Assessing Soil Carbon Sequestration in Turfgrass Systems Using Long-Term Soil Testing Data." Agronomy Journal, 94(4), 930–935. Retrieved from https://doi.org/10.2134/agronj2002.9300
10. Selhorst, A. L., & Lal, R. (2011). "Carbon budgeting in golf course soils of Central Ohio." Urban Ecosystems, 14, 771–781. Retrieved from https://doi.org/10.1007/s11252-011-0168-5
11. Selhorst, A., & Lal, R. (2012). "Carbon Sequestration in Golf Course Turfgrass Systems and Recommendations for the Enhancement of Climate Change Mitigation Potential." In R. Lal & B. Augustin, eds., Carbon Sequestration in Urban Ecosystems, pp. 249–263. Springer. Retrieved from https://doi.org/10.1007/978-94-007-2366-5_13
12. Wang, R., Mattox, C. M., Phillips, C. L., & Kowalewski, A. R. (2022). "Carbon Sequestration in Turfgrass–Soil Systems." Plants, 11(19), 2478. Retrieved from https://doi.org/10.3390/plants11192478
13. Roald, E., & Guðmundsson, J. (2022). "Carbon Par: Estimating carbon status of land used by Icelandic golf courses and measuring carbon storage of turfgrass on golf fairways and mown roughs." International Turfgrass Society Research Journal, 14(1), 1061–1062. Retrieved from https://doi.org/10.1002/its2.121
14. Bartlett, M. D., & James, I. T. (2011). "Are golf courses a source or sink of atmospheric carbon dioxide? A modelling approach." Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology, 225(2), 75–83. Retrieved from https://doi.org/10.1177/1754337110396014
15. Bartlett, M. D., & James, I. T. (2011). "A model of greenhouse gas emissions from the management of turf on two golf courses." Science of the Total Environment, 409(23), 5137–5147. Retrieved from https://doi.org/10.1016/j.scitotenv.2011.07.054
16. Bekken, M. A. H., Soldat, D. J., & Frank, K. W. (2022). "Estimated energy use and greenhouse gas emissions associated with golf course turfgrass maintenance in the northern USA." International Turfgrass Society Research Journal, 14(1), 58–75. Retrieved from https://doi.org/10.1002/its2.61
17. Tidåker, P., Wesström, T., & Kätterer, T. (2017). "Energy use and greenhouse gas emissions from turf management of two Swedish golf courses." Urban Forestry & Urban Greening, 21, 80–87. Retrieved from https://doi.org/10.1016/j.ufug.2016.11.009
18. Doll, S., & Duinker, P. N. (2020). "Characterization and Justification of Trees on an Inner-City Golf Course in Halifax, Canada: An Investigation into the Ecological Integrity of Institutional Greenspace." Forests, 11(1), 96. Retrieved from https://doi.org/10.3390/f11010096
19. The R&A. (2025). The Climate Impact of Golf Courses: Carbon Balances in Golf Course Landscapes. Golf Course 2030, Version 2. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/97ed7a38-a664-4441-ae79-186ed1441621/Climate%20Impact%20of%20Golf%20Courses%20Version%202.pdf
20. The R&A. (2025). The Climate Impact of Golf Courses: A Case Study from Minchinhampton Golf Club, UK. Golf Course 2030, Version 2. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/97ed7a38-a664-4441-ae79-186ed1441621/Climate%20Impact%20of%20Golf%20Courses%20Version%202.pdf
21. The R&A. (2025). The Climate Impact of Golf Courses: A Soil Sampling Protocol to Determine Golf Course Soil Carbon Fluxes. Golf Course 2030, Version 2. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/97ed7a38-a664-4441-ae79-186ed1441621/Climate%20Impact%20of%20Golf%20Courses%20Version%202.pdf
22. Golf Course Superintendents Association of America. (2017). Golf Course Environmental Profile: Land Use Characteristics and Environmental Stewardship Programs on U.S. Golf Courses. GCSAA. Retrieved from https://www.gcsaa.org/what-we-do/environmental-stewardship/golf-course-environmental-profile
23. Scandinavian Turfgrass and Environment Research Foundation. (2025). Multifunctional Golf Courses and Ecosystem Services: Research and Development Programme. STERF. Retrieved from https://sterf.org
24. Wicker, P. (2019). "The carbon footprint of active sport participants." Sport Management Review, 22(4), 513–526. Retrieved from https://doi.org/10.1016/j.smr.2018.07.001
25. Wilby, R. L., Orr, M., Depledge, D., Giulianotti, R., Havenith, G., Kenyon, J. A., Matthews, T. K. R., Mears, S. A., Mullan, D. J., & Taylor, L. (2023). "The impacts of sport emissions on climate: Measurement, mitigation, and making a difference." Annals of the New York Academy of Sciences, 1519(1), 20–33. Retrieved from https://doi.org/10.1111/nyas.14925

CASE STUDY:

INVESTING IN SUSTAINABILITY: ENERGY EFFICIENCY AND RENEWABLE ENERGY

Lincoln Golf Club, England



The solar panels at the maintenance complex now power all our electric and hybrid equipment – including six electric golf carts, eight hybrid ride-on mowers and two electric leaf blowers.



We have made several energy-efficient investments to enhance sustainability and improve operational efficiency. One key initiative is the Solar Panel Project within our Greenkeeping complex, which harnesses renewable energy to power the course irrigation system and greens equipment. Additionally, we've recently invested in five new electric buggies, a hybrid fairway mower, and an electric Workman utility vehicle.

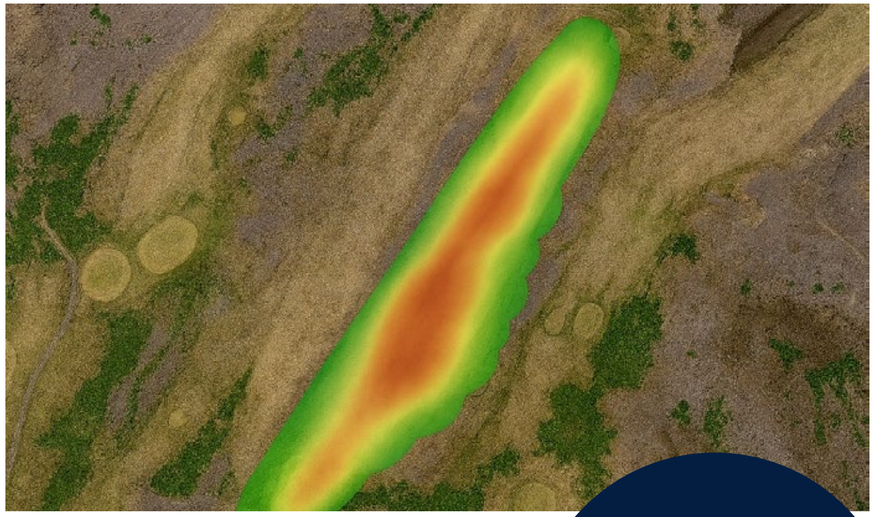
At the clubhouse, we've installed a Smart Energy Free air cooling system that utilises ambient air to power and cool our bar cellar when temperatures drop below 10°C, helping reduce electricity costs. The solar panels at the maintenance complex now power all our electric and hybrid equipment – including six electric golf carts, eight hybrid ride-on mowers and two electric leaf blowers.

Even more impressively, the solar panels generate surplus energy, which is sold back to the grid. Additionally, a green power supplier is used for the clubhouse and other buildings, ensuring that all electricity is sourced from renewable energy.

CASE STUDY:

REDUCING MANAGED TURF THROUGH DATA-DRIVEN ANALYSIS

Golfklúbbur Þorlákshafnar, Iceland



We combined golf course architecture expertise with custom shot-forecasting software to identify regularly mown areas receiving minimal play. Analysis of shot-dispersion patterns and playing frequency enabled 18,204m² of maintained turf to be converted into natural grassland, reducing the course's mown footprint by 12.66%. This data-led approach supports climate action by reducing mowing, fuel use and other maintenance inputs, while enhancing biodiversity and strengthening the natural character of the landscape.

We combined golf course architecture expertise with custom shot-forecasting software to identify regularly mown areas receiving minimal play.



CASE STUDY:

FROM BOTTLES TO BUNKERS

The Ranch at Laguna Beach, United States

We use an on-site crusher to transform empty glass bottles into sand for bunkers, pavement repairs and pool filtration. The initiative produces approximately 70 US tons of reusable sand annually and reduces the volume of glass waste by 90%. By repurposing bottles on site, the club also avoids the transport and external processing associated with glass disposal, improving operational efficiency while reducing waste and related carbon emissions.



CASE STUDY:

TIDAL WETLANDS AND ECOLOGICAL RESTORATION

Royal Queensland Golf Club, Australia

We restored previously blocked tidal flows from the adjoining Brisbane River and expanded saline wetlands across the course. Mangroves, sedges, rushes and other salt-tolerant plants help filter water, trap pollutants, stabilise shorelines and provide habitat for fish, birds and invertebrates. The wetlands also store carbon and absorb excess water during heavy rainfall and high tides, reducing flood and erosion risks while strengthening the course's climate resilience. Ongoing environmental monitoring is assessing how these restored habitats continue to develop.

TOPIC 6

PEOPLE AND COMMUNITIES

Golf can support healthier, more connected communities by providing lifelong outdoor physical activity and wellbeing benefits,[1] social connection[2] and opportunities for people to spend time in nature across ages, abilities and playing formats.[3] [4]



Key Term:
NATURE CONNECTION

The relationship people feel with the natural world is shaped by time outdoors, sensory experience and care for wildlife. In golf, it can be strengthened when players, staff and communities engage with course landscapes, habitats and species.

40%

A large Swedish cohort study found that golfers had a 40% lower mortality rate than non-golfers of the same sex, age and socioeconomic status, corresponding to around five years' longer life expectancy.[12]

112M+

More than 112 million adults and juniors now play golf across all formats in The R&A's affiliated markets outside the USA and Mexico, giving the sport a substantial platform to promote active, social and connected lifestyles.[13]

Global Context

Health and wellbeing are shaped by the places, communities and everyday experiences that help people live active, connected and fulfilling lives. As populations age, cities grow and sedentary lifestyles become more common, access to safe, welcoming and restorative outdoor spaces is increasingly important.[5] [6] [7]

Green spaces are associated with a wide range of health and social benefits, including physical activity, psychological relaxation, stress reduction, social cohesion and reduced exposure to air pollution, noise and excessive heat.[8] [9] These benefits are particularly important as communities respond to changing patterns of urbanisation, public health pressure, social isolation and climate risk.

This creates a close connection between environmental and social sustainability. When habitats are protected, water is managed well, landscapes are restored and places are made more resilient, the benefits can extend beyond nature alone. These actions can also make outdoor environments healthier, more attractive and more meaningful for the people who use, work in and live around them.[8] [9]

For golf, this is an important opportunity. As a multi-generational outdoor sport with facilities embedded in local landscapes, golf can support health, employment, volunteering, learning, social connection and nature connectedness alongside playing the game. The strongest contribution comes when clubs and facilities are inclusive, accessible and actively connected to their communities.[10] [11]

References

1. Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., Grant, L., & Mutrie, N. (2017). The relationships between golf and health: a scoping review. British Journal of Sports Medicine, 51(1), 12–19. Retrieved from https://doi.org/10.1136/bjsports-2016-096625
2. Sorbie, G., Richardson, A. K., Glen, J., Hardie, S., Taliep, S., Wade, M., Broughton, L., Mann, S., Steele, J., & Lavallee, D. (2021). The association of golf participation with health and wellbeing: A comparative study. International Journal of Golf Science, 9(1). Retrieved from https://doi.org/10.1123/ijgs.2020-0016
3. Murray, A. D., Archibald, D., Murray, I. R., Hawkes, R. A., Foster, C., Barker, K., Kelly, P., Grant, L., & Mutrie, N. (2018). 2018 international consensus statement on golf and health to guide action by people, policymakers and the golf industry. British Journal of Sports Medicine, 52(22), 1426–1436. Retrieved from https://doi.org/10.1136/bjsports-2018-099509
4. Fouillouze, A., Lacoeuilhe, A., & Truong, M.-X. A. (2023). A step towards a greener green? Investigating golfers' relationships with nature and attitudes about biodiversity conservation in golf courses. Journal of Outdoor Recreation and Tourism, 43, 100659. Retrieved from https://doi.org/10.1016/j.jort.2023.100659
5. World Health Organization. (2018). Global action plan on physical activity 2018–2030: More active people for a healthier world. World Health Organization. Retrieved from https://www.who.int/publications/i/item/9789241514187
6. World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. World Health Organization. Retrieved from https://www.who.int/publications/b/55518
7. United Nations Department of Economic and Social Affairs. (2018). 68% of the world population projected to live in urban areas by 2050, says UN. Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html
8. World Health Organization Regional Office for Europe. (2016). Urban green spaces and health. WHO Regional Office for Europe. Retrieved from https://www.who.int/europe/publications/i/item/WHO-EURO-2016-3352-43111-60341
9. Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environmental Research, 166, 628–637. Retrieved from https://doi.org/10.1016/j.envres.2018.06.030
10. The R&A. (2026). Golf and Health Report 2021–2025. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/a9992353-da7d-4bab-9998-2752ee626b04/Golf%20and%20Health%20Report%202021-2025.pdf
11. Sheffield Hallam University Sport Industry Research Centre & The R&A. (2023). The Social Value of Golf in the UK. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/2e00e1db-3154-49ac-a87d-d19a961cb8a2/The%20Social%20Value%20of%20golf%20in%20the%20UK%20-%202023.pdf
12. Farahmand, B., Broman, G., de Faire, U., Vågerö, D., & Ahlbom, A. (2009). Golf: a game of life and death – reduced mortality in Swedish golf players. Scandinavian Journal of Medicine & Science in Sports, 19(3), 419–424. Retrieved from https://doi.org/10.1111/j.1600-0838.2008.00814.x
13. The R&A. (2026). Junior golf growth helps drive sustained increase in global participation. The R&A. Retrieved from https://www.randa.org/articles/junior-golf-growth-helps-drive-sustained-increase-in-global-participation

Research finding Industry insight



HIGHLIGHTS:

PHYSICAL ACTIVITY, HEALTH AND LIFELONG PARTICIPATION

Playing golf, particularly when walking, can contribute to recommended physical activity through sustained low- to moderate-intensity movement over several hours.[2 3]

40%

Golf is associated with longer life expectancy, with a large Swedish cohort study reporting a 40% lower mortality rate among golfers after stratification by age, sex and socioeconomic status.[1]

PHYSICAL HEALTH BENEFITS

Golf can provide moderate-intensity physical activity and is associated with physical health benefits, including improved cardiovascular, respiratory and metabolic profiles.[2]



Golf has strong potential as a lifelong sport because it can be played and adapted across ages, abilities, fitness levels and participation formats.[4 5]



HIGHLIGHTS:

OUTDOOR WELLBEING AND NATURE CONNECTION

NATURE-RICH GOLF SETTINGS

Nature connection is linked to wellbeing, conservation concern and pro-environmental behaviour, suggesting that nature-rich golf settings can have value for both people and stewardship.[10 11 12]



Golfers' relationships with nature can influence their attitudes towards biodiversity conservation and ecological management on golf courses.[13]

WELLBEING

Physical activity in outdoor natural environments may provide additional wellbeing benefits, including greater enjoyment, revitalisation, positive affect and reduced anxiety or fatigue compared with similar activity in indoor or urban settings.[7 8]

Golf's wellbeing value comes from more than movement alone, it combines physical activity with time outdoors, social contact and broader wellbeing benefits.[2 9]

Access to green space is associated with a range of health and wellbeing benefits, including physical activity, mental health, reduced stress and improved physiological outcomes.[6]

Research finding Industry insight



HIGHLIGHTS:

SOCIAL CONNECTION, ACCESS AND INCLUSION

Golf participation is associated with social wellbeing, with one comparative study finding that golfers reported significantly higher levels of social trust and personal wellbeing than national population.[9]

Shorter formats, accessible pricing structures, family sessions, adapted equipment, coaching and welcoming club cultures can help broaden access to the health and social benefits of golf.[4 5 14 15]

Disabled people can gain health and social benefits from golf, while barriers and facilitators, including accessibility, services, social interaction, adapted equipment and cost, also shape participation.[15]

ACCESSIBILITY

Golf's social value depends on access, not participation numbers alone, with cost, time, confidence, culture, accessibility and playing format shaping who benefits.[4 5 14]



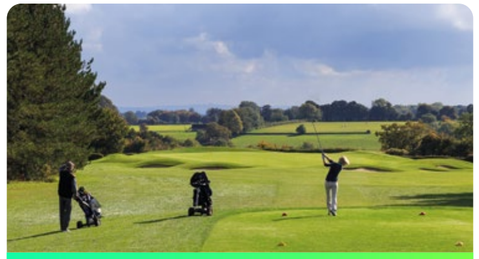
HIGHLIGHTS:

COMMUNITY VALUE AND WIDER INFLUENCE

Habitat projects, outdoor learning, nature walks, volunteering, citizen science and visible conservation work can turn environmental management into opportunities for education, participation and community engagement.[17 18]



Multifunctional golf facilities can provide ecosystem services and wider community value in urban and peri-urban settings when managed as shared green infrastructure.[16]



Golf's global participation reach gives the sport a substantial platform to promote active, inclusive and nature-connected lifestyles, provided this is aligned with credible sustainability action.[18 19]

References

1. Farahmand, B., Broman, G., de Faire, U., Vågerö, D., & Ahlbom, A. (2009). "Golf: a game of life and death — reduced mortality in Swedish golf players." Scandinavian Journal of Medicine & Science in Sports, 19(3), 419–424. Retrieved from https://doi.org/10.1111/j.1600-0838.2008.00814.x
2. Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., Grant, L., & Mutrie, N. (2017). "The relationships between golf and health: a scoping review." British Journal of Sports Medicine, 51(1), 12–19. Retrieved from https://doi.org/10.1136/bjsports-2016-096625
3. Murray, A. D., Archibald, D., Murray, I. R., Hawkes, R. A., Foster, C., Barker, K., Kelly, P., Grant, L., & Mutrie, N. (2018). "2018 international consensus statement on golf and health to guide action by people, policymakers and the golf industry." British Journal of Sports Medicine, 52(22), 1426–1436. Retrieved from https://doi.org/10.1136/bjsports-2018-099509
4. The R&A. (2026). Golf and Health Report 2021–2025. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/a9992353-da7d-4bab-9998-2752ee626b04/Golf%20and%20Health%20Report%202021-2025.pdf
5. White, R., & Lundkvist, E. (2018). Golf: A fair way to human health and wellbeing? GoGolf Europe Literature Review. GoGolf Europe. Retrieved from https://research-portal.st-andrews.ac.uk/en/publications/golf-a-fair-way-to-human-health-and-wellbeing-gogolf-europe-liter
6. Twohig-Bennett, C., & Jones, A. (2018). "The health benefits of the great outdoors: a systematic review and meta-analysis of greenspace exposure and health outcomes." Environmental Research, 166, 628–637. Retrieved from https://doi.org/10.1016/j.envres.2018.06.030
7. Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). "Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review." Environmental Science & Technology, 45(5), 1761–1772. Retrieved from https://doi.org/10.1021/es102947t
8. Wicks, C., Barton, J., Orbell, S., & Andrews, L. (2022). "Psychological benefits of outdoor physical activity in natural versus urban environments: a systematic review and meta-analysis of experimental studies." Applied Psychology: Health and Well-Being, 14(3), 1037–1061. Retrieved from https://doi.org/10.1111/aphw.12353
9. Sorbie, G., Richardson, A. K., Glen, J., Hardie, S., Taliep, S., Wade, M., Broughton, L., Mann, S., Steele, J., & Lavallee, D. (2021). "The association of golf participation with health and wellbeing: A comparative study." International Journal of Golf Science, 9(1). Retrieved from https://doi.org/10.1123/ijgs.2020-0016
10. Zylstra, M. J., Knight, A. T., Esler, K. J., & Le Grange, L. L. L. (2014). "Connectedness as a core conservation concern: An interdisciplinary review of theory and a call for practice." Springer Science Reviews, 2, 119–143. Retrieved from https://doi.org/10.1007/s40362-014-0021-3
11. Whitburn, J., Linklater, W. L., & Milfont, T. L. (2019). "Exposure to urban nature and tree planting are related to pro-environmental behavior via connection to nature, the use of nature for psychological restoration, and environmental attitudes." Environment and Behavior, 51(7), 787–810. Retrieved from https://doi.org/10.1177/0013916517751009
12. Whitburn, J., Linklater, W. L., & Abrahamse, W. (2020). "Meta-analysis of human connection to nature and proenvironmental behavior." Conservation Biology, 34(1), 180–193. Retrieved from https://doi.org/10.1111/cobi.13381
13. Fouillouze, A., Lacoeuilhe, A., & Truong, M.-X. A. (2023). "A step towards a greener green? Investigating golfers' relationships with nature and attitudes about biodiversity conservation in golf courses." Journal of Outdoor Recreation and Tourism, 43, 100659. Retrieved from https://doi.org/10.1016/j.jort.2023.100659
14. Sheffield Hallam University Sport Industry Research Centre & The R&A. (2023). The Social Value of Golf in the UK. The R&A. Retrieved from https://assets.randa.org/c42c7bf4-dca7-00ea-4f2e-373223f80f76/2e00e1db-3154-49ac-a87d-d19a961cb8a2/The%20Social%20Value%20of%20golf%20in%20the%20UK%20-%202023.pdf
15. Monforte, J., Smith, B., & Bennett, T. (2021). "Benefits, barriers and facilitators to golf participation among disabled people: Identifying opportunities to increase uptake and foster inclusion." International Journal of Golf Science, 10(1). Retrieved from https://doi.org/10.1123/ijgs.2020-0007
16. Dahl Jensen, A.-M., Caspersen, O. H., Jensen, F. S., & Strandberg, M. (2017). "Multifunctional golf facilities as a resource of important ecosystem services in a changing urban environment: Nordic case studies." International Turfgrass Society Research Journal, 13, 236–239. Retrieved from https://doi.org/10.2134/itsrj2016.05.0424
17. Australian Golf Industry Council. (2020). Golf: Benefits to the Environment. Retrieved from https://static.golf.com.au/clubs/1000/uploads/resources/attach__5__golf__benefits__to__the__environment__2020__final__june20.pdf
18. Fitzpatrick, R. D. J., White, R., & Matthews, I. M. (2022). Seeking green grass: strong sustainability for golf and turfgrass. International Turfgrass Society Research Journal, 14(1), 23–30. https://doi.org/10.1002/its2.22
19. The R&A. (2026). Junior golf growth helps drive sustained increase in global participation. The R&A. Retrieved from https://www.randa.org/articles/junior-golf-growth-helps-drive-sustained-increase-in-global-participation

CASE STUDY:

BIODIVERSITY ENHANCEMENTS SUPPORT COMMUNITY ENGAGEMENT

Annanhill Golf Course, Scotland



Replacing the existing turf with diverse wildflower planting has reduced maintenance requirements while providing valuable habitat and food resources for pollinating insects.





Throughout the winter, we undertook several environmental projects across the golf course. Three wildlife ponds were created to provide a natural drainage solution and establish habitats for insects, amphibians and birds.

We also developed a wildlife corridor by constructing a ditch and bund, planting 2,105 Hawthorn and Blackthorn trees and establishing wildflowers on a sloping bank that was difficult to maintain using machinery and required weekly hand strimming. Replacing the existing turf with diverse wildflower planting has reduced maintenance requirements while providing valuable habitat and food resources for pollinating insects.

These environmental features were brought together through a newly created ‘Mile a Day’ path network. The pathway allows the public to connect with the golf course in a designated and safe manner, winding through woodlands, past the ponds and alongside the wildflower corridor. It provides an attractive setting in which local people can walk, exercise and experience the nature found across the course.

The project has been well received by members of the public using the path network, many of whom have commented positively on the colour and variety of the wildflowers. Interpretation boards installed along the route explain the importance of wildflowers and the role pollinators play in healthy ecosystems, helping visitors understand and engage with the habitats around them.

By connecting environmental improvements with public access, outdoor activity and education, the project has successfully brought golfers and path users together, providing a safe and harmonious way for everyone to enjoy the facility. We plan to maintain and expand the initiative by creating additional wildflower areas across the course in the coming years.

CASE STUDY:

ACTIVATING THE GOLF COURSE FOR MENTAL HEALTH AND WELL-BEING

Corica Park, United States



To mark Mental Health Awareness Month, the club hosted four weeks of community wellbeing workshops across its nine-hole course, private practice area and communal spaces. Expert practitioners led sessions in art therapy, music therapy, yoga and mindful movement, activating the golf course as a space for relaxation and mental wellbeing. The workshops gave community members opportunities to reconnect with nature, unwind and find balance outdoors. Sessions were offered on a voluntary donation basis, with all proceeds supporting future wellbeing programmes.

Expert practitioners led sessions in art therapy, music therapy, yoga and mindful movement, activating the golf course as a space for relaxation and mental wellbeing.



CASE STUDY:

MEMBERS SHED STRENGTHENS WELLBEING AND COMMUNITY

Corrstwon Golf Club, Ireland

Inspired by the Men's Shed concept, we established a Members' Shed welcoming both men and women. Created in response to concerns about social isolation, loss of purpose and physical and mental wellbeing, the initiative transformed an unused storeroom into a meeting room and workshop, with a greenhouse supporting practical activities. Participants can develop skills, work on shared projects and build meaningful social connections. Founded on the belief that people thrive when they feel useful, respected and connected, the Members' Shed has become a valued part of club life, promoting wellbeing, inclusion and a stronger sense of community.



CASE STUDY:

SCHOOL KIDS STUDY COURSE ECOLOGY

Montrose Golf Links, Scotland

Two bug hotels were built on the Broomfield Course using old wooden pallets, spare materials and natural items collected around the course. They now support the Golf Trail education programme delivered to every Primary 4 pupil in the Montrose area. During their visit, children learn about local habitats, bug hotels, bird boxes and wildflowers alongside course design, golf coaching, rules and etiquette. The programme gives pupils and teachers an engaging outdoor learning experience while introducing them to both the environmental value of the course and the game of golf.

PART 3

DRIVING FURTHER



Real progress will come from many people taking practical steps in their own areas of influence, then connecting those efforts into something larger.

THE OPPORTUNITY NOW

is to show that golf is not only adapting to a changing world but also contributing to a better one: protecting the landscapes that sustain the game, strengthening the communities it serves and building a future that is resilient, responsible and full of possibility.

LOOKING FORWARD – SUSTAINABILITY AND THE FUTURE OF GOLF

There can be no doubt that over the coming decades, as population and consumption continue to grow, the global movement towards more sustainable use of land and resources will tangibly affect the sport of golf.

In the eyes of regulators and the public, sustainability is fast becoming part of the sport's licence to operate. For golf facilities, resilience will move from concept to real-world imperative.

But this shift also brings real opportunity. When done well, sustainability can help golf become more efficient, more trusted, more resilient and more valuable to the people and places around it.

Courses that restore nature can become richer and more distinctive places to play. Facilities that conserve water, energy and materials can reduce pressure on resources and strengthen their long-term business. Clubs that communicate well and engage with their communities can build trust, attract support and show leadership.



THE BIG QUESTIONS ARE HOW THE SPORT ITSELF WILL ADAPT, INNOVATE AND COMMUNICATE.

Will this be a proactive journey where pain points are minimised?

Will we anticipate the pressures and respond on our own terms?

Will the public know that golf is leaning into this evolution - that it is on the same page?

These are the elements that will define how well golf succeeds, and what the provision and profile of golf will look like around the world.

The opportunity now is to show that golf is not only adapting to a changing world but also contributing to a better one: protecting the landscapes that sustain the game, strengthening the communities it serves and building a future that is resilient, responsible and full of possibility.

To do that well, the sport will need more than ambition. It will need evidence, data and knowledge that help guide better decisions, support credible communications and show where golf can make the greatest difference.



STRENGTHENING DATA, KNOWLEDGE AND RESEARCH – BETTER EVIDENCE TO GUIDE BETTER DECISIONS

Golf already has a strong and growing body of evidence across many areas of sustainability. Research, case studies and industry experience show a sport that is taking meaningful action: supporting nature, conserving resources, strengthening communities, improving resilience and contributing positively to wider sustainable development.

They also point to something bigger.

As knowledge grows, innovation advances and more facilities, organisations and partners become involved, golf has a significant opportunity to expand its positive impact and demonstrate even greater value for people, places and the planet.

However, there remains a need for more multinational, regional and empirical studies to understand the full impact and potential of golf across different landscapes, climates, business models and communities.

Current research indicates both positive and negative outcomes, highlighting the complexity of these interactions and the importance of better data, clearer methods and more consistent reporting.

This is not only a research challenge, but a leadership opportunity - what if golf could show, with greater confidence, where it is protecting nature, conserving resources, strengthening communities and improving resilience?

Better evidence will help the sport target investment, improve performance, support credible communications and build greater trust with regulators, communities, partners and the public.

Stronger data will help move golf beyond isolated examples of good practice towards a clearer, more confident picture of its collective impact.

In essence, more research and more knowledge will help the sector understand what works, where the greatest opportunities lie, and how golf can increase its positive impact over time.

The task now is to keep strengthening the evidence base behind sustainable golf, so that action is not only well intentioned, but informed, credible and capable of shaping a better future for the sport.

Strengthening data, knowledge and research – better evidence to guide better decisions. continued



LAND USE AND ECOSYSTEM SERVICES

What we know

Golf is a major global network of managed green spaces that can provide recreation, cooling, water management, habitat, employment and wider community value when planned and managed well.

Where stronger evidence can help

- Ecosystem-service valuation
- Urban, coastal, rural and restored-land comparisons
- Multifunctional land-use value and trade-offs
- Integrated social, ecological and economic measurement.



NATURE AND BIODIVERSITY

What we know

Golf courses can support habitats, species and ecological connectivity, especially where out-of-play areas, native vegetation, water bodies, woodland, wetlands and rough grasslands are protected, restored and connected.

Where stronger evidence can help

- Long-term and multinational biodiversity studies
- Habitat value of roughs, hazards, wetlands, woodlands and non-play areas
- Effects of naturalisation, reduced mowing and native planting
- Risks where golf replaces high-value natural habitat.



SUSTAINABLE AGRONOMY

What we know

Sustainable agronomy can deliver high-quality playing conditions while reducing pressure from water, fertiliser, pesticides and intensive maintenance.

Where stronger evidence can help

- IPM effectiveness in real course settings
- Pesticide reduction and plant protection alternatives
- Turfgrass selection, drought tolerance and disease resilience
- Soil health, regenerative practices and precision management
- Links between lower-input agronomy, playability and player satisfaction.



WATER STEWARDSHIP

What we know

Golf can reduce demand, diversify supply and use soils, ponds, wetlands, drainage and irrigation systems to support water storage, water quality and resilience.

Where stronger evidence can help

- Total water use, sources and potable reliance
- Reclaimed water, harvesting, storage and reuse
- Irrigation efficiency, soil moisture sensing and deficit irrigation
- Watershed value, runoff reduction and flood resilience
- Water security under climate and regulatory pressure.



CLIMATE ACTION

What we know

Golf can reduce emissions and strengthen climate-ready landscapes through carbon storage, urban cooling, stormwater management, adaptation and lower-impact operations.

Where stronger evidence can help

- Carbon baselines and accounting methods
- Soil, turfgrass, tree, woodland and wetland carbon
- Energy, fertiliser, machinery and maintenance emissions
- Materials, sands, aggregates, circularity and embodied carbon
- Travel, tournaments and event emissions
- Cooling, flood resilience, drought adaptation and coastal protection.



PEOPLE AND COMMUNITIES

What we know

Golf supports health, wellbeing, social connection, employment, volunteering, learning and community value, with further opportunity to widen access and build public trust.

Where stronger evidence can help

- Social value, health and wellbeing measurement
- Accessibility, diversity, inclusion and participation barriers.
- Shorter, flexible and multifunctional formats
- Education for golfers, staff, committees and communities
- Adoption barriers: cost, culture, governance and expectations
- Credible communication, public image and trust.

PLAY YOUR PART – CONTRIBUTING TO GOLF'S NEXT CHAPTER

Research is one important strand of action, but it is not the only one. Every part of golf has a reason and a role to play in sustainability.

The scale of the opportunity is much bigger than any one organisation, facility or event. Real progress will come from many people taking practical steps in their own areas of influence, then connecting those efforts into something larger.

For every stakeholder, this is both a responsibility and a chance to lead: to overcome challenges, unlock new opportunities, strengthen trust and help show what golf can contribute.

Some of the most important steps we can each and all take include:



GOLF ASSOCIATIONS



Start by setting direction: develop and communicate comprehensive sustainability and climate action strategies; establish key goals and targets for nature, resources, climate and community.

Support the sector: provide support to members; share guidance, research, tools, case studies and practical programmes that help clubs, facilities and events review, plan, track and report progress.

Lead by example: embed sustainability across operations, governance, events, procurement, communications and partnerships.

Track and report progress: track key indicators, develop sustainability reports and use credible data to show progress across the sector.

Build wider support: invite corporate, governmental and civic partners to engage and support, helping golf become recognised as part of wider action for nature, resources, climate and communities.

CLUBS AND FACILITIES



Start with commitment: make a commitment and put together a dedicated team, and sign the Sustainable Golf Pledge.

Review and plan: use industry programmes to review, plan, track and report progress across nature, resources, climate and community.

Build knowledge and capacity: ensure staff are well-educated and qualified; review the latest research and solutions in sustainability and agronomy.

Take practical action: improve habitat and biodiversity, reduce water and energy demand, manage materials responsibly, strengthen climate resilience and create wider value for golfers and the local community.

Track, recognise and improve: gain recognition through credible awards and certification, then continue to improve performance over time.

Communicate clearly: to golfers and the local community, show how sustainability supports better playing conditions, stronger businesses, healthier landscapes, and broader community value.

TOURS AND TOURNAMENTS



Set clear direction: develop and communicate comprehensive sustainability and climate action strategies.

Lead by example: with owned and staged events, including venues, operations, procurement, energy, materials, transport, waste, nature and community engagement.

Bring partners with you: invite sponsors and partners to support delivery and activations; invite players to get involved.

Support tournament delivery: guide tournaments to industry programmes for reviewing, planning, tracking, and reporting progress.

Gain recognition: gain awards and certification for events where appropriate.

Use the platform of golf: to create and deliver communications plans with credible claims and inspiring calls to action for spectators and fans, helping to make sustainability more visible, positive, and engaging across the sport.

DEVELOPERS AND DESIGNERS



Start at concept stage: integrate the Sustainable Golf Framework into project development, design concepts and materials from the beginning.

Understand the site: assess land, water, biodiversity, climate, community and cultural context so that development decisions respond to the landscape and local priorities.

Design for sustainability and play: build best practices, innovation and technology — including nature-based solutions — into detailed design and construction.

Reduce impact and create value: design projects that protect and restore nature, use water and materials responsibly, reduce emissions, strengthen resilience and enhance the playing experience.

Communicate responsibly: connect marketing and communications to stewardship of nature, responsibility and experience.

Back up claims: back up claims with interim reporting of actions and outcomes through concept, planning, design and construction.

Secure the legacy: ensure development vision, goals and targets continue into operations.

COMMS AND MEDIA



Raise awareness: increase content and coverage of sustainability issues and support golf's calls to action.

Make sustainability engaging: tell clear, credible and inspiring stories about golf's contribution to nature, resources, climate and communities.

Share practical examples: highlight clubs, facilities, tournaments, people and partners taking meaningful action, so others can learn from and build on their progress.

Strengthen public understanding: help explain the value of golf landscapes, the work being done by the sector and the opportunities for golf to contribute positively.

Support credible communication: encourage accurate claims, transparent reporting, and balanced storytelling that build trust and avoid greenwashing.

MANUFACTURERS AND SUPPLIERS



Innovate for sustainability: continue to innovate and embed sustainability and resource efficiency into the development and use of products and services.

Support lower-impact operations: help clubs, facilities, events and organisations reduce energy, water, materials, emissions, waste and pollution through better products, services and advice.

Provide practical solutions: develop technologies, materials, equipment and services that improve efficiency, resilience, agronomy, nature protection, circularity and operational performance.

Share evidence and guidance: provide clear information on product impacts, responsible use, maintenance, end-of-life options and performance benefits.

Work in partnership: collaborate with golf associations, clubs, facilities, tournaments and developers to test, demonstrate and scale sustainable solutions across the sport.



PARTING SHOT

The sport of golf delivers many genuine and meaningful environmental and social benefits.

It protects over 3 million hectares of land, often in strategically important locations in cities and along coastlines, delivering a range of ecosystem services. It maintains stable landscapes for the conservation of thousands of species, including rare and declining.

Golf also provides considerable community value, from the obvious health and wellbeing benefits for participants to often-overlooked aspects of accessibility, equity, outreach, and other positive social influences that are now growing the game.

But the sector has much to do to avoid or reduce negative environmental impacts and control resource consumption.

In particular, golf must become more efficient and circular in its use of water, energy consumption and associated emissions, and in the sourcing, use, and reuse of materials.

It would also benefit from increasing external collaborations and partnerships with organisations that prioritise sustainability, giving rise to positive social and environmental multiplier effects.

Amongst the non-golfing public, some regulators and parts of the sustainability movement, golf still has an image problem. But what if, instead, golf was seen as a catalyst for authentic, active sustainable development?

What if golf was recognised not only for the land it uses, but for the value it creates? For the landscapes it protects and restores. For the resources it uses more carefully. For the communities it supports. For the people it brings together. For the positive impact it can multiply far beyond the boundary of the course.

Of course, this cannot just be a communications campaign. It needs commitment by golf's many stakeholders, and it needs to be backed up by evidence.

Now is the time to seize the initiative and instil in the sport a commitment to efficiency, resilience, positive impact and a sustainable future.

If golf can do that, it can move forward with confidence: not simply defending its place in a changing world, but helping to shape one that is healthier, more connected and more sustainable for generations to come.

PART 4

ANNEX



Research included supplied documents, peer-reviewed academic papers, industry studies, technical guidance, policy documents, sustainability frameworks, case studies and data from The R&A, GEO Sustainable Golf Foundation and other contributors.

METHODOLOGY

This review was developed through a structured desk-based methodology, combining literature review, document analysis, expert consultation and thematic synthesis.

Research included supplied documents, peer-reviewed academic papers, industry studies, technical guidance, policy documents, sustainability frameworks, case studies and data from The R&A, GEO Sustainable Golf Foundation and other contributors.

The GEO Sustainable Golf Foundation team brought significant experience and expertise to the process, supporting the analysis, sorting and interpretation of information. Targeted consultation with key R&A staff members and leading experts and practitioners was used to test interpretation, identify emerging issues and ensure the findings reflected both current evidence and operational realities across golf.

Evidence was assessed across the report's main themes: land use and ecosystem services, nature and biodiversity, sustainable agronomy, water stewardship, climate action, and people and communities. Claims were reviewed for relevance, credibility and strength of support, with a clear distinction made between peer-reviewed research, industry insight and practical case-study evidence.

The findings were organised through thematic synthesis to identify areas of strong evidence, areas where evidence is mixed or context-specific, and priorities for further research.

This review is intended as a robust synthesis current knowledge, not a final or exhaustive account. It will be updated periodically as new research, data, sector experience and stakeholder engagement become available, helping ensure the content and insights remain relevant and contemporary.

GEO Foundation for Sustainable Golf



FURTHER **REFERENCES**

Further references List/ Documents reviewed

Academic/peer reviewed research papers:

- Alice Fouillouze, Aurélie Lacoeuilhe, Minh-Xuan A. Truong, "A step towards a greener green? Investigating golfers' relationships with nature and attitudes about biodiversity conservation in golf courses" (2023), *Journal of Outdoor Recreation and Tourism*, Volume 43, 100659, ISSN 2213-0780.
- Burgin, S. and Wotherspoon, D., "The potential for golf courses to support restoration of biodiversity for biobanking offsets" (2008), *Urban Ecosystems*, 12(2), 145-155. https://doi.org/10.1007/s11252-008-0076-5.
- Colding, J. and Folke, C., "The role of golf courses in biodiversity conservation and ecosystem management" (2008), *Ecosystems*, 12(2), 191-206. https://doi.org/10.1007/s10021-008-9217-1.
- Colding, J., Lundberg, J., Lundberg, S., & Andersson, E., "Golf courses and wetland fauna" (2009), *Ecological Applications*, 19(6), 1481-1491. https://doi.org/10.1890/07-2092.1.
- Dai, Z., Puyang, X., & Han, L., "Using assessment of net ecosystem services to promote sustainability of golf courses in China" (2016), *Ecological Indicators*, 63, 165-171. https://doi.org/10.1016/j.ecolind.2015.11.056.
- Dobbs, E., and Potter, D., "Naturalized habitat on golf courses: source or sink for natural enemies and conservation biological control?" (2016), *Urban Ecosystems*, 19(2), 899-914. https://doi.org/10.1007/s11252-015-0521-1.
- Hammond, R., and Hudson, M., "Environmental management of UK golf courses for biodiversity—attitudes and actions" (2007), *Landscape and Urban Planning*, 83(2-3), 127-136. https://doi.org/10.1016/j.landurbplan.2007.03.004.
- Hejduk, S., Bitomský, M., Pornaro, C., & Macolino, S., "Establishment of a hemiparasite Rhinanthus alectorolophus and its density-dependent suppressing effect on a grass: A case study from golf roughs" (2020), *Agronomy Journal*, 112(5), 3619-3628. https://doi.org/10.1002/agj2.20300.
- López-Bonilla, J., Reyes-Rodríguez, M., & López-Bonilla, L., "Interactions and relationships between personal factors in pro-environmental golf tourist behaviour: A gender analysis" (2019), *Sustainability*, 12(1), 332. https://doi.org/10.3390/su12010332.
- Malíčková, L., "Plastic reduction as part of sustainable golf tourism in Slovakia" (2023). https://doi.org/10.15240/tul/009/lef-2023-46.
- Mas, F., Jupp, W., Massaro, M., Bagnoli, C., & Marseglia, G., "Corporate social responsibility and intellectual capital in sports and leisure: The case of a golf club" (2022), *European Conference on Knowledge Management*, 23(1), 269-277. https://doi.org/10.34190/eckm.23.1.161.
- Nguyen, T., Barber, P., Harper, R., Linh, T., & Dell, B., "Vegetation trends associated with urban development: The role of golf courses" (2020), PLoS One, 15(2), e0228090. https://doi.org/10.1371/journal.pone.0228090.
- Pornaro, C., Macolino, S., Luca, A., Sallenave, R., & Leinauer, B., "Plant species diversity of naturalized roughs as affected by conversion strategies" (2018), *Agronomy Journal*, 110(5), 1709-1717. https://doi.org/10.2134/agronj2017.11.0666.
- Saarikivi, J., Tähtinen, S., Malmberg, S., & Kotze, D., "Converting land into golf courses – effects on ground beetles (Coleoptera, Carabidae)" (2014), *Insect Conservation and Diversity*, 8(3), 247-251. https://doi.org/10.1111/icad.12103.
- Beard, J. B., & Green, R. L., "The role of turfgrasses in environmental protection and their benefits to humans" (1994), *Journal of Environmental Quality*, 23, 452-460. https://doi.org/10.2134/jeq1994.00472425002300030007x.
- Braun, R. C., Mandal, P., Nwachukwu, E., & Stanton, A., "The role of turfgrasses in environmental protection and their benefits to humans: Thirty years later" (2024), *Crop Science*, 64, 2909–2944. https://doi.org/10.1002/csc2.21383.
- Bekken, M. A. H., & Soldat, D. J., "Estimated energy use and greenhouse gas emissions associated with golf course turfgrass maintenance in the northern USA" (2021), *International Turfgrass Society Research Journal*. https://doi.org/10.1002/its2.61.
- Thompson et al., "Economic and sustainability benefits of the United States Golf Association's investment in water, fertilizer, and pesticide management research" (2022), *International Turfgrass Society Research Journal*. doi:10.1002/its2.91.
- Emmanuel, A. (2017). Benefits of golf tourism to a suburban settlement: the case of Ilara-Mokin in Ondo State, Nigeria. *European Journal of Multidisciplinary Studies*, 4(4), 64. https://doi.org/10.26417/ejms.v4i4.p64-72
- Mas, F., Jupp, W., Massaro, M., Bagnoli, C., & Marseglia, G. (2022). Corporate social responsibility and intellectual capital in sports and leisure: the case of a golf club. *European Conference on Knowledge Management*, 23(1), 269-277. https://doi.org/10.34190/eckm.23.1.161
- Minoli, D. (2018). Influences on the diffusion of environmental programmes in small businesses in the greening of an industry for sustainability: the case of golf. *Journal of Management and Sustainability*, 8(2), 1. https://doi.org/10.5539/jms.v8n2p1
- Murray, A., Hawkes, R., Kelly, P., Grant, L., & Mutrie, N. (2019). Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK. *BMJ Open Sport & Exercise Medicine*, 5(1), e000503. https://doi.org/10.1136/bmjsem-2018-000503
- Xu, H., Wang, J., & Tan, H. (2022). Analysis of sustainable development of the Chinese golf industry from the perspective of environmental social responsibility. *The Northeast Asian Business and Economics Association*, 3(1), 29-40. https://doi.org/10.51156/jnabe.2022.3.1.29
- Yordanov, S., Yordanov, P., & Zdravkov, I. (2022). Modern practice and methods for integration through golf., 73-77. https://doi.org/10.37393/icass2022/12
- Social Value of Golf UK - Sport Industry Research Centre (SIRC) at Sheffield Hallam University. The report has been commissioned by but does not necessarily represent the views of the R&A. https://www.sportanddev.org/sites/default/files/2023-07/FuturePlus-x-Relative-Insight-Sports-Report-compressed.pdf
- The R&A Global Golf Participation Report 2023
- The R&A Golf & Health Report 2020
- More projects: https://www.randa.org/key-projects/golf-and-health
- Barometer Q35 Questionnaire – Golf Perception
- AIG Women's Open Volunteer Survey Results
- Article on Golf Participation: https://www.randa.org/en/articles/golf-participation-continues-to-enjoy-growth-globally
- 2021 Golf Around The World Fourth Edition
- R&A GC 2030 Projects: The Climate Impact of Golf Courses
- Bekken, M.A.H., & Soldat D.J. (2022). Estimated energy use and greenhouse gas emissions associated with golf course turfgrass maintenance in the Northern USA.
- Golf Course Superintendents Association of America (GCSAA) (2017). Golf Course Environmental Profile: Land Use Characteristics and Environmental Stewardship Programs on U.S. Golf Courses.
- Qian, Y., & Follett, R.F. (2002). Assessing soil carbon sequestration in turfgrass systems using long-term soil testing data.
- Selhorst, A., & Lal, R. (2011). Carbon budgeting in golf course soil of Central Ohio.
- Tidåker, P., Wesström, T., & Kätterer, T. (2017). Energy use and greenhouse gas emissions from turf management of two Swedish golf courses.
- Warming Up: How Climate Change is Changing Sport – Madeleine Orr (2024).
- Rings of Fire II: Extreme Heat at the Paris Olympics – British Association for Sustainability in Sport (BASIS) (2024).

Further references continued

- Rugby and Climate Change – World Rugby (2024).
- Climate Change and Legal Liability in Australian Sport – Front Runners (2023).
- STERF Multifunctional Golf Courses and Ecosystem Services Program. https://greenkeeperverband.de/wp-content/uploads/2023/05/STERF-progr-multifunctional-golf-courses-and-ecosystem-services-1.pdf
- Carbon Par Study – Iceland (2020–2023). https://www.carbonpar.org/
- Bartlett, M. & James, I. (2011). A model of greenhouse gas emissions from the management of turf on two golf courses. The Science of the Total Environment, 409(8), 1357-1367. https://doi.org/10.1016/j.scitotenv.2010.12.041
- Doll, S. & Duinker, P. (2020). Characterization and justification of trees on an inner-city golf course in Halifax, Canada: An investigation into the ecological integrity of institutional greenspace. Forests, 11(1), 96. https://doi.org/10.3390/f11010096
- Fang, H. & Chen, G. (2015). A relevant research between climatic factors and regional distribution and development of Chinese golf courses. Journal of Sports Science, 3(6). https://doi.org/10.17265/2332-7839/2015.06.008
- Gelernter, W., Stowell, L., Johnson, M., & Brown, C. (2017). Documenting trends in land-use characteristics and environmental stewardship programs on U.S. golf courses. Crop Forage & Turfgrass Management, 3(1), 1-12. https://doi.org/10.2134/cftm2016.10.0066
- Gelernter, W., Stowell, L., Johnson, M., Brown, C., & Beditz, J. (2015). Documenting trends in water use and conservation practices on U.S. golf courses. Crop Forage & Turfgrass Management, 1(1), 1-10. https://doi.org/10.2134/cftm2015.0149
- Keogh, C., Mallen, C., Chard, C., & Hyatt, C. (2014). Greener golf operations: A comparative case study of Ontario golf courses engaged in environmental sustainability initiatives. Management and Organizational Studies, 1(2). https://doi.org/10.5430/mos.v1n2p100
- Perea-Moreno, A., Ureña, M., Larriva, J., & Manzano-Agugliaro, F. (2016). Assessment of the potential of UAV video image analysis for planning irrigation needs of golf courses. Water, 8(12), 584. https://doi.org/10.3390/w8120584
- Selhorst, A. & Lal, R. (2011). Carbon sequestration in golf course turfgrass systems and recommendations for the enhancement of climate change mitigation potential., 249-263. https://doi.org/10.1007/978-94-007-2366-5_13

R&A documents reviewed on Nature & Biodiversity strand

- Golf & Nature Reports Year 1 & 2
- GC2030 Docs: Biodiversity and Carbon Sequestration (Finland)
- GC2030Golf and Biodiversity Seminar 2024

Articles reviewed

- https://wcl.org.uk/assets/uploads/img/files/WCL__2023__Progress__Report__on__30x30__in__England__1.pdf
- https://www.southdowns.gov.uk/new-initiative-putts-nature-recovery-into-the-golf-sector/
- https://scottishwildlifetrust.org.uk/news/ukrsquos-smallest-butterfly-given-space-to-spread-its-wings-in-ayrshire/
- Golf Australia/Australian Golf Industry Council: Golf Benefits to the Environment
- https://www.theguardian.com/environment/2024/nov/20/patches-of-wildflowers-in-cities-can-be-just-as-good-for-insects-as-natural-meadows-study-aoe
- https://www.southdowns.gov.uk/new-initiative-putts-nature-recovery-into-the-golf-sector/
- Syngenta
- https://www.syngentagolf.com/news/sustainability/sustainability-drive-asia-pacific
- https://www.syngentagolf.com/sustainability-golf
- croplife uk (none found)
- STI
- EGA Data
- GCSAA DATA
- Turfgrass: Golf Course 2030: Implementing UN sustainable development goals to identify industry and research needs for greater resiliency in golf course playability - Steve Isaac
- https://www.sciencedirect.com/science/article/abs/pii/S0048969723011142
- https://boothgolfandleisure.co.uk/about-us/news/how-golf-clubs-can-use-water-more-sustainably/
- https://www.usga.org/content/dam/usga/pdf/Water%20Resource%20Center/how-much-water-does-golf-use.pdf
- https://sustainable.golf/news/articles/three-proven-ways-use-less-water-golf-course
- Where would your water come from if golf clubs were banned from using mains resources? | BIGGA
- https://news.sky.com/story/climate-uk-could-face-water-shortages-if-action-is-not-taken-to-conserve-supplies-12253886
- https://sterf.org/wp-content/uploads/2024/09/Irrigation-management-practices-in-four-Nordic-countries-.pdf
- https://sustainabilityreport.com/2022/05/12/two-ways-sport-should-evolve-to-meet-sustainability-challenges/

References list/Documents reviewed

- **Academic/Peer Reviewed Research Papers:**
- Burgin, S. and Wotherspoon, D. (2008). The potential for golf courses to support restoration of biodiversity for biobanking offsets. Urban Ecosystems, 12(2), 145-155. https://doi.org/10.1007/s11252-008-0076-5
- Colding, J. and Folke, C. (2008). The role of golf courses in biodiversity conservation and ecosystem management. Ecosystems, 12(2), 191-206. https://doi.org/10.1007/s10021-008-9217-1
- Colding, J., Lundberg, J., Lundberg, S., & Andersson, E. (2009). Golf courses and wetland fauna. Ecological Applications, 19(6), 1481-1491. https://doi.org/10.1890/07-2092.1
- Dai, Z., Puyang, X., & Han, L. (2016). Using assessment of net ecosystem services to promote sustainability of golf course in china. Ecological Indicators, 63, 165-171. https://doi.org/10.1016/j.ecolind.2015.11.056
- Dobbs, E. and Potter, D. (2016). Naturalized habitat on golf courses: source or sink for natural enemies and conservation biological control?.
- Urban Ecosystems, 19(2), 899-914. https://doi.org/10.1007/s11252-015-0521-1 Hammond, R. and Hudson, M. (2007). Environmental management of uk golf courses for biodiversity—attitudes and actions. Landscape and Urban Planning, 83(2-3), 127-136. https://doi.org/10.1016/j.landurbplan.2007.03.004
- Hejduk, S., Bitomský, M., Pornaro, C., & Macolino, S. (2020). Establishment of a hemiparasite rhinanthus alectorolophus and its density dependent suppressing effect on a grass: a case study from golf roughs. Agronomy Journal, 112(5), 3619-3628. https://doi.org/10.1002/agj2.20300
- Kwon, Y. (2005). Changes of biodiversity due to golf course operation. Korean Journal of Nature Conservation, 3(2), 205-216. https://doi.org/10.30960/kjnc.2005.3.2.205
- López-Bonilla, J., Reyes-Rodríguez, M., & López-Bonilla, L. (2019). Interactions and relationships between personal factors in pro-environmental golf tourist behaviour: a gender analysis. Sustainability, 12(1), 332. https://doi.org/10.3390/su12010332
- Malíčková, L. (2023). Plastic reduction as part of sustainable golf tourism in slovakia. https://doi.org/10.15240/tul/009/lef-2023-46
- Mas, F., Jupp, W., Massaro, M., Bagnoli, C., & Marseglia, G. (2022). Corporate social responsibility and intellectual capital in sports and leisure: the case of a golf club. European Conference on Knowledge Management, 23(1), 269-277. https://doi.org/10.34190/eckm.23.1.161
- Moufakkir, O. and Burns, P. (2011). Controversies in tourism. https://doi.org/10.1079/9781845938130.0000
- Nguyen, T., Barber, P., Harper, R., Linh, T., & Dell, B. (2020). Vegetation trends associated with urban development: the role of golf courses. Plos One, 15(2), e0228090. https://doi.org/10.1371/journal.pone.0228090
- Pornaro, C., Macolino, S., Luca, A., Sallenave, R., & Leinauer, B. (2018). Plant species diversity of naturalized roughs as affected by conversion strategies. Agronomy Journal, 110(5), 1709-1717. https://doi.org/10.2134/agronj2017.11.0666
- Saarikivi, J., Tähtinen, S., Malmberg, S., & Kotze, D. (2014). Converting land into golf courses – effects on ground beetles (coleoptera, carabidae). Insect Conservation and Diversity, 8(3), 247-251. https://doi.org/10.1111/icad.12103

NATURE OF THE GAME.

SUSTAINABLE GOLF REVIEW | EDITION 1, 2026

A global insights report from The R&A and GEO Sustainable Golf Foundation

SHARE, LEARN ACT AND TELL