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Conservation Objectives Series

Glenade Lough SAC 001919

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Introduction

The overall aim of the Habitats Directive is to maintain or restore the favourable conservation status of habitats and species of community interest. These habitats and species are listed in the Habitats and Birds Directives and Special Areas of Conservation and Special Protection Areas are designated to afford protection to the most vulnerable of them. These two designations are collectively known as the Natura 2000 network.

European and national legislation places a collective obligation on Ireland and its citizens to maintain habitats and species in the Natura 2000 network at favourable conservation condition. The Government and its agencies are responsible for the implementation and enforcement of regulations that will ensure the ecological integrity of these sites.

A site-specific conservation objective aims to define favourable conservation condition for a particular habitat or species at that site.

The maintenance of habitats and species within Natura 2000 sites at favourable conservation condition will contribute to the overall maintenance of favourable conservation status of those habitats and species at a national level.

Favourable conservation status of a habitat is achieved when:

- its natural range, and area it covers within that range, are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable.

The favourable conservation status of a species is achieved when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Notes/Guidelines:

1. The targets given in these conservation objectives are based on best available information at the time of writing. As more information becomes available, targets for attributes may change. These will be updated periodically, as necessary.
2. An appropriate assessment based on these conservation objectives will remain valid even if the targets are subsequently updated, providing they were the most recent objectives available when the assessment was carried out. It is essential that the date and version are included when objectives are cited.
3. Assessments cannot consider an attribute in isolation from the others listed for that habitat or species, or for other habitats and species listed for that site. A plan or project with an apparently small impact on one attribute may have a significant impact on another.
4. Please note that the maps included in this document do not necessarily show the entire extent of the habitats and species for which the site is listed. This should be borne in mind when appropriate assessments are being carried out.
5. When using these objectives, it is essential that the relevant backing/supporting documents are consulted, particularly where instructed in the targets or notes for a particular attribute.

Qualifying Interests

**** indicates a priority habitat under the Habitats Directive***

001919	Glenade Lough SAC
1092	White-clawed Crayfish *Austropotamobius pallipes*
1833	Slender Naiad *Najas flexilis*
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation

Please note that this SAC is adjacent to Ben Bulben, Gleniff and Glenade Complex SAC (000623), Lough Gill SAC (001976) and Sligo/Leitrim Uplands SPA (004187). See map 2. The conservation objectives for this site should be used in conjunction with those for the adjacent sites as appropriate.

Supporting documents, relevant reports & publications

Supporting documents, NPWS reports and publications are available for download from: www.npws.ie/Publications

NPWS Documents

Year :	1984
Title :	The vegetation of Irish lakes
Author :	Heuff, H.
Series :	Unpublished report to NPWS
Year :	2002
Title :	*Najas flexilis* in Donegal
Author :	Roden, C.M.
Series :	Unpublished report to NPWS
Year :	2004
Title :	The distribution of *Najas flexilis* in Ireland 2002-2004
Author :	Roden, C.M.
Series :	Unpublished report to NPWS
Year :	2007
Title :	Supporting documentation for the Habitats Directive Conservation Status Assessment - backing documents. Article 17 forms and supporting maps
Author :	NPWS
Series :	Unpublished report to NPWS
Year :	2009
Title :	Monitoring of white-clawed crayfish *Austropotamobius pallipes* in Irish lakes in 2007
Author :	O'Connor, W.; Hayes, G.; O'Keeffe, C.; Lynn, D.
Series :	Irish Wildlife Manuals, No. 37
Year :	2010
Title :	A technical manual for monitoring white-clawed crayfish (*Austropotamobius pallipes*) in Irish lakes
Author :	Reynolds, J.; O'Connor, W.; O'Keeffe, C.; Lynn, D.
Series :	Irish Wildlife Manuals, No.45
Year :	2013
Title :	The status of EU protected habitats and species in Ireland. Volume 2. Habitats assessments
Author :	NPWS
Series :	Conservation assessments
Year :	2013
Title :	Article 17 assessment form and audit trail for *Najas flexilis*, the slender naiad (species code 1833). Backing document. April 2013
Author :	O Connor, Á.
Series :	Unpublished report by NPWS
Year :	2014
Title :	Targeted survey of *Najas flexilis*
Author :	Roden, C.; Murphy, P.
Series :	Unpublished report to NPWS
Year :	2015
Title :	Habitats Directive Annex I lake habitats: a working interpretation for the purposes of site-specific conservation objectives and Article 17 reporting
Author :	O Connor, Á.
Series :	Unpublished document by NPWS

Year :	2017
Title :	Ballyhoorisky Point to Fanad Head SAC (site code: 1975) Conservation objectives supporting document- *Najas flexilis* V1
Author :	NPWS
Series :	Conservation objectives supporting document
Year :	2017
Title :	Mweelrea/Sheeffry/Erriff Complex SAC (site code: 1932) Conservation objectives supporting document- *Najas flexilis* V1
Author :	NPWS
Series :	Conservation objectives supporting document
Year :	2017
Title :	Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment SAC (site code: 365) Conservation objectives supporting document- *Najas flexilis* V1
Author :	NPWS
Series :	Conservation objectives supporting document
Year :	2019
Title :	The Status of EU Protected Habitats and Species in Ireland. Volume 2: Habitat Assessments
Author :	NPWS
Series :	Conservation assessments
Year :	2019
Title :	The Status of EU Protected Habitats and Species in Ireland. Volume 3: Species Assessments
Author :	NPWS
Series :	Conservation assessments
Year :	in prep.
Title :	A study of lakes with Slender Naiad (*Najas flexilis*)
Author :	Roden, C.; Murphy, P.; Ryan, J.B.
Series :	Irish Wildlife Manuals
Year :	in prep.
Title :	Survey of the status of white-clawed crayfish, *Austropotamobius pallipes*, in designated SACs in 2017
Author :	Gammell, M.; McFarlane, A.; Brady, D.; O'Brien, J.; Mirimin, L.; Graham, C.; Lally, H.; Minto, C.; O'Connor, I.
Series :	Irish Wildlife Manuals

Other References

Year :	2001
Title :	Aquatic plants in Britain and Ireland
Author :	Preston, C.D.; Croft, J.M.
Series :	Harley Books, Colchester
Year :	2004
Title :	The ecology of *Najas flexilis*
Author :	Wingfield, R.A.; Murphy, K.J.; Hollingsworth, P.; Gaywood, M.J.
Series :	Scottish Natural Heritage Commissioned Report No. 017 (ROAME No. F98PA02)
Year :	2006
Title :	A reference-based typology and ecological assessment system for Irish lakes. Preliminary investigations. Final report. Project 2000-FS-1-M1 Ecological assessment of lakes pilot study to establish monitoring methodologies EU (WFD)
Author :	Free, G.; Little, R.; Tierney, D.; Donnelly, K.; Coroni, R.
Series :	Environmental Protection Agency, Wexford

Year :	2016
Title :	A narrative for conserving freshwater and wetland habitats in England
Author :	Mainstone, C.; Hall, R.; Diack, I.
Series :	Natural England Research Reports Number 064
Year :	2020
Title :	Slender Naiad (*Najas flexilis*) habitat quality assessment
Author :	Gunn, I.D.M.; Carvalho, L.
Series :	CRW2018_27. Scotland's Centre of Expertise for Waters (CREW)

Spatial data sources

Year :	2008
Title :	OSi 1:5000 IG vector dataset
GIS Operations :	WaterPolygons feature class clipped to the SAC boundary. Expert opinion used to identify Annex I habitat and to resolve any issues arising
Used For :	3150 (map 3)
Year :	2021
Title :	NPWS rare and threatened species database
GIS Operations :	Dataset created from spatial references in database records. Expert opinion used as necessary to resolve any issues arising
Used For :	1092 (map 4)

3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation

To restore the favourable conservation condition of Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation in Glenade Lough SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Habitat area	Hectares	Area stable or increasing, subject to natural processes	Lake habitat 3150 is no longer believed to occur in Glenade Lough, rather the lake is considered to be a *Najas*-type lake with high plant species and community diversity. As such, it is treated here as lake habitat 3130 in respect of the targets applied. Glenade Lough is an important lake. Its diversity may largely result from the mixed geology of its catchment, with base-poor springs and seepages likely to be a key driver. It is unusual in the co-occurrence of slender naiad (*Najas flexilis*) and white-clawed crayfish (*Austropotamobius pallipes*), although the former has not been seen since 1978 (see the conservation objective for slender naiad in this volume) and was considered extinct in Roden and Murphy (2014) and NPWS (2019). Lake surface area is the simplest measure of extent and should be stable or increasing. For further information on all attributes and an overview of slender naiad-type lakes see Roden et al. (in prep.). See also O Connor (2015)
Habitat distribution	Occurrence	No decline, subject to natural processes	As noted above, habitat 3130, and not 3150, is considered to occur in Glenade Lough. This is based on the reinterpretation of these lake habitats (O Connor, 2015) and the findings of Heuff (1984), Roden and Murphy (2014) and Roden et al. (in prep.). Roden and Murphy (2014) found that Glenade is suffering from eutrophication. Enrichment may already have begun when it was surveyed in 1978 by Heuff (1984). As a result, and owing to reclassification as 3130, the conservation objective is to restore the habitat to favourable conservation condition. Further data are also available from the Environmental Protection Agency (EPA) (Water Framework Directive (WFD) monitoring)
Vegetation species richness	Occurrence	Maintain/restore appropriate species richness	Roden and Murphy (2014) reported that 16 plant species were recorded in Glenade over time. See also Heuff (1984). There should be no decline in species richness (see Roden et al., in prep.). Roden et al. (in prep.) found that habitat 3130 has a varied and species-rich flora, with high conservation value examples having more than 30 species of aquatic macrophytes. Almost all lakes with more than 30 species had euphotic depth >3m (Roden et al., in prep.). The number of species recorded increases with sampling effort (Roden et al., in prep.)

Vegetation composition: typical species	Occurrence	Restore typical species, in good condition, and demonstrating typical abundances and distribution	Restore condition and extent of *Najas flexilis* (see 1833 conservation objective) and other typical species. Roden and Murphy (2014) recorded habitat 3130 typical species at Glenade including *Chara virgata, Callitriche hermaphroditica, Elatine hexandra, Isoetes lacustris, Potamogeton gramineus, P. lucens, P. perfoliatus, P. x zizii*. Many of these were recorded by Heuff (1984) but her 1978 survey also found a wider range of charophyte species: *Chara aspera, C. globularis, C. virgata, Nitella flexilis s.l., Tolypella glomerata*, as well as *P. praelongus* and *Najas flexilis*. Roden et al. (in prep.) described 3130 typical species and indicators of good condition. 3130 has a varied and species-rich flora with several rare species that can include *Baldellia ranunculoides* subsp. *repens, Hydrilla verticillata, Isoetes echinospora, Najas flexilis, Pilularia globulifera, Fissidens fontanus*. See also NPWS (2013, 2019) and O Connor (2015)
Vegetation composition: characteristic zonation	Occurrence	Restore characteristic deep-water vegetation	The vegetation of Glenade Lough was described by Heuff (1984). While Roden and Murphy (2014) said Glenade's vegetation resembled that of other species-rich *Najas* lakes, they also found significant changes from the 1978 survey, including loss of *Najas flexilis* and *Potamogeton praelongus* zone. The characteristic zonation (3 or more zones) is described in Roden et al. (in prep.). Shallow water has a *Lobelia-Littorella* zone (0-1.5m), then an *Isoetes lacustris* zone (0.5-3m), both also typical of oligotrophic lakes and habitat 3110. The characteristic deep-water community is the most sensitive element and consists of some or all of *Callitriche hermaphroditica, Hydrilla verticillata, Najas flexilis, Potamogeton berchtoldii, P. perfoliatus, P. pusillus, Nitella confervacea, Nitella flexilis, Nitella translucens* . Full development is when a distinct deep-water zone is present, with one or more of its typical species having >25% cover
Vegetation distribution: maximum (euphotic) depth	Metres	Restore maximum depth of vegetation, subject to natural processes	Heuff (1984) found vegetation to 3.5m in Glenade. Roden and Murphy (2014) found this had decreased to 2.8m. Euphotic depth ranged from 5.2m to 1.9m in lakes surveyed 2016-2018 and the target for maximum depth of vegetation colonisation (euphotic depth) in 3130 lakes was set as at least >3m (Roden et al., in prep.). Site-specific targets must be considered, however, as euphotic depths of >4m or >5m have been recorded in species-rich lakes in good condition. Maximum depth is considered to have declined in many lakes, owing to increased water colour. Lakes within undisturbed peatland are expected to have clear water and large maximum vegetation depth
Hydrological regime: water level fluctuations	Metres	Maintain appropriate hydrological regime necessary to support the habitat	The mixed geology of the basin and catchment leads to a complex hydrological regime at Glenade. Surface and groundwater discharges of base-poor water to Glenade from surrounding blanket bog and acid rocks exert significant influence over the vegetation, particularly obligate CO2 photosynthesisers such as slender naiad (Jim Ryan, pers. comm.). Calcareous springs and seepages also occur (Heuff, 1984). Roden et al. (in prep.) said exposure of >half of the typically submerged *Littorella* zone in summer is cause for concern and water level should never be lower than the top of the *Isoetes* zone. Natural fluctuations in lake water level can be amplified by activities such as abstraction, drainage and overgrazing, increasing wave action and turbidity, up-rooting vegetation, altering substratum and releasing nutrients from sediment. The hydrological regime must support maintenance of the area, distribution and depth of the habitat and its characteristic vegetation zones/species

Lake substratum quality	Various	Maintain/restore appropriate substratum type, extent and chemistry to support the vegetation	Heuff (1984) described the substratum of Glenade as sand and stone in the shallows, mud in deeper water. Roden et al. (in prep.) found that the habitat is generally dominated by bedrock, sand and loose stones, silt mud or hard peat, and stated that the appearance of large expanses of unconsolidated peat would indicate excessive sediment input. Groundwater inputs are likely to be important for the substratum of the characteristic deep-water zone and *Najas flexilis* (Gunn and Carvalho, 2020). Research is required to further characterise the chemical composition of the substratum
pH and Alkalinity	pH units, mg/l	Maintain/restore appropriate water and sediment pH, alkalinity and cation concentrations to support the habitat, subject to natural processes	Free et al. (2006) reported pH of 8.16 and alkalinity of 74mg/l for Glenade. EPA average alkalinity was 67-72mg/l in 2007-15. Seepages and springs appear to be important in the maintenance of appropriate sediment conditions for the vegetation of Glenade. Groundwater can contribute base-poor water to obligate CO2 photosynthesisers, such as *Najas flexilis*, in more calcareous lakes, and more base-rich water to highly oligotrophic lakes. The habitat is associated with intermediate alkalinity, largely between 20-80mg/l, but lower values may occur on Old Red Sandstone (Roden et al., in prep.). Surveyed lakes had average alkalinity of 25mg/l (range 5.5-73mg/l) (Roden et al., in prep.). In line with targets for *N. flexilis*, median pH values should >7 pH units. Acidification by organic acids released from degraded peatland and conifer plantations may impact on the habitat. See also The European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2019
Nutrients	µg/l P; mg/l N	Restore the concentration of nutrients in the water column to sufficiently low levels to support the habitat and its typical species	EPA average total phosphorus (TP) was 0.015, 0.016 and 0.012mg/l TP in the 2007-09, 2010-12 and 2013-15 reporting periods. Roden et al. (in prep.) found that the best quality lakes surveyed had average total phosphorus of <0.015mg/l TP. Lakes in good condition with high-frequency nutrient data had an overall average of 0.011mg/l TP (lake averages ranged 0.008-0.015mg/l TP). While Roden et al. (in prep.) suggested a target of <0.015mg/l TP, a precautionary target for good condition is set as ≤0.010mg/l or WFD High Status; however, vegetation attributes determine the overall conservation condition. See also The European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2019). WFD High Status targets for total ammonia (annual average ≤0.04mg/l N and annual 95th percentile ≤0.09mg/l N) may also be appropriate
Water colour	mg/l PtCo	Maintain/restore appropriate water colour to support the habitat	Heuff (1984) described Glenade as 'a clear water lake'. Free et al. (2006) reported colour of 28mg/l PtCo in Glenade Lough. The habitat is found in clear water, and water colour (dissolved light-absorbing compounds) is negatively correlated with maximum vegetation (euphotic) depth; lakes with euphotic depth >3m had colour <40mg/l PtCo, while those with euphotic depth >3.5m had <35mg/l PtCo (Roden et al., in prep.). Water colour directly controls light penetration and, therefore, euphotic depth and vegetation extent. Roden et al. (in prep.) set good condition at <40mg/l PtCo; however, this was considered to be an impacted state some distance from reference condition. The primary source of increased colour in Ireland is peatland disturbance, e.g. through turf-cutting, overgrazing, plantation forestry. Further work is necessary to determine water colour in intact peatland catchments and sustainable levels for the habitat, which may be <30 or even <20mg/l PtCo

Dissolved organic carbon (DOC)	mg/l	Maintain appropriate organic carbon levels to support the habitat	Dissolved organic carbon (DOC) in the water column is linked to water colour and acidification (organic acids). It can provide a substrate (food source) for heterotrophic organisms, which can impact directly (e.g. shading) and indirectly (e.g. nutrient release) on the characteristic lake communities. Damage and degradation of peatland, e.g. through afforestation or turf-cutting, leading to decomposition of peat is likely to be the predominant source of dissolved and particulate organic carbon in Ireland
Turbidity	Nephelometric turbidity units/ mg/l SS/ other appropriate units	Maintain appropriate turbidity to support the habitat	Turbidity can significantly affect the quantity and quality of light reaching rooted and attached vegetation and can, therefore, impact on lake habitats. The settlement of higher loads of inorganic or organic material on lake vegetation communities may also have impacts on sensitive, delicate species. Turbidity can increase as a result of re-suspension of material within the lake, higher loads entering the lake, or eutrophication. Particulate loads from peatlands are the most likely sources of increased turbidity in lakes with the habitat. Turbidity measurement and interpretation is challenging. As a result, it is likely to be difficult to set habitat-specific targets for turbidity in lakes
Transparency	Metres	Maintain/restore appropriate Secchi transparency. There should be no decline in Secchi depth/transparency	Heuff (1984) recorded Secchi transparency in Glenade of 2.2m in July and 2.3m in September 1978. Roden and Murphy (2014) recorded Secchi depth of 3m and described transparency as 'moderate'. Transparency relates to light penetration and, hence, to the depth of colonisation of vegetation. Roden et al. (in prep.) advised it is preferable to measure euphotic depth directly by observation, but noted that a decreasing trend in Secchi depth indicates declining water quality. Transparency can be affected by phytoplankton blooms, water colour and turbidity. Secchi depth in marl lakes in Good condition is generally >6m. The OECD fixed boundary system set transparency targets for oligotrophic lakes of ≥6m annual mean Secchi disk depth and ≥3m annual minimum Secchi disk depth
Attached algal biomass	Algal cover	Maintain/restore trace/absent attached algal biomass (<5% cover)	Roden and Murphy (2014) described *Cladophora* sp. as 'very common' in Glenade Lough. Nutrient enrichment can favour epiphytic and epipelic algae that can out-compete the submerged vegetation. Roden et al. (in prep.) noted that occasional blooms of filamentous algae occur in 3130 lakes in the absence of excess nutrients, especially species of the orders Zygnematales or Oedogoniales, but that drifting masses of *Cladophora* species may indicate a decline in water quality. In general, the cover abundance of attached algae in lakes with 3130 should be trace/absent (<5% cover)
Fringing habitat: area and condition	Hectares	Maintain the area and condition of fringing habitats necessary to support the natural structure and functioning of the habitat	In this SAC, a band of emergent vegetation occurs around much of the lake with *Phragmites australis* and *Schoenoplectus lacustris*, also *Typha latifolia, Equisetum fluviatile* and *Eleocharis palustris*. The fringing habitats include freshwater marsh, calcareous fens and flushes, cutaway peatland, wet grassland and wet woodland. Heterogeneous lake fringes with a range of natural and semi-natural habitats are preferable. Restoration or maintenance of open, species-rich fen, marsh and grassland can be particularly important. Fringing habitats along lakes intergrade with and support the structure and functions of the lake habitat. Equally, fringing wetland habitats are dependent on the lake, particularly its water levels, and support invertebrate and plant communities and species of high diversity and conservation concern. See also Mainstone et al. (2016)

1092 White-clawed Crayfish *Austropotamobius pallipes*

To maintain the favourable conservation condition of White-clawed Crayfish (*Austropotamobius pallipes*) in Glenade Lough SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Distribution	Number of occupied 1km squares	No reduction from baseline. See map 4	White-clawed crayfish (*Austropotamobius pallipes*) has been known from Glenade Lough since 1998, though the lack of records before then is not necessarily an indication of recent colonisation. The species was recorded by both O'Connor et al. (2009) and Gammell et al. (in prep.). All the records have come from the accessible eastern shoreline in the 1km square G8345. There is no reason to assume that crayfish should not be present in other 1km squares that intersect the lake. However, this needs to be confirmed by appropriate survey
Population structure: recruitment	Percentage occurrence of juveniles and females with eggs	Juveniles and females with eggs in at least 50% of positive samples taken at appropriate time and methodology	See Reynolds et al. (2010) for further details. Gammell et al. (in prep.) found juveniles in Glenade Lough
Population size	Catch per unit effort	No reduction from baseline of 2.27	The population in Glenade Lough was assessed as having a Population abundance grade of Moderate to High (Gammell et al., in prep.). This is based on the CPUE (catch per unit effort) figures from that study. It is only applicable to the hand search methodology. CPUE figures have not been calculated for other methodologies
Negative indicator species	Occurrence	No non-indigenous crayfish species	Non-indigenous crayfish species (NICS) are identified as a major direct threat to the white-clawed crayfish and as a disease vector, in particular crayfish plague (*Aphanomyces astaci*), which is fatal to white-clawed crayfish. The possession, import and intentional release of five species of invasive alien crayfish is banned by Statutory Instrument No. 354/2018
Disease	Occurrence	No instances of disease	Crayfish plague, caused by the water-borne mould *Aphanomyces astaci*, is identified as a major threat to the species in Ireland. Instances of crayfish plague have occurred in Ireland since 2015 causing local extinctions. There have been no confirmed or suspected outbreaks in this SAC
Water quality	Water chemistry measures	Maintain appropriate water quality, particularly pH and nutrient levels, to support the natural structure and functioning of the habitat	Water quality status of Glenade Lough is poor and has declined. White-clawed crayfish are not considered very sensitive of water quality but are intolerant of low pH and poorest water quality, and lack of calcareous influence. There should be no decline in the water quality as defined by the targets for the 3130 lake habitat, as these are more stringent than white-clawed crayfish require. See also the conservation objective for the lake habitat (3150) in this volume; while the SAC was selected for lake habitat 3150, it is clear that the habitat naturally present in Glenade is lake habitat 3130, and targets appropriate to this latter habitat are used

Habitat quality: heterogeneity	Occurrence of positive habitat features	No decline from the baseline	White-clawed crayfish need high habitat heterogeneity. Larger crayfish must have stones to hide under, or an earthen bank in which to burrow. Hatchlings shelter in vegetation, gravel and among fine tree roots. Smaller crayfish are typically found among weed and debris in shallow water. Larger juveniles in particular may also be found among cobbles and detritus such as leaf litter. These conditions and habitat features must be available on the whole length of occupied habitat. Gammell et al. (in prep.) scored the habitat heterogeneity as between 0.32 and 0.48 in this SAC and there should be no decline from this baseline range

1833 Slender Naiad *Najas flexilis*

To restore the favourable conservation condition of Slender Naiad (*Najas flexilis*) in Glenade Lough SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population extent	Hectares; distribution	Restore the spatial extent of slender naiad (*Najas flexilis*) within the lake, subject to natural processes	*Najas flexilis* was discovered in Glenade Lough by Hester Heuff and Jim Ryan in 1978 (Heuff, 1984). The species was widespread, occurring from very shallow water amongst *Schoenoplectus lacustris* to depths of >3m. The species has not been seen at Glenade since, despite dedicated snorkel survey in 2004, 2005 and 2014, and is considered to now be extinct (Roden and Murphy, 2014; NPWS, 2019). Roden and Murphy (2014) stated that the vegetation of Glenade Lough resembled that of other species-rich *Najas flexilis* lakes, but showed significant changes since 1978 that indicate eutrophication. For further information on all attributes and targets, see Roden et al. (in prep.), O Connor (2013) and *Najas flexilis* conservation objective supporting documents for other SACs, for example SACs 001975 (NPWS, 2017), 001932 (NPWS, 2017) and 000365 (NPWS, 2017)
Population depth	Metres	Restore the depth range of *Najas flexilis* within the lake, subject to natural processes	In 1978, *Najas flexilis* was found 'throughout the reed bed zone down to the deepest vegetated areas' in Glenade (Heuff, 1984). It grew in very shallow water in the *Schoenoplectus* reedbed in July, but in September had gone from these shallow areas. Heuff (1984) also recorded *Najas flexilis* in relevés at 1.8m and 3m. As depth increased, *Najas flexilis* and *Sparganium emersum* became more frequent. *Najas flexilis* is part of the characteristic deep-water community of lake habitat 3130 (Roden et al., in prep.). *Najas flexilis* is frequently associated with the lower depths of macrophyte growth, where scattered plants gradually give way to bare mud or silt (Preston and Croft, 2001; Roden, 2002)
Population viability	Plant traits	Restore plant fitness, subject to natural processes	Wingfield et al. (2004) used certain traits (leaf area/shoot length x reproductive number/shoot length) to assess *Najas flexilis* plant fitness and indicated a score of less than one would give rise to concern. Roden et al. (in prep.) suggested size measurements and photographs of the largest plants encountered may be non-destructive indicators of plant health
Population abundance	Square metres	Restore the cover abundance of *Najas flexilis*, subject to natural processes	Heuff (1984) described *Najas flexilis* as thriving in Glenade, being found throughout the reedbed zone and within the littoral zone to depths of over 3m, reaching higher cover abundance in deeper water. Cover abundance is likely to vary within a lake, with depth, substratum and exposure. It may also vary inter-annually. Such variations may be even more marked in small, marginal populations. However, there should be no sustained decline in the extent, overall size, cover abundance or density of the population in the lake and the absence of the species from Glenade in 2004, 2005 and 2014 demonstrates a genuine decline
Species distribution	Occurrence	Restore distribution, subject to natural processes	In 1978, *Najas flexilis* was found in and adjacent to relevé 46, in a sheltered bay along the southern shore of Glenade Lough (see map in Volume 2 of Heuff, 1984). Her survey was concentrated on the central area of the lake, however, and did not map the species full extent of the species in the lake at that time. For further information on the species and its distribution in Ireland, see O Connor (2013), *Najas flexilis* conservation objective supporting documents for other SACs and NPWS (2019)

Habitat extent	Hectares	Restore habitat extent, subject to natural processes	Habitat for the species relates to the area and quality of the available habitat for the species. The quality of the habitat for *Najas flexilis* in Glenade Lough is impacted by eutrophication (Roden and Murphy, 2014). See also the conservation objective for the lake habitat (3150) in this volume. While the SAC was selected for lake habitat 3150, it is clear that the habitat naturally present in Glenade is 3130, and targets appropriate to this latter habitat are used. See Roden et al. (in prep.) for further information on the species and its habitat
Vegetation distribution: maximum (euphotic) depth	Metres	Maintain/restore maximum depth of vegetation, subject to natural processes	Heuff (1984) recorded a maximum vegetation depth of 3.8m in Glenade, and found *Najas flexilis* in the relevé at 3m. Roden and Murphy (2014) recorded a euphotic depth of 2.8m. Euphotic depth ranged from 5.2m to 1.9m and the most extensive populations were found in lakes with euphotic depths >2.5m; however, several lakes with *Najas flexilis* had lower euphotic depths (Roden et al., in prep.). The target for maximum depth of vegetation colonisation (euphotic depth) was set as at least >3m (Roden et al., in prep.). Site-specific targets must be considered, however, as euphotic depths of >4m or >5m have been recorded in lakes with *Najas flexilis* in good condition. See also the conservation objective for habitat 3150 in this volume and Roden et al. (in prep.)
Hydrological regime: water level fluctuations	Metres	Maintain appropriate natural hydrological regime necessary to support the habitat for the species	The hydrological regime of the lakes must be maintained so that the area, distribution and depth of the *Najas flexilis* habitats can be restored. Run-off, seepages, and perhaps springs, discharging base-poor water to Glenade from surrounding blanket bog and acid rocks exert significant influence over the vegetation, particularly obligate carbon dioxide photosynthesisers such as *Najas flexilis* (Jim Ryan pers. comm.). Groundwater inputs are likely to be important for the characteristic deep-water zone and *Najas flexilis* in many lakes (Gunn and Carvalho, 2020). See also the conservation objective for the lake habitat (3150) in this volume and Roden et al. (in prep.)
Lake substratum quality	Various	Maintain/restore appropriate substratum type, extent and chemistry to support a population of the species	Heuff (1984) described the substratum of Glenade as sand and stone in the shallows, mud in deeper water, with *Najas flexilis* occurring on mud. *Najas flexilis* is typically found on soft substrata of mud, silt or fine sand (Preston and Croft, 2001; Roden, 2002, 2004). The sediment chemistry of *Najas flexilis* lakes is described by Wingfield et al. (2004) and Gunn and Carvalho (2020). See also the conservation objective for the lake habitat (3150) in this volume and Roden et al. (in prep.)
Nutrients	mg/l P; mg/l N	Restore the concentration of nutrients in the water column to sufficiently low levels to support a population of the species	The EPA recorded average total phosphorus in Glenade of 0.015, 0.016 and 0.012mg/l TP in the 2007-09, 2010-12 and 2013-15 reporting periods, respectively. *Najas flexilis* is typically associated with high water quality. This is demonstrated by naturally low dissolved nutrients, clear water and low algal growth. The species' association with mixed geology, including some base-enrichment, is well-documented (Preston and Croft, 2001; Roden, 2004; Wingfield et al., 2004). While Roden et al. (in prep.) suggested a target of <0.015mg/l TP, a precautionary target for good condition is set as ≤0.010mg/l or Water Framework Directive High Status; however, population attributes determine the species' overall conservation condition. See also the conservation objective for habitat 3150 in this volume and Roden et al. (in prep.)

Water colour	mg/l PtCo	Maintain/restore appropriate water colour to support a population of *Najas flexilis*	Free et al. (2006) reported colour of 28mg/l PtCo in Glenade. The species is found in clear water (Roden et al., in prep.). Increased water colour (dissolved light-absorbing compounds) and turbidity decrease light penetration and can reduce the area of available *Najas flexilis* habitat, particularly at the lower euphotic depths. Roden et al. (in prep.) set good condition at <40mg/l PtCo; however, this was considered to be an impacted state some distance from reference condition. Further work is necessary to determine sustainable water colour levels for the species which may be <30 or even <20mg/l PtCo. The primary source of increased colour in Ireland is peatland disturbance, e.g. through turf-cutting, overgrazing, plantation forestry. See also the conservation objective for habitat 3150 in this volume and Roden et al. (in prep.)
Dissolved organic carbon (DOC)	mg/l	Maintain/restore appropriate organic carbon levels to support a population of *Najas flexilis*	Dissolved organic carbon (DOC) in the water column is linked to water colour and acidification (organic acids). It can provide a substrate (food source) for heterotrophic organisms, which can impact directly (e.g. shading) and indirectly (e.g. nutrient release) on the characteristic lake communities. Damage and degradation of peatland, e.g. through afforestation or turf-cutting, leading to decomposition of peat is likely to be the predominant source of dissolved and particulate organic carbon in Ireland
Acidification status	pH units; mg/l	Maintain appropriate water and sediment pH, alkalinity and cation concentrations to support a population of *Najas flexilis*, subject to natural processes	Free et al. (2006) reported pH of 8.16 and alkalinity of 74mg/l for Glenade. The EPA found average alkalinity of 67-72mg/l in 2007-15. Seepages and springs appear to be important in the maintenance of appropriate sediment conditions for *Najas flexilis* in Glenade. Groundwater may influence sediment and water chemistry and contribute base-poor water to *Najas flexilis*, an obligate carbon dioxide photosynthesiser, in more calcareous lakes, and more base-rich water in highly oligotrophic lakes. The species is associated with intermediate alkalinity, largely between 20-80mg/l, but also occurs in some lakes with lower values on Old Red Sandstone (Roden et al., in prep.). Acidification is a significant threat to the species (Preston and Croft, 2001; Roden, 2004; Wingfield et al., 2004; Gunn and Carvalho, 2020). Wingfield et al. (2004) considered that it has specific environmental requirements and occupies a relatively narrow realised niche. See also Roden et al. (in prep.)
Associated species	Species composition and abundance	Restore appropriate associated species and vegetation communities to support a population of *Najas flexilis*	In 1978 at Glenade, *Najas flexilis* occurred with *Chara virgata, Nitella flexilis s.l., Tolypella glomerata, Callitriche hermaphroditica* and *Potamogeton pusillus* in the *Schoenoplectus* reedbed (Heuff, 1984). At 1.8m, it grew with *Nitella flexilis s.l., T. glomerata, Fontinalis antipyretica, C. hermaphroditica* and *Elodea canadensis*, and at 3m with dominant *P. praelongus*. See also Roden and Murphy (2014) and the conservation objective for 3150. *Najas flexilis* is part of the characteristic and highly sensitive deep-water community of habitat 3130 that consists of some or all of *Callitriche hermaphroditica, Hydrilla verticillata, Najas flexilis, P. berchtoldii, P. perfoliatus, P. pusillus, Nitella confervacea, N. flexilis, N. translucens* (Roden et al., in prep.). See also Preston and Croft (2001); Roden (2004, 2007 in NPWS, 2007); Wingfield et al. (2004); O Connor (2013); NPWS (2019); Gunn and Carvalho (2020)

Fringing habitat: area and condition	Hectares	Maintain the area and condition of fringing habitats necessary to support a population of *Najas flexilis*	In Glenade Lough, a band of emergent vegetation occurs around much of the lake with *Phragmites australis* and *Schoenoplectus lacustris*, also *Typha latifolia, Equisetum fluviatile* and *Eleocharis palustris*. Heuff (1984) found *Najas flexilis* within *Schoenoplectus* reedbeds, with a *Chara aspera* zone on the landward side. The fringing habitats of Glenade Lough include freshwater marsh, calcareous fens and flushes, cutaway peatland, wet grassland and wet woodland. Fringing habitats are an integral part of the structure and functioning of lake systems. Heterogeneous lake fringes with a range of natural and semi-natural habitats are preferable. Restoration or maintenance of open, species-rich fen, marsh and grassland can be particularly important. See also Mainstone et al. (2016)

Creevelea

Cullionbo

Leckanara

Glenade Lough

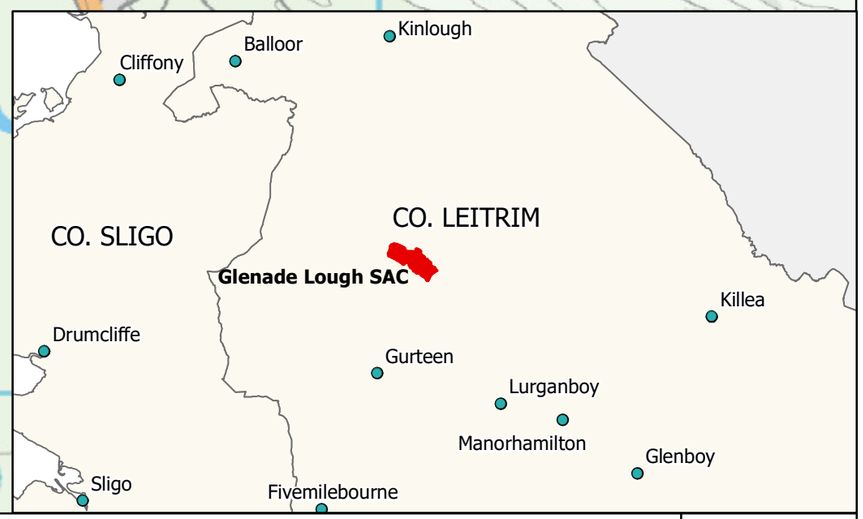
Peyton's Is.

Loch Ghleann Eada

Balloona Br.

Megalithic Tomb

100 150 200 300 310 320 290 270 250



Legend

Glenade Lough SAC 001919

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MAP 1:
GLENADE LOUGH SAC
CONSERVATION OBJECTIVES
SAC DESIGNATION

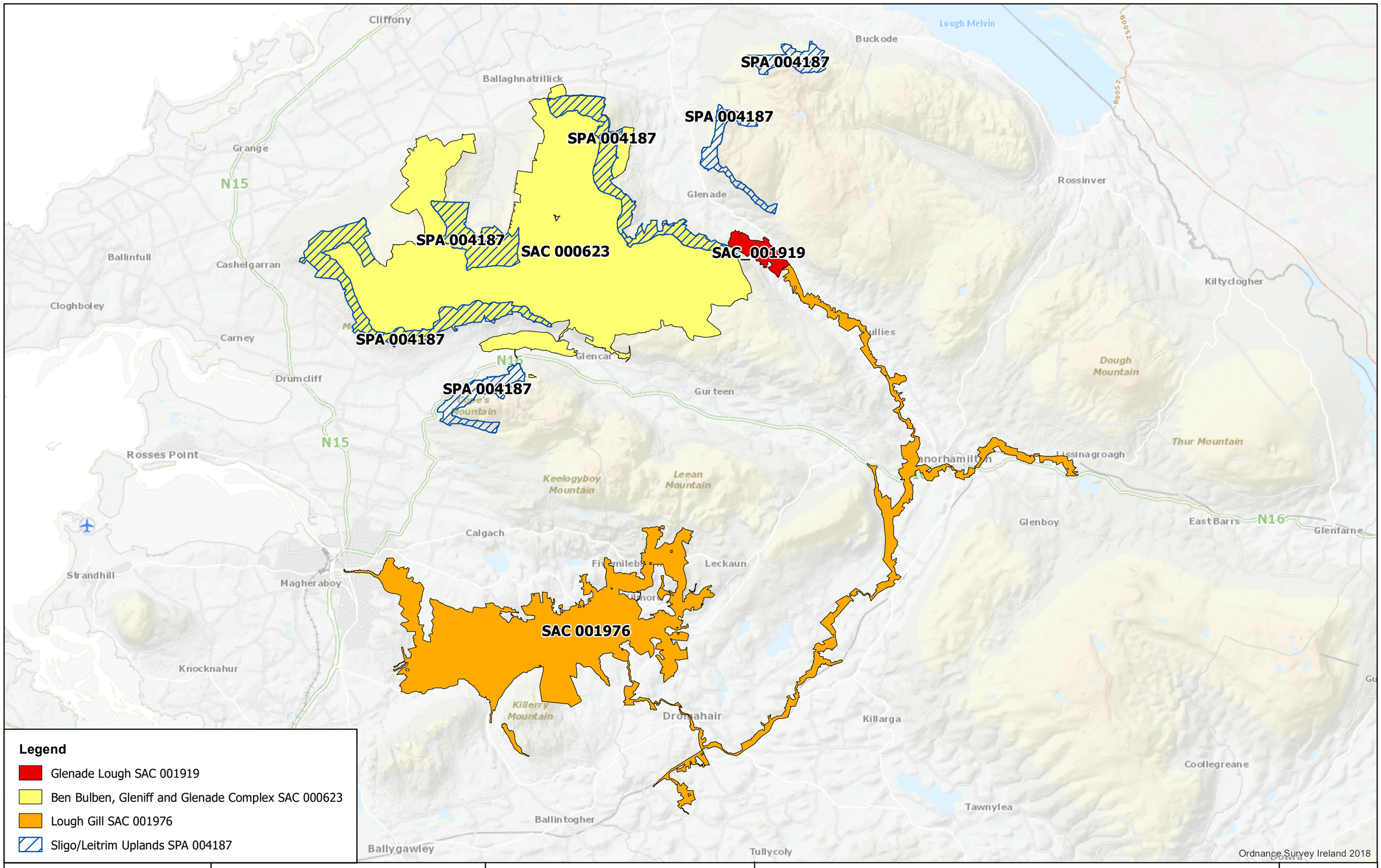
Map to be read in conjunction with the NPWS Conservation Objectives Document

SITE CODE:
SAC 001919; version 3.03.
CO. LEITRIM

0 100 200 400 Metres

N

Date: March 2021



An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

MAP 2:
GLENADE LOUGH SAC
CONSERVATION OBJECTIVES
ADJACENT SITES

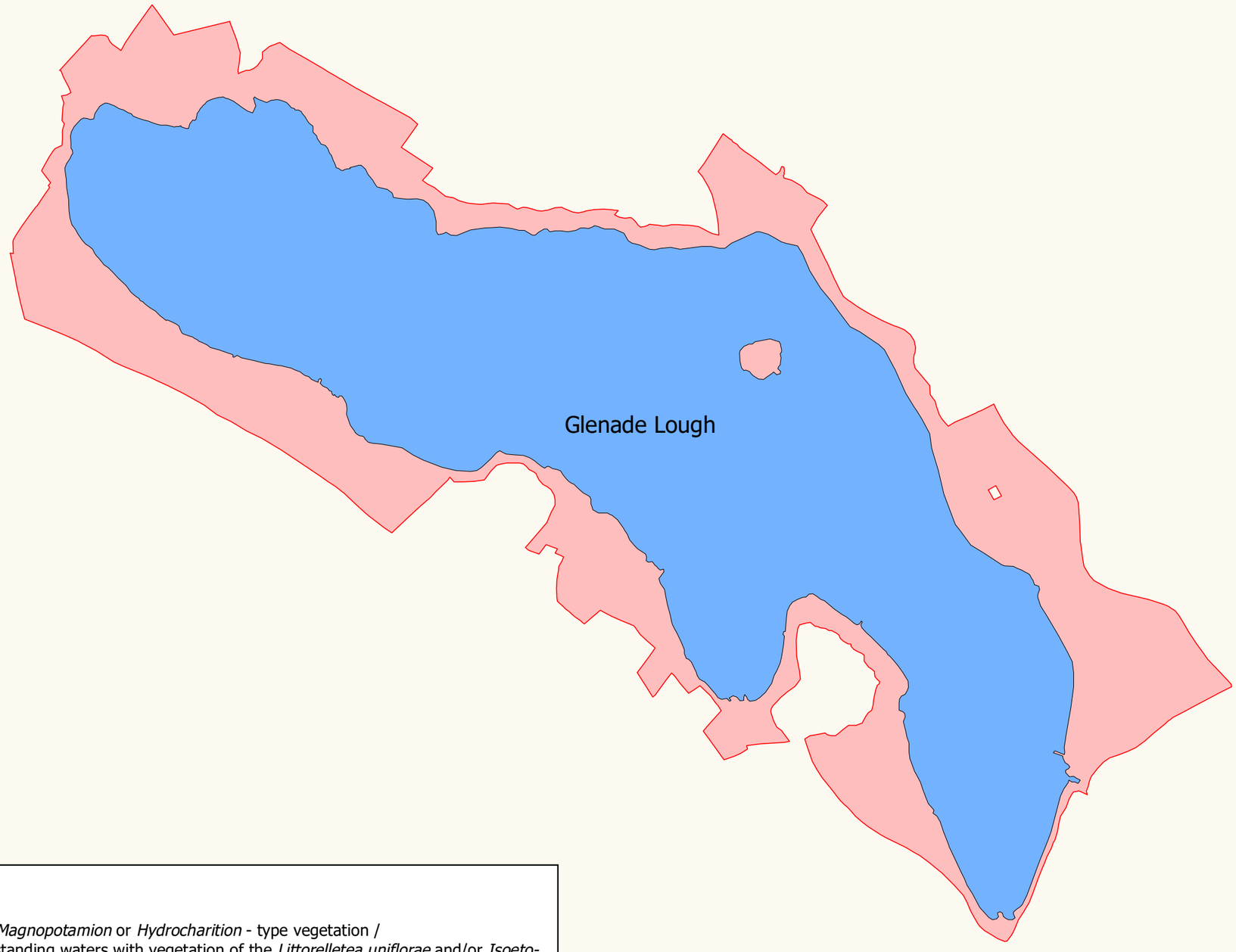
Map to be read in conjunction with the NPWS Conservation Objectives Document

SITE CODE:
SAC 001919; version 3.03.
CO. LEITRIM

0 1,250 2,500 5,000 Metres

N

Date: March 2021



Legend

- 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation / 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*
- Glenade Lough SAC 001919
- OSi Discovery Series County Boundary

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

MAP 3:
GLENADE LOUGH SAC
CONSERVATION OBJECTIVES
INDICATIVE LAKE HABITATS

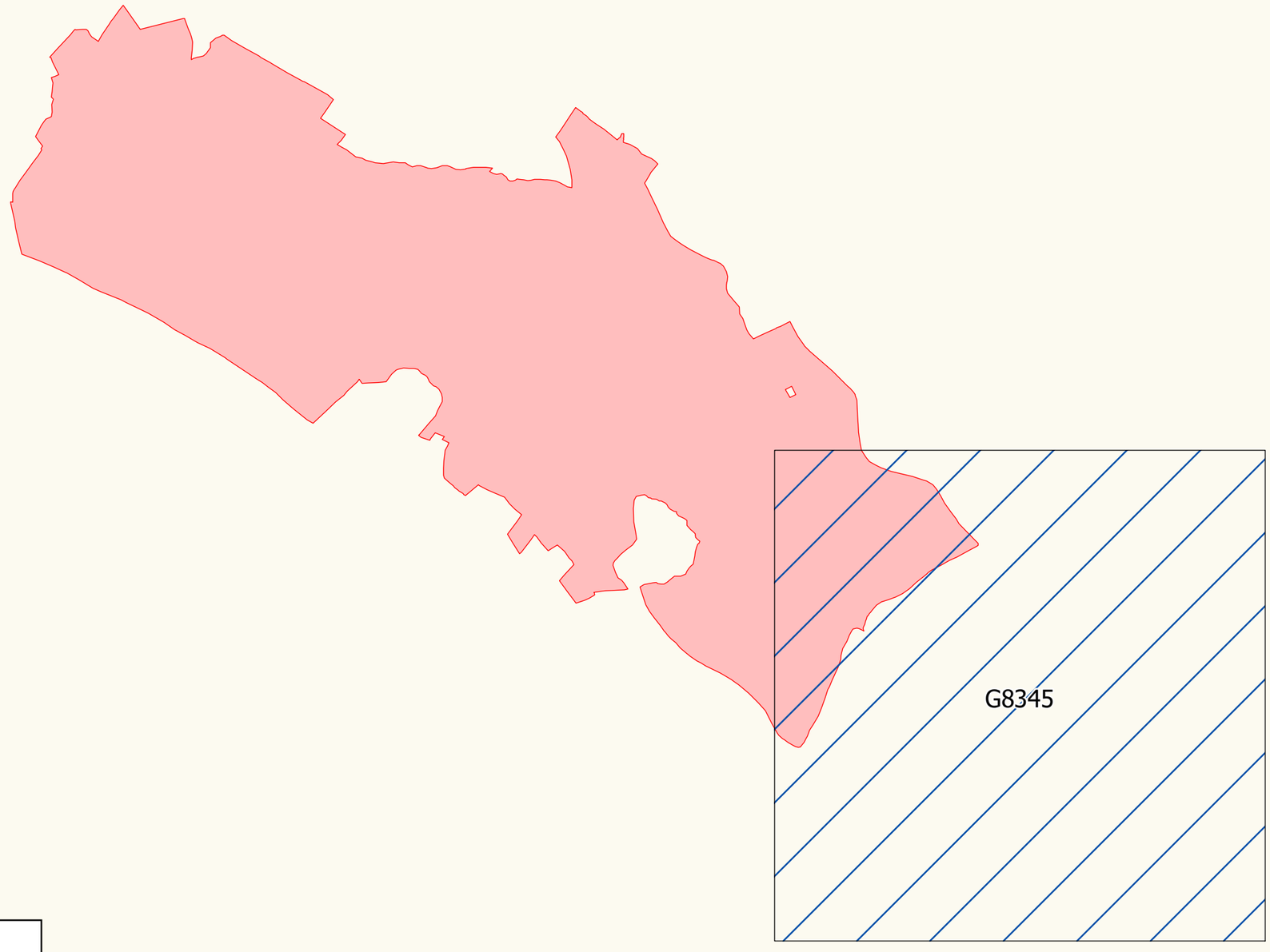
Map to be read in conjunction with the NPWS Conservation Objectives Document

SITE CODE:
SAC 001919; version 3.03.
CO. LEITRIM

0 75 150 300 Metres

N

Date: March 2021



Legend

- 1092 White-clawed crayfish Austropotamobius pallipes 1km grid square
- Glenade Lough SAC 001919
- OSi Discovery Series County Boundary

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

MAP 4:
GLENADE LOUGH SAC
CONSERVATION OBJECTIVES
WHITE-CLAWED CRAYFISH

Map to be read in conjunction with the NPWS Conservation Objectives Document

SITE CODE:
SAC 001919; version 3.03.
CO. LEITRIM

0 100 200 400 Metres

N

Date: March 2021