Howth Golf Club Biodiversity Action Plan

Mary Tubridy and Associates

December 2022

Howth Golf Club
Dublin
Est. 1916

Comhairle Contae
Fhine Gall
Fingal County
Council

An tSeirbhís Páirceanna Náisiúnta
agus Fiadhúlra
National Parks and Wildlife Service

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Summary

Howth Golf Course is in a remarkable location because surrounding it on the hills is an international important wildlife habitat, dry heathland, which is rare in Europe and is protected by EU law. Fieldwork in 2022 revealed that examples of this habitat are also present on the golf course.

Within the club there is also a remarkable diversity of habitats; eighteen. The principal habitat is amenity grassland which forms the fairways and greens. This is of relatively lower biodiversity value. While dry heathland is of international importance, three other habitats are also present which are of county importance. These are the artificial pond known as the Tank, the stretches of original Balsaggart and Carrickbrack Streams and the acid grassland which is found close to the heathland.

This document contains recommendations for actions to maintain and enhance biodiversity while continuing to use the land as a golf course. These relate to the heathland where it is necessary to ensure 1) that areas with the dry heathland habitat and associated acid grassland within the course are protected by the golf club, staff and members and 2) the margin (the rough) between the fairways and this habitat is increased to 3m to protect the heathland grassland.

Other recommendations are that the club use mechanical methods to manage semi-natural vegetation (bracken and plants in drainage channels) and selectively establish biodiversity friendly species in landscaping works on the course.

The existing drainage network should be more environmentally friendly. As golf course development was associated with the removal of a large natural wetland it is recommended that the club consider (when resources permit) expanding the area of wetland on the course. Consideration should also be given to reviewing the hard engineering approach to drainage management and excessive use of herbicides. This has increased the rate of erosion, causing drains to become deeper and increasing the risk of flooding downstream. It is recommended that this should be changed to a management focus which would better serve both drainage and biodiversity. The plan contains numerous recommendations for actions to support this change in management emphasis.

Introduction

Golf courses consist of a mosaic of natural and created environments that either have high natural values or have great potential to develop high natural values. The Howth Golf Club is surrounded by the heathland of the Howth Head Special Area of Conservation. This heathland landscape combined with the views of Dublin Bay provides a spectacular backdrop to a round of golf.

A biodiversity emergency was declared by the Irish Government in 2019. Efforts to manage biodiversity have increasingly focussed on encouraging all sectors of society to play their part. The Howth Golf Club is keen to explore the possibilities for enhancing biodiversity and making the course more climate change resilient. Fingal County Council is keen to support the Howth Golf Club in making the golf course more biodiversity friendly due to the nature conservation value of the surrounding lands.

Much has been done over the last number of years to reduce the environmental footprint of the golf club through good management practices.

The objectives of this Biodiversity Plan are to describe environmental and biodiversity interest of the golf course and make recommendations for actions to maintain and enhance environmental quality and biodiversity values.

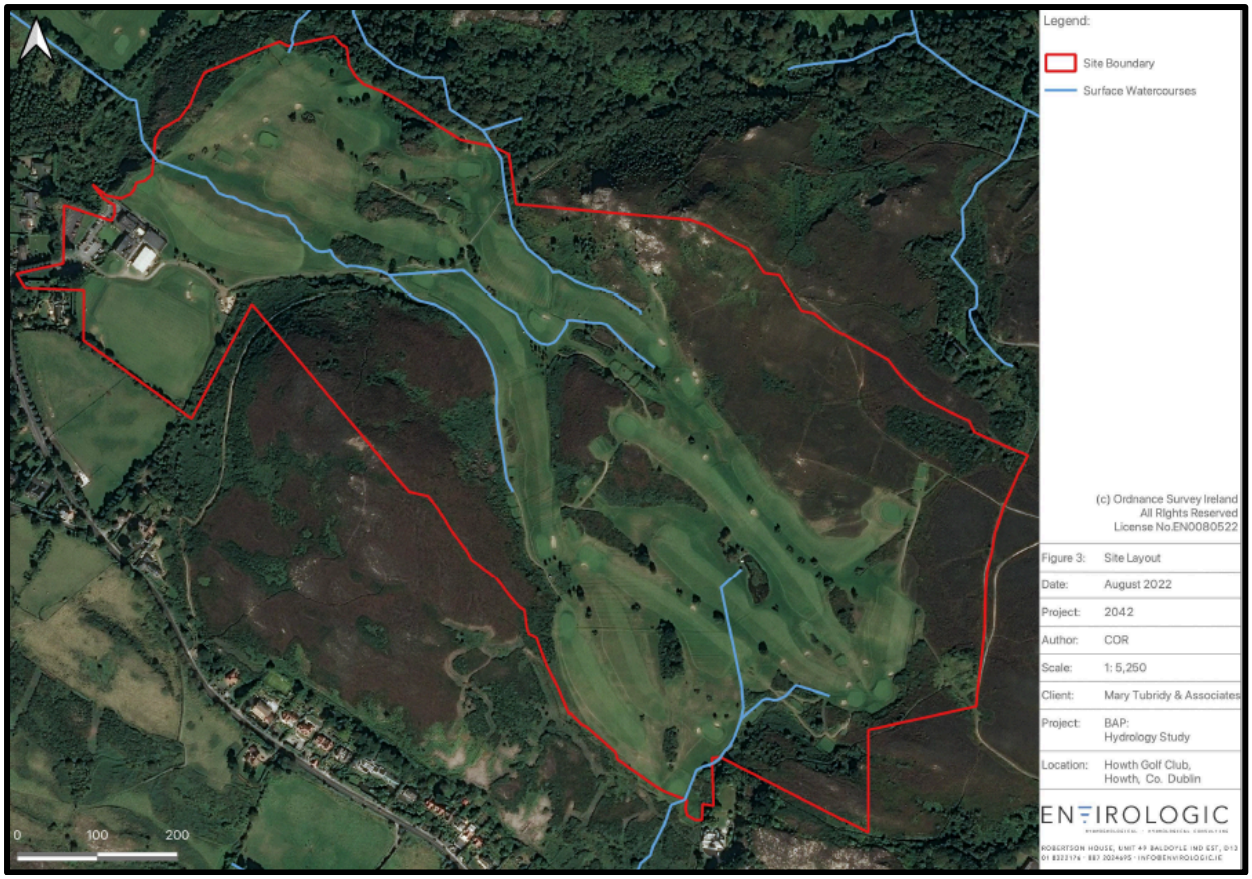


Fig. 1 Area managed by the golf club

Fig. 2 Area managed by the golf club studied for this BAP

Fig. 3 Area designated as an SAC

To prepare the Biodiversity Plan for the golf course a team was assembled by Dr Mary Tubridy to address the issues included in the brief prepared by Fingal County Council Team members are Dr Colin O Reilly, hydrologist; Alexis Fitzgerald, botanist, Joe Adamson, ornithologist and Willie Carr, mammal specialist. All these specialists were briefed by Mary Tubridy. Results of their studies were used to inform the Biodiversity Action Plan, drafts of which were discussed with the golf club.

Dr Colin O Reilly's brief specified that his input would involve:

- Discuss and review groundwater pumping regime with Howth Golf Club in order to better manage the water sources in the area for biodiversity. Consider long-term water level monitoring in the pond.

- Consider commissioning a small project to assist groundsmen at Howth Golf Club in the development of a course drainage map.

- Sample stream downgradient of Howth Golf Course. Include in the sampling parameters to assess use of fertilisers, pesticides and/or herbicides. Assess bacteria in order to measure efficacy of biocycle and percolation at inner course toilet of Howth Golf Course.

- Analysis of existing ground maintenance regime, including irrigation and pesticide use. This will include a description of the existing maintenance regime followed by a description of measures that will help to reduce water use, fertilizer use and pesticide use.

- Mapping and analysis of drainage system of golf course (do the drains contain water year round or only seasonally?)

- Potential expansion of wetlands.

To address this brief work involved desk research, fieldwork and consultations.

Desk research involved an inspection of the report provided to the golf club by the specialist who examined groundwater at the Tank and information about bedrock and subsoil contained in the Geological Survey of Ireland website. Consultations took place with members of the golf club to discover the history of drainage works, with members of relevant golf club committee and club manager to discuss preliminary results and recommendations for improved management (one of which was attended by the head greenkeeper). The consultant hydrologist engaged in detailed consultations with the maintenance staff, during 7-8 on course meetings, a 1-to1 hour long 'interview' style meeting, and 2 meetings with the committee.

Fieldwork was carried out on several occasions to directly examine the direct the surface drainage network. On one of these occasions the hydrologist and ecologist examined the biodiversity status of the drainage network and potential for new wetland establishment within the course.

Water quality analysis was carried out on three occasions. On the 30th May water samples were taken from three locations analysed for the full suite of measurements requested by the brief. Unfortunately one of these samples, the Carrickbrack Stream was lost by the lab. On 18th July water samples were taken from the supply well and Tank (as other sources were dry) and on 1st September from the Tank only (as other sources were dry). See Fig. 4 for location of water samples.

Fig.4 Water sampling points

Colin O Reilly took direct responsibility for reviewing results of water sampling which integrated with the assessment of general hydrology. Reports were presented in a series of reports (outline, draft and final) provided to Mary Tubridy.

Alexis Fitzgerald's brief, specified that his work would involve:

> Preparation of a level 3 habitat map of land within the study area boundary. Carry out flora study within this area.
>
> Production of a habitat map in hard copy for report and also as digital files.
>
> Production of a short report to provide a short description of each habitat i.e. location, account of flora indicating typical species (common and rare) found.
>
> Provision of brief recommendations 1-2 per habitat on what should be done to maintain and enhance habitat and flora biodiversity for discussion with golf club.

The habitat/plant walkover surveys were carried out on the 8th June and 17th July 2022, with reference to Smith *et al.* (2011). The habitats were classified according to the Irish Heritage Council classification system (Fossitt, 2000). The abundance of each species present in each habitat was recorded using the Domin scale. EU Habitats Directive Annex I habitats were classified as per Commission of the European Communities (2013), also with reference to the corresponding national habitat survey reports and descriptions, particularly NPWS (2019). The nomenclature for the Annex I habitats also follows Commission of the European Communities (2013), with any abbreviated names for the habitats following NPWS (2019). Vascular plant taxonomy and nomenclature follows Stace (2019), whilst bryophyte taxonomy and nomenclature follow Atherton *et al.* (2010).

Ecological evaluations were made according to the criteria developed by the NRA.

Joe Adamson's brief specified that he characterise breeding bird activity within the study area, ideally by habitats, make notes of what should be done to enhance this through fieldwork (three visits) starting as soon as possible: late May, late June, late July. To characterise breeding birds three visits were undertaken, on the 26th of May, the 13th of June and the 11th of July 2022. These inspection visits took place in early morning when the course and its environs were walked and notes taken of the bird species present. Information was also gathered through consultations with Willie Carr, mammal specialist and Ben Moore, head Green Keeper. A report was produced listing all the birds present and their likely breeding areas.

Willie Carr's brief specified that he characterise bat and small mammal activity through fieldwork (one mammal and two bat visits), examine habitats used and specify actions which would enhance bat and mammal biodiversity within the study area boundary. To examine the resident non-volant mammals two visits were conducted on the 6th and 7th of July 2022 when the rough vegetation around the greens, stone walls surrounding the site, scrubland and soil banks were examined for any of the typical signs of these mammals. These included areas where mammals live (setts, earths and warrens) drop their faeces (droppings, dung, scats, spraints of the respective mammals), digging, footprints and carcases. Notes were taken of any mammal signs. Photos were taken of a fox at the 12th and 13th green and rabbits throughout. As this was conducted during the summer the vegetation was very dense and therefore signs were harder to locate. Where there was bramble and bracken, they were penetrated as much as possible and all scrub was checked for badger setts and any other potential mammals where access was possible. A list was compiled of mammals seen, had been reported locally or which could be present on or adjacent to the course. To examine bat activity four site visits were conducted on the 11th and 12th July between the time of 10pm and 2am and on 23rd and 26th of September 2022 between 19:30 and 00:30. Eleven (11) locations were surveyed using a Batbox baton detector for 10 minutes on two separate occasions (see figure 1 for site locations) at each date.

Figure 5: Locations where the Batbox baton detector was used over four nights

The results of all commissioned studies are in Appendices to this report and are summarised in the following section.

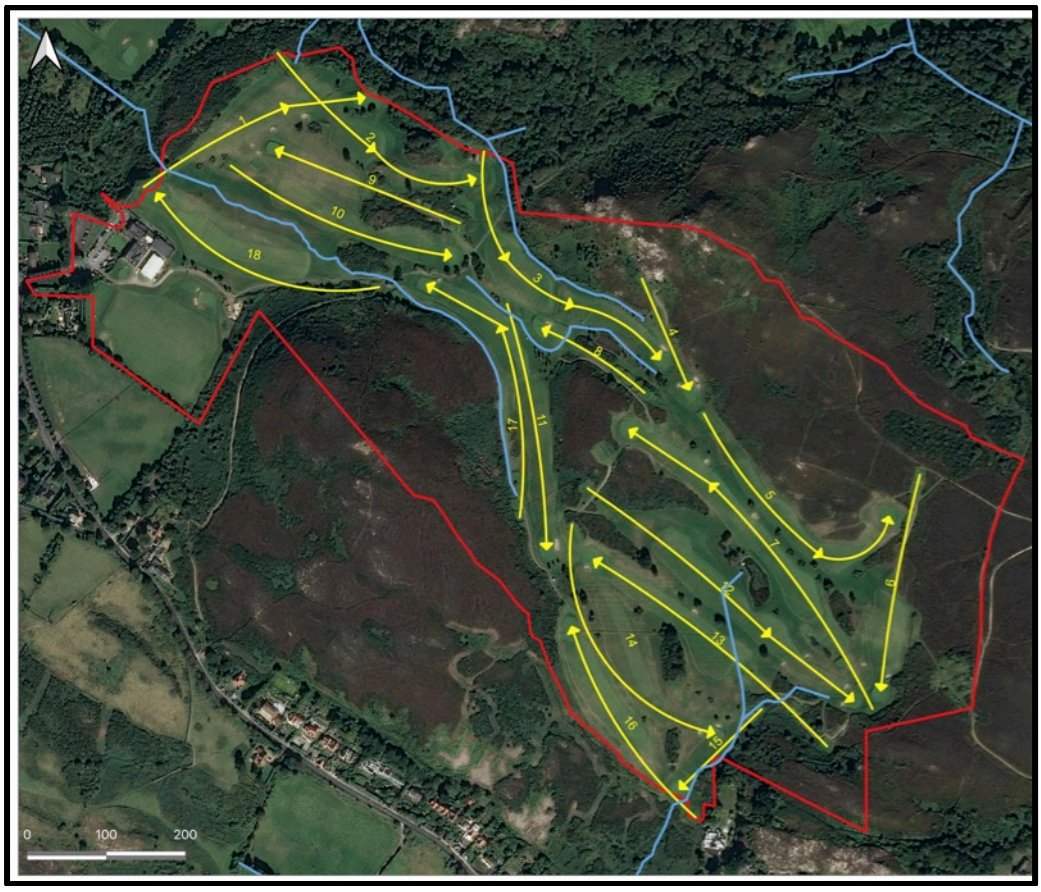
Biodiversity at the course

Introduction

The Howth golf course started in 1915 when 80 acres of land was leased from Howth estate (for 50 years) by a local resident and keen golfer, Mr Butson. The nine-hole course near the current clubhouse was designed by Tom Shannon, professional at Portmarnock. It became a members owned club soon after and due to its popularity more land adjacent to the nine holes, covered in heathland and wetlands was bought in 1925/1927. James Braid laid out the 18th hole course, the only course designed by him in north County Dublin. The website states that the golf club is *Dublin's only pure heathland golf course* and uses the tag line *beauty has an address*.

The golf course shown in Figure 6 covers an area of approximately 56 hectares. It is broadly rectangular in shape with a length of 1,200 m width along a northwest-southeast axis and a perpendicular northeast-southwest width of 350 m at the western end, widening to 600m in the eastern half. Fig. 6 shows the layout of the course, its different tees and fairways

Fig. 6 Layout of the golf course

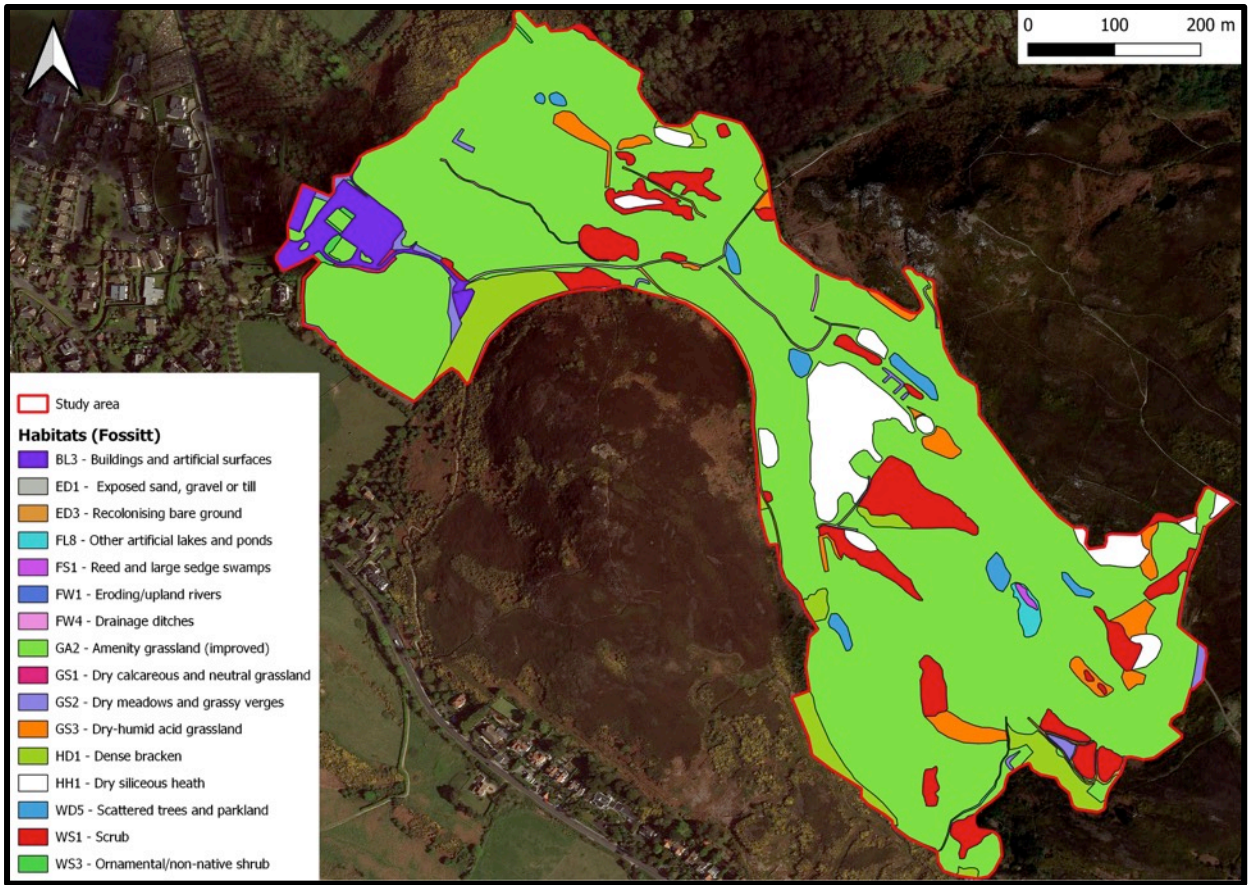


Habitats and plants

Eighteen different habitats can be found within the study area /golf course. These are shown on Fig. 7 and Table 1 summarises their biodiversity status.

The club owns substantial areas of the valuable dry heathland habitat outside the course and eleven patches within the golf course. The habitat map shows where these are found. Three habitats are of county importance, the rivers and ponds and acid grassland. All other areas with semi-natural vegetation, around the tank, on rock outcrops, the hedgerow bordering Gerry Gannon's land are locally important. Of lower value are all the remaining habitats, including the grassland on the fairways and greens, areas dominated by bracken, buildings and hard surfaces, landscaped shrubberies and areas with spoil.

Fig. 7 Habitat map



No plant species listed on the Flora (Protection) Order, 2015, were recorded during the field surveys in 2022. Three locally rare native species were recorded within the study area (see Fig. 8), namely, *Warnstorfia fluitans, Nitella flexilis* agg. and *Senecio sylvaticus*. The latter vascular plant species is rare in Co. Dublin, according to Doogue *et al*. (1998). According to the plant distribution maps of Botanical Society of Britain and Ireland (2022), this species is still rare in Co. Dublin, but it is listed as Least

Concern (LC) by Wyse Jackson *et al.* (2016). The bryophyte species *Warnstorfia fluitans* is only known from a handful of sites in Co. Dublin and is therefore rare at a county level (Joanne Denyer, pers. comm., July 2022). *Warnstorfia fluitans* is also listed as Least Concern (LC) by Lockhart *et al.* (2012). The charophyte species *Nitella flexilis* agg. is only known from a handful of sites in Co. Dublin but has been recorded previously from likely this same wetland site by Robert Lloyd Praeger in 1894 (Doogue *et al.* 1998). *Senecio sylvaticus* is common in heathland particularly after fire.

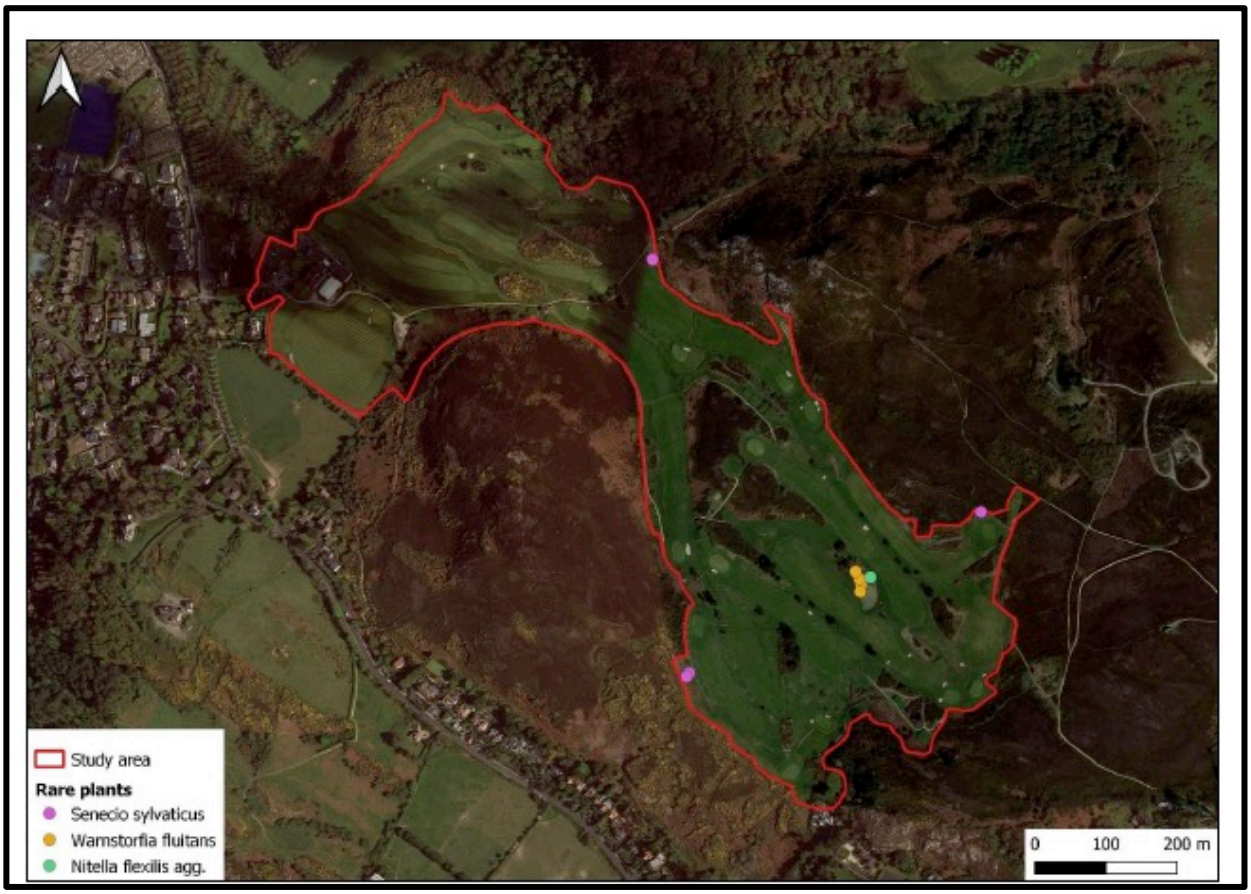


Fig. 8 Location of locally rare plants

Fig. 9 *Senecio sylvaticus* (wikipedia commons)

Table 1 Biodiversity interest of habitats in Howth Golf Course

Habitat (Fossitt Code)	Status	Characteristics
Dry siliceous heath (HH1), including the EU Habitats Directive Annex I habitat [4030] European dry heaths	International importance	An abundance of *Calluna vulgaris* and *Erica cinerea*, as well as a significant presence of the dwarf shrub *Ulex gallii*, along with the herbaceous species *Molinia caerulea, Deschampsia flexuosa* and the bryophyte species *Hypnum cupressiforme* and *Hypnum jutlandicum*.
Other artificial lakes and ponds (FL8) The Tank	County importance	*Potamogeton natans, Nitella flexilis* agg. (a rare charophyte in Co. Dublin) and *Callitriche* agg. The rare Dublin bryophyte species *Warnstorfia fluitans* occurs on the margins of the pond, alongwith the commoner species *Ranunculus repens* and *Juncus articulatus.*
Eroding/upland rivers (FW1) Free flowing streams	County importance	Natural stretches of original Balsaggart and Carrickbrack Streams which still support wetland plants
Dry-humid acid grassland (GS3)	County importance	Found in a mosaic with dry heathland and scrub. Typical plant species are *Agrostis capillaris, Anthoxanthum odoratum, Poa pratensis* agg., *Holcus lanatus* and *Festuca rubra* agg., whilst herbaceous species like *Rumex acetosella, Senecio sylvaticus* and *Galium saxatile* were also recorded widely.
Exposed siliceous rock (ER1)	Local importance (higher value)	Hardy tufted grasses such as *Festuca ovina* agg. have become established, along with occasional low woody shrubs like *Ulex gallii*. Herbaceous species such as *Rumex acetosella, Teucrium scorodonia* and *Sedum anglicum* can be found here also.
Reed and large sedge swamp (FS1)	Local Importance (Higher value)	Found at the Tank. Features large grass species *Phragmites australis* and *Equisetum fluviatile,* along with lesser quantities of *Ranunculus flammula and Typha latifolia.*
Dry meadows and grassy verges (GS2)	Local importance (higher value)	Un-mown areas where grasses are allowed flower and set seed. i.e. beside tee boxes.
Dry calcareous and neutral grassland (GS1)	Local importance (higher value)	Occurs on rare examples of calcareous soils. Flora different from other grasslands and includes *Festuca rubra* agg., *Carex flacca, Holcus lanatus* and *Agrostis capillaris, Achillea millefolium, Primula veris, (Primrose) Senecio erucifolius* and the orchid species *Anacamptis pyramidalis (Pyramidal orchid)*
Scrub (WS1)	Local importance (higher value)	Has either *Rubus fruticosus* agg., *Ulex europaeus* and *Crataegus monogyna,* as well as the tall fern species *Pteridium aquilinum* (Bracken)

Habitat (Fossitt Code)	Status	Characteristics
Hedgerows (WL1) *Forming boundary between golf club and Gerry Gannon's land*	Local importance (higher value)	Reservoir of local hawthorn
Dense bracken (HD1)	Local Importance (Lower Value)	Monoculture of bracken prevents much species diversity underneath plants.
Scattered trees and parkland (WD5)	Local Importance (Lower Value)	Lacking a shrub layer habitat of little value to nesting birds.
Amenity grassland (GA2) *Principal habitat on the golf course*	Local Importance (Lower Value)	Limited plant diversity maintained by intensive management. Some areas could be important for feeding waders.
Drainage ditches (FW4) *Man made drainage channels*	Local Importance (Lower Value)	Few plant species and none characteristic of wetlands
Ornamental/non-native shrub (WS3)	Local Importance (Lower Value)	Mixture of garden and native shrubs of possible value to pollinators.
Exposed sand, gravel or till (ED1)	Negligible	Flora dominated by common opportunistic plant species
Recolonising bare ground (ED3)	Negligible	Flora dominated by common opportunistic plant species
Buildings and artificial surfaces (BL3) *Clubhouse and car park*	Negligible	Very low value unless being used by nesting birds or roosting bats

Fig. 10
Dry-humid acid grassland (GS3) vegetation in the south-east of the study area – the green fairway amenity grassland (GA2) is in view in the background of the image. Habitat of County Importance

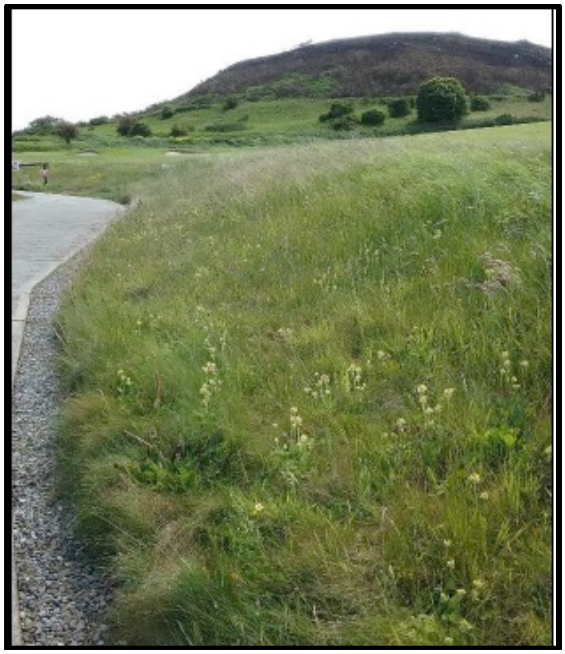


Fig. 11 Dry calcareous and neutral grassland (GS1) habitat in the north-west of the study area, with abundant *Primula veris (*Cowslip*)* in view. Habitat of local importance (higher value)

Fig. 12 Dry Heath (HH1) internationally important habitat within the golf course

Birds

Due to lack of suitable habitat and disturbance few birds are seen on the golf course and none were breeding there. Present during fieldwork are Hooded Crow and Magpie, with the very occasional Meadow Pipit, Linnet and Goldfinch. A pair of Stonechats was observed on the course, but are likely to breed within the Gorse at the perimeter of the course, as are Meadow Pipit, Linnet and Goldfinch. Hooded Crow and Magpie are likely to breed in the conifers within the golf course. The occasional Swallow and Blackbird were observed feeding over the course on several occasions. In general the golf course was devoid of birds.

Gulls use the Tank for bathing and preening. Up to thirty Herring Gulls and one Great Black-backed Gull were observed on or by the Tank during the July 2022 visit. It is likely that additional species can be found on the golf course during the winter such as Curlew and Oystercatcher, the former confirmed by Ben Moore.

The woodland around the perimeter to the north of the golf course was of greater interest for birds and contained species such as Chaffinch, Robin and Wren and summer visitors such as Willow Warbler and Chiffchaff. Winter thrushes such as Redwing and Fieldfare are also likely to be present in the woodland along the perimeter of the course.

Fig. 13 Curlew
(from Birdwatch Ireland website)

Fig. 14 Stonechat
(from Birdwatch Ireland website)

Mammals

The mammal survey confirmed the abundance of rabbits and the presence of an occasional fox. Rabbits (*Oryctolagus cuniculus)* were found throughout the site especially near the edge of the greens. They did not move out to far from where brambles created cover for the warren. The rabbits were active all day. A fox *(Vulpes vulpes)* was seen walking on the greens during the survey. Stoats have been reported on the course by staff and the Fingal Biodiversity Officer. Stoat (*Mustela erminea hibernica*) is very difficult to locate. They will typically den in rabbit warrens that they have taken over after killing the occupants. As they are widespread it is very probable that they are present here as there is a large amount of prey species. Other species likely to be present are hedgehog, grey squirrel, house and wood mouse.

No signs of bats were detected, which is somewhat surprising, particularly along the wooded perimeter of the course. Bat surveys elsewhere on Howth have found Common pipistrelle, Soprano pipistrelle, Brown long-eared bat and Leisler's bat (Keeley 2006). The site is very open and exposed, which may explain the absence of bats.

Invasive plant species

Fieldwork revealed the presence of *Rhododendron ponticum* within the golf course. Seven other non-native plants are found in semi-natural habitats (Fig. 15) thus threatening their integrity. The presence of these non-native plants is not surprising given the club's location in a suburban environment. However one of these plants: Chamomile *Chamaemelum nobile* was probably introduced through the use of a wildflower seed mix.

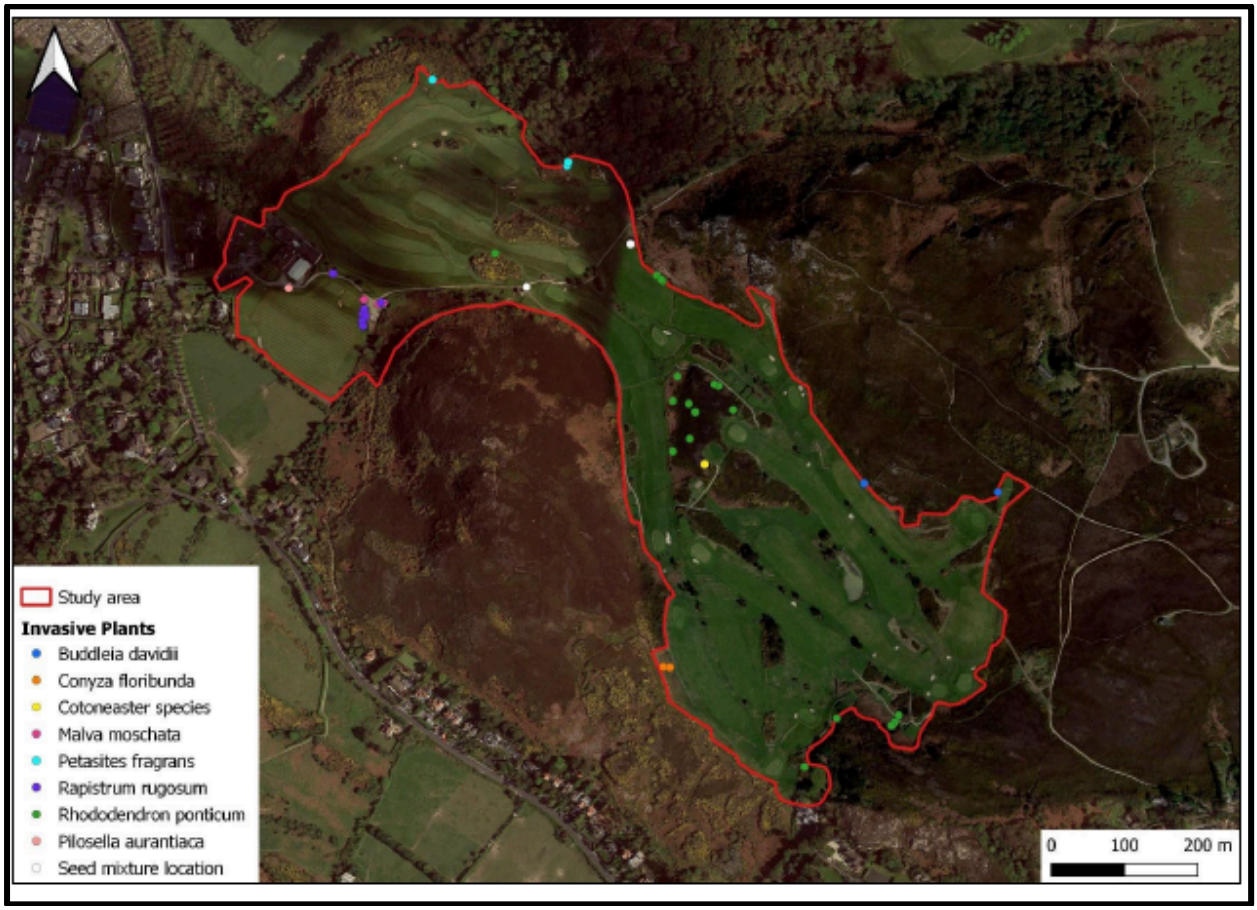


Fig. 15 Location of invasive plant species on the golf course

Conclusions

The presence of pockets of annex 1 habitat dry heathland on the golf course is significant. This is found on islands which were not developed as fairways and thus links the golf course to the large expanses of heathland in the SAC. The presence of acid grassland near heathland adds to its value as this habitat is usually found in a mosaic with heathland. Other semi-natural grassland types are also of biodiversity value,particularly the wetland at the Tank, where wetland plants have survived including a locally rare species.

Except for the presence of these small pockets of valuable habitats the majority of the land now forming the golf course is of low biodiversity interest as it is covered in intensively managed grassland. Management of fairways, tees and greens has led to the removal of the original semi-natural grassland and wetland habitats and their replacement with a type of grassland which has few species. Regular cutting which is an important feature of golf course management does not allow these plants to flower or set seed thus reducing the value of these plants to pollinators, all invertebrates and birds. Some of the recent tree planting of non-native species is of little value to biodiversity or birds as single trees provide little cover for nesting. The absence of bat activity is confirmation that the golf course generally is a poor habitat for biodiversity.

The course offers many opportunities to enhance biodiversity for habitats and species.

The extent of valuable semi-natural acid grassland (a constituent of the mosaic wth heathland) can be increased by extending the width of the buffer between the heathland habitat and current fairways. These buffer strips can still be considered as part of the course and would be managed by less frequent mowing to improve their biodiversity value. This would involve cutting twice a year; in April when growth commences and after August/September when all species have flowered and set seed. On both occasions all cuttings should be removed.

All types of biodiversity will be enhanced if the club adopts a policy of only planting native trees and shrubs around the course and allowing them to flower and set seed. Native plants have been around for milennia and animals big and small have adapted to use them as food and living spaces. Planting natives and allowing them to mature and decompose will increase the population of all invertebrates, and thus food for birds and bats. Allowing dead timber to decompose on site will achieve the same result.

A different policy could be followed around the clubhouse where non-native plants could be used. In this area the policy should be to plant pollinator friendly species only.

The value of the golf course to birds will be improved by planting shrubberies of natives under trees or in isolated blocks. In contrast to what is currently assumed, that birds nest in trees, they are most likely to nest in dense vegetation at chest height. By allowing dense shrubberies of native species to establish the populations of small song birds will increase. Around these blocks grassland (1m width) should be allowed flower and set seed, thus improving the value of the adjacent habitat for food. Similarly native timber could be allowed to decompose in their environs to benefit invertebrates.

Where possible a no mow policy should deliberately be followed resulting in grasslands being of greater value to biodiversity. This applies to intensively managed grasslands as they would also provide food for invertebrates if allowed to flower and set seed. Mowing could occur after seed is produced (meadow approach to management). Cuttings should be removed thus reducing soil fertility and encouraging the growth of native plants. The consistent application of this policy to suitable grasslands (with some plant diversity already) would eventually result in a significant improvement to biodiversity in grasslands.

Water management and drainage practises at the Golf Course

As fertiliser usage has the potential to change nutrient levels in local watercourses and thus their biodiversity this issue was given careful examination through analysis of surface water quality and discussion with course green keeper. Consultations revealed that the current cost of fertiliser is a major contraint to usage and that is only used as necessary to keep the course in optimum condition. Frequencies of application described below are indicative only. They can vary depending upon course conditions and weather and are regularly appraised by the head greenkeeper. The primary areas receiving fertiliser are fairways, greens and teeboxes and there is limited scope for change of fertiliser application protocol regarding greens.

Teeboxes are fertilised on demand with granular (21-5-11+2.9 CAO) approximately every 2 months. This form releases nutrients over an 8-12 week period. Fairways are fertilised every 6 weeks with urea (10-10-10) during summer months and with ammonium sulphate during winter months. Application rates are typically 20 kg/ha.

Nitrogen is typically applied as protected urea throughout the year. The use of protected urea slows the rate at which urea converts to ammonia and thereby minimises ammonia gas emissions. A mixture of inorganic and organic fertiliser is applied in granular and liquid form. Granular fertiliser is applied using a disc spreader whereas liquid feed is mixed with water and applied using a sprayer. The organic, liquid based seaweed fertiliser is not applied in winter as the lower temperatures can inhibit microbial activity necessary for uptake.

According to Regulation 17 of S.I. No. 31 of 2014 (European Union (Good Agricultural Practice for Protection of Waters) Regulations), no chemical fertiliser should be applied to land within 2m of any surface waters. While not investigated it is assumed that this practise does not occur beside drainage channels at Howth Golf Course.

Pesticide use

HGC utilise Roundup, Pistol and Praxys as herbicides. Roundup is used via a knapsack sprayer for spot applications around fixed structures and under trees. It is not known which herbicide is used on drainage channels. Pistol is used mostly on concrete around HGC clubhouse. Pistol is listed as a non-selective herbicide for the control of a wide-range of annual and perennial broad-leaved weeds and grasses. Its active ingredients are diflufenican and glyphosate. According to product specification it is hydrophobic and rainfast within 1 hour (i.e. following 1 hour the product will not be washed away by rainfall). It is stated as remaining near the surface of the soil with little or no lateral movement. It is applied from a quad sprayer or knapsack sprayer.

Praxys is listed as a post-emergence herbicide for the control of specific weeds. Its active ingredients are clopyralid, florasulam and fluroxypyr. It is applied from a quad sprayer or knapsack sprayer. It is used on fairways and possibly tee boxes for weed control, primarily at start of season to eliminate daisies (pers.comm., Ben Moore).

Winter maintenance focuses on disease management, to minimise the use of fungicides on greens. Greens are scarified regularly to improve drainage and encourage growth of grass species which are less vulnerable to fungal infections. Natural chemicals are preferentially used if necessary to control plant diseases.

When herbicide application is immediately followed by rainfall it can be mobilised and transported directly downstream. Herbicides can have a significant, negative impact on stream and coastal habitats by reducing numbers and diversity of aquatic animals and vegetation.

Ideally, there would be no use of herbicides within the golf course. It is acknowledged that this is probably not feasible in terms of weed control. It might be useful however to have an overarching aim towards eliminating its use and shifting towards mechanical control with strimmers and mowers.

This aim can be broken down further into the following:

- Minimise frequency of use. Rather than routine applications consider utilising mechanical intervention until weed growth reaches a stage whereby mechanical intervention is inadequate.

- Minimise rates/volumes of herbicide application.

- Minimise areas receiving herbicide application (see below).

- Minimise/eliminate use in an around watercourses (see below).

- Adhere to buffer zones and setbacks listed on product labels.

Given the direct connectivity between watercourses and downgradient surface water receptors, application of herbicides in water channels and open drains with water in them carries the highest risk of impact. In recent years, the majority of products being authorised in the EU require an unsprayed area to be maintained adjacent to rivers, lakes and drains. The extent and size of these buffer zones vary considerably and can range from 1m to 70m. In all instances pesticides must not be applied within 1m of any surface water body, i.e., a minimum buffer zone of 1m applies to all pesticides regardless of rate of application, type of nozzles used and whether water is present in the surface water body. Accordingly, the application of chemical sprays to banks and beds of open channels should be stopped altogether.

It is advised that the club adopt a policy to minimise chemical inputs into local waters by referencing EU legislation such as Part 4 of S.I. No. 31 of 2014 (European Union (Good Agricultural Practice for Protection of Waters) Regulations). While developed principally for farms it should also be adhered to by the club in order to prevent migration of fertiliser and pesticides into surface waters.

Examples of relevant measures which should be adhered to by the golf course include:

- Regulation 17 (1) - chemical fertiliser shall not be applied to land within 2m of any surface waters
- Regulation 18 (2) – organic and chemical fertilisers or soiled water shall not be applied to land in any of the following circumstances:
    a) The land is waterlogged
    b) The land is flooded or likely to flood;
    c) The land is snow-covered or frozen;
    d) Heavy rain is forecast within 48 hours, or
    e) The ground slopes steeply and there is a risk of water pollution having regard to factors such as surface runoff pathways, the presence of land

drains, the absence of hedgerows to mitigate surface flow, soil condition and ground cover.

Irrigation

With the expected increase in extreme events because of climate change, the management and sustainable use of water is becoming increasingly important. Droughts will require a careful selection of grass species on the tees and fairways and irrigation will become increasingly necessary. At present water supply is adequate to irrigate greens and tees but if it is necessary to reduce the need for irrigation the club could consider changing grass species or using water retention granules in tee boxes.

Irrigation water used on teeboxes and greens is a mixture of rainfall run-off and groundwater that is fed into a tank from which it is distributed throughout the golf course. HGC maintain flow data pumped to the on-course irrigation network. Night time irrigation is utilised to minimise losses due to evapotranspiration. Typical irrigation cycles during dry summer periods include irrigation of all greens at night with 1mm (equal to 19 m3/d) and irrigation of all tees at night with 1 mm (equal to 30 m3/d).

The Tank is the only open waterbody within HGC. It occupies a topographical depression in the centre of the eastern part of the course and has a footprint of approximately 1,200 m2. An artificial liner was reportedly installed at the time of excavation though the current condition of the liner is unknown. As such there is potential for the pond to be leaking water through the base or sides. Although difficult to quantify precisely it is estimated that an area of approximately 10ha drains to the tank, with runoff collected from holes 5, 6, 7, 12, and 13 along with surrounding hillslopes.

The southern half of the Tank is relatively shallow (c. < 0.3 m) and has a grey, silty bed with little vegetation. This area was apparently cleaned (dredged) within the past 3 years. The northern part of the pond contains established vegetation and appears slightly deeper (c. 0.3 - < 1 m). The pond outlet is located at its northwestern corner. The outlet itself directs pond water into a concrete chamber which contains two shallow submersible pumps, suspended from above at ground level. These pumps supply the on-course irrigation network directly.

It is likely that immediately downstream of this pump chamber there is a level control structure though its nature and precise location are unconfirmed. This level structure maintains water levels in the pond and ensures the pumps are always submerged. The water level control appears to be fixed and not capable of raising or lowering pond levels.

In addition to input from rainfall-runoff the Tank is topped up with groundwater on an intermittent basis. When inflows exceed irrigation demand Tank water overflows the level control structure and enters a culvert which traverses southeast towards the 15th teebox. The culvert routing is estimated from three concrete manhole chambers on the 12th and 13th fairways.

There are two groundwater sources on site, with both of these located approximately 20m northwest of the Tank. PW1 is a redundant well. It's installation date is

unconfirmed but estimated as being over 10 years ago. It is exposed at surface as a 200 mm diameter steel casing to just below ground level. PW1 was taking out of use in 2019 due to repeated pump burnout. Due to a prolonged dry spell in 2019 a new well was deemed necessary and in May 2019 a new well PW2 was developed. Groundwater is delivered to the surface in PW2 via a 32 mm (1¼") HDPE pipe which discharges to the Tank. The pump operates broadly on a 2 hours on – 2 hours off cycle during summer months. The instantaneous pumping rate was visibly estimated as 150 m 3 /d.

Opportunities to improve irrigation system

There is an overriding view that the pond liner may be leaking. This may be the case but it is difficult to quantify the amount of water being lost through the pond base. It is unclear to what height the liner is in good condition. The pond is topped up for up to 12 hours per day from the groundwater well. If the pond is leaking significantly through the base there is likely to be significant recirculation of pumped groundwater, which will be causing unduly high running costs (and associated carbon cost). It is noted that cost of a liner upgrade is likely to be significant.

It is recommended that a flowmeter be installed on the groundwater pumping line. This can be a manual totaliser which is read regularly (daily/weekly) or a magmeter which measures live rates. Magmeter rates can be recorded on a datalogger (typically 5-minute recording intervals) and transmitted using telemetry to an online drive and viewer. HGC should be aware that the EPA maintain a register of groundwater abstractions in Ireland. There are different thresholds on the register. The lowest threshold for registration is 25m3/d.

It is recommended that a new Tank water level control mechanism be installed that can be adjusted more easily. This can be in the form of a cofferdam, the height of which can be adjusted by removable boards, or an adjustable weir-gate (screw) or sluice-gate. The height could be increased to increase water storage during summer and lowered to assist drainage during winter months. A float switch connected to the well pump would switch off the well pump when the overflow spillover level is reached.

Drainage network

An increase in the intensity of rain in the future as a result of climate change requires the implementation of measures to divert high rainfall quickly away from playing field. The existing drainage network on the golf course is a mixture of historic mole drains (from when the lands were still in agricultural use), and piped drains and open drainage channels installed over many decades to improve the playability of the golf course. All lands within HGC drain to either the Carrickbrack Stream or the Balsaggart Stream.

Typically for a golf course most of the drainage ditches are solely managed to transport water and to maintain the playability of the course with less regard for biodiversity or sustainable surface water management. No vegetation is present in most drainage ditches as a result of herbicide application to the drains. It is interesting to note that where herbicides have not been applied to open channels, a diverse range of plants have encroached from adjacent areas, e.g. open channel along the left side of the 3rd fairway (upper) and open channel left of 14th green, These channels should be retained in their current condition. They should not be cleaned or targeted for herbicide application.

Some of the open channel bank profiles within the course have steep vertical sides. Although this makes the drains very effective at getting rid of surplus water from the golf course, it increases flood risk to downstream receptors and it can also cause erosion of the drains (particularly where vegetation that can stabilise the sides of the drain is absent due to herbicide application). Many of the channels were narrow when installed and their current depth means that banks and overlying soil/subsoil are being undermined in several locations (see Fig. 16).

Fig. 16
Deep drainage channels to which herbicide is applied

The steep channel gradients mean high flow velocities following heavy rainfall cause more bank erosion which causes undermining and bank collapse which requires mechanical cleaning and the cycle repeats. This pattern can become self-perpetuating once it has commenced and long -term can result in unintended drain expansion.

Furthermore, many of the open channels in and around the course may be too deep, examples of which are illustrated in Fig. 16. This likely occurred progressively during seasonal drain maintenance over many years. It may have been performed with the intention of lowering water table which can be effective where thick heavy overburden is present, but that is not the case at the HGC. In several sections the channel base has been mechanically deepened below weathered bedrock and into composite bedrock. This is unlikely to benefit soil/subsoil drainage and is unlikely to improve playing conditions. The dimensions of the open channels do not restrict flows following heavy

rainfall and therefore drain deepening will not prevent overtopping during high flows. Weathered bedrock is the primary route for shallow groundwater flow and exposing this profile merely intercepts groundwater flows that would otherwise continue to flow below surface. On a practical level the deeper, steep-sided channels can make it more difficult for players to retrieve golf balls.

Toeslope drains have been installed around much of the perimeter of the playing area, e.g. left hand side of 6th and 17th fairways. These are intended to capture rainfall-runoff from steep sided hillslopes. These toeslope drains only need to be shallow as the contributing catchment is very small. The open channel along the left side of the 17th hole is adequate in size.

Fig. 17 Open channel beside the 17th hole is a swale like feature

In some instances these drains are unnecessarily deep, e.g. left side of 3rd fairway. Deep drains lower groundwater levels in the underlying bedrock which in turn dries out the surrounding peats outside the playing area. Drained peats are less capable of supporting high species diversity. Dry peats may also increase risk of wildfire. It is difficult to undo the impact of drainage channels but it is advised that a policy should be adopted to ensure that there are no additional toe slope drains and that those present are not deepened further.

Opportunities to improve drainage network for biodiversity

Many of the open channels are narrow and have vertical sides. Consideration should be given to altering the morphology of these open steep sided drains, with a progression towards shallow-sloped swales where grass can be established. The bank slopes should be shallow enough to let the mower cross the channel in order to facilitate mechanical control of vegetation. This is achieved in the drain adjacent to the 15th green.

Another approach is to incorporate swale-type features, as evidenced running alongside the left side of the 17th green. If the base of this feature were to contain a french drain covered in sandy soil it may be adequate for disposing of water by infiltration followed by subsurface pipes. If successful this approach could be applied

to replace smaller open channels and toe drains. As many of the toe drains are penalty areas there is no perceptible disadvantage in allowing the base of the swale to be wet during parts of the year. Again, these decisions must be balanced against playability.

Flow velocities within the drains can be reduced by reducing channel gradients, introducing bends and inserting steps. Bends have been incorporated to some extent on the 18th hole but any positive effect is negated by the steep gradients.

Inserting of steps/shelves promotes retention of water in small pools which can provide some attenuation storage of rainfall/runoff and entrapment of suspended solids. The small pools can support small localised, wetland habitats. Pool overflows are via small cascades which can improve water quality through oxygenation. It is acknowledged this may be difficult due to the steep gradients and shallow subsoil cover. It may be possible where gradient is shallower (e.g. stream alongside 15th hole) or where channels are deep (e.g. left side of 3rd fairway).

Some of the internal access roads and tracks act as rainfall-runoff routes and during high flows are clearly prone to erosion. Consideration should be given to interrupting runoff on these overland flow routes before flow velocities get sufficiently high to cause erosion. This applies to the path on the left side of the 18th hole which continues for a prolonged distance before outfalling to an ACO drain towards the rear of the clubhouse. Flow velocities can be reduced through installation of pooled sections.

The pattern of glacial erosion on elevated ground in Howth is such that subsoil cover is thin and contains a high amount of sand, gravel and fragmented rock.

During high runoff events erosion of both mineral and organic soils (peats) occurs and over time these materials tend to accumulate in topographically enclosed depressions. At a large scale this has happened at the Tank. This also occurs at a much smaller scale meaning small depressions or hollows (e.g. left hand side of 2nd fairway at base of bank) and around raised greens are prone to wetness but only following prolonged rainfall. Land drains and french drains have been utilised in these areas to remove this ponded water and divert these waters towards open channels.

Where open channels are not active in receiving surface runoff, consideration should be given to piping and covering them with grass. This would reduce herbicide use, erosion and movement of suspended solids. One example is the channel on the 18th fairway which runs parallel rather than perpendicular to slope gradient and is therefore functions more as a conduit route rather than for active drainage of adjacent lands. The pipe that outfalls at the 18th tee could be culverted from this point to the western boundary via an alternative route. Other areas include the open channel and semi-covered pipe on the right side of the 17th fairway and the open channel to the right of the 3rd green. The open channel on the right side of the 17th fairway appears to be oversized since runoff from the 3rd and 4th greens and 5th tee box are now diverted across the 3rd fairway. Waters from the 8th hole may also enter the channel across the 3rd fairway.

Some of the culvert diameters are very small, which would again reinforce the suggestion that open channels are oversized. If flooding is known to occur at certain points it is more likely caused by undersized culvert diameters rather than undersized open sections. It would be useful to identify with the greenkeeper any culverts which

are prone to surcharging and may need upgrading. For example the culvert outlet at the end of the 18th open channel is effectively 100mm, and appears undersized. It was noted at this location that some greenfield runoff appears to bypass this drainage outlet, between the 18th fairway and 10th tee box. A subtle berm could be installed to direct runoff at this location into the open channel. This would reduce the reliance on the large triple culvert in front of the 1st tee box.

There may be scope to make some of the channels more sensitive to the surrounding environment. For example, the angular limestone gravel used to backfill the open drain on the left side of the 17th hole looks out of place.

On the course an examination was made by Drs Colin O' Reilly and Mary Tubridy of areas prone to wetness, seasonal ponding, with a view to developing a new, or enhancing an existing, wetland area. Areas examined included:

- Low area right of 10 th tee box;
- Low area left of 1 st green;
- Low area left of 2 nd fairway (below ledge);
- Stream left of 3 rd fairway (upper and lower sections);
- Tank;
- Front of 15 th green;
- Between 15 th green and 16 th tee box;
- Rear of 15 th green;
- Left of 17 th green;
- Periphery of 8 th green;
- Right of 5 th tee box.

However due to small catchments, steep topography and free-draining soils almost all of the areas inspected above suffer from drying out during prolonged periods of no rainfall and have little potential for wetland development.

There is scope to improve habitat for wetland species at the Tank. The Tank already has variable submergence depths and these do not appear to host aquatic vegetation. One option is to shelve out the perimeter, such that the depth to groundwater (being depth to saturated soil) varies on each shelf, from depths of 0mm to 100mm. This depends somewhat on the plan for level control.

The only area that currently receives a consistent freshwater flow all year round is the channel that runs adjacent to the 15 th hole. This freshwater is actually excess groundwater from the Tank. However as part of a previous recommendations that excess groundwater overflow is eliminated, this action would conflict with the development of a wetland feature at this site.

There are three areas that can be manipulated to create a new wetland feature at the 15th hole. A new pond type feature could be excavated in front of the 15th green. The pond can be shelved to support different water depths and various habitat supporting conditions. The existing stream to the left of the 15th fairway would provide an obvious inlet and outlet, the inverts of which could be set to control water depths. Consider multiple small interconnected cells. Such ponds can provide attenuation to protect downgradient receptors from flooding. Either separately or concurrently the stream that runs along the left side of the fairway and green could be widened to generate a shallow swale type feature.

Water quality assessments

Water quality analyses did not reveal traces of herbicide in waters sampled. Herbicides are potentially toxic to human health and classed as 'possibly carcinogenic to humans'. Herbicides are used on golf courses and this was recognised by the Golfing Union of Ireland being part of the National Pesticides and Drinking Water Action Group (NPDWAG). The initial focus of the HGC sampling programme was to determine whether herbicides applied within the course are migrating to groundwater and surface water resources. A single drop of herbicide lost to a waterbody such as a small stream (1 m wide, 0.3 m deep), for example, can be enough to breach the legal limit for pesticides in drinking water of 0.1 parts per billion along 30 km of its length (Teagasc).

The parametric limit under the Surface Water Regulations (2014) is 0.1 μ/l on an individual basis and 0.5 μ/l for total pesticides. Results showed no detections of herbicides or pesticides at any locations sampled. Given the complete lack of detection it is likely that migration of herbicides is most likely to occur immediately after application and requires mobilisation by rainfall. Results suggest that the herbicides used on course do not appear to leave a residual deposit which can subsequently be mobilised.

Water quality analyses did not reveal excess amounts of nitrate, nitrite and ammonia in all waters sampled. The low ammonia levels suggest that discharge of treated effluent to ground from the nearby on-course toilet is not a potential source of contamination.

However orthophosphate concentrations in the Tank and the Balsaggart Stream tributary were above the guideline value of 0.035 mg/l. Potential sources are fertiliser and (more likely) faeces from wading birds. Birds also contribute to high levels of faecal coliforms in the Tank. It is known that birds typically make use of the open water in the southern half of the Tank and there is clear evidence of faeces, feathers, etc. on the water surface (the detritus and silty water from the southern portion of the pond). This is reflective of the laboratory analysis which show gross bacterial contamination in the Tank. Groundwater in the groundwater taken from the first pumping station is free of microbial contamination.

In conclusion there is no sign of herbicide in the water bodies on the course. However there are elevated levels of orthophosphate and faecal coliforms in the Tank which is due to bird activity. This contamination is not affecting groundwater. There is a problem with the water clarity between the well discharge and the pond outlet. There

are significant ferrous oxide deposits and ferric bacteria are evident as a foam-like scum.

Actions and priorities

The following section describes management actions in order of priority recommended to protect and enhance biodiversity at Howth Golf Club:

1. Protect and improve existing biodiversity on the golf course
2. Improve the value of the drainage network for water management and biodiversity
3. Reduce herbicide use to minimise risk to human health & biodiversity
4. Improve water quality in the Tank
5. Optimise groundwater pumping regime and irrigation network
6. Communicate biodiversity management to golfers to add to their enjoyment of the golf experience and promote the need for new management practises
7. Engage in networking to support biodiversity actions

The following section lists the actions required to deal with these issues. The timeline column specifies the urgency required and the category KPI represents Key Performance Indicators or evidence that these actions were carried out.

1. **Actions to protect and improve existing biodiversity on the golf course**

	Actions	**Rationale**	**Timeline**	**KPI**
	Identify suitable locations and width of rough grassland buffer along heathland boundaries with fairways	To create more space along heathland edge for heather spreading into adjoining grassland	Year 1	Extent of new rough created each year
	Mow areas of heathland and GS grassland shown on habitat map once a year and remove the cuttings.	To enhance the ecological condition of the heathland and grassland	Year 1	Acreage of new area of rough maintained by cut and collect once a year
	Identify suitable locations for rough grassland within the course	To create more rough species rich grassland	Year 1	extent of new rough created each year
	Identify environmentally friendly measures to manage rabbits	Manage the impact of rabbit grazing on golf club	Year 1	Number of measures identified and implemented
	Control bracken by cutting regime and native woodland planting left of lower 3rd fairway, left of 17th hole and area between 11th, 12th, 7th and 8th and LHS of 13th fairway, back towards 15th tee by means	To manage Bracken in an environmentally friendly manner	Year 1-5	Acreage of bracken controlled by means of strimming Acreage of woodland planted in Bracken areas

1. Actions to protect and improve existing biodiversity on the golf course

	Carry out feasibility study on restoring the original course of the Balsaggart Stream and installing a pond in front of 15th green or series of ponds and connecting spillovers between 14th green and 15th green	To restore the Balsaggart stream to good ecological condition and to create new wetlands.	Year 2	Feasibility study carried out
	Add biodiversity friendly species to shrubbery in Commemorative Garden with	To increase the biodiversity value of the commemorative garden	Year 3	Planting scheme designed and carried out
	Plant suitable native trees and shrubs on the course i.e. rowan, sessile oak, hawthorn	To increase the use of native planting on the course	Year 1-5	Number of new trees planted per year
	Remove Rhododendron ponticum left of lower 3rd fairway, left of 17th hole and area between 11th, 12th, 7th and 8th	To remove invasive species from the golf club as part of wider control program of rhododendron control on Howth	Year 2	Number of Rhododendron stands left within golf club lands
	Remove European Gorse in areas with dry heathland on the course	To reduce the impact of European Gorse on the dry heathland habitat	Year 1-5	Acreage of dry heathland where European Gorse is controlled
	Expand area of woodland at LHS of 13th fairway, back towards 15th tee	Increase woodland cover in golf course	5 years	Area (m^2) of woodland established over 5 years

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	Expand area of woodland at LHS of 13th fairway, back towards 15th tee	Increase woodland cover in golf course	5 years	Area (m^2) of woodland established over 5 years

2 Actions to improve the value of the drainage network for water management and biodiversity

	Measure	Rationale	Timeline	KPI
Drainage Network	Identify pilot channel and carry out management to improve its value as a drain and for biodiversity	To improve drain management and reduce herbicide use	1 year	Pilot project undertaken and results presented to staff and members
	Undertake one drain improvement project every year in years 2-5	To improve drain management and reduce herbicide use	Years 2-5	Number of drain improvement projects undertaken and results presented to staff and members

3 Actions to reduce herbicide use to minimise risk to human health & biodiversity

	Action	Rationale	Timeline	KPI
Herbicides	Audit herbicide usage each year and aim to reduce year on year by 20%	To reduce herbicide usage	year 1 – 5	Quantity of herbicides used Quantify reduction of herbicide use in terms of area sprayed and active ingredient used
	Carry out staff training to pinpoint areas of semi-natural vegetation, which are of biodiversity interest and where herbicides should not be used.	To protect areas of biodiversity value within the golf club	Within first 6 months	Training session organised No herbicide use visible in important biodiversity areas
	Identify opportunities for other vegetation control methods i.e. strimming and costings for same	To provide suitable alternatives to herbicide use	Within first 6 months	Number of areas where vegetation management has changed from herbicide use to alternative method.

4 Actions to improve water quality in the Tank

	Action	Rationale	Timeline	KPI
Water quality in tank and well	Establish 2m wide wetland vegetation in buffer around the open water tank	Improve water quality by establishing a fringe of wetland vegetation around the tank which will also deter gull usage.	2 year	Vegetation strip along edge of tank created Improved Water Quality of water in tank
	Install berm through centre of Tank, or reposition well outfall along eastern boundary of pond	To increase groundwater circulation around the tank to prevent stagnation	3 years	Improved Water Quality of water in tank
	Chemical dosing and jetting of well and tank	Reduce iron concentrations in well and tank	5 years	Visual assessment and test PW2 iron concentrations post-works
	Install 1 m3 concrete chamber prior to outfall to collect initial heavy precipitate	Reduce iron concentrations in well and tank	5 years	Visual assessment and test Tank iron concentrations post-works

5 Actions to optimise groundwater pumping regime and irrigation network

	Actions	Rationale	Timeline	KPI
Water Resource Management	Inspect and record current level control downstream of irrigation pumps	Improve understanding of Tank level control	2 years	Report on water levels prepared
	Install new level control structure at tank (e.g. sluice or cofferdam)	Gain ability to control tank water level – lower level in winter to improve drainage and raise level in summer to increase water storage volume	5 years	Level control structure installed
	Establish if Tank liner is intact	Better water management at tank	3 years	Study undertaken
	Install flowmeter(s) on well pump PW2 and irrigation pumps	Quantify water management	3 years	Flow meters installed
	Identify opportunities to further optimise irrigation network and nozzles on greens and tee boxes	Increase water usage efficiency	5 years	Study carried out to identify opportunities
	Install rainwater harvesting on clubhouse	Increase water usage efficiency	5 years	Rainwater harvesting system installed

6 Actions to communicate biodiversity and site management changes to members and staff

	Action	Rationale	Timeline	KPI	Additional comment
Communications	Organise an annual presentation and walk for members and staff on the Biodiversity and biodiversity enhancement measures.	To inform members of biodiversity value of golf club and surrounding lands. To inform members of work being done to enhance the golf club lands for biodiversity	Once a year	Number of presentations and walks organised per year	Other options of raising awareness include: Prepare a special edition of the weekly newsletter about the BAP Ask members to provide good pics of local species and add this info to weekly newsletters Display Images of Giant Irish Elk, curlew and pyrammidal orchid in communal areas
	Add BAP to the Howth Golf Club website.	To ensure guests are aware of BAP	6 months	BAP info available on website	

7 Actions to engage in networking to support biodiversity actions

	Action	Rational	Timeline	KPI	Additional comment
	Arrange knowledge exchange with other golf courses of biodiversity management and member education	Learn about similar activities in golf courses in Ireland	6 months	Number of exchanges per year	Royal Dublin would be a good starting point
	Join Sustainable Golf, an organisation which supports golf clubs to operate sustainably including looking after biodiversity. Actively participate in relevant projects.	Learn about similar activities in golf courses outside Ireland	1 year	Membership obtained Number of projects participated in.	

8 Actions to include biodiversity policies related to these issues in the club's strategic plan

	Topic	Proposed Objectives	Proposed KPIs
	Drainage network	Reduce channel erosion and prevent bank undermining Establish vegetation on channel banks and bases Reduce risk of flooding to downstream receptors Introduce attenuation in the form of swales, in-stream shelves and stepped ponds. Reduce drain depth for easier ball retrieval Prevent excessive deepening of drains Pipe and cover channels not collecting surface runoff	Specify distance (m) over which gradients will been reduced. Specify area m2 over which vegetation has been established on channel banks and bases. Specify volume (m^3) of attenuation created Specify length (m) of drains where depth has been reduced
	Pesticide use	Complete ban on herbicides throughout the club Establish more suitable types of vegetation in areas where herbicides previously used	Quantify current annual volume of pesticides applied Aim to reduce volume applied by 10% per annum Quantify length (m) of channels receiving herbicide Length (m) of channels not receiving herbicide
	Protect and enhance biodiversity	No clearance of heathland or areas with GS grassland No application of fertiliser in the buffer of the heathland with the fairways Aspire to expand heathland by managing acid grassland adjacent to it. No use of wildflower mixes in golf course except around the club house	Acreage of GS grassland Acreage of new heatland created

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Appendix 1

An Ornithological Survey of Howth Golf Club
Joe Adamson October 22nd 2022

- An ornithological Survey was carried during the summer of 2022 at Howth Golf Club, located on the south-facing slopes of The Hill of Howth. Three visits were undertaken, on the 26th of May, the 13th of June and the 11th of July 2022.

- The site was surveyed by walking within the grounds of the golf course and bird species were recorded through observations and call. Information was also obtained from the head greenkeeper and observations from Willie Carr who also carried out fieldwork to survey mammals.

- The site is dominated by the golf course, with small patches of conifers. The northern, eastern and western edges of the golf course are dominated by woodland, with Sycamore, Elder and Ash present. There are also areas of outcropping rock, with Gorse and Rhododendron present. There is a small pond at the east central part of the site. The area abutting the south of the golf course was extensively burnt in 2021. This area had been dominated by Gorse. In 2022 the area had started to revegetate, with Bracken colonising the area.

- A total of nineteen bird species were recorded. These are listed at the end of the report. To this list was added species observed by Willie Carr and Ben Moore, the head greenkeeper.

- All species recorded were typical of the habitats present.

- The golf course was generally devoid of birds, as golfers were present on all dates visited, resulting in disturbance. Birds present on the golf course included Hooded Crow and Magpie, with the occasional Meadow Pipit, Linnet and Goldfinch. A pair of Stonechats was observed on the golf course, but are likely to breed within the Gorse at the perimeter of the course, as are Meadow Pipit, Linnet and Goldfinch. Hooded Crow and Magpie are likely to breed in the conifers within the golf course. The occasional Swallow was observed feeding over the course on several occasions.

- The woodland around the perimeter to the north of the golf course contained species such as Chaffinch, Robin and Wren and summer visitors, including Willow Warbler and Chiffchaff. Blackbird was occasionally observed feeding on the golf course.

- Gulls were observed on the small pond, bathing and preening. The pond appeared to be highly eutrophic due to gull droppings in the pond and runoff

from gull droppings around the edges. Up to thirty Herring Gulls and one Great Black-backed Gull were observed on or by the pond during the July 2022 visit. The perimeter of the pond contained many gull feathers during the July visit, as gulls moult at this time of the year.

- It is considered that a visit in winter is likely to produce additional species feeding on the golf course, such as Curlew and Oystercatcher. Winter thrushes such as Redwing and Fieldfare are likely to be present over the woodland around the perimeter of the course.

- Due to the fact that the main habitat present at the site is amenity grassland, it is likely that there will not be high numbers or variety of birds present within the site, with the areas abutting the site being more productive for birds.

List of birds observed at Howth Golf Club in Spring/Summer 2022

Herring Gull *Larus argentatus*
Great Black-backed Gull *Larus marinus*
Wood Pigeon *Columba palumbus*
Barn Swallow *Hirundo rustica*
Meadow Pipit *Anthus pratensis*
Wren *Troglodytes troglodytes*
Robin *Erithacus rubecula*
Stonechat *Saxicola rubecula*
Blackbird *Turdus merula*
Willow Warbler *Phylloscopus trochilus*
Chiffchaff *Phylloscopus collybita*
Blue Tit *Parus caeruleus*
Magpie *Pica pica*
Jackdaw *Corvus monedula*
Rook *Corvus frugilegus*
Hooded Crow *Corvus cornix*
Chaffinch *Fringilla coelebs*
Linnet *Carduelis cannabina*
Goldfinch *Carduelis carduelis*

Birds reported by Ben Moore

Oystercatcher
Curlew

Birds observed by Willie Carr in 2022

Flock of curlew on the golf club
Jay

ENVIROLOGIC

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Appendix 2
Hydrological Assessment

LOCATION:	Howth Golf Club
PREPARED FOR:	Mary Tubridy & Associates
PREPARED BY:	Colin O'Reilly PhD (Hydrology)
DATE:	11th October 2022
REFERENCE:	2042

Contents

1 Introduction

The following hydrological assessment has been prepared by Colin O'Reilly PhD (Hydrology) of Envirologic Ltd., on behalf of Mary Tubridy & Associates. It is intended to inform a Biodiversity Action Plan (BAP) for Howth Golf Club (HGC) which has been commissioned with assistance from Fingal County Council.
Colin O'Reilly of Envirologic attended an initial kick-off meeting at HGC on 13th May 2022. The following persons were in attendance:

- Mary Tubridy – Ecologist & Biodiversity Action Plan Project Lead, Mary Tubridy & Associates;
- Hans Visser - Biodiversity Officer, Fingal County Council;
- Simon Duffield, General Manager, Howth Golf Club;
- Paddy Cooney – Course Convenor, Howth Golf Club
- Michael O'Neill – Greens Committee, Howth Golf Club

Aims and objectives were agreed in principle by all in attendance.
On-going discussions were held with Ben Moore (Head Greenkeeper) throughout field surveying.
Interim findings and recommendations contained within this report were presented to listed members of the Greens committee in HGC as part of consultation.

1.1 Aim

The aim of the study as tendered by Fingal County Council was as follows:

- Address hydrological issues highlighted in the 2019 wetland survey report ('*Hydrological Assessment of Howth Wetlands*', issued by Envirologic, January 2021);
- Analyse additional objectives regarding hydrology. This is to include surface water management, irrigation protocol, pesticide use;
- Produce a brief report on the above issues and recommend actions, which could be carried out by HGC (subject to further discussion and agreement). Summarise measures, which could be included in the BAP.

Howth Golf Club stated their aims with respect to the BAP are as follows:

- To seek professional advice from a team of experts with the aim of enhancing biodiversity and environmental sustainability of Howth golf course and its associated activities;
- To inform and educate members and visitors (Irish and overseas) of unique flora and fauna at HGC;
- To contribute to the aims and objectives of Howth Special Amenity Area Order (SAAO).

1.2 Objectives

The study shall be performed taking cognisance of the following objectives:

1. Compile desk study to demonstrate the environmental setting in terms of hydrology and hydrogeology;
2. Survey on-site drainage features and compile map to illustrate golf course drainage network;
3. Review groundwater resources and groundwater pumping regime with HGC;
4. Discuss grassland management programme with HGC;
5. Assist with water sampling programme and interpretation of hydrochemistry;
6. Propose draft mitigation measures;
7. Explore feasibility of enhancing existing wetland features and/or development of a new wetland at HGC.

2 Site Location

2.1 Landscape Position

Howth can be considered broadly circular in shape, with a diameter of between 3 and 4 km (Figure 1). Up until around 3,500 years ago the peninsula was an island though it is now connected to the mainland via a raised sand and gravel beach protruding westwards from the northwest corner at Sutton.
The highest region of Howth is located just south of the centre point where a number of peaks exist in close proximity to the golf course, these being referred to as follows:
(i) Ben of Howth (Black Linn) (171 mOD) – notable by the presence of a telecommunications mast;
(ii) Shielmartin (163 mOD) – surrounded to the west, north and east by Howth Golf Club while the southern slope falls to the south coast;
(iii) Carrickbrack – east of Howth Golf Club and south of Ben of Howth;
(iv) Muck Rock - raised bedrock plateau southwest of Deer Park Hotel which has a steep, north-facing escarpment.
(v) Dun Hill – peak short distance south of Muck Rock, adjacent to the northern boundary of Howth Golf Club.
The southern coastline is characterised by shallow cliffs and a rugged foreshore (Figure 2). Howth Golf Club is flanked by predominantly greenfield setting to the south (Bellingham's Farm) and to the north (Deer Park).

2.2 Site Layout

The golf course site as shown in Figure 3 covers an area of approximately 56 hectares. It is broadly rectangular in shape with a length of 1,200 m width along a northwest-southeast axis and a perpendicular northeast-southwest width of 350 m at the western end, widening to 600 m in the eastern half.
The course is regarded as having two distinct areas, these being the western half and eastern half, separated by a ridge through the centre line (135 mOD), corresponding to the 8th green and 12th tee area.
The western half slopes with a relatively uniform gradient from this central peak down towards the western boundary at the 1st tee (74 mOD) and 2nd tee (76 mOD), and the clubhouse compound (67mOD). A public right of way bisects the approximate midpoint of this western slope and has elevations between 102 and 105 mOD.
Lands to the east of the central peak tend to fall inwards from surrounding elevated topography towards a low point which contains an artificial pond, referred to as the Tank (123 mOD). The lowest point on the rim of this enclosed topographical depression is to the southeast (124 mOD), beyond which lands fall gradually towards the southeast boundary which coincides with the 15th green (114 mOD). From this point lands fall steeply towards the coastline.

3 Environmental setting

3.1.1 Bedrock Geology

Geology has formed the landscape of Howth. Essentially there are two types of bedrock in Howth: (i) older and harder Cambrian rocks on the higher ground in the central and eastern parts of the peninsula, and (ii) younger Carboniferous limestones on the lower ground that occupies the western side of Howth (Figure 4).
These are separated by a structural fault that runs from southwest, close to the entrance of Redrock, to northeast at Balscadden Beach. It is evident inland along the escarpment that runs along the northwestern boundary of HGC and on to the rear of Deer Park Hotel. A secondary faultline runs parallel, offset 0.5 km to the southeast, and can be observed as a narrow valley running between the Bog of Frogs, following the public right of way and through to the rear of HGC practice area.
Bedrock on higher ground east of the major fault is composed of metasediments created in the Cambrian Period. These rocks are categorised as the second oldest rock type in Ireland (500 million years) and contain the earliest evidence of life. They are sedimentary in nature so were laid down in horizontal bedded sequences, however these have largely been shattered and contorted by tectonic movements which gives a chaotic appearance and variation in size from pebbles to blocks of massive structure.
Within this Bray Group several distinguishable bedrock formations are mapped, these being illustrated in Figure 4 (compiled using bedrock data obtained from GSI database at www.gsi.ie). Underlying HGC are the:
(i) Drumleck Formation – quartzite blocks and pebbles in a mudstone matrix. The quartzite is made distinct by its purer sand content. It tends to be mostly visible on the highest areas as it is more resistant to erosion. Clearly exposed on Muck Rock and Dun Hill. This is mapped as underlying the area west of the public right of way, including holes 1, 2, 9, 10 and 18.
(ii) Elsinore Formation – mixture of greywacke, siltstone, mudstone, sandstone and quartzite, often massive in structure. Clearly exposed in the central area around Ben of Howth and Greenhollows and also at Kilrock quarry and nose of Howth. These rocks are often rusty brown in colour and termed locally as 'Howth stone'. This rock underlies the area east of the public right of way.

3.1.2 Quaternary Deposits

Howth was covered in an ice sheet during the last Ice Age. During the glacial retreat approximately 14,000 years ago the ice and meltwaters scoured various small valleys which terminate at the coast. Most, but not all, of these valleys transmit the main streams that flow radially from the centre.
The hard Cambrian rocks that underlie the golf course aren't prone to significant weathering so subsoils are almost entirely absent across large areas. Where present they are mapped as a till derived from quartzites. This unit tends to be quite sandy in texture which gives it improved drainage characteristics. It can be clearly observed on the eastern cliff faces of Howth as having thickness up to 5 m. The more typical thin profiles can be seen in many of the drainage cuttings across the golf course.

The lower ground in Howth is overlain by superficial calcareous glacial deposits of variable thickness comprised of a boulder clay intermixed with gravel of Irish Sea origin. This till tends to be heavy and of low to moderate permeability.
Lacustrine deposits are mapped in the depression occupied by the Tank on Howth Golf Club. These represent old lake sediments.
Howth peninsula is connected to the mainland by a post-glacial tombolo, consisting of raised marine sands and gravels resting on limestone bedrock.

3.1.3 Soils

Soil covering much of the Cambrian rock in Howth is thin, acidic and has a very low nutrient status. It also has poor moisture retention capability. Soils derived from these rocks are a simple blend of fine fragments of weathered bedrock sheared from the bedrock and peaty podzols, derived from the accumulation of organic matter arising from the cyclical degradation of vegetation at the surface. Organic matter that gets washed into topographical depressions and valley floors means that soil depth is greater in these localised areas.

3.1.4 Hydrogeology

Unsurprisingly the Cambrian rocks have been classified by the GSI as a poor aquifer which is generally unproductive except for local zones. Poorly productive aquifers are characterised by very low permeabilities and transmissivities and are therefore low yielding. Consequently, groundwater movement within this bedrock is relatively low and is often restricted to shallow flow paths near the surface or along fracture zones. Well and spring yields within this aquifer class are typically low.
Given the lack of protective overburden the Cambrian rocks in Howth are considered to be vulnerable to contamination (E/X).
There is little detail regarding groundwater abstractions on Howth. The GSI database contains records of shallow wells at St Fintan's (holy well) and Balsaggart. These wells are mapped close to the primary fault line and the presence of broken rocks (breccia) along the faultline caused by tectonic movement may be a primary groundwater flow path. At a local level there are reportedly domestic wells with moderate yields on Burrow Road and close to the southern coastline.

3.1.5 Hydrology

The EPA database of watercourses in Ireland shows five first order streams on Howth peninsula. These have been included in Figure 5 along with additional watercourses as illustrated in Rivers of Dublin (Sweeney, 2017). All lands within HGC drain to either the Carrickbrack Stream or the Balsaggart Stream with the catchments being topographically controlled.
Catchment boundaries have been delineated by Envirologic using OS 1:50,000 Discovery Maps. The upper end of the Carrickbrack Stream and Balsaggart Stream catchments corresponds to the raised ridge that runs approximately through the 4th green, 7th green, 12th tee and 17th tee. Both catchments contain parts of the golf course which are drained by subsurface stormwater networks and in these areas the catchment boundaries are estimated.
With respect to the Carrickbrack catchment rainfall-runoff is captured from the playing areas within the course, the northern slopes of Shielmartin and the southern

and western slopes of Dun Hill. Water is collected primarily in two tributaries which exit the course at the northern end of the public right of way and the 1st tee, respectively. These subsequently converge, along with waters collected from Deer Park, at Howth Celtic AFC where they are culverted beneath Carrickbrack Road, before outfalling to the sea along Strand Road. The area within HGC that drains to the Carrickbrack Stream is 26 ha, within an overall catchment area of 98 ha.
East of the above catchment divide waters drain to the Balsaggart Stream. Rainfall-runoff is captured from the playing areas within the course, the northern slopes of Shielmartin, the southern slopes of the Ben of Howth, and the western slopes of Carrickbrack. The Balsaggart Stream leaves the site behind the 15th green before continuing south beneath the Carrickbrack Road, through a working farm and outfalling to the sea in an area known as 'The Cliffs'. The area within HGC that drains to the Balsaggart Stream is 26 ha, within an overall catchment area of 91 ha.
A minor area (3.5 ha) including the clubhouse and practice area drain naturally to an unnamed first order stream which runs to the rear of new houses on the southern side of Carrickbrack Road, passing adjacent to the cemetery, and culverted beneath houses in Carrickbrack Lawns.
Given the low permeability of underlying bedrock and the steep hydraulic gradients most of the streams exhibit quite a flashy hydrograph in that they display a rapid flow response following rainfall and tend to have very low flow, or dry up completely, during summer months.

4 Site-Specific Data Collection

4.1 Drainage Network

Envirologic undertook topographical surveying on 13th June 2022 and 9th August 2022. Items of interest, ground levels and water levels were surveyed using Trimble RTK R4 VRS with vertical and horizontal accuracy of 0.025 m. Easting and northing coordinates are stated relative to ITM; elevations are relative to Malin Head datum.
Envirologic have categorised four distinct types of drainage feature on Howth Golf Course, listed below in ascending order of capacity:

1. Historic mole drainage;
2. Historic tile drains and perforated land drains, generally 75 – 100 mm;
3. PVC pipes and concrete culverts, generally 150 – 300 mm;
4. Open drainage channels.

The routings of these, as best understood at time of writing, are shown in Figure 6.

4.1.1 Historic Mole Drainage

Parallel ridges and valleys with a depth of up to 300 mm, and spaced at approximately 1-3 m, are prolific across much of the golf course, with many of these tending to fall towards open channels (see Plate 1). Although there is some uncertainty around their original function their high density now forms an inherent feature of the golf course.
Though these ridges are suggestive of remnants of historic mole drainage channels it has been suggested that these are more likely to be a legacy of potato ridges on poor

upland ground that was unsuitable for grassland or tillage agriculture. It is notable that grass growth tends to be slightly stronger in the small valleys, likely a combination of mowers not being able to reach the base of the valleys floors along with the role these trenches serve in the routing of surface runoff.

Plate 1 – Example of Historic Mole Drainage on 3rd Fairway (stone-filled subsurface drain in foreground)

4.1.2 Historic Tile Drains and Perforated Land Drains

The outfall points of several small diameter clay tile drains were encountered on the banks of several open channels. These are a legacy of historical drainage and are largely unmapped. Given their age many of these may not be functioning as intended due to collapse or siltation but several are known to be important in carrying significant volumes of water.

More recently installed (implying last 30 years) perforated land drains were encountered on banks of open channels, with typical diameters of 75 – 100 mm. These were mostly observed around greens and near localised depressions.

4.1.3 PVC Pipes & Concrete Culverts

Solid wall PVC pipes and concrete culverts which mostly range in diameter from 150 mm to 300 mm are generally in place as subsurface connections between open channels and to provide crossing points for carts, trolleys and greenkeeping machinery. Open channels are more prevalent across the course relative to the frequency of culverted sections.

The routings of these pipes are not mapped precisely but are guided by surveyed culvert inlets and outlets. In the western catchment the primary culverts transfer water from the open channels on either side of the 17th fairway and deliver it to the open channel on the 18th fairway. In the eastern catchment the main culverts connect the Tank outlet with the open channel that runs alongside the 15th hole in addition to a connection between an open drain on the 6th hole and the 15th hole.

4.1.4 Open Channels

In the upper part of the Carrickbrack catchment rainfall-runoff is collected in three distinct channels:

i. Northern open channel – fed by runoff on the northern slopes of the golf course, rising in a minor valley between the 5th and 7th fairways. The open channel runs west past the 3rd green before traversing north across the 3rd fairway in a drain that was reportedly installed 10-15 years ago. This crossing enters a deeper cutting along the northern boundary, which passes under the public right-of-way and leaves the course next to the 3rd tee boxes. It continues through woods on Deer Park lands before entering Deer Park Golf Course. Runoff generated on the 2nd hole and parts of the 1st and 9th holes flows northwards towards this woodland stream.

ii. Central open channel – rises on the 8th hole and runs in an open channel along the right side of the 17th fairway.

iii. Southern open channel – fed by runoff on the southern slopes of the golf course, rising around the 11th green. Runs in a shallow open channel along the left side of the 17th fairway. Merges with the central open channel in front of the 18th tee box and continues as an open channel alongside the 18th fairway, leaving the course via a culvert in front of the 1st tee box. The open channel along the 18th fairway was reportedly installed 10-15 years ago.

4.2 The Tank

The tank is the only open waterbody within HGC. It occupies a topographical depression in the centre of the eastern part of the course and has a footprint of approximately 1,200 m^2 (0.1 ha). An artificial liner was reportedly installed at the time of excavation though the current condition of the liner is unknown. As such there is potential for the pond to be leaking water through the base or sides.
Although difficult to quantify precisely it is estimated that an area of approximately 10 ha drains to the Tank, with runoff collected from holes 5, 6, 7, 12, and 13 along with surrounding hillslopes.
The southern half of the Tank is relatively shallow (c. < 0.3 m) and has a grey, silty bed with little vegetation. This area was apparently cleaned (dredged) within the past 3 years. The northern part of the pond contains established vegetation and appears slightly deeper (c. 0.3 - < 1 m).
The pond outlet is located at its northwestern corner. The outlet itself directs pond water into a concrete chamber, which contains two shallow submersible pumps, suspended from above at ground level. These pumps supply the on-course irrigation network directly.
It is likely that immediately downstream of this pump chamber there is a level control structure though its nature and precise location are unconfirmed. This level structure maintains water levels in the pond and ensures the pumps are always submerged. The water level control appears to be fixed and not capable of raising or lowering pond levels.
In addition to input from rainfall-runoff the Tank is topped up with groundwater on an intermittent basis. When inflows exceed irrigation demand Tank water overflows

the level control structure and enters a culvert which traverses southeast towards the 15th tee box. The culvert routing is estimated from three concrete manhole chambers on the 12th and 13th fairways

4.3 Groundwater

4.3.1 Groundwater Sources

There are two known groundwater sources on site, with both of these being approximately 20 m northwest of the Tank.
PW1 is a redundant well. Its installation date is unconfirmed but estimated as being over 10 years ago. A drilling log is not available for this borehole. It is exposed at surface as a 200 mm diameter steel casing to just below ground level. It is understood that PW1 was taking out of use in 2019 due to repeated pump burnout. Due to a prolonged dry spell in 2019 a new well was deemed necessary and in May 2019 a new well, PW2, was drilled within 10 m of PW1. Well installation was undertaken Dunnes Drilling; the drilling log is included as Appendix A. The log shows the following lithology profile along with estimated cumulative groundwater flows at different depths:

- 0 – 6 m = clay;
- 6 – 12 m = very soft, heavily weathered, yellow rock;
- 12 – 18 m = very soft grey rock. Water strike;
- 18 – 24 m = medium hardness grey rock;
- 24 – 36 m = grey rock with bands of yellow rock. 22 – 33 m^3/d;
- 36 – 48 m = grey rock. 33 – 44 m^3/d;
- 48 – 67 m = grey rock. 66 – 76 m^3/d;
- 67 – 73 m = grey rock, broken. Water increasing;
- 73 – 92 m= grey rock into white rock. Water increasing.
- Final yield estimation post airlifting = **327 m^3/d**.

The log shows the following construction profile:

- 0 – 18 m = 200 mm steel casing, annulus sealed with bentonite pellets;
- 18 – 24 m = 150 mm steel casing;
- 24 – 92 m = open hole;
- 0 – 86 m = 125 mm PVC casing.

The pump depth is unconfirmed.

4.3.2 Groundwater Level Monitoring

Groundwater level was measured at the on-site wells on 18/07/22 as follows:

- PW1 gwl = 18.82 m below top of casing (mbtoc);
- PW2 gwl = not measured. Dipper refused at 15 m.

Resting groundwater level under non-pumping conditions is not known.

4.3.3 Groundwater Pumping Regime

Groundwater is delivered to surface in PW2 via a 32 mm (1¼") HDPE pipe which discharges to the Tank. The pump reportedly operates broadly on a 2 hours on – 2 hours off cycle during summer months. The instantaneous pumping rate was visibly estimated as 150 m^3/d.
The drilling log shows that the well has a very good yield, which is inconsistent with the aquifer class. A pumping test was not performed following drilling to assess sustainable yield.

5 Hydrochemistry

5.1 Sample collection

A sampling programme was agreed as part of the project brief. The focus was on assessing whether herbicide use on the golf course was migrating to local groundwater and surface water resources.
Sampling locations are shown in Figure 7. A summary of groundwater hydrochemistry is presented in Table 7; Certificates of Analysis are included as Appendix B.
For reasons outlined below the sampling programme evolved throughout the duration of the project:

Fig. 7 Location of water sampling points

1. Sampling Round 1 took place on 31st May 2022 and was carried out by Mary Tubridy. Round 1 sampling locations were as follows:

    a. Tributary of Carrickbrack Stream, adjacent to 3rd tee box (downstream of public right-of-way), referenced 1/1;

    b. The Tank (southern end), referenced 1/2;

    c. Tributary of Balsaggart Stream, adjacent to 15th green, referenced 1/3;

    Samples were submitted to City Analysts on day of sampling. Results are not available for 1/1 due to City Analysts misplacing the sample bottles.

2. Sampling Round 2 took place on 18th July and was carried out by Colin O'Reilly and Pat Breheny of Envirologic. On Round 2 day of sampling the tributary of the Carrickbrack Stream and the tributary of the Balsaggart Stream were both dry. Hence the Round 2 sampling locations were as follows:

    a. Groundwater supply well, PW1;

    b. The Tank (southern end);

    Samples were submitted to ALS on day of sampling for time-dependent parameters and couriered to Element UK for all other analysis. Field hydrochemical parameters including temperature, conductivity, pH, dissolved oxygen and redox potential, were recorded using InSitu Aquatroll.

3. Sampling Round 3 took place on 1st September and was carried out by Pat Breheny. On Round 3 day of sampling the tributary of the Carrickbrack Stream and the

tributary of the Balsaggart Stream were both dry. Round 3 was only intended to quantify the difference between groundwater and surface water in and around the Tank, specifically relating to iron and manganese. A full analysis suite was not performed.

Table 1 – Groundwater & Surface Water Quality Results

Parameter	Units	The Tank	Balsaggart Stream (15th hole)	The Tank	PW1	The Tank	PW1	Groundwater Regulation Threshold Values (2010, as amended 2016) *	Drinking Water Regs (SI 278 of 2010)	Surface Water Regs (2009) as amended 2015 & 2019
Date		31/05/22	31/05/22	18/07/22	18/07/22	01/09/22	01/09/22			
Ref.		1/2	1/3	Tank	PW1	Tank	PW1			
Field Temperature	°C			19.9	12.7	21.6	14.4	Not specified		Not specified
Lab. Electrical Conductivity	µS/cm	338	329	379	334			1875		
Field Electrical Conductivity	µS/cm			356	332	339	296			
Lab. pH		7.8	7.9	7.8	7.0	8.1	6.7	6.5 - 9.5	6.5-9.5	5.5-9.0
Field pH				7.4	6.7	8.4	7.8			
Field DO	mg/l			7.7	3.25	10.7	5.42	Not specified		Not specified
Iron	µg/l				**5689**	**329**	**5900**	200	200	Not specified
Manganese	µg/l				**927**	**46**	**927**	50	50	Not specified
Potassium	mg/l	0.88	0.78	1	1.3			Not specified		Not specified
Sodium	mg/l	19.5	19.1	28	26			150	200	Not specified
Calcium	mg/l							Not specified		Not specified
Magnesium	mg/l							Not specified		Not specified
Sulphate	mg/l	<20	<20	17	19	14.2	14.5	187.5	250	
Chloride	mg/l	52	50	47	45	46	44	187.5	250	
Nitrate (as N)	mg/l	<2	<2	<0.045	<0.045			8.47	11.3	
Nitrite (as N)	mg/l	<0.005	<0.005	<0.006	<0.006			0.03	0.05	
Ammoniacal Nitrogen (as N)	mg/l	0.034	0.015	<0.03	<0.03			0.175	0.23	0.065-0.14
Total N										
Orthophosphate as P	mg/l	**0.039**	**0.038**	<0.03	<0.03			0.035		0.035-0.075
Total Phosphorus	mg/l	<0.05	<0.05	6	57			Not specified		Not specified
Faecal coliforms	Cfu/100ml	**700**	**27**	**>2420**	0				0	
Total coliforms	Cfu/100ml	**2420**	**125**	**>2420**	0				0	
BOD	mg/l			**4**	2	2	2			1.5-2.6
TOC	mg/l					1.3	<0.7			
Suspended Solids	mg/l					2	**12**			
Acid Herbicides	µg/l	<0.01	<0.01	<0.01	<0.01				0.1	
Pesticides**	µg/l	<0.01	<0.01	ND	ND				0.1	

* Threshold values relevant to an assessment of the general quality of groundwater in a groundwater body in terms of its ability to support human uses has been significantly impaired by pollution. Where this threshold was not stated, that relevant to an assessment of whether groundwater intended for human consumption in drinking water areas is impacted by pollutants and/or is showing a significant and sustained rise in pollutant levels was applied.
** ND = no detection.

5.2 Interpretation of Groundwater & Surface Water Quality

5.2.1 Unstable Chemistry

Temperature in the Tank was reflective of ambient air temperatures at time of sampling. The high temperatures are likely maintained during summer months due to low rainfall-runoff. Groundwater temperatures were lower at 12-14 °C but still marginally above what is expected for groundwater (10 °C). The higher pond temperature suggests that groundwater doesn't mix entirely through the impounded pond waters.
Conductivity values are relatively consistent though noted as being slightly lower in groundwater.
There is a significant difference between dissolved oxygen levels. Groundwater has low dissolved oxygen which infers confined groundwater conditions.
pH values show both surface and groundwater to be slightly alkaline, though this is not consistent with two of the samples showing groundwater to be slightly acidic.

5.2.2 Herbicides

Herbicides are potentially toxic to human health and classed as 'possibly carcinogenic to humans'. Herbicides are used on golf courses and this was recognised by the Golfing Union of Ireland being part of the National Pesticides and Drinking Water Action Group (NPDWAG).
The initial focus of the HGC sampling programme was to determine whether herbicides applied within the course are migrating to groundwater and surface water resources. A single drop of herbicide lost to a waterbody such as a small stream (1 m wide, 0.3 m deep), for example, can be enough to breach the legal limit for pesticides in drinking water of 0.1 parts per billion along 30 km of its length (Teagasc).
The parametric limit under the Surface Water Regulations (2014) is 0.1 μ/l on an individual basis and 0.5 μ/l for total pesticides. Results showed no detections of herbicides or pesticides at any locations sampled in Rounds 1 and 2. Given the complete lack of detection it is likely that migration of herbicides is most likely to occur immediately after application and requires mobilisation by rainfall. Results suggest that the herbicides used on course do not appear to leave a residual deposit which can subsequently be mobilised.

5.2.3 Nutrients

Nitrate, nitrite and ammonia values were very low. The low ammonia levels suggest that discharge of treated effluent to ground from the nearby on-course toilet is not a potential source of contamination.

Orthophosphate concentrations in the Tank and the Balsaggart Stream tributary were above the guideline value of 0.035 mg/l. The source of orthophosphates is not known at time of writing. Potential sources are fertiliser and faeces from wading birds.

5.2.4 Metals

PW1 results showed iron and manganese levels to be extremely high in groundwater. Groundwater in the Cambrian rock formations contains dissolved iron under confined conditions; these ions precipitate out of solution upon contact with the atmosphere. The acidic groundwater and iron content also promote the growth of ferric bacteria. The steel well casing on both wells was also noted being in a heavily corroded condition. The elevated suspended solids in Sampling Round 3 groundwater are attributed to the iron precipitate.
Between the well discharge and the pond outlet the water clarity is very poor and significant ferrous oxide deposits and ferric bacteria are evident as a foam-like scum (Plate 2). Particles of ferric oxide precipitate were also clearly observed in groundwater sample collection containers. Waters in the southern and northern halves of the Tank do not appear to mix (see Plate 2).

Plate 2 – Visible water quality issues in the Tank

5.2.5 Microbiology

Birds typically make use of the open water in the southern half of the pond and there is clear evidence of faeces, feathers, etc. on the pond surface (the detritus and silty water from the southern portion of the pond is shown on the right side of the image included as Plate 2.). This is reflective of the laboratory analysis which show gross bacterial contamination in the Tank.
Groundwater in PW1 is free of microbial contamination.

6 Golf Course Management

6.1 Fertiliser Use

The current cost of fertiliser means it is used only as necessary to keep the course in optimum condition. Frequencies of application outlined below are indicative only and can vary depending upon course conditions and weather. The primary areas receiving fertiliser are greens and tee boxes and there is limited scope for change of fertiliser application protocol regarding greens. Fertiliser application at the course is planned to continue as per present.
Nitrogen is typically applied as protected urea throughout the year. The use of protected urea slows the rate at which urea converts to ammonia and thereby minimises ammonia gas emissions.
A mixture of inorganic and organic fertiliser is applied in granular and liquid form. Granular fertiliser is applied using a disc spreader whereas liquid feed is mixed with water and applied using a sprayer. The organic, liquid based seaweed fertiliser is not applied in winter as the lower temperatures can inhibit microbial activity necessary for uptake.

6.2 Green Maintenance

The primary grass species encouraged on greens at HGC are browntop bent and fescue. Ryegrass and meadowgrass are undesirable species in terms of green management.
The following list is a basic summary of green maintenance activities performed during the year at HGC:

- Scarified once a year (removal of organic thatch);
- Groomed three times a year;
- Monthly liquid fertiliser (e.g. Seamac ProTurf Fe; 17-2-5);
- Bi-monthly granular fertiliser (TX10 + Mycorrhiza (5-2-8) slow release organic seaweed extract);
- Winter maintenance focuses on disease management, primarily:
    - Anthrachnodes (treated with feed)
    - Fuzarium (treated with fungicides)
    - Take all patch

6.3 Tee box Maintenance

Tee boxes are fertilised on demand with granular (21-5-11+2.9CAO) approximately every 2 months. This form releases nutrients over an 8-12 week period.

6.4 Fairway Maintenance

Fairways are fertilised every 6 weeks with urea (10-10-10) during summer months and with ammonium sulphate during winter months. Application rates are typically 20 kg/ha.

6.5 Herbicide Use

HGC utilise Roundup, Pistol and Praxys as herbicides.
Roundup is reportedly used via a knapsack sprayer for spot applications around fixed structures.
Pistol is listed as a non-selective herbicide for the control of a wide-range of annual and perennial broad-leaved weeds and grasses. Its active ingredients are diflufenican and glyphosate. According to product specification it is hydrophobic and Rainfast within 1 hour (i.e. following 1 hour the product will not be washed away by rainfall). It is stated as remaining near the surface of the soil with little or no lateral movement. It is applied from a quad sprayer or knapsack sprayer. Pistol is used mostly on concrete around HGC clubhouse.
Praxys is listed as a post-emergence herbicide for the control of specific weeds. Its active ingredients are clopyralid, florasulam and fluroxypyr. It is applied from a quad sprayer or knapsack sprayer. Used on fairways for weed control, primarily at start of season to eliminate daisies on fairways.

6.6 Irrigation

Irrigation water sourced from the Tank is used on tee boxes and greens. HGC maintain flow data pumped to the on-course irrigation network.
Night time irrigation is utilised to minimise losses due to evapotranspiration.
Typical irrigation cycles during dry summer periods include irrigation of all greens at night with 1mm (equal to 19 m3/d) and irrigation of all greens and tees at night with 1 mm (equal to 30 m^3/d).

7 Mitigation Measures

As an introductory comment it is worth reading the following list bearing in mind that all of the options have a knock-on effect to some aspect of golf-course management and playability. For example, the general approach to improving playability on a golf course is to optimise drainage. Drainage tends to makes habitats across the course more homogenous and is less likely to encourage species diversity. Similarly, options selected to improve drainage will decrease risk of flooding on the course, but will increase risk of flooding downstream. Drainage can also remove the inherent buffer that the course develops over time to combat soil moisture loss during extended dry periods.

7.1 Minimise/Eliminate use of herbicides

When herbicide application is immediately followed by rainfall it will likely be mobilised and transported directly downstream. Herbicides can have a significant, negative impact on stream and coastal habitats by reducing numbers and diversity of aquatic animals and vegetation. Pesticides are potentially toxic to other organisms, including humans, and must be used safely and disposed of properly (WHO).
Statutory no-use zones of between 5 – 200 m apply to drinking water abstraction points, depending on abstraction rate. Ideally, there would be no use of herbicides within the golf course. It is acknowledged that this is not feasible in terms of weed control. It might be useful however to have an overarching aim towards eliminating its use and shifting towards mechanical control with strimmers and mowers.
This aim can be broken down further into the following:

- Minimise frequency of use. Rather than routine applications consider utilising mechanical intervention until weed growth reaches a stage whereby mechanical intervention is inadequate.
- Minimise rates/volumes of herbicide application.
- Minimise areas receiving herbicide application (see below).
- Minimise/eliminate use in an around watercourses (see below).
- Adhere to buffer zones and setbacks listed on product labels.
- Don't apply pesticides near open drains, wells or springs (Teagasc).
- Do not perform handling operations (filling, mixing or washing of sprayer) near water bodies, open drains or well heads. A distance of least 10 m should be maintained and preferably 50 m, where possible (Teagasc).

Herbicides should not be applied in advance of any rainfall forecast within the following 24-48 hours and should not be applied when there is any detectable wind.

Given the direct connectivity between watercourses and down gradient surface water receptors direct application of herbicides in active water channels and open drains carries the highest risk of impact. This practice should therefore be minimised insofar as possible with the long-term aim of eliminating this activity altogether. The primary aim should be to eliminate application of chemical sprays to banks and beds of open channels. At a minimum, the span of drain currently being sprayed should be minimised (examples shown in Plates 3(a) and 3(b)).

Plate 3 – Examples of herbicide application (a) around 8th green, (b) 3rd fairway.(c)

drain outlet near 1st tee

Many of the open channels are narrow and have vertical sides. Consideration should be given to altering the morphology of these open drains, with a progression towards shallow-sloped swales where grass can be established. The bank slopes should be shallow enough to let the mower cross the channel in order to facilitate mechanical control of vegetation. This is achieved in the drain adjacent to the 15th green (Plate 4(a)).
Another approach is to incorporate swale-type feature, as evidenced running alongside the left side of the 17th green (Plate 4(b)). If the base of this feature were to contain a french drain covered in sandy soil it may be adequate for disposing of water by infiltration followed by subsurface pipes. If successful this approach could be applied to replace smaller open channels and toe drains. As many of the toe drains are penalty areas there is no perceptible disadvantage in allowing the base of

the swale to be wet during parts of the year. Again, these decisions must be balanced against playability.

Plate 4 – (a) Grassed channel banks alongside 15th green (b) Swale type feature around 17th green

Where herbicides have not been applied to open channels a diverse range of vegetative species have encroached from adjacent areas, e.g. open channel along the left side of the 3rd fairway (upper) and open channel left of 14th green, These channels should be retained in their current condition. They should not be cleaned or be targeted for herbicide application.

7.2 Reduce Channel Flow Velocities

Some of the open channel bank profiles within HGC are deep with vertical sides. This accelerates movement of water which can increase flood risk to downstream receptors. It can also cause erosion.
Reducing channel gradients, introducing bends and inserting steps can reduce flow velocities. Bends have been incorporated to some extent on the 18th hole but any positive effect is negated by the steep gradients.
Inserting of steps/shelves promotes retention of water in small pools which can provide some attenuation storage of rainfall/runoff and entrapment of suspended solids. The small pools can support small localised, wetland habitats. Pool overflows are via small cascades which can improve water quality through oxygenation. It is acknowledged this may be difficult due to the steep gradients and shallow subsoil cover. It may be possible though where gradient is shallower (e.g. stream alongside 15th hole) or where channels are deep (e.g. left side of 3rd fairway).

Some of the internal access roads and tracks act as rainfall-runoff routes and during high flows are clearly prone to erosion. Consideration should be given to interrupting runoff on these overland flow routes before flow velocities get sufficiently high to cause erosion. This applies to the path on the left side of the 18th hole which continues for a prolonged distance before out falling to an ACO drain towards the rear of the clubhouse. Flow velocities can be reduced through installation of pooled sections.

7.3 Prevent further Channel Deepening

Many of the open channels in and around the course may be too deep, examples of which are illustrated in Plate 5. This likely occurred progressively during seasonal drain maintenance. It may have been performed with the intention of lowering water table which can be effective where thick heavy overburden is present, which isn't the case at HGC.

Plate 5 – Examples of deepened channels (a) 18th hole, (b) 3rd hole (north), (c) 3rd hole (south), (d) 17th hole

In several sections the channel base has been mechanically deepened below weathered bedrock and into composite bedrock. This is unlikely to benefit soil/subsoil drainage and unlikely to improve playing conditions. It is unlikely that cross-sectional dimensions of open channels restrict flows following heavy rainfall and therefore drain deepening will not prevent overtopping during high flows. Weathered bedrock is the primary route for shallow groundwater flow and exposing this profile merely intercepts groundwater flows that would otherwise continue to flow below surface. During prolonged dry weather this zone may provide some groundwater storage.
Many of the channels were narrow when installed and their current depth means that banks and overlying soil/subsoil are being undermined in several locations (see Plate 5(a) and (c)). The steep channel gradients mean high flow velocities following heavy rainfall cause more bank erosion which causes undermining and bank collapse which requires mechanical cleaning and the cycle repeats. This pattern can become self-perpetuating once it has commenced and long -term can result in unintended drain expansion.
On a practical level the deeper, steep-sided channels can make it more difficult for players to retrieve golf balls.

7.4 Toeslope drains

Toeslope drains have been installed around much of the perimeter of the playing area, e.g. left hand side of 6th and 17th fairways. These are intended to capture rainfall-runoff from steep sided hillslopes. These toeslope drains only need to be shallow as the contributing catchment is very small. The open channel along the left side of the 17th hole is adequate in size.
In some instances these drains are unnecessarily deep, e.g. left side of 3rd fairway (Plate 5(b)). Deep drains lower groundwater levels in the underlying bedrock which in turn dries out the surrounding peats outside the playing area. Drained peats are less capable of supporting high species diversity. Dry peats may also increase risk of wildfire. It is difficult to undo the impact of drainage channels but it is advised that no additional toe slope drains are installed and that those present are not deepened further.

7.5 Management of Areas Prone to Wetness

The pattern of glacial erosion on elevated ground in Howth is such that subsoil cover is thin and contains a high amount of sand, gravel and fragmented rock. These characteristics give the course its inherently good drainage characteristics.
During high runoff events erosion of both mineral and organic soils (peats) occurs and over time these materials tend to accumulate in topographically enclosed depressions. At a large scale this has happened at the Tank. This also occurs at a much smaller scale meaning small depressions or hollows (e.g. left hand side of 2nd fairway at base of bank) and around raised greens are prone to wetness but only following prolonged rainfall. Land drains and french drains have been utilised in these areas to remove this ponded water and divert these waters towards open channels.

The areas prone to wetness in winter on Hole 1 (right of tee box and left of green), Hole 2 (left of fairway), Hole 5 (right of tee box) were inspected and dry out completely during summer. Upon review there are no wet areas within the course with scope to improve biodiversity.

7.6 Replace Open Channels with New Culvert Sections

Where open channels are not active in receiving surface runoff consideration should be given to piping and covering them with grass. This would reduce herbicide use, erosion and movement of suspended solids.
One example is the channel on the 18th fairway which runs parallel rather than perpendicular to slope gradient and is therefore functions more as a conduit route rather than for active drainage of adjacent lands. The pipe that outfalls at the 18th tee could be culverted from this point to the western boundary via an alternative route.
Other areas include the open channel and semi-covered pipe on the right side of the 17th fairway and the open channel to the right of the 3rd green.
The open channel on the right side of the 17th fairway appears to be oversized since runoff from the 3rd and 4th greens and 5th tee box are now diverted across the 3rd fairway. Waters from the 8th hole may also enter the channel across the 3rd fairway.
It is acknowledged that some of these drains are integral features of the golf course design.

7.7 Appearance of Drainage Channels

There may be scope to make some of the channels more sensitive to the surrounding environment. For example, the angular limestone gravel used to backfill the open drain on the left side of the 17th hole looks out of place. This comment also applies to the exposed bedrock in many of the open channels, as described above.

7.8 Replace/Upgrade Culverts

Some of the culvert diameters are very small, which would again reinforce the suggestion that open channels are oversized. If flooding is known to occur at certain points it is more likely caused by undersized culvert diameters rather than undersized open sections.
Identify with the greenkeeper any culverts which are prone to surcharging and may need upgrading. For example the culvert outlet at the end of the 18th open channel is effectively 100 mm, and appears undersized. It was noted at this location that some greenfield runoff appears to bypass this drainage outlet, between the 18th fairway and 10th tee box. A subtle berm could be installed to direct runoff at this location into the open channel. This would reduce the reliance on the large triple culvert in front of the 1st tee box.

7.9 Replace Tank Liner

From the outset there was an overriding view that the pond liner may be leaking. This may be the case but it is difficult to quantify the amount of water being lost through the pond base. It is unclear to what height the liner is in competent condition.
The pond is topped up for up to 12 hours per day from the groundwater well. If the pond is leaking significantly through the base there is likely to be significant recirculation of pumped groundwater, which will be causing unduly high running costs (and associated carbon cost). It is noted that cost of liner upgrade is likely to be significant.

7.10 Quantify Groundwater Pumping Regime

It is recommended that a flowmeter be installed on the groundwater pumping line. This can be a manual totaliser which is read regularly (daily/weekly) or a magmeter which measures live rates. Magmeter rates can be recorded on a datalogger (typically 5-minute recording intervals) and transmitted using telemetry to an online drive and viewer.
HGC should be aware that the EPA maintain a register of groundwater abstractions in Ireland. There are different thresholds on the register. The lowest threshold for registration is 25 m^3/d. The next threshold has not been approved yet but is likely to be in the order of 250 m^3/d.

7.11 Tank Water Level Control

It is recommended that a new Tank water level control mechanism be installed that can be adjusted more easily. This can be in the form of a cofferdam, the height of which can be adjusted by removable boards, or an adjustable weir-gate (screw) or sluice-gate. The height could be increased to increase water storage during summer and lowered to assist drainage during winter months.
A float switch connected to the well pump would switch off the well pump when the overflow spillover level is reached.

7.12 Aquifer Properties

Liner remediation may reduce the reliance on groundwater, which in turn should reduce running costs. Groundwater will still be required for irrigation during dry periods. In this regard the production well is a highly valuable asset to HGC.
Given the dynamic depth to groundwater (18 mbgl in July 2022) cessation of pumping may lead to groundwater rebound and recovery of groundwater levels, which in turn may have a negative impact on drainage in this part of the golf course. This is considered unlikely given recovery would have to be in the order of 18 m to have a tangible effect on drainage. A pumping test would shed some light on this but is not recommended at this stage.

7.13 Groundwater & Tank Water Quality

Groundwater and surface water in the pond do not mix. Installation of a baffle may help to divert waters in the southern half of the pond directly towards the overflow outlet. It may also serve to push groundwater around the pond, promoting oxygen levels. The downside of this is that it might spread iron precipitate, which visually may be undesirable.
Remediation of iron problems involves two approaches:

1. Isolating the steel casing from the well casing. PVC casing must be suspended to a level below the base of the steel casing. A spacer is installed between the PVC casing and the steel casing and the annulus (gap) is filled with cement grout.
2. The well is chemically treated for removal of ferric bacteria. Pamela Bartley of Hydro-G is recommended if these works are desired. This may need to become part of annual well maintenance.
3. It may be worth considering releasing the pump discharge into a dedicated chamber initially which will subsequently overflow to the Tank. This may capture some of the initial heavy iron precipitate.
4. Once these measures are implemented the pumping regime should be altered such that the well pump remains on for longer periods, pumping at lower rates. The pump should only be on as required.

In combination these measures combined should prolong the operational lifespan of the pumps and other water management infrastructure. There have been issues with previous well pumps and it is likely due to iron precipitate or ferric bacteria clogging the pump intake screen, which can cause motor burnout.

7.14 Development of a New On-Course Wetland Feature

Mary Tubridy and Colin O'Reilly visited several areas within the confines of Howth Golf Club with a view to developing a new, or enhancing an existing, wetland area. These were a mixture of areas prone to wetness, seasonal ponding, stream channels and permanent waterbodies and included the following:

- Low area right of 10th tee box;
- Low area left of 1st green;
- Low area left of 2nd fairway (below ledge);
- Stream left of 3rd fairway (upper and lower sections);
- Tank;
- Front of 15th green;
- Between 15th green and 16th tee box;
- Rear of 15th green;
- Left of 17th green;
- Periphery of 8th green;
- Right of 5th tee box.

Due to small catchments, steep topography and free-draining soils almost all of the areas inspected above suffer from drying out during prolonged periods of no rainfall.
There is scope to improve habitat for wetland species at the tank. The tank already has variable submergence depths and these do not appear to host aquatic vegetation. One option is to shelve out the perimeter, such that the depth to groundwater (being depth to saturated soil) varies on each shelf, from depths of 0 mm to 100 mm. This depends somewhat on the plan for level control.
The only area that receives a consistent freshwater flow all year round is the channel that runs adjacent to the 15th hole. This freshwater is actually excess groundwater from the Tank. As part of the previous recommendations the excess groundwater overflow may be eliminated, so clearly that must be factored into any consideration of developing a wetland feature at the 15th hole. There are three areas that can be manipulated to create a new wetland feature at the 15th hole.
A new pond type feature could be excavated in front of the 15th green. The pond can be shelved to support different water depths and various habitat supporting conditions. The existing stream to the left of the 15th fairway would provide an obvious inlet and outlet, the inverts of which could be set to control water depths. Consider multiple small interconnected cells. Such ponds can provide attenuation to protect downgradient receptors from flooding. Mary Tubridy added that the upslope area to the right of the 15th fairway could support a low nutrient wildflower area.
Either separately or concurrently the stream that runs along the left side of the fairway and green could be widened to generate a shallow swale type feature. Envirologic carried out a drone survey of the 15th hole with the intention of producing a topographical map, and to facilitate further discussion on this potential measure. This can be presented on a screen to relevant committee if desired.

7.15 Fertiliser Use

In order to develop low-nutrient areas around or on tee box banks requires a review of fertiliser application methods in these areas. There is likely to be peripheral loss of fertiliser to these banks during application. Any fertiliser applied to the tee box will likely hit the root system of grasses growing on the banks.
Almost all of the tee boxes and greens in HGC are raised. They were likely constructed using overburden stripped from elsewhere on the course. If these mounds contain clay-rich mineral soils they will be capable of binding nutrients such as orthophosphate. This will provide a long-term reservoir of nutrients which can be released slowly. For this reason it will be difficult to increase plant species diversity on tee box banks.
Heather thrives in very organic, low-nutrient growing medium (i.e. peat), which is why it thrives on the upper slopes surrounding the golf course. There is a pattern of gorse growth on a margin of approximately 2-3 m alongside the fairways around the course perimeter. Gorse does not favour low nutrient status and has a preference for some mineral content in the soil. It may the case that the ground on the margins of the course are receiving fertiliser inadvertently from spray drift. Need to have review fertiliser application method, risk of drift, and general approach to fertiliser use on fairways and maybe develop protocol for weather dependency (i.e. no wind).
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7.16 Impact of Climate Change

The primary impacts of climate change are likely to be higher intensity rainfall events and increasingly prolonged drought periods. Long-term planning should include some of the following measures:

- Optimisation of irrigation system;
- Drought resistant grass species on fairways;
- Irrigation points to serve drought-susceptible parts of the course;
- Increase water storage capacity;
- Irrigation should be applied according to soil moisture status and weather forecasts rather than programmed intervals.
- Rainwater harvesting from clubhouse roof, hardstanding areas.
- Recovery of excess irrigation water, surface runoff and drainage water.

The R & A Golf Course 2030 Water Project is a useful resource for additional measures. (https://golfcourse2030water.com/)

7.17 Monitoring Infrastructure

Ultimately, more efficient water management systems require reliable and accurate monitoring infrastructure. In the long-term improved understanding of water usage and power consumption would benefit from the following monitoring infrastructure:

- Flowmeter on groundwater well discharge line availing of datalogger and telemetry;
- Groundwater level logger on groundwater levels in pumping well and/or redundant well;
- Irrigation water monitoring.
- Water level logger to monitor Tank water levels;
- Rainfall gauge;
- Soil moisture probes.

APPENDICES

Appendix A - PW2 Drilling Log

Appendix B - Laboratory Certificates of Analysis

Appendix 3
Mammal (including bat) assessment of Howth Golf Club

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Report to Mary Tubridy and Associates

August 2022

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Introduction:

Following the last glacial period Howth was an island, with its landward-facing shoreline corresponding roughly with the current western boundary wall of Howth Demesne (Mitchell 1956). A sandbank has since risen up connecting the island to the main land at Sutton and this created the peninsula as it exists today. Howth is thought to have been nearly bare of trees from at least the 15th century to as late as the 19th century; however, individual native and exotic trees and shrubs have been planted around the demesne by successive generations of the St. Lawrence family. Howth golf club was founded in 1916 on the southern side of the Howth Sutton peninsula on the north side of Dublin city. In 2021 there was a large gorse fire that burned for nearly six weeks destroying much (TheJournal.ie 2021) of the habitat around the study site. This is starting to recover at present. There is a high maintenance regime on the golf course which removes a lot of the tracks and signs of mammals. The site is approximately 58ha. There is a large population of Rabbits (*Oryctolagus cuniculus)* that are out during the day. A fox *(Vulpes vulpes)* could be seen walking on the greens. There were other signs of mammals around the site but in a study this short the mammals themselves were not visible.

Methods:

Mammal Survey

To examine the resident non-volant mammals of Howth golf course site two visits were conducted. The method used was to walk the site during daylight hours and as most Irish land mammals are nocturnal, they are detected by identifying their tracks and signs etc. rather than any visual determinations. The site was investigated on the 6th and 7th of July 2022 for any signs of mammals. This was principally done by examining the rough vegetation around the greens, stone walls surrounding the site, scrubland and soil banks for any of the typical signs of these mammals. These included where mammals live (setts, earths and warrens), their faeces (droppings, dung, scats, spraints of the respective mammals), digging, footprints and carcases. As this was conducted during the summer the vegetation was very dense and therefore signs were harder to locate. Where there was Bramble and Bracken, they were penetrated as much as possible and all scrub was checked for badger setts and any other potential mammals where access was possible.

Bat Survey

To examine for Bats on the Howth golf course two site visits were conducted at night on the 11th and 12th July 2022 between 10pm and 2am and the evening of the 23rd and 26th of September.

Eleven (11) locations (see Figure 1) were selected and surveyed using a Batbox baton detector for 10 minutes.
On the survey nights weather conditions deteriorated. Although dry the wind picked up each evening and this would affect the amount of insect flying.

Fig. 1 Locations examined for bat activity

Results

There were no signs of protected mammals. No breeding sites or signs for Badgers were determined during this survey.

No signs of bats were detected. The site is very open. Weather suited bats in early evening around 17:30, but around 21:30 the wind picked up again.

Notes on recorded species:

Red Fox:

Red Fox *(Vulpes vulpes)* was seen on day one of the study walking on the green near the pond (see figure 2). Fox earths are often developed by the expansion of rabbit burrows or they also take advantage of disused badger sett. Earths are always malodorous. Earths typically have one entrance and a simple construction. No earths were detected.

Figure 2: Red Fox *(Vulpes vulpes)* walking between 12th and 13th Green.

Rabbits:

Rabbits (*Oryctolagus cuniculus)* were found throughout the site (see figure 3) especially near the edge of the greens, they did not move out to far from where brambles created cover for the warren. The rabbits were active all day.

Figure 3:

Mammals that may be present:

Grey squirrel:

Eastern grey squirrel *(Sciurus carolinensis)* has been seen in the woodland to the north of Howth golf course (pers.comm. walker crossing the golf course). Previous studies carried out on the grounds of Howth castle showed the presence of grey squirrel.

Hedgehog:

Hedgehogs are active at night but would be difficult to detect in a short-term study. It is very probable that they are present here as the habitat is suitable.

Brown Rat:

Brown rat (*Rattus norvegicus)* is very common and all do there were very little signs of rats around the golf course the staff said they were present (pers. comm.Ben Moore, head greenkeeper)

House mouse:

It is very probable that House mouse *(Mus musculus)* is present here as the surrounding area has been developed for residential units. They were reported to me by staff found in the seed store, (pers.comm.Ben Moore)

Wood mouse:

it is very probable that Wood mouse *Apodemus sylvaticus* (Field mouse) are present here as there were signs along the edge of the greens.

Stoat:

Stoat (*Mustela erminea hibernica*) Stoats are very difficult to locate in any short-term study. They will typically den in rabbit warrens that they have taken over having killed the occupants. They are a very widespread mammal. Stoat were reported to me (pers.comm.Ben Moore). It is very probable that they are present here as there is a large amount of prey species.

Bats

No bats were detected on the golf course on the nights that the survey was conducted. But from the literature they have been reported on the peninsula in a survey by Brian Keeley (2006). Species recorded were the Common pipistrelle (*Pipistrellus pipistrellus),* Soprano pipistrelle (*Pipistrellus pygmaeus),* Brown long-eared bat (*Plecotus auratus)* and Leisler's bat (*Nyctalus leisleri).* There was a more resent report of a bat in Vogue Williams home in Howth on the 6th of June 2022 (www. Sundayworld.com).

Other fauna noted during and prior to the survey

Flocks of Curlew (*Numenius arquata*) were seen on the greens. This is the only Irish bird on the IUCN Red list of threatened species (IUCN 2022). Blackbird *(Turdus merula*), Robin (*Erithacus rubecula*), Stonechat *(Saxicola rubicola*), Magpie (*Pica pica*) and Jay (Garrulus glandarius).

Figure 4: Flock of Curlew on the 12th Green and a Stonechat at the edge of the 4th green.

Discussion:

This was a very short study of the 58ha site and it can only give an indication of what mammal species are using this habitat. This is a well-maintained site with very well defined habitats throughout and signs of a healthy balance between recreation and wildlife areas. A full mammal survey should be undertaken. This should involve live trapping under licenses from NPWS using Longworth trap, Trap man mink traps, and footprint tracking tunnels. Trap cameras could also be employed and night lamping. The literature suggests that bats are present on the Howth peninsula but no roost was found on the site of the golf course. It is likely that bats use the golf course occasionally.

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Vogue Williams reveals she was left 'screaming' after finding bat in Howth home - SundayWorld.com (2022)

'The situation has vastly improved': Gorse fires on Howth Head now contained (thejournal.ie) 2021

Summary

Appendix 4
Flora Study of Howth Golf Club, Co. Dublin

Report for Mary Tubridy & Associates

By Alexis FitzGerald, *FitzGerald Ecology*

October 2022

Table of Figures

1. Introduction

In 2022, Mary Tubridy & Associates commissioned FitzGerald Ecology to produce a flora study of Howth Golf Club on Howth Head, north Co. Dublin. This study will help to inform a wider Biodiversity Management Plan for Howth Golf Club.

A full vegetation study of the habitats on site was conducted (including rare/legally protected plant and invasive species surveys), along with a detailed summary report outlining and describing the various habitats and plants present on site, including detailed habitat maps and species lists. The report was also to include a section on proposed management recommendations for the enhancement of habitats and plants within the site. This report is presented herein.

The study area for this vegetation study was all accessible areas of the Howth Golf Club course (see Figure 1). The site encompasses an extended granitic slope with extensive areas of amenity grassland, scrub, dry-humid acid grassland and dry heath. The site is generally at higher, more exposed elevations at the eastern and northern edges of the site where the slope raises up to higher altitudes towards the Ben of Howth.

Howth Golf Club is surrounded to the south, east and north by the *Howth Head Special Area of Conservation (SAC)* and the edges of the study area overlap in some places with the SAC (see Figure 2). Howth Golf Club is therefore directly adjacent to a site of **International importance**. This SAC was primarily designated for its important coastal and heathland habitats. Fingal County Council therefore has an important role internationally in protecting and enhancing the various habitats and species within this SAC.

2. Methodology

The habitat/plant walkover surveys were carried out by Alexis FitzGerald B.A. M.Sc. on the 8th June and 17th July 2022, with reference to Smith *et al.* (2011). The habitats were classified according to the Irish Heritage Council classification system (Fossitt, 2000). The abundance of each species present in each habitat was recorded using the Domin scale[1]. EU Habitats Directive Annex I habitats were classified as per Commission of the European Communities (2013), also with reference to the corresponding national habitat survey reports and descriptions, particularly NPWS (2019). The nomenclature for the Annex I habitats also follows Commission of the European Communities (2013), with any abbreviated names for the habitats following NPWS (2019). Vascular plant taxonomy and nomenclature follows Stace (2019), whilst bryophyte taxonomy and nomenclature follow Atherton *et al.* (2010). Ecological evaluations were made according to the criteria as set out in Appendix II.

3. Baseline Study

Legally Protected and Rare Flora

No plant species listed on the Flora (Protection) Order, 2015, were recorded during the field surveys in 2022. Three locally rare native species were recorded within the study area (see Figure 7), namely, *Warnstorfia fluitans*, *Nitella flexilis* agg. and *Senecio sylvaticus*. The latter vascular plant species is rare

[1] The Domin scale is used to estimate the abundance of a particular species in a particular area of vegetation. The scaleutilised here is from + to 10, each stage representing a range of percentage values from + = cover of <1% and a single individual, to 10 = cover of 91-100%.

in Co. Dublin, according to Doogue *et al.* (1998). According to the plant distribution maps of Botanical Society of Britain and Ireland (2022), this species is still rare in Co. Dublin, but it is listed as Least Concern (LC) by Wyse Jackson *et al.* (2016). The bryophyte species *Warnstorfia fluitans* is only known from a handful of sites in Co. Dublin and is therefore rare at a county level (Joanne Denyer, pers. comm., July 2022). *Warnstorfia fluitans* is also listed as Least Concern (LC) by Lockhart *et al.* (2012). The charophyte species *Nitella flexilis* agg. is only known from a handful of sites in Co. Dublin but has been recorded previously from likely this same wetland site by Robert Lloyd Praeger in 1894 (Doogue *et al.* 1998).

Non-native (Invasive) Flora

One plant species listed on the Third Schedule of the *European Communities (Birds and Natural Habitats) Regulations, 2011* was recorded during the field surveys in 2022, namely, *Rhododendron ponticum*. This species is established in a number of locations on site, mostly in scrub (WS1) habitat, but it also potentially threatens Annex I dry heath (HH1) habitat here. Fingal County Council are already aware of these populations and are currently undertaking an eradication programme for thisspecies in multiple locations on Howth Head.

Seven (non-listed) non-native/introduced plant species were also recorded across the study area during the field surveys, and these are considered to be invasive in some habitats and contexts. These species have arrived by various means, including natural and human routes, such as being transported here by birds, small mammals and wind, as well as via accidental transport on human visitors and/or their equipment. The relevant species are as follows: *Buddleia davidii, Pilosella aurantiaca, Conyza floribunda, Cotoneaster* species, *Petasites fragrans, Malva moschata* and *Rapistrum rugosum*. None of these species are expected to cause a significant threat in the future via rapidly expanding populations on site.

Chamaemelum nobile was also recorded on site and this species is often considered to be introduced in Ireland, although its status is uncertain. Stace (2019) considers it to be native in Ireland, but introduced in Scotland. It is possible that it may have spread from introduced 'wildflower' seed mixtures in the golf club, although it could also be an archaeophytic remnant population which has come to the soil surface due to recent disturbance (scrub removal and fires). Its true origins on site remain unclear.

All of the non-native species recorded on site are mapped in Figure 6.

Habitats

The habitat types (and/or mosaics) recorded within the study area according to the Heritage Council classification system (Fossitt, 2000) are described in detail in section 3.1 (and are also mapped in Figures 3 to 5). Full plant species lists (with Domin abundance estimates for each species) for each recorded habitat are also presented in Appendix I of this report.

The following 17 habitat types (and/or mosaics) were recorded within the study area during the field surveys in 2022:

- Dry siliceous heath (HH1), including the EU Habitats Directive Annex I habitat [4030]European dry heaths
- Exposed siliceous rock (ER1)
- Other artificial lakes and ponds (FL8)
- Reed and large sedge swamp (FS1)

- Eroding/upland rivers (FW1)
- Dry meadows and grassy verges (GS2)
- Dry calcareous and neutral grassland (GS1)
- Dry-humid acid grassland (GS3)
- Scrub (WS1)
- Dense bracken (HD1)
- Scattered trees and parkland (WD5)
- Amenity grassland (GA2)
- Drainage ditches (FW4)
- Ornamental/non-native shrub (WS3)
- Exposed sand, gravel or till (ED1)
- Recolonising bare ground (ED3)
- Buildings and artificial surfaces (BL3)

Fig. 1 Study Area (outlined by red boundary)

Figure 2. Overlap between the Howth Golf Club study area and the Howth Head SAC

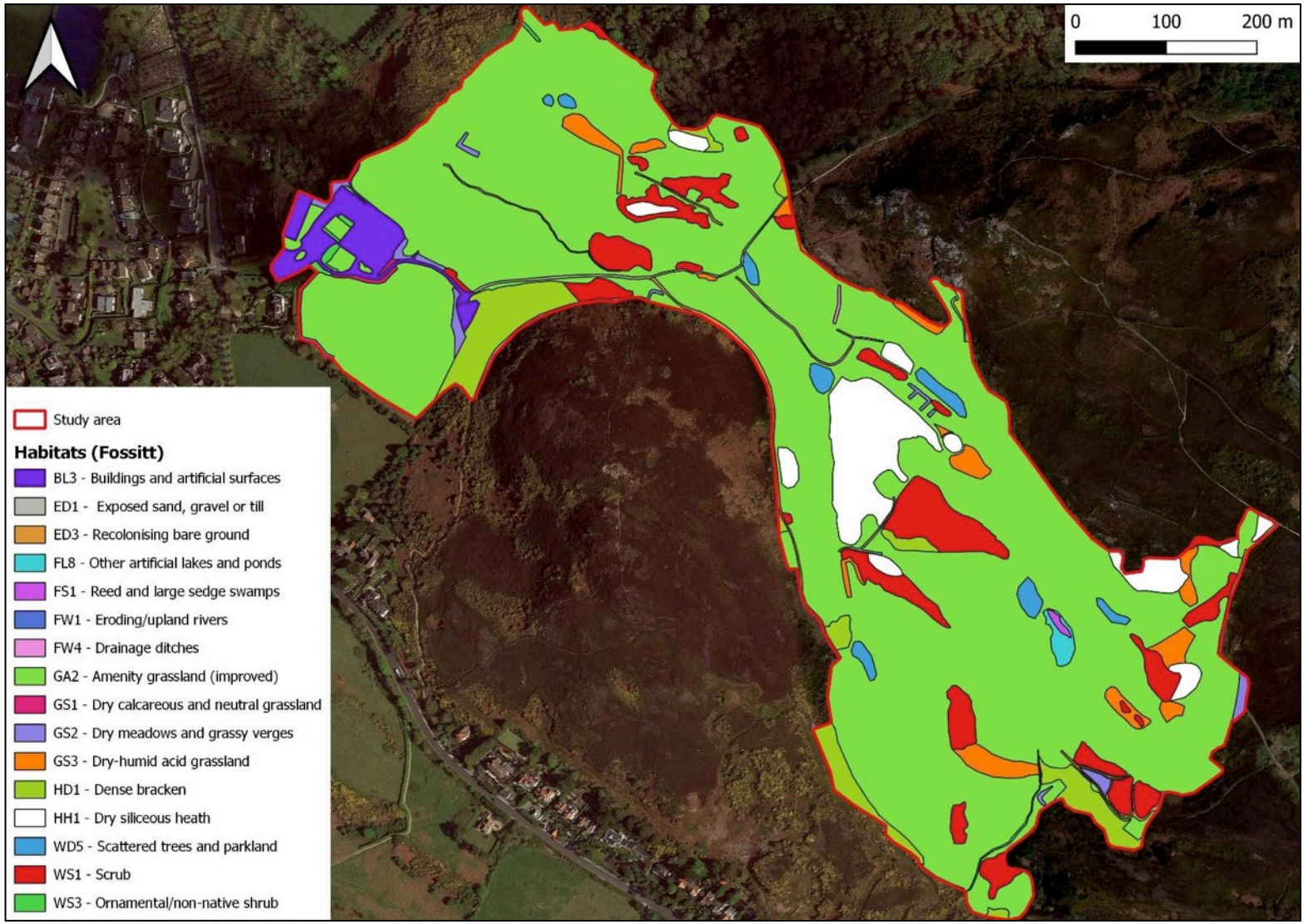

Figure 3. All habitats recorded within the study area during the field surveys in 2022 – the dominant habitat in each polygon is displayed here (habitat mosaics do occur but are not displayed for ease of viewing)

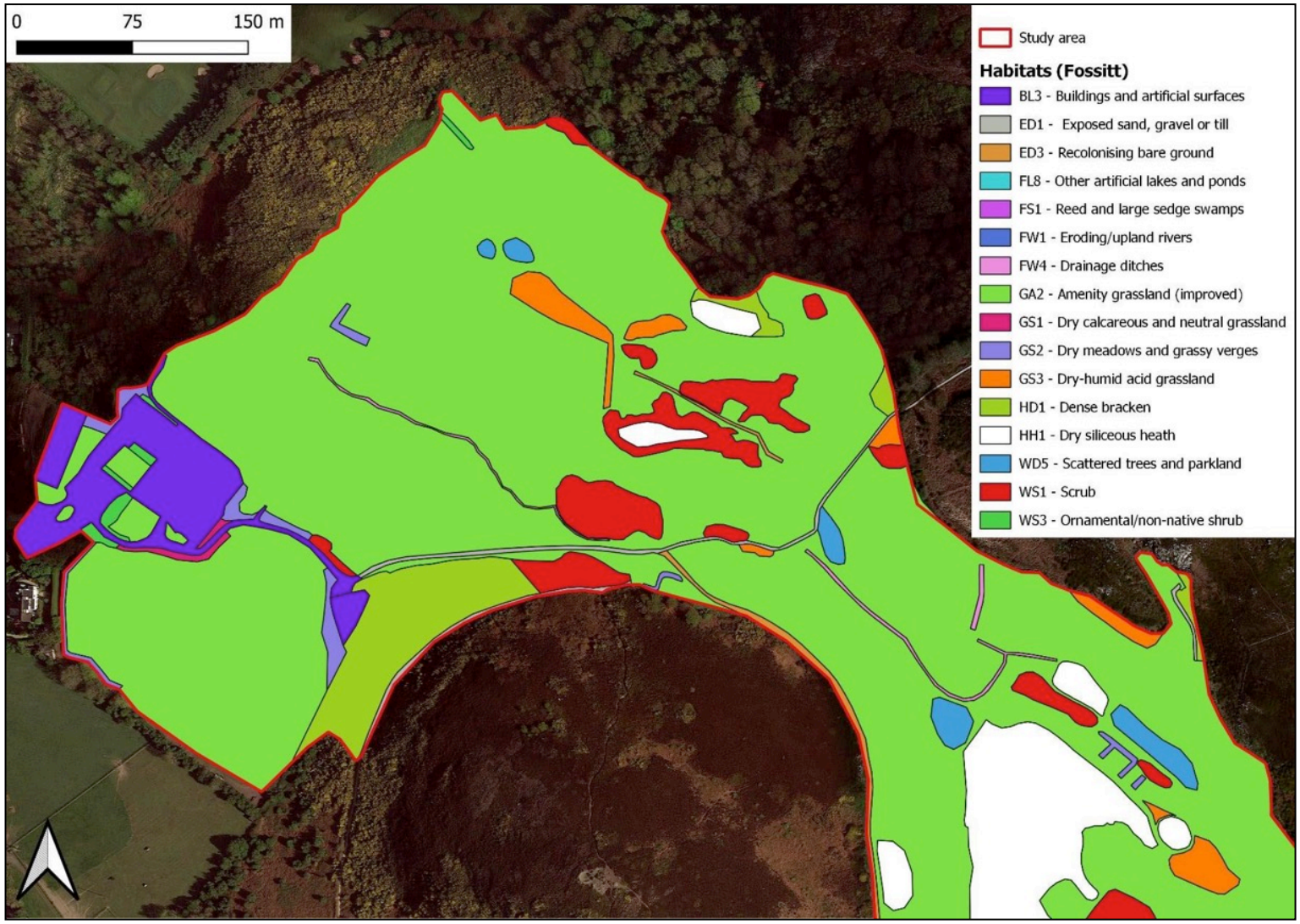

Figure 4. Close up view of habitats recorded within the northern section of the study area during the field surveys in 2022 – the dominant habitat in each polygon is displayed here (habitat mosaics do occur but are not displayed for ease of

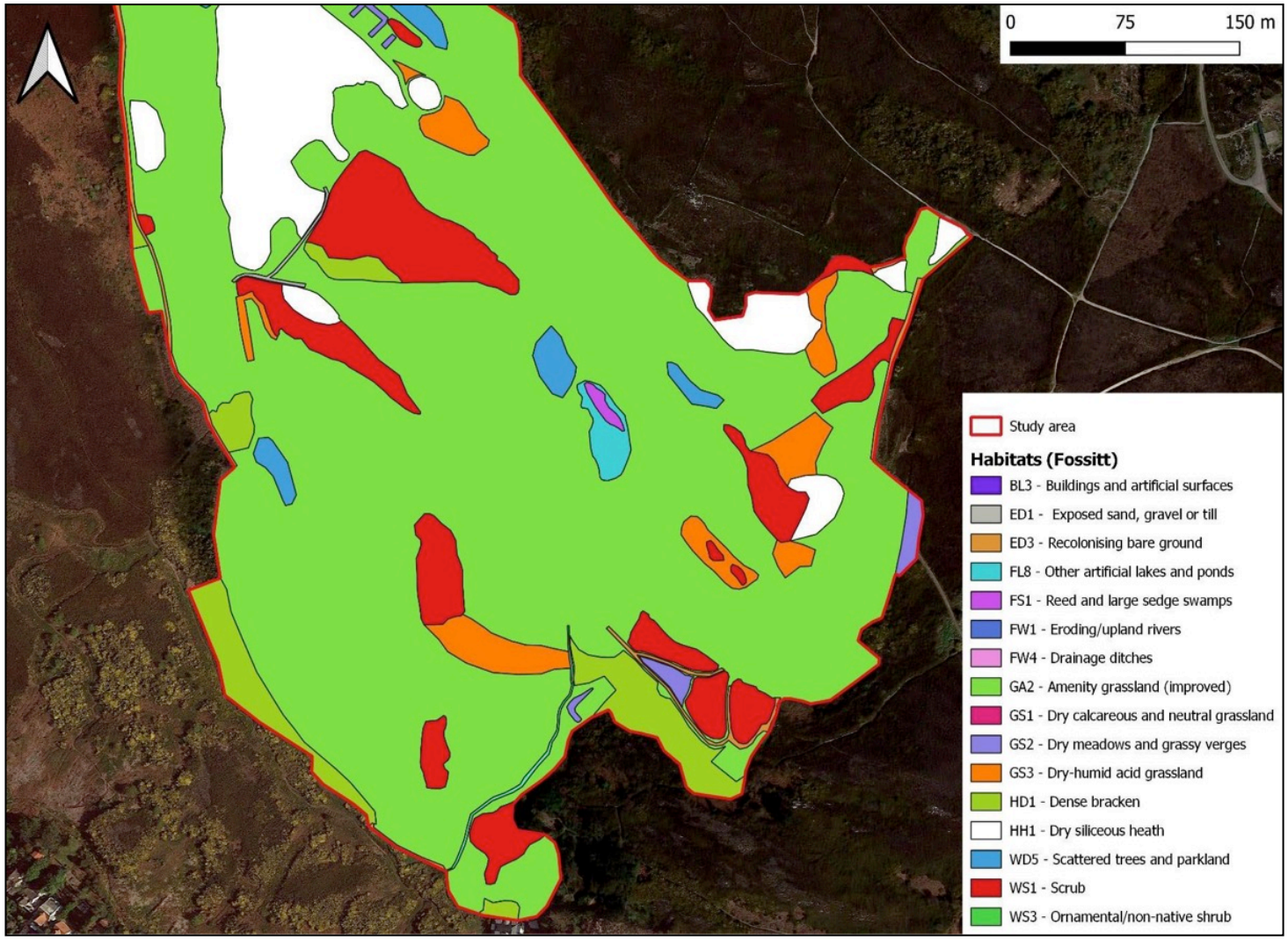

Figure 5. Close up view of habitats recorded within the southern section of the study area during the field surveys in 2022 – the dominant habitat in each polygon is displayed here (habitat mosaics do occur but are not displayed for ease of

Figure 6. Locations of all non-native invasive plant species recorded within the study area during the field surveys in 2022

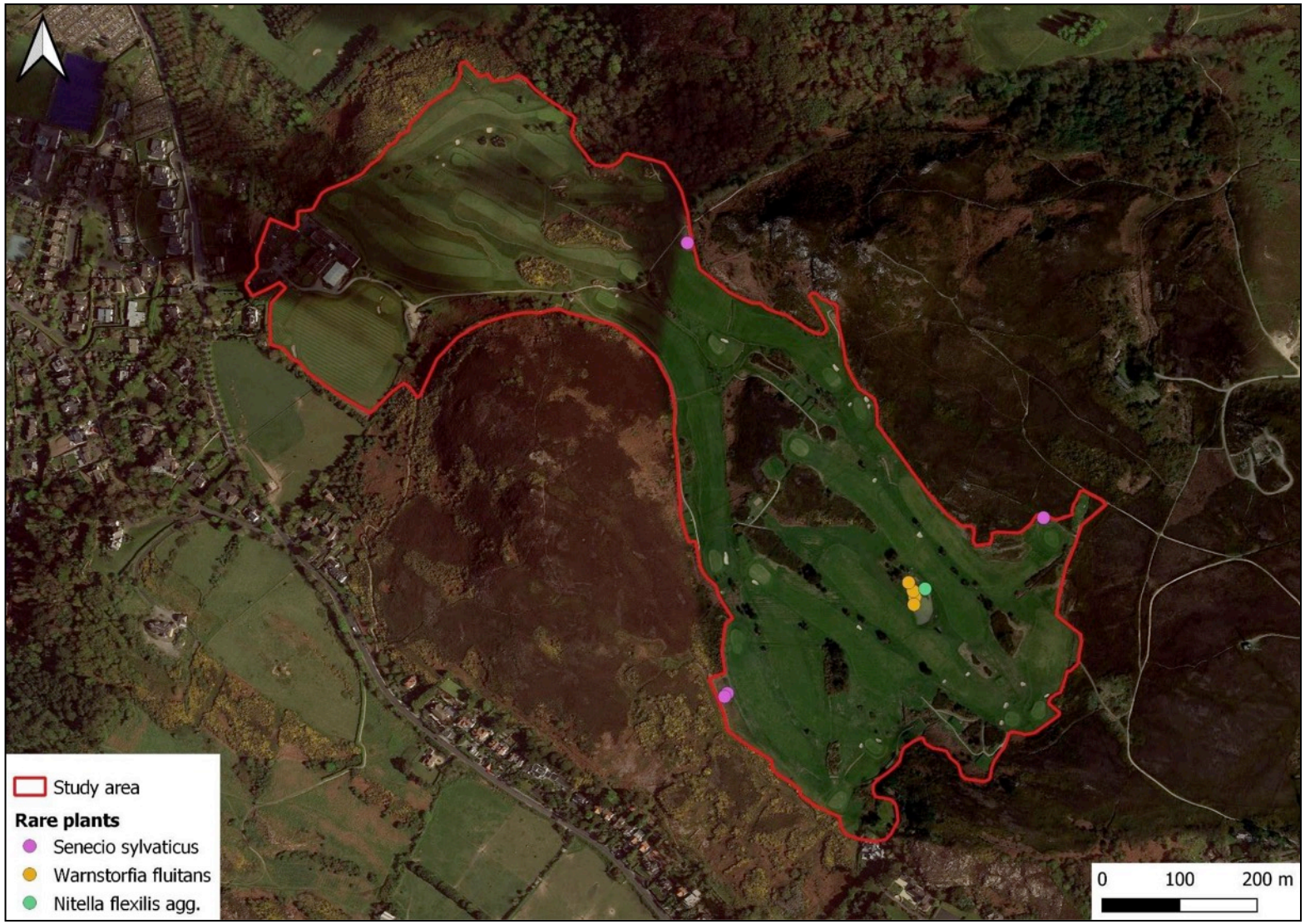

Figure 7. Locations of all rare plant species recorded within the study area during the field surveys in 2022

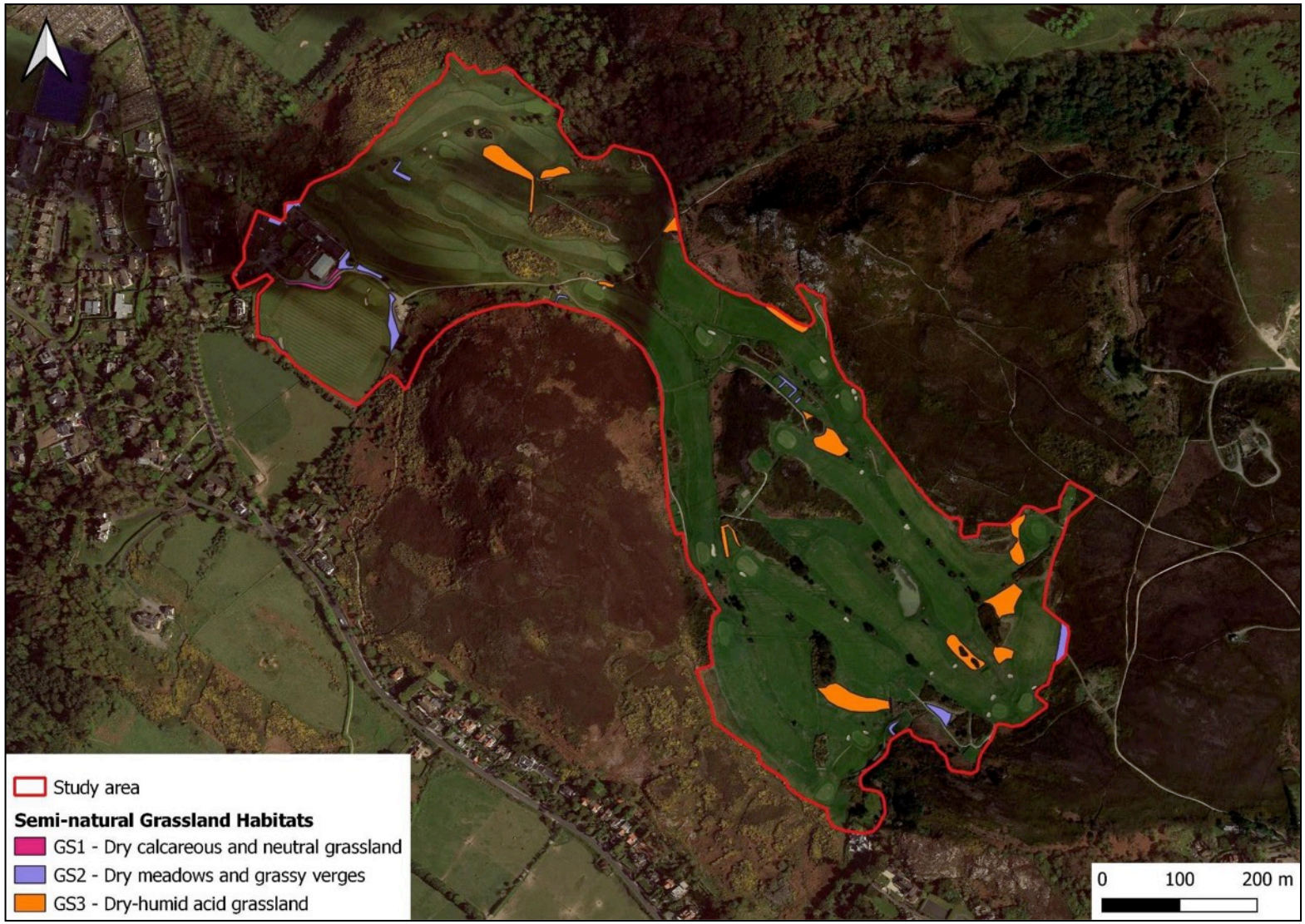

Figure 8. Locations of all semi-natural grassland habitats recorded within the study area during the field surveys in 2022

1.1.1 Dry siliceous heath (HH1), including the EU Habitats Directive Annex I habitat [4030] European dryheaths

Dry siliceous heath (HH1) (see Plate 1) habitat occurs in scattered patches on higher rocky ground between the fairways, mostly in the south-east of the site and is often found in mosaic with scrub (WS1), dry-humid acid grassland (GS3) and exposed siliceous rock (ER1) habitats. This habitat contains an abundance of the characteristic heathland species *Calluna vulgaris* and *Erica cinerea*, as well as a significant presence of the dwarf shrub *Ulex gallii*, along with the herbaceous species *Molinia caerulea, Deschampsia flexuosa* and the bryophyte species *Hypnum cupressiforme* and *Hypnum jutlandicum*.

All of the areas of dry siliceous heath within the site were classified as the EU Habitats Directive Annex I habitat [4030] European dry heaths. As some of these heath areas are within the Howth Head SAC and this is a qualifying interest (QI) habitat for the SAC, this habitat on site is therefore considered to be of **International importance**.

Plate 1. Dry siliceous heath (HH1) vegetation within the study area

1.1.2 Exposed siliceous rock (ER1)

Exposed siliceous rock (ER1) habitat occurs scattered across the site, always found in lesser quantity in mosaic with scrub (WS1) and other habitats. The vegetation is generally patchy and often sparse in this habitat, due to the significant presence of acidic (siliceous) bedrock on the surface. Hardy tufted grasses such as *Festuca ovina* agg. have become established, along with occasional low woody shrubs like *Ulex gallii*. Herbaceous species such as *Rumex acetosella, Teucrium scorodonia* and *Sedum anglicum* can be found here also.

This habitat is considered to be of **Local importance (higher value)**, due to its relatively high species diversity and its scarcity at a county level.

1.1.3 Other artificial lakes and ponds (FL8)

Other artificial lakes and ponds (FL8) (see Plate 2) habitat can be found as one pond in a natural hollow in the south-east of the study area. This pond is very likely to have been once the site of a natural lough and wetland site, as can be seen on the historic six-inch colour maps of the area from 1837- 1842 (Scott Cawley, 2021). The pond/wetland has since been deepened and re-profiled and is now used to provide irrigation water for the surrounding golfing fairways. The pond contains such aquatic species as *Potamogeton natans, Nitella flexilis* agg. (a rare charophyte in Co. Dublin) and *Callitriche* agg. The rare Dublin bryophyte species *Warnstorfia fluitans* occurs on the margins of the pond, alongwith the commoner species *Ranunculus repens* and *Juncus articulatus.*

This habitat is considered to be of **County importance**, due to its relative scarcity within the county council area and due to the presence here of plant species which are rare on a county level.

Plate 2. Other artificial lakes and ponds (FL8) pond in the south-east of the study area, with reed and large sedge swamp (FS1) habitat also on display in the centre of the image (see below)

1.1.4 Reed and large sedge swamp (FS1)

Reed and large sedge swamp (FS1) (see Plate 2) habitat occurs within the pond in the south-east of the site. This habitat contains a predominance of the large grass species *Phragmites australis* and the herbaceous species *Equisetum fluviatile,* along with lesser quantities of *Ranunculus flammula, Typha latifolia,* etc.

This habitat is considered to be of **Local importance (higher value)**, due to the scarcity of such wetlandhabitats in the vicinity.

1.1.5 Eroding/upland rivers (FW1)

Eroding/upland rivers (FW1) (see Plate 3) habitat within the site comprises of the upper reaches of the Balsaggart Stream, which flows from the pond southwards in the south-east of the golf course fairways on open ground. The stream has been heavily modified, canalised and partly culverted due to the surrounding golf course developments. As such, the stream does not preserve its natural flow dynamics and the channel bed is mostly muddy/silty with little gravels or sands. The stream was seen to be still (shallow) wet in the height of the summer months.

A few aquatic species were seen occurring in the stream, including *Potamogeton natans* and *Callitriche* agg. Macrophytes present include *Apium nodiflorum* and *Epilobium parviflorum*, and the bryophyte species *Pellia endiviifolia* and *Cratoneuron filicinum* also occur.

The stream habitat on site is considered to be of **County importance** due to the scarcity of the habitat locally and given that it flows into and through an SAC directly south of the study area.

Plate 3. Heavily modified eroding/upland rivers (FW1) habitat in the south-east of the study area

1.1.6 Dry meadows and grassy verges (GS2)

Dry meadows and grassy verges (GS2) habitat is scattered throughout the site, in restricted areas that are not mown for extended periods of time, usually on banks adjoining tee off areas. This habitat is characterised by being rarely mown or grazed, which causes the grassland to become rank over time. As a result, it is often dominated by such perennial tussocky grass species as *Arrhenatherum elatius* and *Dactylis glomerata*, as are present within the habitat on site (predominantly the former), along with significant quantities of *Poa trivialis, Holcus lanatus, Urtica dioica* and *Epilobium* species.

This habitat is considered to be of **Local importance (higher value)**, due to its broad habitat potentialand relatively high species diversity.

1.1.7 Dry calcareous and neutral grassland (GS1)

Dry calcareous and neutral grassland (GS1) (see Plate 4) habitat occurs along two path-side banks in the north-western end of the site. The substrate within these banks is largely calcareous in nature and they are not often mown, thus allowing calcareous grassland to develop. This habitat has a relatively high level of plant species diversity, including such grass and sedge species as *Festuca rubra* agg., *Carex flacca, Holcus lanatus* and *Agrostis capillaris,* and herbaceous species such as *Plantago lanceolata*, *Achillea millefolium, Primula veris, Senecio erucifolius* and the orchid species *Anacamptis pyramidalis.*

Some areas of GS1 grassland may be classified as the EU Habitats Directive Annex I habitat [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometea) (including the priority orchid-rich variety, *6120). However, the GS1 grassland on site does not classify as such due to the insufficient number of positive indicator species present for this habitat type.

This habitat is considered to be of **Local importance (higher value)**, due its high species diversity, including at least one orchid species.

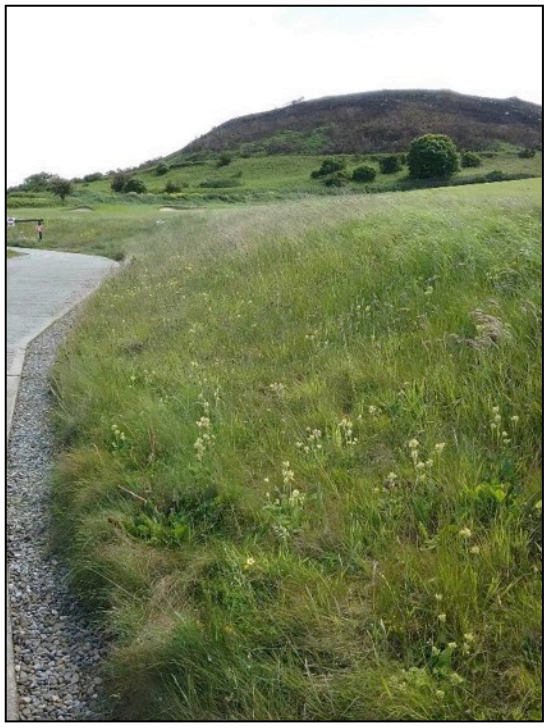

Plate 4. Dry calcareous and neutral grassland (GS1) habitat in the north-west of the study area, with abundant Primula verisin view

1.1.8 Dry-humid acid grassland (GS3)

Dry-humid acid grassland (GS3) (see Plate 5) habitat was recorded scattered across the site in low management rough areas between the heavily managed fairways, and it is also found in lesser quantities in mosaic vegetation with scrub (WS1) and exposed siliceous rock (ER1). Grass species recorded in GS3 habitat on site include *Agrostis capillaris*, *Anthoxanthum odoratum*, *Poa pratensis* agg., *Holcus lanatus* and *Festuca rubra* agg., whilst herbaceous species like *Rumex acetosella*, *Seneciosylvaticus* and *Galium saxatile* were also recorded widely.

The grassland on site does not correspond with the priority Annex I habitat type [*6230] Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe), as there are insufficient positive indicator species for this habitat within the site (including *Nardus stricta*).

The GS3 habitat on site is considered to be of **County importance**, given its relatively high species diversity and the relative scarcity of this habitat within Co. Dublin, some of which is present in an internationally designated site.

Plate 5. Dry-humid acid grassland (GS3) vegetation in the south-east of the study area – the green fairway amenity grassland (GA2) is in view in the background of the image

1.1.9 Scrub (WS1)

Scrub (WS1) habitat was recorded widely across the site on higher rocky ground between the fairways. This habitat is characterised by the dominance of such shrub species as *Rubus fruticosus* agg., *Ulex europaeus* and *Crataegus monogyna*, as well as the tall fern species *Pteridium aquilinum*. Non-native shrub species also occur scattered within the vegetation, including *Buddleia davidii* and *Rhododendron ponticum*. In the ground layer of these shrubs, some tall and/or shade-tolerant, perennial grass species occur, including *Arrhenatherum elatius* and *Dactylis glomerata*, as well as creeping herbaceous species like *Galium aparine*.

This habitat is considered to be of **Local importance (higher value)**, due to its relatively high species diversity and broad habitat potential.

3.1.2. Local Importance (Lower Value) Habitats

Dense bracken (HD1), scattered trees and parkland (WD5), amenity grassland (GA2), drainage ditches (FW4), ornamental/non-native shrub (WS3) and recolonising bare ground (ED3) habitats have all been recorded on site during the field surveys in 2022 and are mapped in Figures 3-5. All of these habitats

are considered to be of **Local importance (lower value)** due to their low species diversity, poor habitatpotential and lack of scarcity at a local level.

3.1.3. Negligible Habitats

Buildings and artificial surfaces (BL3), and exposed sand, gravel or till (ED1) habitats have both been recorded on site during the field surveys in 2022 and are both mapped in Figures 3-5. Both of these habitats are considered to be of **Negligible importance** due to their very low species diversity and very poor habitat potential.

4. Management Recommendations for Habitats

A series of priority management recommendations are presented below for each of the most important habitats on site. These management recommendations will be considered as part of a future biodiversity management plan for the site. They are as follows:

1.1.10 **Dry calcareous and neutral grassland (GS1), dry-humid acid grassland (GS3) and dry meadows and grassy verges (GS2) –**

1) All areas of these existing semi-natural grasslands (mapped on Figure 8) on site should not be planted with any further 'wildflower' seed mixtures as this is introducing numerous non- native species (nationally and/or locally) to the site (see Plate 6) – all seed mix species already sown on site should also be removed by hand (see Figure 6 for locations of seed mixes).

2) Limit/eliminate herbicide use on site.

3) Furthermore, very few areas of low management grassland exist at present on site so it is recommended that there be a significant increase in areas of low intensity management grassland on the golf course. These 'rough' areas can be integrated with the wider golf course design, which will allow play to continue on site seamlessly whilst enhancing further grasslandhabitats in the locality.

1.1.11 **Dry siliceous heath (HH1), scrub (WS1) and exposed siliceous rock (ER1) –**

1) Consider removing all invasive species on site, with the removal of *Rhododendron ponticum* from the dry siliceous heath areas being a priority.

2) Consider the local, selective removal of *Ulex europaeus* shrubs (and other scrub species) from dry siliceous heathlands on site, where they are dominating the true heath species (*Calluna vulgaris, Erica cinerea,* etc.).

1.1.12 **Other artificial lakes and ponds (FL8), reed and large sedge swamp (FS1) and eroding/upland rivers(FW1) –**

1) Create a low intensity management buffer zone of approximately 3-5 metres (or more if feasible) around all wetland habitats on site, with the pond and the canalised Balsaggart Stream in the south-east of the site being prioritised.

2) Consider de-culverting/de-canalising the Balsaggart Stream.

3) Consider widening the existing pond and creating new additional ponds – this may require adaptation/improvement of the existing water management/irrigation regime on site, in conjunction with Howth Golf Club site managers.

Plate 6. 'Wildflower' seed mixture species sown in the north of the site – these species should be removed as they are non-native (nationally and/or locally).

5. Summary

This report presents a summary of findings from botanical field surveys in the summer of 2022 at Howth Golf Club, on Howth Head, north Co. Dublin. A total of 17 separate habitat types were recorded across the study area, including one EU Habitats Directive Annex I habitat, namely, [4030] European dry heaths. Three rare Dublin plant species were also recorded, along with a wide range of non-native invasive plant species, including one species which is listed on the Third Schedule of the *European Communities (Birds and Natural Habitats) Regulations, 2011*, namely, *Rhododendron ponticum*. A series of management recommendations have also been provided for the most important habitats on site. These will be considered as part of a future biodiversity management plan for the site, which is currently being prepared.

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