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Conservation Objectives Series

Kindrum Lough SAC 001151

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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***

001151 Kindrum Lough SAC

1833	Slender Naiad *Najas flexilis*
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea

Supporting documents, relevant reports & publications

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

NPWS Documents

Year :	2004
Title :	The distribution of *Najas flexilis* in Ireland 2002-2004
Author :	Roden, C.M.
Series :	Unpublished report to NPWS
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 :	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 Manual

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 :	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 :	3130 (map 2)

3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea

To restore the favourable conservation condition of Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoëto-Nanojuncetea in Kindrum 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 3130 is found in Kindrum Lough. See map 2. This habitat occurs in clear-water lakes of intermediate alkalinity where *Isoetes lacustris and Potamogeton perfoliatus/praelongus* co-occur and is characterised by high species-richness and a deep-water flora that can include *Najas flexilis* (Roden et al., in prep.). Kindrum was assessed as in poor conservation condition in 2016 (Roden et al., in prep.). Habitat 3130 was in poor deteriorating conservation status across Ireland in the two reporting periods, 2007-2018 (NPWS, 2013, 2019). The majority of lakes with 3130 appear to be damaged and high conservation value 3130 lakes in good condition are extremely rare (Roden et al., in prep.). The 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. See map 2	Kindrum is a mesotrophic lake with several charophyte species (more typical of marl lakes) and a very diverse *Potamogeton* flora (Roden et al., in prep.). Lake habitat 3130 was surveyed in Kindrum in 2016 (Roden et al., in prep.). Other surveys at Kindrum have included by G.R. Bullock-Webster in 1916, R.L. Praeger in 1937 and 1939, C.D. Preston and N.F. Stewart in 1989 and C. Roden in 2002 (see Roden et al., in prep.). Further data are also available from Environmental Protection Agency (EPA) (Water Framework Directive (WFD) monitoring)
Vegetation species richness	Occurrence	Maintain/restore appropriate species richness	26 species were recorded in Kindrum in 2016, out of a total species list for the lake of 37 (Roden et al., in prep.). Species of note found in 2016 included *Najas flexilis, Chara curta, C. rudis, Nitella spanioclema, N. confervacea*. There should be no decline in species richness (see Roden et al., in prep.). Roden et al. (in prep.) found that lake 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 conservation objective for the species in this volume) and other typical deep-water species. In 2016, *Najas flexilis* no longer occurred at the south-east of the lake, where it had been recorded in 2002 (Roden et al, in prep.). Roden et al. (in prep.) described the typical species of lake habitat 3130 and those present in lakes in good condition. Lake habitat 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*, also two uncertain charophyte taxa: *Chara muscosa; Nitella spanioclema*. See also NPWS (2013, 2019) and O Connor (2015)

Vegetation composition: characteristic zonation	Occurrence	Restore characteristic deep-water vegetation	Roden et al. (in prep.) found the deep-water vegetation was poorly developed in Kindrum. The characteristic zonation (three or more zones) is described in Roden et al. (in prep.): a shallow water *Lobelia-Littorella* zone (0-1.5m); an *Isoetes lacustris* zone (0.5-3m), both also typical of oligotrophic lakes and lake habitat 3110; a characteristic deep water community of some or all of *Callitriche hermaphroditica, Hydrilla verticillata, Najas flexilis, Potamogeton berchtoldii, P. perfoliatus, P. pusillus, Nitella flexilis, N. confervacea, N. translucens*, which is the most sensitive element. 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	Maximum depth of vegetation or euphotic depth was 3.5m in Kindrum in 2016 (Roden et al., in prep.), and there was only partial development of the characteristic deep-water vegetation. Euphotic depth ranged from 5.5 to <2m in lakes surveyed 2016-2018 and the target for maximum depth of vegetation colonisation (euphotic depth) in 3130 lakes is set as at least >3m (Roden et al., in prep.). Site-specific conditions must be considered, however, and the target for Kindrum is set as at least 4m, owing to the occurrence of deep-water flora to 4m in 2002, as well as the fact that other species-rich, clear-water lakes in good condition had euphotic depths of >4m and >5m. 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	Roden et al. (in prep.) found that, in summer, the *Littorella* zone is typically submerged and said if more than half is exposed it is a matter of concern and water level should never be lower than the top of the *Isoetes* zone. Fluctuations in lake water level are typical in Ireland, but can be amplified by activities such as abstraction, drainage and overgrazing. Increased water level fluctuations can increase wave action, up-root vegetation, increase turbidity, alter the substratum and lead to release of nutrients from the sediment. Groundwater inputs are likely to be important for the characteristic deep-water zone and *Najas flexilis* (Gunn and Carvalho, 2020). The hydrological regime of the lake must be maintained so that the area, distribution and depth of the lake habitat and its constituent/characteristic vegetation zones and communities are not reduced
Lake substratum quality	Various	Maintain/restore appropriate substratum type, extent and chemistry to support the vegetation	The high occurrence of *Cladophora* and *Elodea canadensis* in deep water in Kindrum in 2002 and 2016 may indicate enrichment of the substratum with nutrients and organic matter. Roden et al. (in prep.) found that the habitat is generally dominated by bedrock, sand and loose stones, silt mud or hard peat, and said 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 for *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 appropriate water and sediment pH, alkalinity and cation concentrations to support the habitat, subject to natural processes	Roden et al. (in prep.) reported average alkalinity of 73mg/l and average pH of 7.9 at Kindrum. 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 *Najas flexilis*, median pH values should be greater than 7 pH units. Groundwater may influence sediment and water chemistry and be important for *Najas flexilis* and other characteristic flora, contributing base-poor water to obligate carbon dioxide photosynthesisers in more calcareous lakes and more base-rich water to highly oligotrophic lakes. 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	mg/l P; mg/l N	Maintain/restore the concentration of nutrients in the water column to sufficiently low levels to support the habitat and its typical species	The occurrence of *Elodea canadensis* and *Cladophora* in deeper water at Kindrum indicate eutrophication pressures (Roden et al., in prep.). EPA average TP was 0.010mg/l for 2013-15, however, or 0.009mg/l 2008-15. 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/lTP). 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	Kindrum has highly coloured water with an average of 28.4 Hazen Units 2008-15 (Roden et al., in prep.). The habitat is found in clear water, and water colour (dissolved light-absorbing compounds) is negatively correlated with 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, the latter should be used as a precautionary target in Kindrum
Dissolved organic carbon (DOC)	mg/l	Maintain/restore 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 unit	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	Roden et al. (in prep.) reported dark water in Kindrum and Secchi depth of 3m, while average Secchi depth was 2.2m from EPA 2013-15 data. 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
Attached algal biomass	Algal cover	Maintain/restore trace/ absent attached algal biomass (<5% cover)	*Cladophora* was recorded in deep water at Kindrum in 2002 and 2016, indicating eutrophication impacts (Roden et al., in prep.). 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/restore the area and condition of fringing habitats necessary to support the natural structure and functioning of lake habitat 3140	Kindrum has reed-beds (*Phragmites australis, Schoenoplectus lacustris*) and swamp (*Cladium mariscus*) and is fringed by fen, wet grassland and scrub, outcropping rock and dry grassland with wind-blown sand. 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)

1833 Slender Naiad *Najas flexilis*

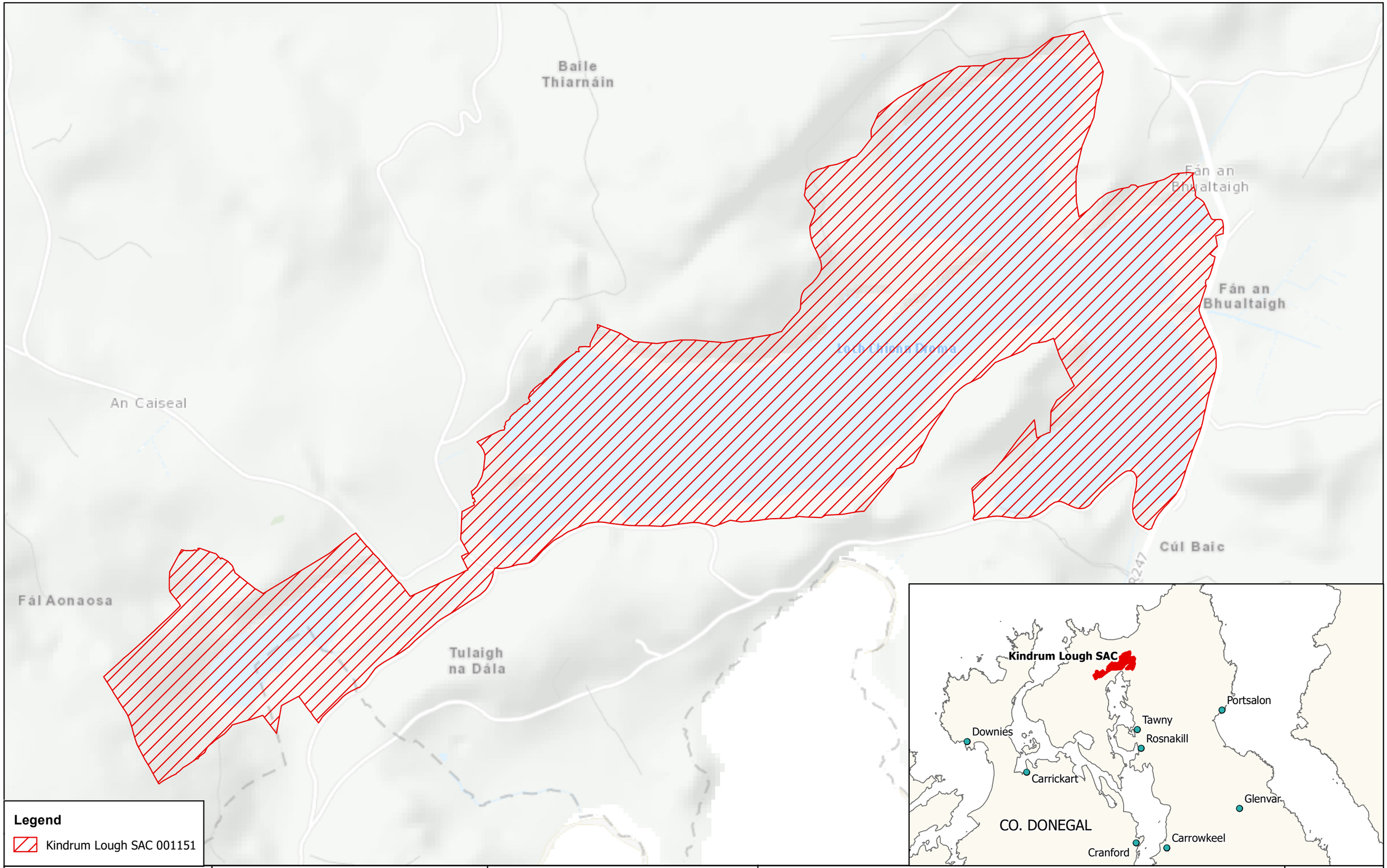
To restore the favourable conservation condition of Slender Naiad in Kindrum Lough SAC, which is defined by the following list of attributes and targets:

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 first recorded in Kindrum in 1916 by Rev. G.R. Bullock-Webster. It has been recorded on at least 8 occasions since, including in 1937, 1939, 1989, 1998, 2000, 2002, 2009 and 2016. In 2002, a large population was found in the south-western corner and some plants were dredged at the south-east of the lake (Roden, 2004). Parts of the substratum were covered with *Cladophora* sp. and *Elodea canadensis* which may have reduced the area available for *Najas flexilis* (Roden, 2004). In 2016, it occurred in only four of the 26 relevés, was assessed as in poor condition and eutrophication was still evident (Roden et al., in prep.). 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 2002, *Najas flexilis* was found at 2-4m in the south-west of Kindrum and dredged from a depth of c.1.5m at the south-east (Roden, 2004). In 2016, the four relevés in which it occurred were at 1.8-3.4m (Roden et al., in prep.). The species would be expected to be naturally frequent at 2 to 4+m in Kindrum. *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	Maintain/restore plant fitness, subject to natural processes	The restricted distribution and low density of the species in Kindrum in 2016 may indicate poor plant health. 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	In 2016, *Najas flexilis* had restricted distribution in Kindrum and low densities (<5% cover) (Roden et al., in prep.). Cover abundance of <25% was recorded in 2002 (Roden, 2004). Cover abundance is likely to vary within a lake, with depth, substratum and exposure. It may also vary inter-annually. However, there should be no sustained decline in the extent, overall size, cover abundance or density of the population in the lake
Species distribution	Occurrence	Restore distribution, subject to natural processes	In 2016, *Najas flexilis* occurred in only four of the 26 relevés, at three locations in Kindrum (north, north-east and south) and could not be re-found in the south-west or south-east (Roden et al., in prep.). The Environmental Protection Agency (EPA) found it in the north and east of the lake. 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 habitat (3130) for *Najas flexilis* in Kindrum Lough was assessed as in poor conservation condition in 2016 (Roden et al., in prep.). See the conservation objective for lake habitat 3130 in this volume and Roden et al. (in prep.)
Vegetation distribution: maximum (euphotic) depth	Metres	Restore maximum depth of vegetation, subject to natural processes	Maximum depth of vegetation or euphotic depth was 3.5m in Kindrum in 2016 (Roden et al., in prep.), and there was only partial development of the characteristic deep-water vegetation. Euphotic depth ranged from 5.5 to <2m 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 and the target for Kindrum is set as at least 4m. See the conservation objective for lake habitat 3130 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 are not reduced. Groundwater inputs are likely to be important for the characteristic deep-water zone and for *Najas flexilis* (Gunn and Carvalho, 2020). See also the conservation objective for habitat 3130 in this volume and Roden et al. (in prep.)
Lake substratum quality	Various	Maintain/restore appropriate substratum type, extent and chemistry to support the population of the species	*Najas flexilis* grew on sandy mud in 2002 and silt and silt/sand in 2016 (Roden, 2004). The high occurrence of *Cladophora* and *Elodea canadensis* in deep water in Kindrum in 2002 and 2016 may indicate enrichment of the substratum with nutrients and organic matter. Wingfield et al. (2004) reported 3.7mg/l available phosphorus in sediment at Kindrum. *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 lake habitat 3130 in this volume and Roden et al. (in prep.)
Nutrients	mg/l P; mg/l N	Maintain/restore the concentration of nutrients in the water column to sufficiently low levels to suppor tthe population of the species	The occurrence of *Elodea canadensis* and *Cladophora* in deeper water at Kindrum indicate eutrophication pressures (Roden et al., in prep.). EPA average TP was 0.010mg/l for 2013-15 and 0.009mg/l for 2008-15. *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 WFD High Status, however population attributes determine the species' overall conservation condition. See also the conservation objective for lake habitat 3130 in this volume and Roden et al. (in prep.)

Water colour	mg/l PtCo	Maintain/restore appropriate water colour to support the population of *Najas flexilis*	The water at Kindrum was noticeably dark in 2002 and 2016 and had average colour of 28.4 Hazen Units 2008-15 (Roden et al., in prep.). 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. Water colour directly controls 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. 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 lake habitat 3130 in this volume and Roden et al. (in prep.)
Dissolved organic carbon (DOC)	mg/l	Maintain/restore appropriate organic carbon levels to support the 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 the population of *Najas flexilis*, subject to natural processes	Wingfield et al. (2004) and Roden et al. (in prep.) reported alkalinity of 65.7mg/l and 73mg/l and pH of 7.9 and 7.85 at Kindrum, respectively. 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 considered a significant threat to *Najas flexilis* (Preston and Croft, 2001; Roden, 2004; Wingfield et al., 2004; Gunn and Carvalho, 2020). Wingfield et al. (2004) considered that *Najas flexilis* has rather specific environmental requirements and occupies a relatively narrow realised niche in Britain and Ireland. Groundwater may influence sediment and water chemistry and be important for *Najas flexilis* contributing base-poor water to this obligate carbon dioxide photosynthesiser in more calcareous lakes and more base-rich water to highly oligotrophic lakes
Associated species	Species composition and abundance	Restore appropriate associated species and vegetation communities to support the population of *Najas flexilis*	Roden et al. (in prep.) found the deep-water vegetation was poorly developed in Kindrum. In 2002 and 2016, *Najas flexilis* grew with *Nitella flexilis, N. confervacea, Chara virgata, Callitriche hermaphroditica, Potamogeton berchtoldii, P. perfoliatus* and others (Roden, 2004; Roden et al., in prep.). *Elodea canadensis* and *Cladophora* sp. has replaced the deep-water community in some areas (Roden et al., in prep.). *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, Potamogeton berchtoldii, P. perfoliatus, P. pusillus, Nitella confervacea, N. flexilis, N. translucens* (Roden et al., in prep.). See also the conservation objective for lake habitat 3130 in this volume, Preston and Croft, 2001; Roden, 2004, 2007; Wingfield et al., 2004; O Connor, 2013; NPWS, 2019; Gunn and Carvalho, 2020

Fringing habitat: area and condition	Hectares	Maintain/restore the area and condition of fringing habitats necessary to support the population of *Najas flexilis*	Kindrum Lough has reed-beds (*Phragmites australis, Schoenoplectus lacustris*) and swamp (*Cladium mariscus*) and is fringed by fen, wet grassland and scrub, outcropping rock and dry grassland with wind-blown sand. 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)



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Local Government and Heritage

MAP 1:
KINDRUM LOUGH SAC
CONSERVATION OBJECTIVES
SAC DESIGNATION

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

SITE CODE:
SAC 001151; version 3.
CO. DONEGAL

0 75 150 300 Metres

N

Date: March 2021

Kindrum Lough

Legend

- 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto- Nanojuncetea*
- Kindrum Lough SAC 001151
- OSi Discovery Series County Boundary

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Department of Housing, Local Government and Heritage

MAP 2:
KINDRUM LOUGH SAC
CONSERVATION OBJECTIVES
INDICATIVE LAKE HABITATS

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

SITE CODE:
SAC 001151; version 3.
CO. DONEGAL

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Date: March 2021