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BENTHIC VEGETATION IN IRISH MARL LAKES: MONITORING HABITAT 3140 CONDITION 2011 TO 2018 – APPENDIX III SITE REPORTS

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

IRISH WILDLIFE MANUALS 124

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Front cover, small photographs from top row:

Limestone pavement, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott; **Garden Tiger** *Arctia caja*, Brian Nelson; **Fulmar** *Fulmarus glacialis*, David Tierney; **Common Newt** *Lissotriton vulgaris*, Brian Nelson; **Scots Pine** *Pinus sylvestris*, Jenni Roche; **Raised bog pool**, Derrinea Bog, Co. Roscommon, Fernando Fernandez Valverde; **Coastal heath**, Howth Head, Co. Dublin, Maurice Eakin; **A deep water fly trap anemone** *Phelliactis* sp., Yvonne Leahy; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson

Main photograph:

Cooloorta/Travaun Lough in 2018, Cilian Roden

Benthic vegetation in Irish marl lakes: monitoring habitat 3140 condition 2011 to 2018 – APPENDIX III, Site Reports

Cilian Roden, Paul Murphy[1] & James Ryan

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Contents

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Introduction to Appendix III

This file accompanies the main report:

> Roden, C., Murphy, P. & Ryan, J. (2020) Benthic vegetation in Irish marl lakes and measuring ecological deterioration. *Irish Wildlife Manuals*, No. 124. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

It contains Appendix III, the Site Reports for marl lakes surveyed in 2011, 2012 and 2018.

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Appendix III Site Reports

This appendix includes site reports for each of the lakes surveyed in 2011, 2012 and 2018. Where a lake was surveyed in more than one year, data are provided for each year. Reports are ordered alphabetically by lake name. Brief notes on cyanobacterial crust (krustenstein) survey are provided. See the Marl Lake (Habitat 3140) Survey and Assessment Methods Manual (Roden *et al.*, 2020) for information on conservation condition assessment. Note that the 2011 and 2018 surveys targeted the most important Irish marl lakes and Special Areas of Conservation designated to protect the habitat and, therefore, were biased towards lakes in better conservation condition. The following is a key to the table provided at the start of each site report:

Name	Lake name used in survey		
Alternative name(s)	Other names used in maps, literature or other sources. Name used by Environmental Protection Agency (EPA) is indicated by 'EPA'		
Grid Reference	12-figure grid reference and 10-figure with grid square for lake centroid	Depth (m)	Depth in metres from bathymetric or other maps, where available
County	County/ies within which lake is situated	EPA code	EPA WFD lake water body code
Area (ha)	Approximate lake surface area in hectares (ha)	OSi 1:50,000 sheet	OSi Discovery Series, 1:50,000 map sheet
Maximum length (km)	Maximum lake surface length, estimated using GIS	Nutrient data	Source, date-span and, where possible, number of samples for water chemistry data
Altitude (m)	Altitude above sea level in metres from OSi Discovery Series, 1:50,000	SAC	6-digit code and name of Special Area of Conservation (SAC), where applicable
Geology	Main bedrock type(s) underlying and surrounding the lake basin.		
Previous survey	Surveyor, survey date and/or citation for previous ecological survey		
Noteworthy species	Lists any noteworthy macrophyte records for the lake from previous surveys		

	Year of 1st survey	**Year of 2nd survey**
Snorkel survey date(s)	Date of first conservation condition snorkel survey of submerged vegetation	Date of second conservation condition snorkel survey of submerged vegetation
Surveyors	Names of surveyors, including snorkellers and recorder: Cilian Roden (CR), Paul Murphy (PM), Jim (James) Ryan (JR)	
Number of transects	Number of transects sampled during the survey	
Number of relevés	Total number of relevés sampled across all transects	
Secchi depth (m)	Secchi depth, where recorded during the survey	
Substrates	Substrates recorded in relevés during the survey	
Noteworthy species	List of any noteworthy macrophyte species recorded during the survey	
A) Vegetation zones	Total number of vegetation zones recorded during the survey, mainly charophyte and cyanobacterial crust zones	
B) Euphotic depth (m)	Maximum depth of colonisation of vegetation, in metres, on each transect surveyed	
C) C&K score	The sum of the cover of charophytes and cyanobacterial crust (krustenstein), divided by total cover on each transect	
D) Total phosphorus (mg/l)	Total phosphorus concentration	
E) Colour (Hazen units)	Water colour	
F) Index (TP × Colour)	The product of total phosphorus in mg/l and water colour in Hazen units	
CONSERVATION CONDITION	Conservation condition of the lake, assessed as per Roden *et al.* (2020)	

The conservation condition of lakes surveyed in 2018 was assessed using the methods of Roden *et al*. (2020), which should be consulted for further information on all parameters and targets. Further information on cyanobacterial (cyanophyte) crust parameters is available from Doddy (2019) and Doddy *et al*. (2019a, b). The following is a simple key to the condition assessment table at the end of each site report for lakes surveyed in 2018:

Parameter	Target	Note	Condition
Area	Stable or increasing	surface area of the lake	Good/Poor/Bad
Number of vegetation zones	4 or more*	The number of distinct charophyte zones occurring. Includes cyanobacterial crust zone. There should be no loss of zones, where previous data exist	Good/Poor/Bad
Euphotic depth (m)	>7	The deepest recorded euphotic depth (across transects) is used. For complex, multi-basin lakes, the deepest euphotic depth per basin is used, however the overall lake condition is determined by the worst basin rating. See Lough Carra for example.	Good/Poor/Bad
Crust cover (%)	>70	Cover of cyanobacterial crust, or krustenstein, from dedicated shoreline survey	Good/Poor/Bad
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	Chlorophyll *a* concentration in cyanobacterial crust, or krustenstein	Good/Poor/Bad
Crust chlorophytes (% frequency, mean ±s.e.)	<45	The presence/absence of chlorophyte cells expressed as a percentage of the total number of samples ('fields-of-view') from microscopic examination	Good/Poor/Bad
C&K score	>0.6	Charophyte and cyanobacterial crust (krustenstein) score – proportion of the total vegetation cover composed of charophyte and cyanobacterial crust	Good/Poor/Bad
Lake level	at or above cyanobacterial crust	Lake water level at time of survey	Good/Poor/Bad
Total phosphorus (TP) (mg/l)	≤0.01	Total phosphorus concentration	Good/Poor/Bad
Colour (Hazen units)	<15	Water colour	Good/Poor/Bad
Index (TP × Colour)	<0.1	The product of total phosphorus in mg/l and water colour in Hazen units	Good/Poor/Bad
Overall assessment			**Good/Poor/Bad**

Aillebrack Lough, 2012			
Name	Aillebrack		
Alternative name(s)			
Grid Reference	058566243406, L5856643406	Depth (m)	
County	Galway	EPA code	31_113
Area (ha)	3.8 ha	OSi 1:50,000 sheet	44
Maximum length (km)	0.3 km	Nutrient data	None available
Altitude (m)	10 m	SAC	002074, Slyne Head Peninsula SAC
Geology	Machair sand and metamorphic rock		
Previous survey	Roden (1999)		
Noteworthy species	*Potamogeton coloratus*, five *Chara* species		

	1999	2012
Snorkel survey date(s)		10/08/2012
Surveyors	CR	CR, PM
Number of transects		2
Number of relevés	5	20
Secchi depth (m)		
Substrates	Sand	Sand
Noteworthy species	*Potamogeton coloratus*	
A) Vegetation zones		
B) Euphotic depth (m)	3	3
C) C&K score		
D) Total phosphorus (mg/l)		
E) Colour (Hazen units)		
F) Index (TP × Colour)		
CONSERVATION CONDITION		**GOOD**

Previous survey

The lake was examined by Roden (1999), he recorded the following species

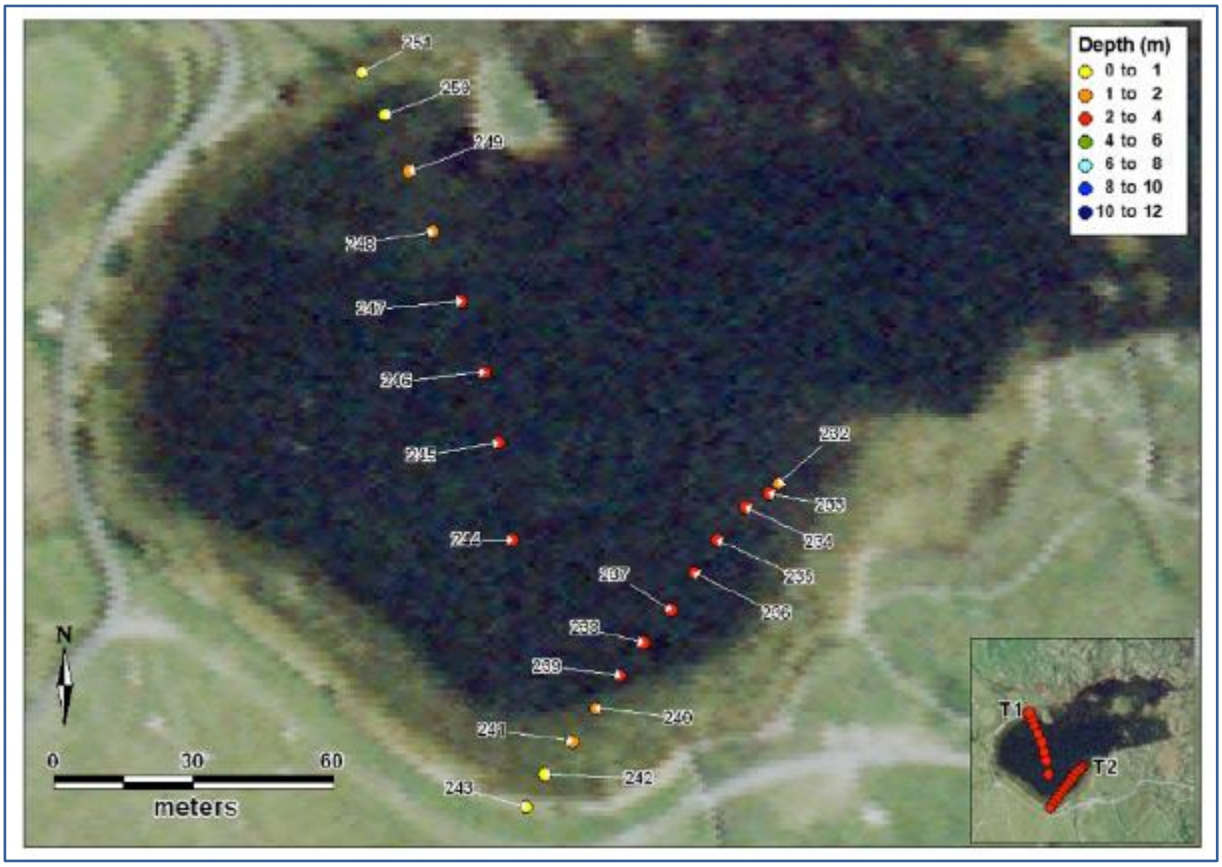
Charophytes	Vascular plants
Chara aspera	*Littorella uniflora*
Chara contraria	*Myriophyllum alterniflorum*
Chara curta	*Myriophyllum spicatum*
Chara globularis	*Potamogeton coloratus*
Chara rudis	*Potamogeton gramineus*
	Potamogeton pectinatus

Vegetation grew to about 3 m, the maximum depth of the lake. No threats were noted.

2012 condition assessment

Machair loughs such as Aillebrack or Fahy differ from marl lakes in being very shallow (less than 5 m) with cloudier water and some characteristic plants such as *Ranunculus baudottii* and *Potamogeton pectinatus*. Nevertheless, a compressed zonation occurs of *Chara aspera* and *C. curta*, in shallow water with intermixed *C. rudis* and *C. globularis /virgata* in 1-4 m. The scarcity of angiosperm vegetation is also a feature shared with marl lakes.

The data from Aillebrack were not used in the analysis in the main report, as machair loughs probably differ from marl lakes on limestone. Nevertheless the diverse charophyte flora and scarcity of vascular plants both in 1999 and 2012 show the lake was in *Good* conservation condition.



Aillebrack Lough showing positions of 2012 transects and relevés with depth.

Aillebrack Lough, 2012; Large *Chara rudis* at 1.5 m (top) and north shore (bottom).

Annaghmore Lough, 2012			
Name	Annaghmore Lough		
Alternative name(s)			
Grid Reference	189972283651, M8997283651	Depth (m)	
County	Roscommon	EPA code	26_669
Area (ha)	53.1 ha	OSi 1:50,000 sheet	33
Maximum length (km)	1.6 km	Nutrient data	EPA
Altitude (m)	46 m	SAC	001626, Annaghmore Lough (Roscommon) SAC (this SAC is **not** selected for habitat 3140)
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring lake		
Noteworthy species	Six charophyte species and *Potamogeton filiformis*		

	2012
Snorkel survey date(s)	01/09/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	22
Secchi depth (m)	3.5 m
Substrates	Marl sand
Noteworthy species	see above
A) Vegetation zones	4
B) Euphotic depth (m)	6 m
C) C&K score	0.763
D) Total phosphorus (mg/l)	0.0091
E) Colour (Hazen units)	20
F) Index (TP × Colour)	0.182
CONSERVATION CONDITION	**GOOD**

2012 condition assessment

This lake has two basins with euphotic depths of 6 m. It is surrounded by farm land and fen. Marl is very extensive in shallow water and there is little rock exposed. Cyanobacterial crust is well developed. A typical zonation of crust/*C. curta*/*C. rudis*/*C. virgata* occurs. Angiosperms are largely confined to the *C. rudis* belt. Both Secchi and euphotic depth are slightly shallow, possibly due to the lake basin being on drift rather than bedrock. However there are no other signs of degradation and the lake's status is rated *Good*.

Annaghmore Lough, 2012; *Hippuris vulgaris* growing on the slope at 1.6 m.

Annaghmore Lough showing positions of 2012 transects and relevés with depth.

Annaghmore Lough, 2012; *Schoenoplectus lacustris* growing on slope break in western basin.

Lough Arrow, 2012			
Name	Lough Arrow		
Alternative name(s)			
Grid Reference	178991312053, G7899112053	Depth (m)	30 m
County	Sligo, Roscommon	EPA code	35_159
Area (ha)	1,247 ha	OSi 1:50,000 sheet	25 & 33
Maximum length (km)	7 km	Nutrient data	EPA
Altitude (m)	53 m	SAC	001673, Lough Arrow SAC
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species	*Aegaropila linnaei*; formerly rich in charophyte species (10 species)		

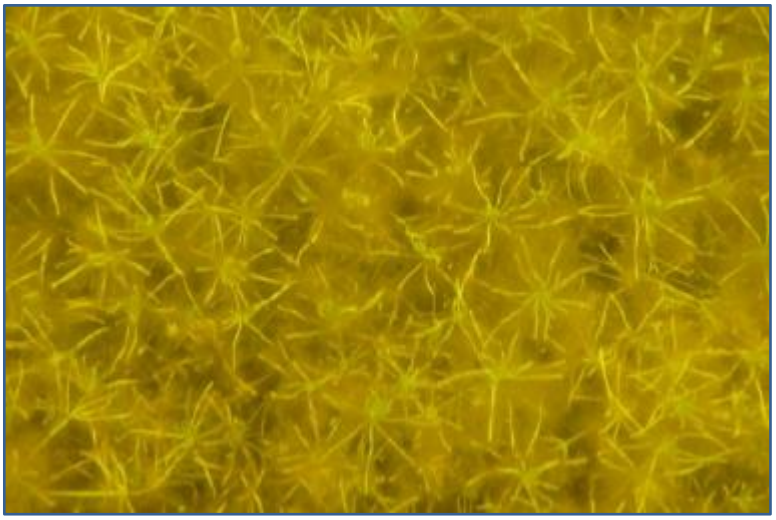
	2012	2019 (CANN project)
Snorkel survey date(s)	01/09/2012	2-3/09/2019
Surveyors	CR, PM	CR, PM
Number of transects	2	10
Number of relevés	14	58
Secchi depth (m)	4.2 m	4
Substrates	Muddy silt	Mud silt rock
Noteworthy species		*Aegaropila linnaei*
A) Vegetation zones	1	2
B) Euphotic depth (m)	T1: 6.7 m; T2: 3.3 m,	4.2
C) C&K score	0.36	0.37
D) Total phosphorus (mg/l)	0.007	0.012
E) Colour (Hazen units)	22.6	21
F) Index (TP × Colour)	0.24	0.25
CONSERVATION CONDITION	**POOR**	**POOR**

2012 condition assessment

Lough Arrow is a large lake showing many signs of eutrophication. Water transparency is poor with much particulate matter. Secchi and euphotic depths are low. No cyanobacterial crust was encountered and *Chara rudis* and *C. virgata* were the only charophytes recorded. Angiosperms, especially *Lemna trisulca* and *Elodea canadensis* were common, along with large *Potamogeton* species.

The Zebra mussel was abundant and the recently introduced *Elodea nuttallii* was found near station 504.

If it is assumed that Arrow was once a typical limestone lake it must be concluded that it is now in a very degraded state with most of the typical vegetation of marl lakes replaced by "weedy" angiosperm species and Zebra Mussel.



Lough Arrow, 2012; *Chara rudis* at 1.3 m covered in *Cladophora* or blanket weed.

Lough Arrow showing positions of 2012 transects and relevés with depth.

Lough Arrow, 2012; looking east. Note extensive reedbeds.

2019 survey and condition assessment for the CANN Project

Roden & Murphy (2020) carried out a survey of the lake on behalf of Sligo Institute of Technology and the INTERREG VA CANN (Collaborative Action for the Natura Network) project in 2019. Their findings were similar to the 2012 results, but some differences were noted. Small patches of cyanobacterial crust, albeit in poor condition, were recorded. A few plants of a third charophyte species, *Chara curta*, were found, but important metrics such as euphotic depth, charophyte and cyanobacterial crust cover were still low in value. The introduced *Elodea nuttallii* was widespread. An interesting addition to the flora was the great abundance at the north of the lake of *Cladophora* balls (*Aegaropila linnaei*).

They noted that the Inland Fisheries Trust had recorded up to 11 charophyte species in 1984 and that water colour was much lower in the 20th Century (Roden & Murphy, 2020). These changes undoubtedly indicate a grave decline in ecological condition during the last 30 years.

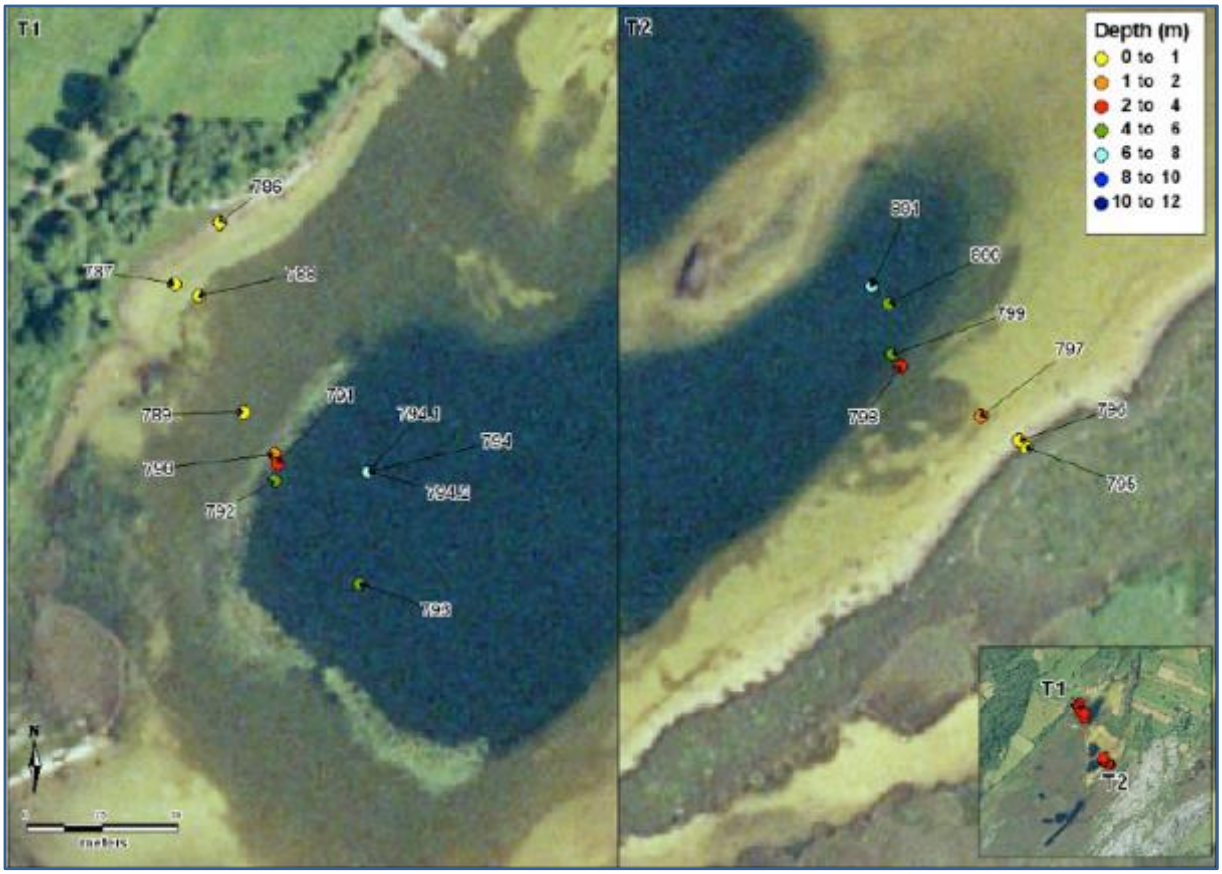
Ballyeighter Lough 2012			
Name	Ballyeighter Lough 1		
Alternative name(s)	Ballyeighter 1, Ballyeighter North, Ballyeighter Lough (northeast). Ballyeighter Lough (1) and Balleighter 2 are both labelled as "Balleighter Lough" on the 6" maps. There are issues with the lake boundaries (shoreline) in this area at 1:50,000 scale, with submerged marl/cyanobacterial crust, *Cladium* swamp and reedbeds all mapped as dry land. This has led to errors in the EPA's WFD datasets. The original Balleighter Lough, as mapped on 6", has 3 separate/discrete WFD lake segment polygons. These are part of a single wetland, and segment 27_269 is connected by open water, while 27_270 is connected by reedbed and swamp		
Grid Reference	135712194040, R3571294040	Depth (m)	>7 m
County	Clare	EPA code	27_106, 27_269, 27_270
Area (ha)	*c.* 28 ha	OSi 1:50,000 sheet	52
Maximum length (km)	1.8 km	Nutrient data	Free *et al.* (2006)
Altitude (m)	17 m	SAC	001926, East Burren Complex SAC
Geology	Limestone		
Previous survey	Langangen (2005) (referred to as "North Ballyeighter Lough (by Treanmanagh)		
Noteworthy species	Six species of charophyte		

	2012
Snorkel survey date(s)	12/07/2012
Surveyors	CR, PD
Number of transects	2
Number of relevés	18
Secchi depth (m)	4 m
Substrates	Marl
Noteworthy species	*Juncus bulbosus*
A) Vegetation zones	4
B) Euphotic depth (m)	6.5 m (south basin), 7.3 m (north basin)
C) C&K score	0.904
D) Total phosphorus (mg/l)	0.005
E) Colour (Hazen units)	27
F) Index (TP × Colour)	0.135
CONSERVATION CONDITION	**GOOD**

2012 condition assessment

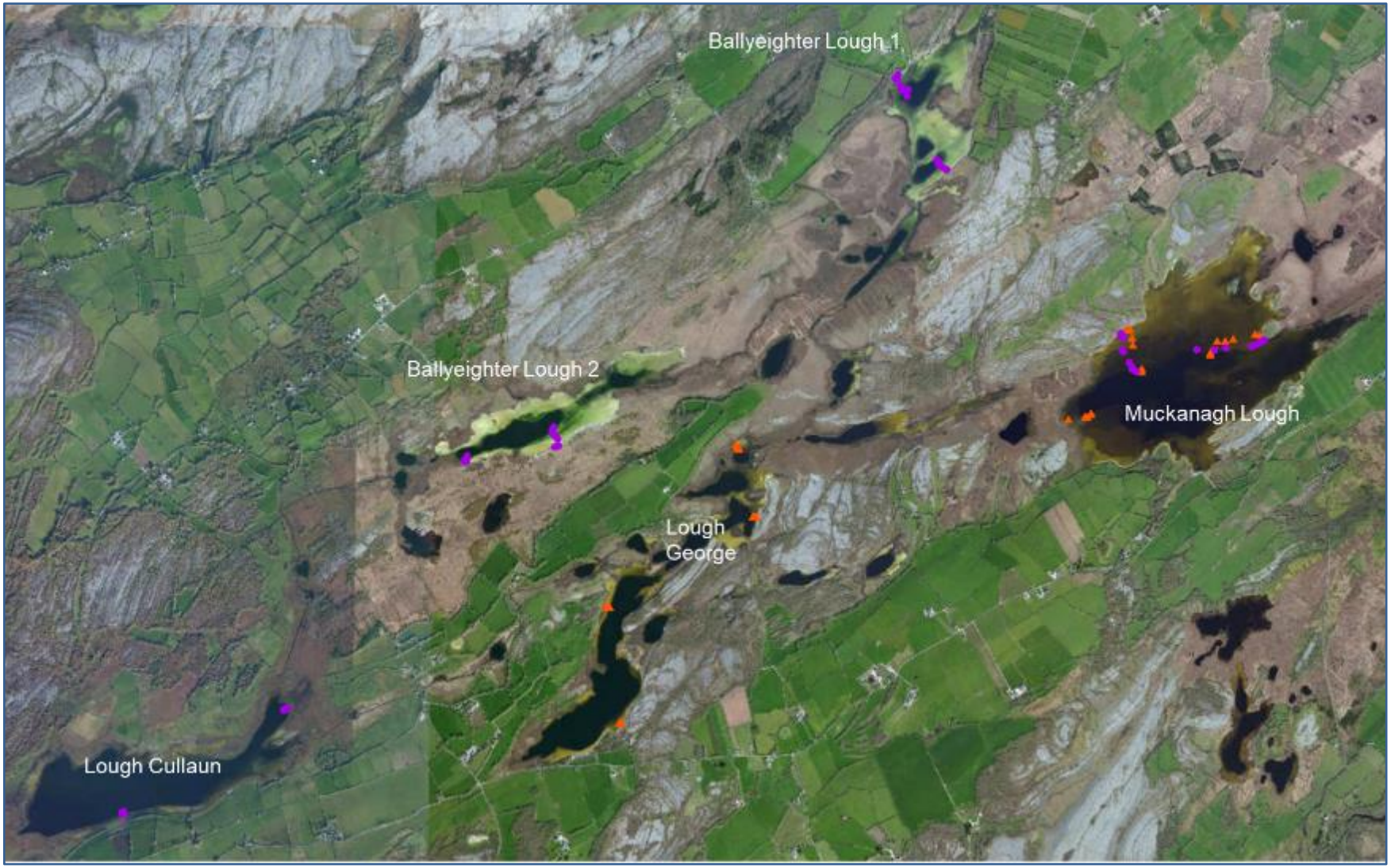
This lake has two basins with euphotic depths of 7.3 m (north basin) and 6.5 m (south basin). While Secchi depth is intermediate, few angiosperms occur and the *Chara rudis* zone is partly replaced by *C. contraria*. The slightly shallow euphotic zone of 6.5 m in the south basin may be due to peat staining of the water. There are no obvious threats to the lake and it is rated as *Good*. The presence of *Juncus bulbosus* is very unusual in such an alkaline environment, (but see Webb & Scannell, 1983).

Ballyeighter Lough 1, 2012; Cyanobacterial crust at 1 m.



Ballyeighter Lough 1 (north-east) showing positions of 2012 transects and relevés with depth.

Ballyeighter Lough 1, 2012; northern shore, note reeds growing on slope edge.



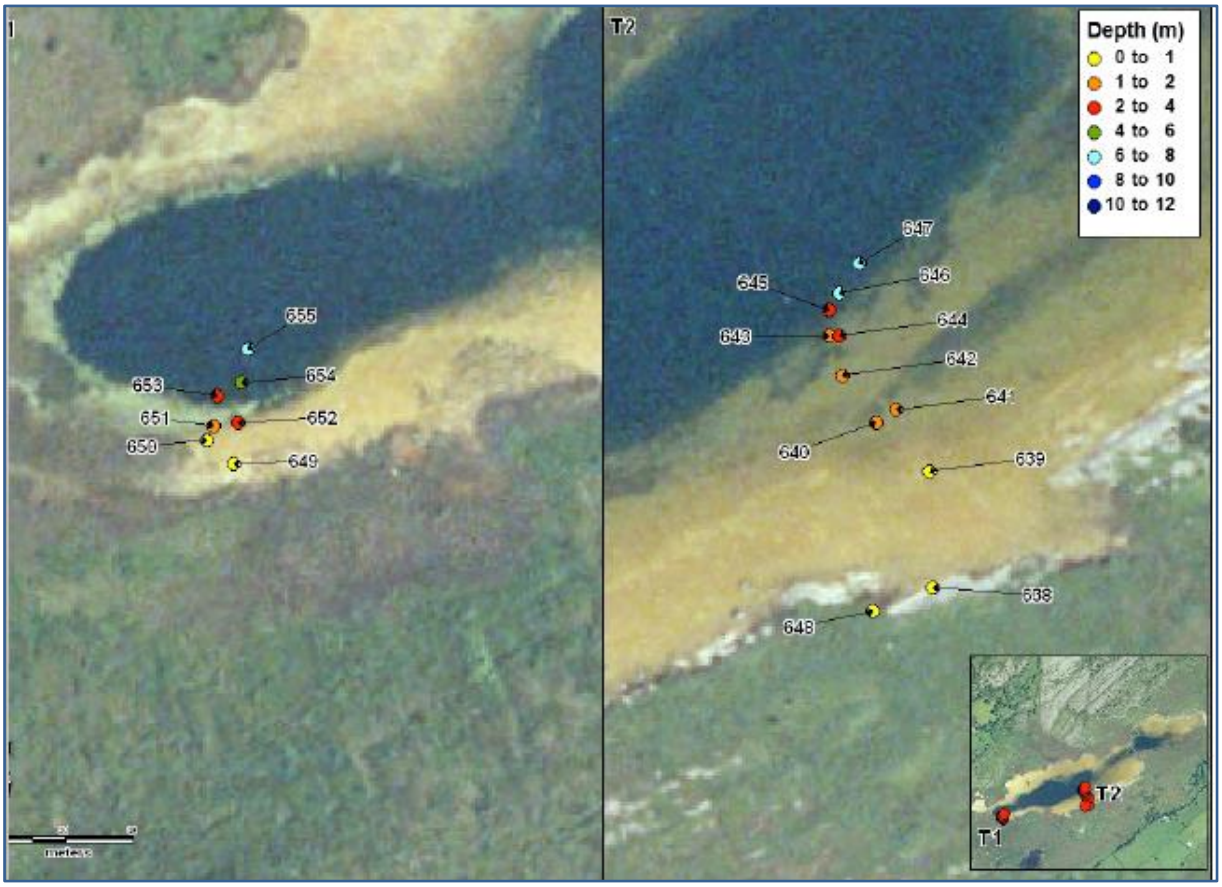
Ballyeighter area, showing Ballyeighter Loughs (1 and 2), Lough George, Lough Cullaun and Muckanagh Lough. Purple discs show positions of relevés from the 2012 survey; orange triangles show positions of relevés from the 2018 survey.

Ballyeighter 2, 2012			
Name	Ballyeighter Lough 2		
Alternative name(s)	Ballyeighter Lough (south-west). Ballyeighter Lough and Balleighter 2 are both labelled as 'Balleighter Lough' on the 6" maps. There are issues with the lake boundaries (shoreline) in this area at 1:50,000 scale, with submerged marl/cyanobacteral crust, *Cladium* swamp and reedbeds all mapped as dry land. This has led to errors in the EPA's WFD datasets. Balleighter 2, as mapped on the 6" (as 'Balleighter Lough'), has 5 separate/discrete WFD lake segment polygons. These are part of a single wetland, and segments 27_303 ('Lake at Aglish') and 27_304 are merely two deeper basins within the main lake, whilst the other 3 are connected by reedbed and swamp		
Grid Reference	133528192434, R3352892434	Depth (m)	
County	Clare	EPA code	27_303, 27_304, 27_302, 27_306, 27_301
Area (ha)	*c.* 37 ha	OSi 1:50,000 sheet	52
Maximum length (km)	1.5 km	Nutrient data	None available
Altitude (m)	17 m	SAC	001926, East Burren Complex SAC
Geology	Limestone		
Previous survey	C.D. Preston 18/07/1994		
Noteworthy species			

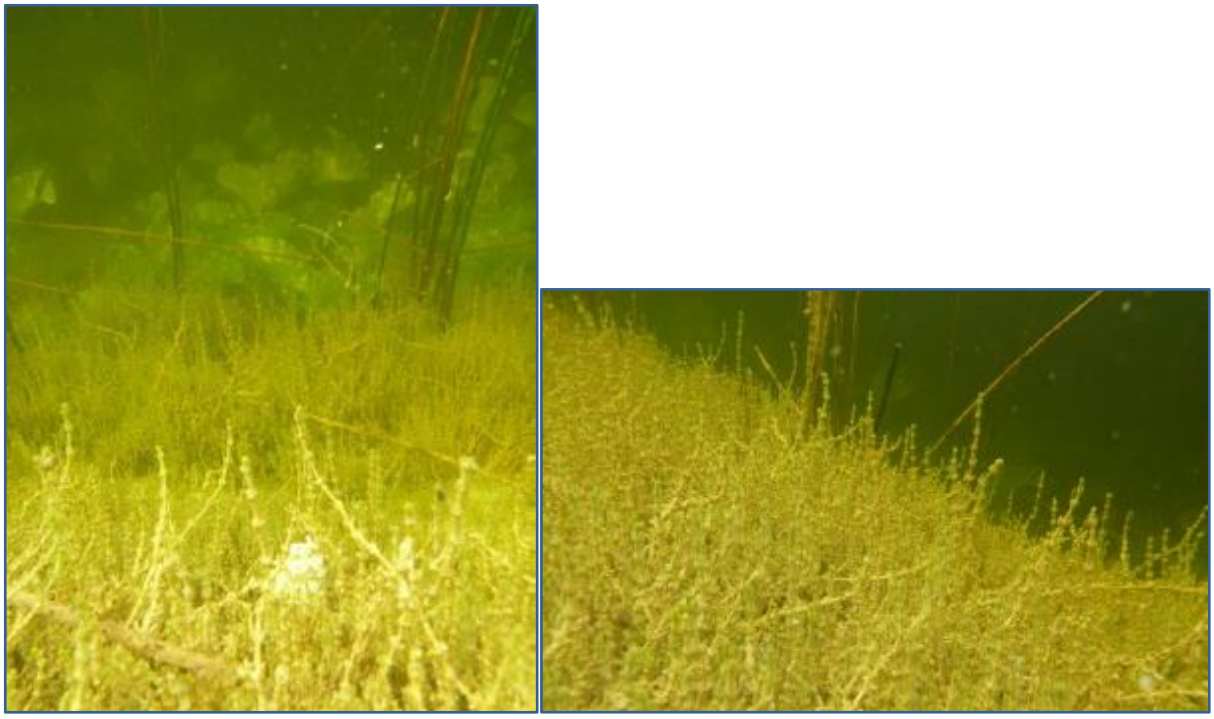
	2012
Snorkel survey date(s)	29/09/2012
Surveyors	CR, PD
Number of transects	2
Number of relevés	16
Secchi depth (m)	5 m
Substrates	Marl
Noteworthy species	*Nitella tenuissima*
A) Vegetation zones	4
B) Euphotic depth (m)	T2: 7.9 m; T1: 6.6 m
C) C&K score	
D) Total phosphorus (mg/l)	
E) Colour (Hazen units)	
F) Index (TP × Colour)	
CONSERVATION CONDITION	**GOOD**

2012 condition assessment

This lake surprisingly has no name on the Discovery Series, so is labelled Ballyeighter 2 here. It is a clear water lake with euphotic zone to 7.9 m and Secchi depth to 5 m. Cyanobacterial crust is well developed, Charophyte zones include *Chara curta, C. rudis*, *C. contraria* and *C. virgata*. The rare *Nitella tenuissima* occurs in shallow water, as does a bryozoan species. No introduced species occur. The lake is an almost text book example of a marl lake in pristine condition and is rated *Good*. Access is difficult and the site is not well known, but it is possibly the best example of the marl lake habitat in Ireland. In the absence of nutrient data, the site could not be included in the data analysis in the main report.



Ballyeighter Lough 2 (south-west) showing positions of 2012 transects and relevés with depth.



Ballyeighter Lough 2, 2012; **Left**: Water Clarity looking from the *C. curta* zone down to the *C. rudis-Nuphar lutea* band. **Right**: *Chara curta* and *C. aculeolata.*

Lough Bane, 2018			
Name	Bane		
Alternative name(s)			
Grid Reference	254766271293, N5476671293	Depth (m)	>16 m based on bathymetric survey in 2007 (Roden 2008)
County	Meath, Westmeath	EPA code	07_270
Area (ha)	75.4 ha	OSi 1:50,000 sheet	42
Maximum length (km)	2 km	Nutrient data	EPA, 1992-2015
Altitude (m)	112 m	SAC	002120, Lough Bane and Lough Glass SAC
Geology	Carboniferous limestone and Chert		
Previous survey	Roden (2008, 2009, 2010), EPA WFD Monitoring Lake		
Noteworthy species	*Chara denudata*		

	Roden (2008, 2009, 2010)	2018
Snorkel survey date(s)	4, 5, 10, 11, 12, 13 & 14/09/2007 and 2 & 3/10/2007, 17/09/2008, 19/06/2009, 31/08/2010, 01/09/2010	02/08/2018
Surveyors	CR, Klaus van de Wyer, John Bruinsma, Geoff Oliver	CR, PM, JR
Number of transects	11	3
Number of relevés	82	20
Secchi depth (m)	5.8	7 m
Substrates	Marl rock mud	Marl, rock mud
Noteworthy species	*Chara denudata*	*Chara denudata*
A) Vegetation zones	5	5
B) Euphotic depth (m)	9 m	T1: 8.5 m; T2: 8.8 m
C) C&K score	0.642	T1: 0.7; T2: 0.73
D) Total phosphorus (mg/l)	0.011	0.006 mg/l
E) Colour (Hazen units)	11.8	4.23
F) Index (TP × Colour)	0.13	0.025
CONSERVATION CONDITION	**GOOD**	**GOOD**

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	Lough Bane
pH		8.1
Alkalinity	mg/l	131
Colour	Hazen units	4.23
Ammonia	mg/l	0.026
Total phosphorus	mg/l	0.006
Chlorophyll *a*	µg/l	3.77

Previous survey

The lake vegetation was mapped by Roden (2008) and two transects were re-sampled in 2008, 2009 and 2010. The EPA surveyed the lakes in 2007, 2010 and 2013. Roden (2009) measured nutrients on a monthly basis for one year (15/07/2008-19/06/2009).

Noteworthy species recorded in 2018

Chara denudata occurs as well as several moss species around an underwater spring (*Amblystgium riparium*, *Straminergon* (*Calliergon*) *stramineum*, *Calliergon giganteum*, *Brachythecium rivulare* and *Fontinalis*

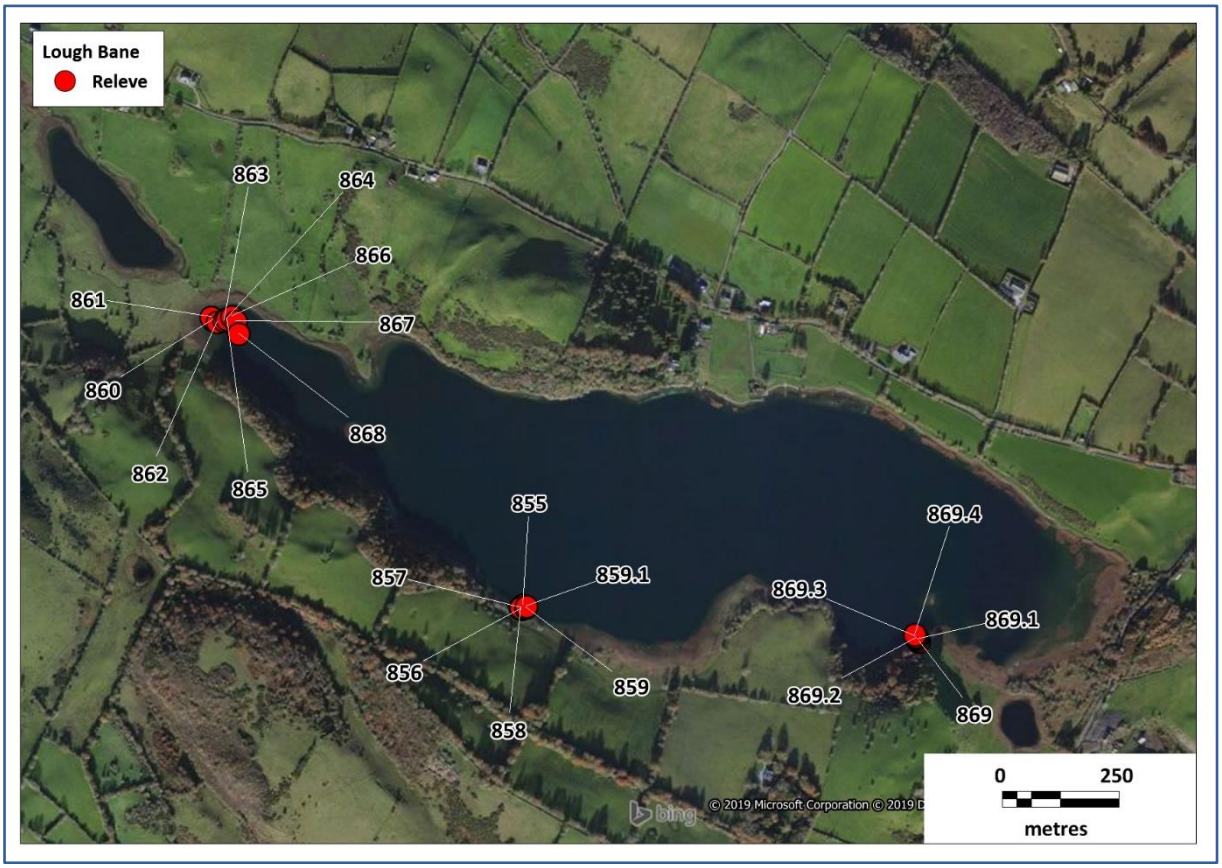
antipyretica) were noted in 2018. In 2010, *Oxrrynchium speciosum* and *Drepanocladus aduncus* were noted from the same station.

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara aculeolata	*Elodea canadensis*	*Fontinalis antipyretica*
Chara contraria	*Hippuris vulgaris*	Other bryophytes
Chara curta	*Lemna trisulca*	Cyanobacterial crust
Chara denudata	*Myriophyllum alterniflorum*	*Ophrydium versatile*
Chara hispida	*Myriophyllum spicatum*	Red cyanophyte
Chara rudis	*Phragmites australis*	
Chara virgata var. *annulata*	*Potamogeton gramineus*	
Chara virgata	*Potamogeton perfoliatus*	
Nitella flexilis	*Ranunculus* sp.	
	Schoenoplectrus lacustris	

Vegetation

The lake is dominated by charophytes with a small cyanobacterial crust zone, due to little outcropping rock. Five vegetation zones are present. An unusual feature is the presence of an underwater spring area where bryophytes and *Rorippa* sp. replace charophytes down to depths of 5 m.



Lough Bane overview map showing positions of 2018 transects and relevés. Transect 1: 855-859; Transect 2: 860-868; 869: survey of an underwater spring.

Cyanobacterial crust

Crust indicator values for Lough Bane are all within the *Favourable* (*Good*) targets. Crust chlorophyll a, at 40 µg/cm³, is towards the high end of *Good*, but the crust in this lake was not previously assessed, so there is no previous figure for comparison.

Change since previous survey

No significant changes noted, except complete recovery from lake lowering episode of 10 years previously.

Threats and pressures

The lake is a water source for Oldcastle Co. Meath. There is little evidence of excess nutrients and water colour is very low. No immediate threats have been noted. Some years ago (2006-07), water abstraction lowered lake level critically, but there is no obvious persistent damage as a result of this episode. The values for both total phosphorus and colour were higher in the 2007-10 period, possibly as a result of the excessive water abstraction.

2018 condition assessment

All parameters were assessed as at Good status, therefore the lake as a whole was assessed as in *Favourable* (*Good*) conservation condition. At present Bane is the best example of a marl lake in Eastern Ireland.

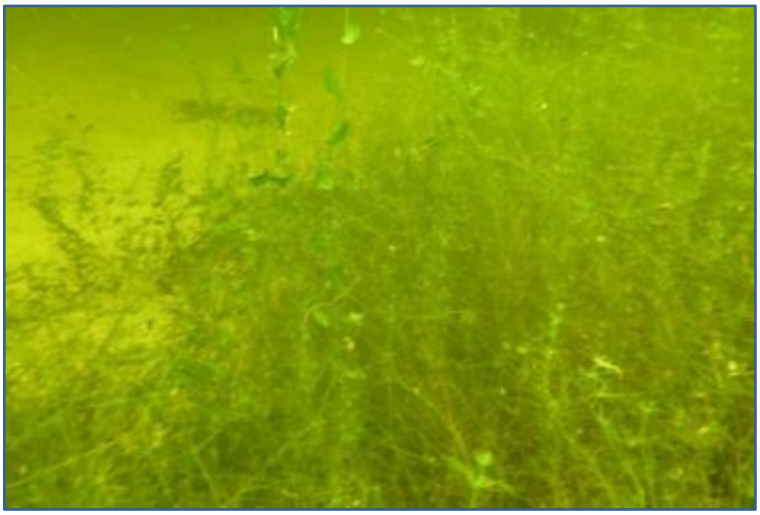
Parameter	Target	Lough Bane 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	5	Good
Euphotic depth (m)	>7	8.8	Good
Crust cover (%)	>70	92	Good
Crust chlorophyll *a* (µg/cm³ ±s.e.)	<45	40±1	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	14.7±1.3	Good
C&K score	>0.6	0.71	Good
Lake level	at or above cyanobacterial crust	above cyanobacterial crust	Good
Total phosphorus (TP) (mg/l)	≤0.01	0.006	Good
Colour (Hazen units)	<15	4.23	Good
Index (TP × Colour)	≤0.1	0.025	Good
Overall assessment			**Good**

Bleach Lough, 2012			
Name	Bleach Lough		
Alternative name(s)			
Grid Reference	144459154653, R4445954653	Depth (m)	
County	Limerick	EPA code	24_90
Area (ha)	18 ha	OSi 1:50,000 sheet	65
Maximum length (km)	0.8 km	Nutrient data	EPA
Altitude (m)	2 m	SAC	n/a
Geology	Drift over limestone		
Previous survey	Reynolds (2013), EPA WFD Monitoring Lake		
Noteworthy species	Six species of charophyte		

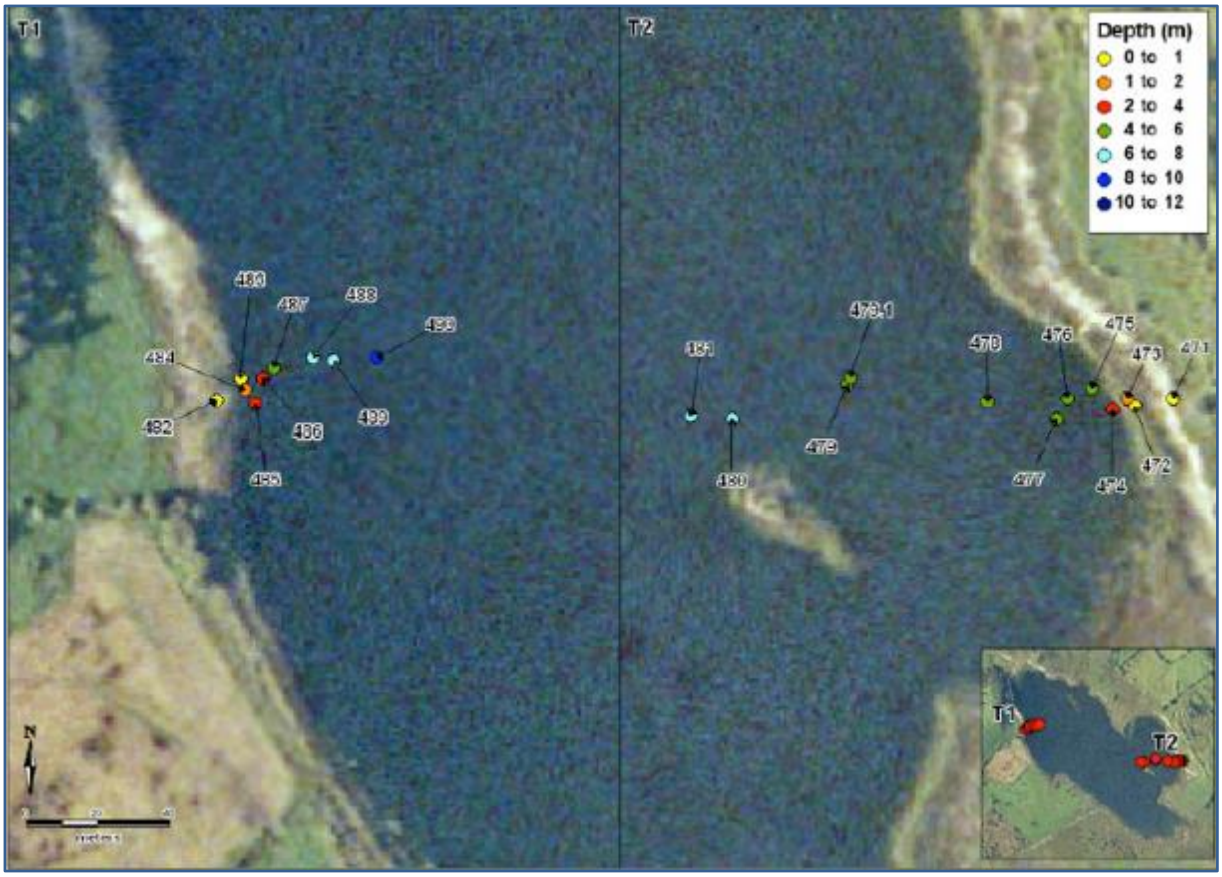
	2012
Snorkel survey date(s)	22/08/2012
Surveyors	CR, PD
Number of transects	2
Number of relevés	21
Secchi depth (m)	5.8 m
Substrates	Marl mud
Noteworthy species	
A) Vegetation zones	4
B) Euphotic depth (m)	T1: 7.5 m; T2: 7.5 m
C) C&K score	0.77
D) Total phosphorus (mg/l)	0.0045
E) Colour (Hazen units)	13
F) Index (TP × Colour)	0.0585
CONSERVATION CONDITION	**GOOD**

2012 condition assessment

Bleach Lough is one of a group of small kettlehole-shaped lakes in drift with unexpectedly high water transparency (see also Brick and Spring Loughs). Secchi and Euphotic depth are high. Cyanobacterial crust is well developed on the few exposed rocks encountered. Charophyte zonation is well developed and extends to 7.5 m, with *C. virgata* and *C. contraria* at station 480. However, the base of the second transect had *C. rudis* at the unusual depth of 7 m (station 488). Angiosperms are few and typical of marl lakes in good condition (*Nuphar lutea*, *Myriophyllum spicatum*, *Hippuris vulgaris* and *Potamogeton perfoliatus*). A very interesting feature is the presence of the Zebra Mussel, as in the case of Lough Lene the animal's population is low and banks of mussels were not seen. The lake's status is rated *Good* and an active angling club endeavours to protect water quality.



Bleach Lough 2012; *Chara rudis* and *Potamogeton perfoliatus* at 7 m near station 488 at the limit of the euphotic zone.



Bleach Lough showing positions of 2012 transects and relevés with depth.

Bleach Lough from the east.

Brick Lough, 2012			
Name	Brick Lough		
Alternative name(s)			
Grid Reference	163540213918, M6354013918	Depth (m)	
County	Galway	EPA code	25_122
Area (ha)	*c.* 1.9 ha	OSi 1:50,000 sheet	52
Maximum length (km)	0.2 km	Nutrient data	None available
Altitude (m)	85 m	SAC	n/a
Geology	Drift over limestone		
Previous survey			
Noteworthy species			

	2012
Snorkel survey date(s)	05/08/2012
Surveyors	CR
Number of transects	2
Number of relevés	14
Secchi depth (m)	
Substrates	Grey silt
Noteworthy species	
A) Vegetation zones	
B) Euphotic depth (m)	T2: 6.8 m; T1: 8.4 m
C) C&K score	0.21
D) Total phosphorus (mg/l)	
E) Colour (Hazen units)	
F) Index (TP × Colour)	
CONSERVATION CONDITION	**GOOD**

2012 condition assessment

Brick Lough resembles Spring and Bleach Loughs in its kettle-hole shape, with very steep sides dropping to >8 m. It is the smallest water body examined in the survey. There are no surface inflowing streams, it is likely the pond is fed by ground-water. The water is very clear and a strong thermocline was present. Euphotic depth is over 8 m. Cyanobacterial crust was well developed on a single boulder, but hard surfaces were very rare. Charophyte diversity is low with only *C. rudis* and *C. virgata*. Equally submerged angiosperms only included *Hippuris vulgaris* and *Potamogeton lucens*, although a fringe of floating plants included *Oenanthe aquatica*, *Potamogeton natans* and *Persicaria amphibia*. The moss *Fontinalis antipyretica* was abundant at depth. The C&K score is very low while the euphotic depth is high. While there is no evidence of eutrophication, Brick Lough is not a typical marl lake. A possible reason is that it is fed by ground-water, which is carbon dioxide-rich, that is not exposed to the surface due to the strong thermocline, in turn a consequence of the lake's small size and comparatively great depth. This would retard charophyte growth. The lake is classified *Good* but is a marginal example of a hard water lake.

Brick Lough 2012; *Potamogeton lucens* at 6.5 m.

Brick Lough showing positions of 2012 transects and relevés with depth.

Brick Lough 2012; *Potamogeton natans* on the surface along the east edge.

Lough Bunny, 2011 and 2018			
Name	Lough Bunny		
Alternative name(s)			
Grid Reference	137491196757, R3749196757	Depth (m)	15 m
County	Clare	EPA code	27_114
Area (ha)	102.9 ha	OSi 1:50,000 sheet	52
Maximum length (km)	2.5 km	Nutrient data	EPA, 2008-2015
Altitude (m)	17 m	SAC	001926, East Burren Complex SAC
Geology	Carboniferous peloidal limestone and chert		
Previous survey	August 1981 (Heuff, 1984), Roden (2001), Roden & Murphy (2013); Langangen (2005), Pybus *et al*. (2003), EPA WFD Monitoring Lake		
Noteworthy species			

	2011	2018
Snorkel survey date(s)	29/06/2011, 01/07/2011, 24/09/2011	22/09/18
Surveyors	CR, PM	CR, PM
Number of transects	5	2
Number of relevés	41	16
Secchi depth (m)	5-6 m	10 m
Substrates	Marl, rock, silt, peat	Marl rock
Noteworthy species	*Potamogeton praelongus* and charophytes	*Potamogeton praelongus* and charophytes
A) Vegetation zones	5	5
B) Euphotic depth (m)	8.4 m	T1: 7.1 m; T2: 7.1 m
C) C&K score	0.59	T1:0.61; T2: 0.64
D) Total phosphorus (mg/l)	<0.013 mg/l (see Roden & Murphy, 2013)	0.005 mg/l
E) Colour (Hazen units)	8.5	10.6
F) Index (TP × Colour)		0.053
CONSERVATION CONDITION	**GOOD**	**GOOD**

2011 Survey

2011 condition assessment

The full report of the 2011 survey of Lough Bunny can be found in Roden & Murphy (2013), when it was assessed as in *Good* condition. Roden & Murphy (2013) noted possible indications of increasing chlorophyll *a*. Their total phosphorus values were based on EPA data from 2010/11, when none of the seven measurements was below 0.01 mg/l were measured, leading to an apparent overestimate of the real value.

2018 Survey

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	Lough Bunny
pH		8.0
Alkalinity	mg/l	154
Colour	Hazen units	10.6
Ammonia	mg/l	0.018
Total phosphorus	mg/l	0.006
Chlorophyll *a*	µg/l	1.44

Previous survey

The lake is described in Roden & Murphy (2013) and a preliminary description is given in Roden (2001). The lake is a WFD monitoring lake and, therefore, surveyed by the EPA every three years. Pybus *et al*. (2003) give an earlier description of the lake's ecology, while Ryan and Heuff surveyed the lake in 1977 (Heuff, 1984). All surveys recorded a vegetation of charophytes.

Noteworthy species recorded in 2018

Potamogeton praelongus is scarce in Co. Clare.

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara virgata var. *annulata*	*Hippuris vulgaris*	Cyanobacterial crust
Chara contraria	*Juncus articulatus*	
Chara curta	*Littorella uniflora*	
Chara rudis	*Nuphar lutea*	
Chara virgata	*Potamogeton gramineus*	
Nitella flexilis	*Potamogeton perfoliatus*	
	Potamogeton praelongus	
	Ranunculus sp.	
	Schoenoplectrus lacustris	
	Utricularia vulgaris/australis	

Vegetation

The lake has two main basins separated by a narrow shallow saddle. Cyanobacterial crust and four charophyte zones are present, while *Nuphar lutea* and *Hippuris vulgaris* occur above the *C. rudis* zone.

Cyanobacterial crust

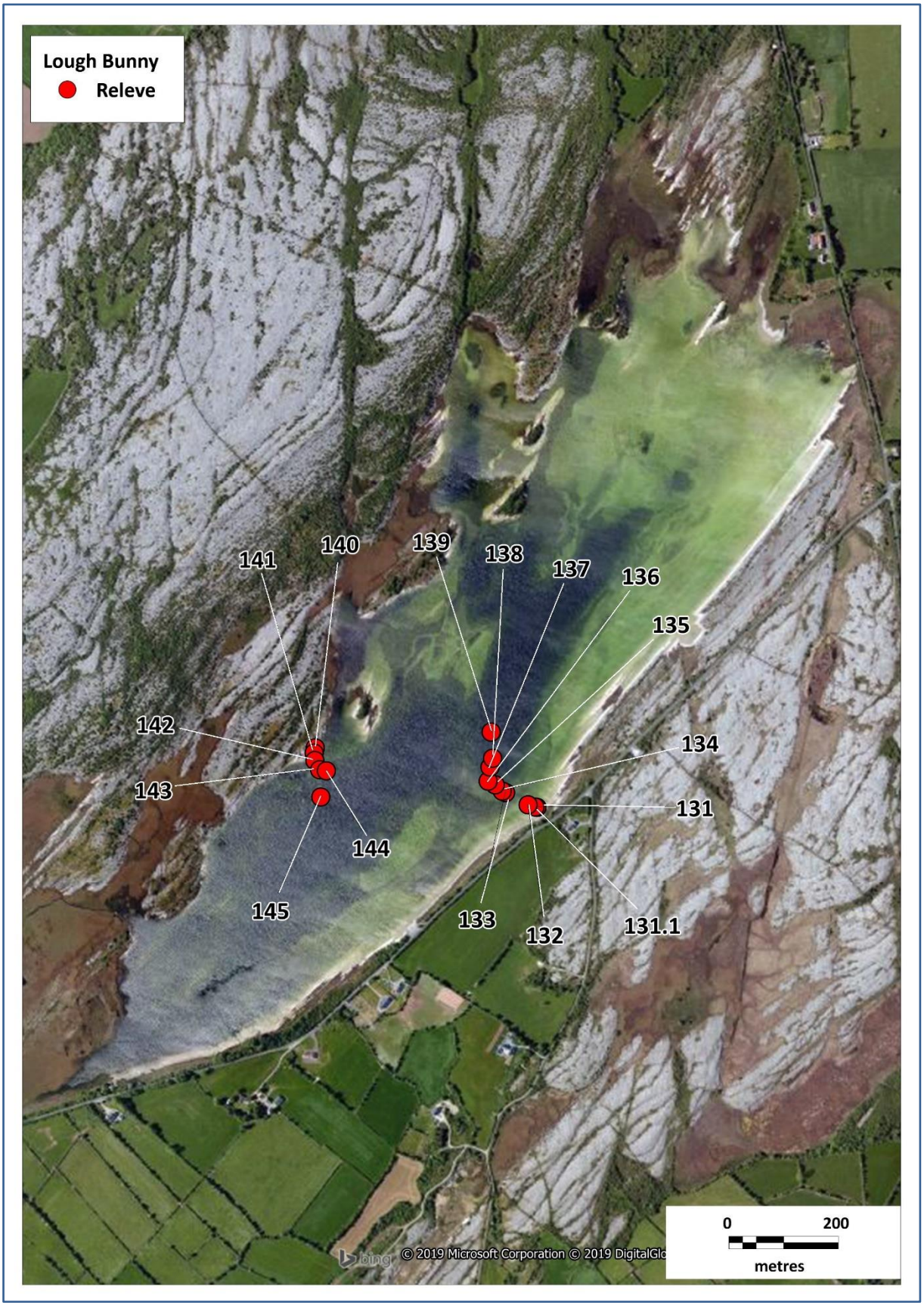
Crust indicator values for Lough Bunny are all within the *Favourable* (*Good*) targets, with a particularly low value for chlorophyte abundance. Lough Bunny is considered to be in *Favourable* (*Good*) condition.

Change since previous survey

No significant changes have been recorded since the survey in 2001.

Threats and pressures

While Lough Bunny is in *Good* conservation condition, improved grassland borders the lake to the south-west and north-east. As the lake is ground-water fed, excess fertiliser use or leaky septic tanks at some distance from the lake might threaten the lake's future. The lake is within the Burren National Park.



Lough Bunny overview map showing positions of 2018 transects and relevés. Transect 1: 131-139; Transect 2: 140-145.

2018 condition assessment

All parameters were assessed as Good, therefore the lake as a whole was assessed as in *Favourable* (*Good*) conservation condition.

Parameter	Target	Lough Bunny 2018	Condition
Area	Stable or increasing	Stable	
Number of vegetation zones	4 or more*	5	Good
Euphotic depth (m)	>7	7.1	Good
Crust cover (%)	>70	94	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	22 (4)	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	5.0 (2.6)	Good
C&K score	>0.6	0.64	Good
Lake level	at or above cyanobacterial crust		Good
Total phosphorus (TP) (mg/l)	≤0.01	0.005	Good
Colour (Hazen units)	<15	10.6	Good
Index (TP × Colour)	<0.1	0.53	Good
Overall assessment			**Good**

Lough Carra, 2011 and 2018			
Name	Lough Carra		
Alternative name(s)			
Grid Reference	117662272566, M1766272566	Depth (m)	>20 m
County	Mayo	EPA code	30_347
Area (ha)	*c.* 1,5464 ha	OSi 1:50,000 sheet	38
Maximum length (km)	10 km	Nutrient data	EPA, 2008-2015
Altitude (m)	18 m	SAC	001774, Lough Carra Mask Complex SAC
Geology	Carboniferous limestone, shale, dark limestone, peloidal limestone, nodular calcarenite		
Previous survey	August 1977 (Heuff, 1984), King and Champ (1996), Roden & Murphy (2013), EPA WFD Monitoring Lake		
Noteworthy species			

	2011	2018
Snorkel survey date(s)	13, 16, 20, 21 & 27/07/2011; 03, 04 & 11/08/2011, 29/09/2011	09&10/08/2018
Surveyors	CR, PM	CR, PM, JR
Number of transects	27	6
Number of relevés	241	36
Secchi depth (m)	3-4 m (Twin Island's Basin), 4 m (Northern Basin), 5 m (Castlecarra Basin)	5.5 m (south of Twin Islands)
Substrates	Marl, some rock, boulder, silt, sand and gravel	Marl, rock
Noteworthy species	*Chara tomentosa, Chara denudata, Myriophyllum verticilliatum*	*Chara denudata, Chara tomentosa*
A) Vegetation zones	5	5
B) Euphotic depth (m)	9 m (Castlecarra); 4.6 m (Gallagh); 8 m (Northern); 6.7 m (Twin Island); 7 m (Cloonkerry)	T1: 8.6 m (Castlecarra); T2: 4.6 m (Gallagh); T3: 8 m (Northern); T4: 5.4 m (Twin Island); T5: 7 m (Cloonkerry)
C) C&K score	0.82 (Castlecarra); 0.92 (Gallagh); 0.79 (Northern); 0.56 (Twin Island); 0.87 (Cloonkerry).	T1: 0.63; T2: 0.68; T3: 0.52; T4: 0.57; T5: 0.99
D) Total phosphorus (mg/l)	0.009 - 0.01	0.007
E) Colour (Hazen units)	5 - 63	12.25
F) Index (TP × Colour)		0.086
CONSERVATION CONDITION	**POOR**	**POOR**

2011 SURVEY

2011 condition assessment

The full report of the 2011 survey of Lough Carra can be found in Roden & Murphy (2013). The Castle Carra or central basin of Lough Carra was assessed as in *Good* condition, however the other two Twin Islands and Northern basins showed clear signs of deterioration. These findings were in keeping with those of Hobbs *et al*. (2005), who showed that sediment phosphorus is increasing in Lough Carra and noted that the increase was greatest in the northern basin and least in the central basin. Roden & Murphy (2013) concluded that Lough Carra was under considerable ecological stress and the assumption that it is Ireland's best example of a marl lake may cease to be true in the near future.

2018 SURVEY

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	Lough Carra
pH		8.1
Alkalinity	mg/l	143
Colour	Hazen units	12.25
Ammonia	mg/l	0.22
Total phosphorus	mg/l	0.007
Chlorophyll *a*	µg/l	3.08
Secchi	m	5.5

Previous survey

Several previous accounts contain good data on the benthic macrophytes of Lough Carra. In 1906, Praeger spent several days with a boat exploring the lake and its surroundings (Praeger, 1906). He noted very clear water, a few starved plants and deeper vegetation of *Chara hispida/rudis*, *Potamogeton perfoliatus* and *Potamogeton nitens*. He did not mention *Chara tomentosa*.

Heuff (1984) reported clear water in Lough Carra when surveyed in 1977 (Secchi of 6.5 m versus 5.0 m in 2011), with *Chara curta* and *Chara contraria* descending to 7 m near the Twin Islands. There is no mention of *Chara tomentosa*, even though the species is abundant in this area in 2011. In 2011, the limit of vegetation off the Twin Islands was at 6 m and *Chara rudis* and *Elodea canadensis* were at the base of the euphotic zone (WP 464- 471). This shift in depth and species composition suggests a decreasing light intensity.

In 1996, a detailed grapnel survey of the benthic macrophytes was undertaken by King & Champ (2000). They recorded most of the species and communities noted in 2011 and 2018, with the exception of the river mouth *Chara hispida/Chara vulgaris* vegetation. They recorded *Chara tomentosa* for the first time in the lake including near the Twin Islands and part of the western shore of Moorehall Bay. However, they did not report the species from the Castle Island transect nor from other places shown in the vegetation map of Roden & Murphy (2013).

Noteworthy species recorded in 2018

Chara denudata and *Chara tomentosa* are rare species, although the latter was probably introduced into the lake-or could be expanding due to nutrient increase.

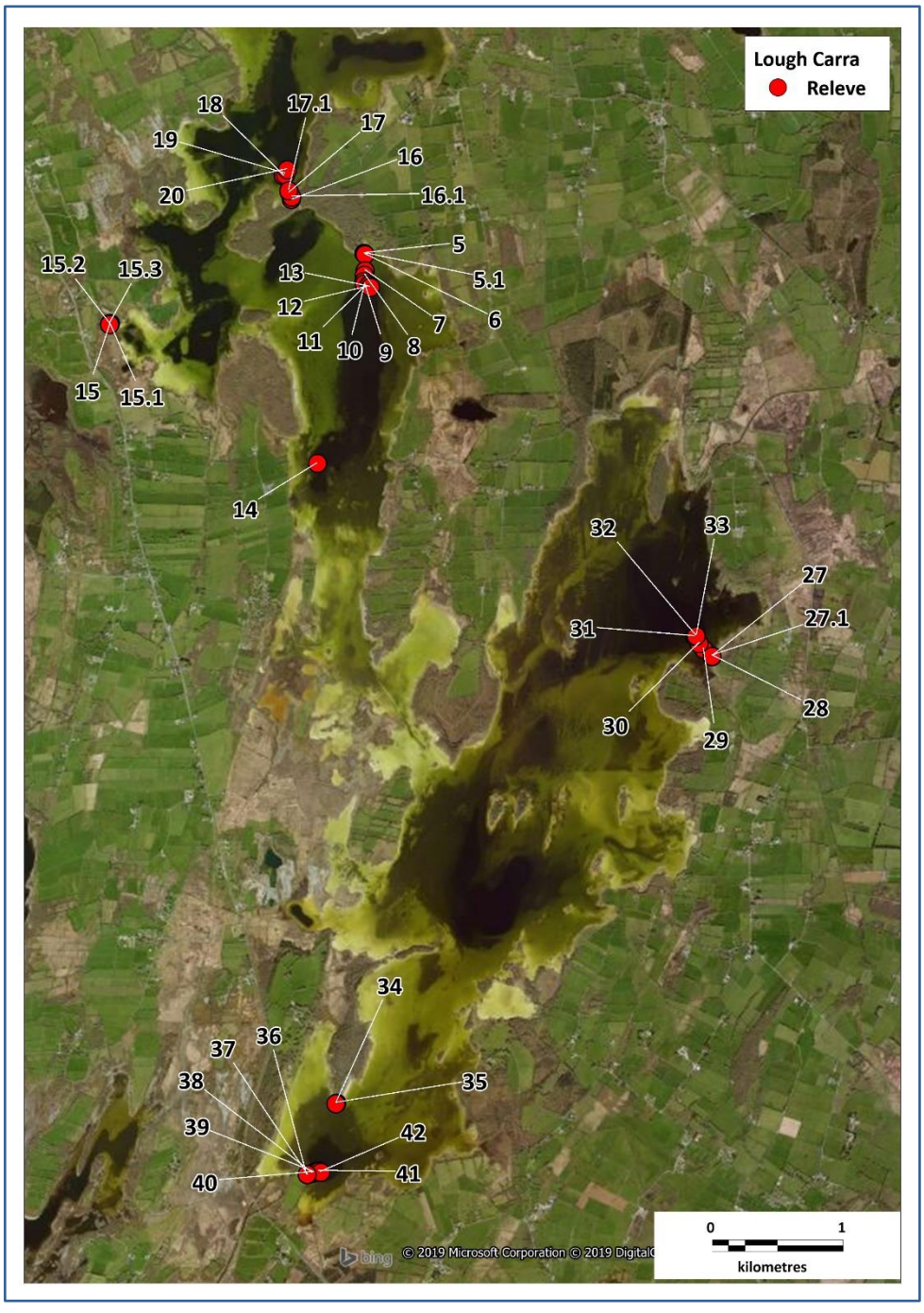
Taxa recorded recorded in 2018

Charophytes	Vascular plants	Vascular plants	Other
Chara aculeolata	*Elodea canadensis*	*Sparganium minimum*	*Callergon giganteum*
Chara contraria	*Lemna trisulca*	*Utricularia vulgaris*	*Fontinalis antipyretica*
Chara curta	*Myriophyllum alterniflorum*	*Utricularia intermedia*	*Scorpidium scorpioides*
Chara denudata	*Myriophyllum verticilliatum*		Cyanobacterial crust
Chara hispida	*Nuphar lutea*		Red cyanophyte
Chara rudis	*Phragmites australis*		*Ophrydium versatile*
Chara tomentosa	*Potamogeton filiformis*		
Chara virgata	*Potamogeton gramineus*		
Chara virgata var. *annulata*	*Potamogeton lucens*		
	Potamogeton perfoliatus		
	Schoenoplectrus lacustris		

Vegetation

The lake vegetation was mapped in 2011 (Roden & Murphy, 2013) and little change was detected in this 2018 survey. The grossly eutrophicated area at the mouth of the Annie's River is still present with a flora very different from the rest of the lake. Species recorded in 2018 included *Sparganium emersum*, *Oenanthe fluviatilis*, *Lemna trisulca*, *Ceratophyllum demersum*, *Elodea canadensis*, along with very dense stands of *Schoenoplectus lacustris*. While such an assemblage might be typical of many lowland lakes and ponds, it contrasts strongly with normal species poor cyanobacterial crust and charophyte-dominated vegetation found in typical marl lakes.

Large stands of *Myriophyllum verticillatum* occur in the Twin Islands basin growing in depths of 4 to 5 m yet forming visible mats on the surface. A new stand not noted in 2011 is located at M1783570390.



Lough Carra overview map showing positions of 2018 transects and relevés. Transect 1: 5-13; Transect 2: 15-15.3; Transect 3: 16-20; Transect 4: 27-33; Transect 5: 34-42; relevé 14: spot measurement of euphotic depth.

Cyanobacterial crust

Lough Carra is a complex, multi-basin lake and research has shown that different nutrient states exist in different basins within the lake, and that these are reflected in the crust metrics (Doddy *et al*., 2019b). For the present study, two stations were sampled, however, it is recommended that additional stations be included if crust indicators are to be used on an ongoing basis for this lake. The mean figures indicated that, overall, Lough Carra falls into the *Favourable* (*Good*) category. Nonetheless, some areas of this lake are in serious decline, and it requires careful monitoring and management.

Change since previous survey

The central Castle Carra basin (T1) remains in *Good* condition. The Twin Island Basin (T4) showed clear signs of deterioration with a C&K score of 0.57 and euphotic depth of 5.4 m. New patches of *Myriophyllum verticillatum* have also appeared in the Twin Islands basin. Angiosperms appear to be increasing in the northern basin (declining C&K score). No other significant changes have been recorded since the survey in 2011. The Gallagh basin has not changed since 2011. The most southern or Cloonkerry basin remains in *Good* condition. A new population of *Chara denudata* has been recorded in the southern basin.

Threats and pressures

Lough Carra continues to show signs of serious eutrophication, possibly due to more intensive agriculture in the catchment.

2018 condition assessment

As several basins are rated *Unfavourable-Inadequate* (*Poor*) (due to decline in euphotic depth, increase in vascular plants and absence of deep charophyte layers) and the Annie's river area is rated *Unfavourable-Bad* (due to poor cyanobacterial crust and absence of typical marl lake vegetation), the entire lake is rated *Unfavourable-Inadequate* (*Poor*). Nevertheless some parts remain in *Good* condition and the crust analysis confirms this picture. It is an open question how long these areas will remain in *Good* condition.

Parameter	Target	Castlecarra Basin 2018		Gallagh Basin 2018		Northern Basin 2018		Twin Island's Basin 2018		Cloonkerry Basin 2018		Lough Carra OVERALL 2018	
Area	Stable or increasing											Yes	Good
Number of vegetation zones	4 or more*	5	Good			4	Good	3	Poor			3	Poor
Euphotic depth (m)	>7	8.6	Good	4.6	Poor	8.0	Good	5.4	Poor	7.0	Good	4.6	Poor
Crust cover (%)	>70											93%	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45											33 µg/cm^3 (±5)	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45											21.47% (±4.7)	Good
C&K score	>0.6	0.63	Good	0.68	Good	0.52	Poor	0.57	Poor	0.99	Good	0.52	Poor
Lake level	at or above cyanobacterial crust											Yes	Good
Total phosphorus (TP) (mg/l)	≤0.01											0.007	Good
Colour (Hazen units)	<15											12.25	Good
Index (TP × Colour)	<0.1											0.086	Good
Overall assessment			**Good**		**Poor**		**Poor**		**Poor**		**Good**		**Poor**

Cooloorta/ Travaun Lough, 2012 and 2018

Name	Cooloorta Lough(Turlough)/ Travaun Lough		
Alternative name(s)			
Grid Reference	135334196517, R3533496517	Depth (m)	>11 m
County	Clare	EPA code	27_80
Area (ha)	27.9 ha	OSi 1:50,000 sheet	52
Maximum length (km)	2.2 km	Nutrient data	2 samples collected in 2018
Altitude (m)	16 m	SAC	001926, East Burren Complex SAC
Geology	Carboniferous massive bedded Limestone		
Previous survey	Roden (2000)		
Noteworthy species			

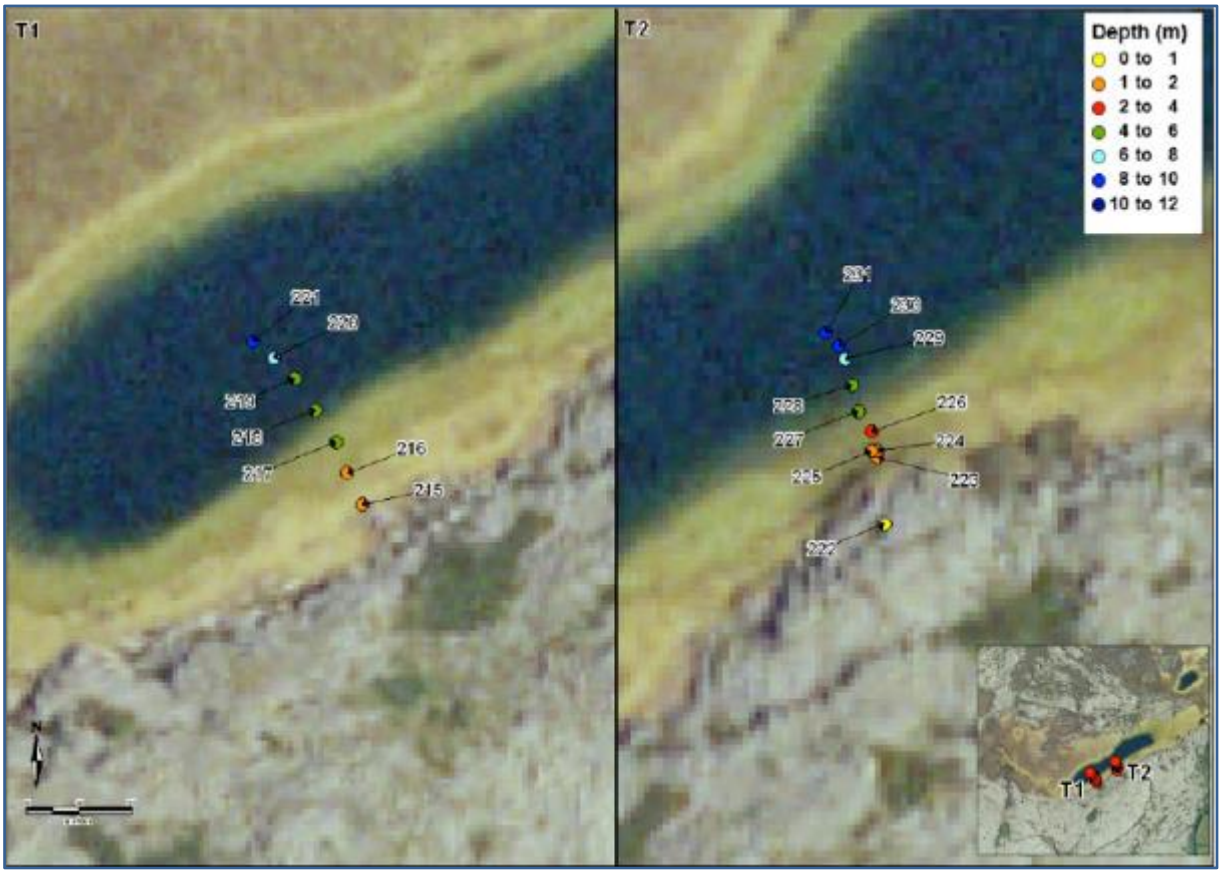
	2012	2018
Snorkel survey date(s)	08/08/2012	04/07/2018
Surveyors	CR, PM	CR, PM
Number of transects	2	2
Number of relevés	17	12
Secchi depth (m)		9 m
Substrates	Marl	Marl, rock
Noteworthy species		*Potamogeton praelongus*
A) Vegetation zones	4	4
B) Euphotic depth (m)	>9 m, vegetation on flat bottom at 9 m	T1: 7.5 m; T2: 7.5 m; spot check: 8.0 m
C) C&K score	0.689	T1: 0.93; T2: 0.87
D) Total phosphorus (mg/l)		0.003
E) Colour (Hazen units)		9.7
F) Index (TP × Colour)		0.029
CONSERVATION CONDITION	**GOOD**	**GOOD**

2012 Survey

2012 condition assessment

Perhaps the most transparent lake in the 2012 survey. The lake bottom is at 9 m and *Chara contraria* was still abundant at this depth. The *Chara rudis* band is reduced and *C. contraria* is abundant. Krustenstein is well developed and angiosperms are very sparse, mainly *Potamogeton* spp. and *Juncus bulbosus*. There are no obvious threats and the lake is in the Burren National Park. Rated as *Good*

Cooloorta Lough, 2012; on the marl slope at 6 m, *Chara contraria* in foreground and *Potamogeton praelongus* in background.



Cooloorta Lough showing positions of 2012 transects and relevés with depth.

Cooloorta Lough, 2012.

2018 SURVEY

Hydrochemical data

Water quality data are based on two samples taken in 2018

Parameter	Unit	Cooloorta Lough
pH		8.1
Alkalinity	mg/l	205
Colour	Hazen units	9.7
Ammonia	mg/l	0.13
Total phosphorus	mg/l	0.003
Chlorophyll *a*	µg/l	0.9
Secchi	m	9

Previous survey

The lake vegetation was described by C. Roden in July 2000 (Roden, 2000). The vegetation was again examined by C. Roden and P. Murphy in 2012. P. Doddy took cyanobacterial crust samples in 2016, as well as nutrient samples. No changes in vegetation are noticeable over this period.

Perhaps the most transparent lake in the survey, the lake bottom is at 9 m and *Chara contraria* was still abundant at this depth. The *Chara rudis* band is reduced and *C. contraria* is abundant. Cyanobacterial crust is well developed and angiosperms are very sparse, mainly *Potamogeton* spp. and *Juncus bulbosus*.

Noteworthy species recorded in 2018

Potamogeton praelongus is rarely recorded in Co. Clare.

Taxa recorded in 2018

Charophytes	Vascular plants
Chara aculeolata	*Potamogeton gramineus*
Chara curta	*Potamogeton perfoliatus*
Chara rudis	*Potamogeton praelongus*
Chara virgata	*Utricularia vulgaris/australis*

Vegetation

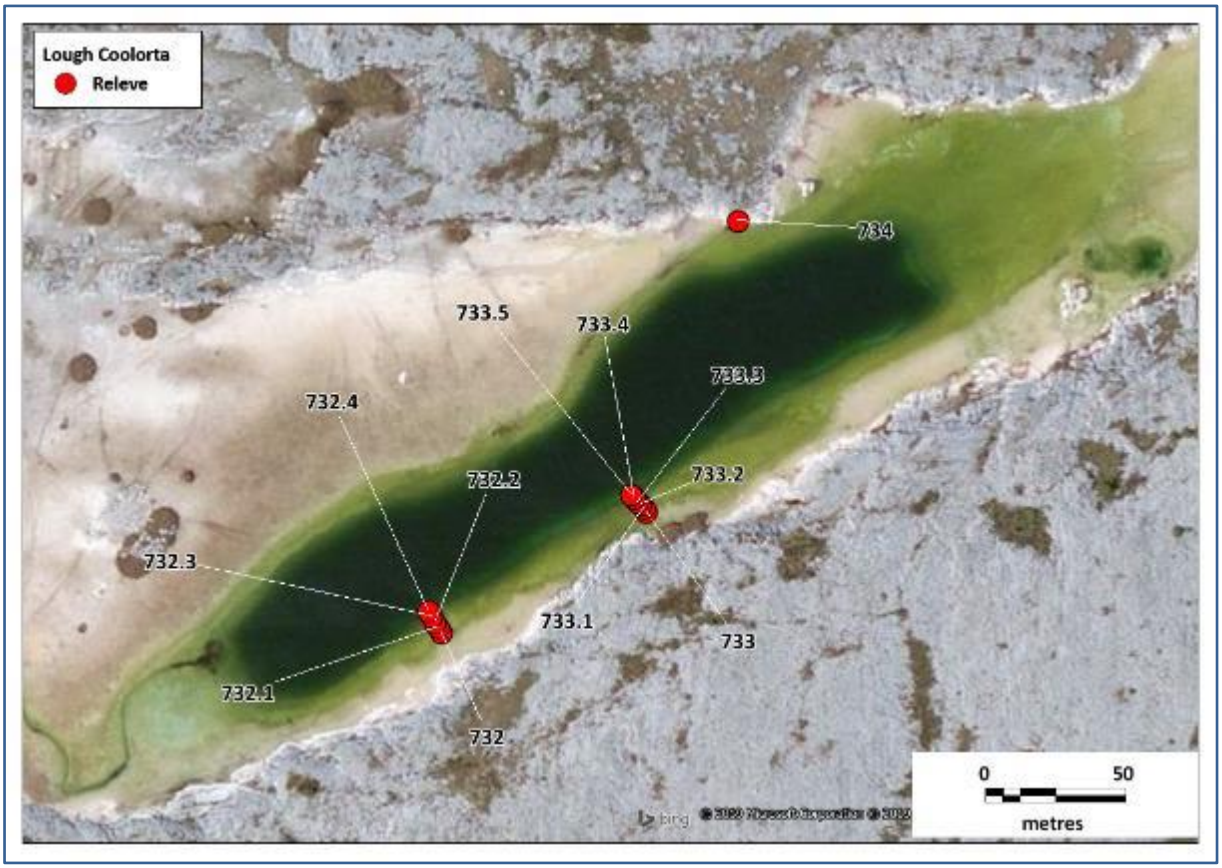
A small, deep, clear water lake with three separate charophyte zones and cyanobacterial crust. Vascular plants are confined to three species of *Potamogeton* and *Urticularia vulgaris/australis*. This low species number probably reflects small size, isolation and very low nutrient levels. Euphotic depth was 7.5 m on Transects 1 and 2, and 8 m adjacent to relevé 734.

Cyanobacterial crust

Cooloorta could not be sampled in 2018 owing to low water levels drying the crust. Doddy *et al*. (2019) give data for 2016 as follows

- Coverage 100%
- Chlorophyll 18 µg/cm^3
- Chlorophytes 8%

These figures place Cooloorta in the *Favourable (Good)* category.



Cooloorta Lough overview map showing positions of 2018 transects and relevés. Transect 1: 732-732.4; Transect 2: 733-733.5.

Change since previous survey

No significant changes note since 2012. Water levels were very low during 2018 sampling, which may have reduced the euphotic depth.

Threats and pressures

There are no obvious threats and the lake is in the Burren National Park.

2018 condition assessment

All metrics were assessed as Good, therefore the lake is assessed as in *Favourable* (*Good*) conservation condition.

Parameter	Target	Cooloorta Lough 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	4	Good
Euphotic depth (m)	>7	7.5, 8.0	Good
Crust cover (%)	>70	100	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	18	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	8	Good
C&K score	>0.6	0.93	Good
Lake level	at or above cyanobacterial crust	at crust level	Good
Total phosphorus (TP) (mg/l)	≤0.01	0.003	Good
Colour (Hazen units)	<15	9.7	Good
Index (TP × Colour)	<0.1	0.029	Good
Overall assessment			**Good**

Lough Corrib, 2012			
Name	Lough Corrib		
Alternative name(s)			
Grid Reference	126698236252, M2669836252	Depth (m)	
County	Galway/Mayo	EPA code	30_84/ 30_666a, 30_66b
Area (ha)	*c*. 16,000 ha	OSi 1:50,000 sheet	45 & 38
Maximum length (km)	*c*. 30 km	Nutrient data	EPA
Altitude (m)	4 m	SAC	000297, Lough Corrib SAC
Geology	Limestone and metamorphic		
Previous survey	August 1977 (Heuff, 1984), Roden (2004), EPA WFD Monitoring Lake		
Noteworthy species			

	2012
Snorkel survey date(s)	02/08/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	18
Secchi depth (m)	4.0 m
Substrates	Marl sand
Noteworthy species	*Chara denudata*
A) Vegetation zones	5
B) Euphotic depth (m)	T1: 5.0 m; T2: 5.0 m
C) C&K score	0.94
D) Total phosphorus (mg/l)	0.009
E) Colour (Hazen units)	20.9
F) Index (TP × Colour)	0.18
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Lough Corrib is a very large lake, so the validity of an assessment based on two transects might be questioned. As well as this survey, C. Roden also surveyed the northern arm of Lough Corrib for Galway County Council in August 2012 and found broadly similar conditions. In addition, he examined two transects at Kilbeg pier, about 5 km north of the present transects, in 2004. Data from all of these surveys was considered.

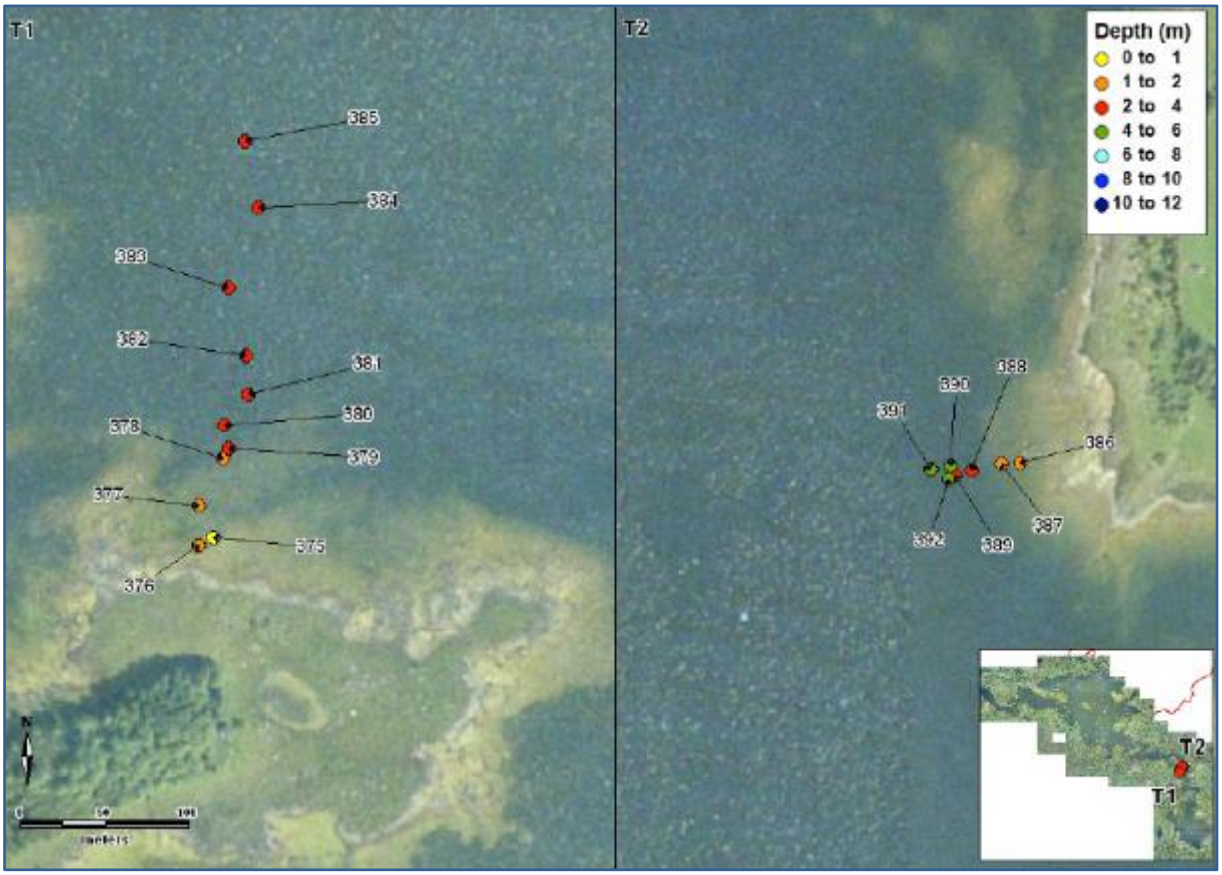
Water colour was dark and Secchi and euphotic depth low. In the northern arm, Secchi was lower again at 2-3 m, as was the euphotic zone. Cyanobacterial crust was either absent or flaking-off limestone boulders and being replaced by Zebra Mussels. Charophyte zonation was intact with *C. curta*, *C. rudis*, *C. virgata* and *C. denudata* zones present; however the euphotic depth was very shallow. Very few angiosperms were encountered, but the introduced *Lagarosiphon major* was widespread in the north of the lake. Some charophytes appeared to be dead or dying (see photo below).

In 2004, C. Roden found the euphotic zone extended to 6 m, charophyte zones included *C. curta*, *C. rudis*, *C. virgata/globularis*, *C. denudata*, *C. contraria* and *Nitella flexilis*. In addition, the cyanobacterial crust was in good conditions and Zebra Mussels absent.

The evidence indicates that the lake's sub-littoral vegetation is declining. In 2012, Lough Corrib was provisionally assessed as *Bad*, but when the data were re-examined here and the methods of Roden *et al*. (2020) applied, it was re-assessed as *Poor*, in particular owing to the continued presence of *C. denudata*.

Significant further work is required to determine the distribution and conservation condition of lake habitats in Lough Corrib. Corrib, with Mask, is one of the most complex and important lake in the British Isles having base-poor, oligotrophic waters at the north-western end and highly calcareous waters in the southern basin. Habitat 3110 occurs in the north, habitat 3140 on limestone to the south, and it is assumed that a *Najas*-type lake (3130) should, naturally, occur somewhere in the mix zone between. This is supported by a record for *Najas flexilis* in Corrib in 1986 (Krause & King, 1994). It follows,

therefore, that three different condition assessment methods need to be applied. A key question is the number and distribution of transects required to reliably assess the condition of each of the habitats in Lough Corrib.



Lough Corrib showing positions of 2012 transects and relevés with depth.

Lough Corrib 2012; **Left**: Zebra Mussel and green algae replacing cyanobacterial crust; **Right**: decaying charophyte lifted from lake floor at 3 m.

Cullaun Lough, 2012			
Name	Lough Cullaun		
Alternative name(s)			
Grid Reference	131562190586, R3156290586	Depth (m)	
County	Clare	EPA code	27_115
Area (ha)	49.7 ha	OSi 1:50,000 sheet	51
Maximum length (km)	1.6 km	Nutrient data	EPA
Altitude (m)	16 m	SAC	001926, East Burren Complex SAC
Geology	Limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

	2012
Snorkel survey date(s)	19/07/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	12
Secchi depth (m)	4 m
Substrates	Marl
Noteworthy species	
A) Vegetation zones	4
B) Euphotic depth (m)	T1: 5.7 m; T2: 6.0 m,
C) C&K score	0.63
D) Total phosphorus (mg/l)	0.0065
E) Colour (Hazen units)	16.5
F) Index (TP × Colour)	0.107
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Lough Cullaun lies close to the Ballyeighter lakes but has a shallower euphotic zone, possibly due to peat staining. Secchi depth is intermediate, but visibility is good underwater. The lake shelves very steeply on its north and south shores but slopes more gently at the east end.

Three charophyte zones occur *C. curta*, *C. rudis* and, on the first transect, *C. virgata* but only to 5.0 m. Cyanobacterial crust is well developed in shallow water.

Cullaun is one of a number of lakes without obvious evidence of habitat degradation, but lacking the deep water communities of the best marl lakes probably due to peat staining of the water reducing the euphotic depth. Some metrics (Colour, index, euphotic depth) just fail to reach the *Good* standard and the lake is rated borderline *Poor*, largely on account of the poor or absent deep water vegetation.

Lough Cullaun 2012; *Potamogeton* x *zizii* growing amongst *C. curta* at station 026.

Lough Cullaun showing positions of 2012 transects and relevés with depth.

Lough Cullaun 2012; looking south-west.

Cullaunyheeda, 2012			
Name	Cullaunyheeda		
Alternative name(s)			
Grid Reference	148435174671, R4843574671	Depth (m)	
County	Clare	EPA code	27_128
Area (ha)	154.8 ha	OSi 1:50,000 sheet	58
Maximum length (km)	2 km	Nutrient data	EPA
Altitude (m)	27 m	SAC	n/a
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

	2012
Snorkel survey date(s)	26/07/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	16
Secchi depth (m)	2 m
Substrates	*Chara* marl
Noteworthy species	
A) Vegetation zones	2
B) Euphotic depth (m)	T1: 4.7 m; T2: 5.6 m
C) C&K score	0.2
D) Total phosphorus (mg/l)	0.017
E) Colour (Hazen units)	39.9
F) Index (TP × Colour)	0.68
CONSERVATION CONDITION	**BAD**

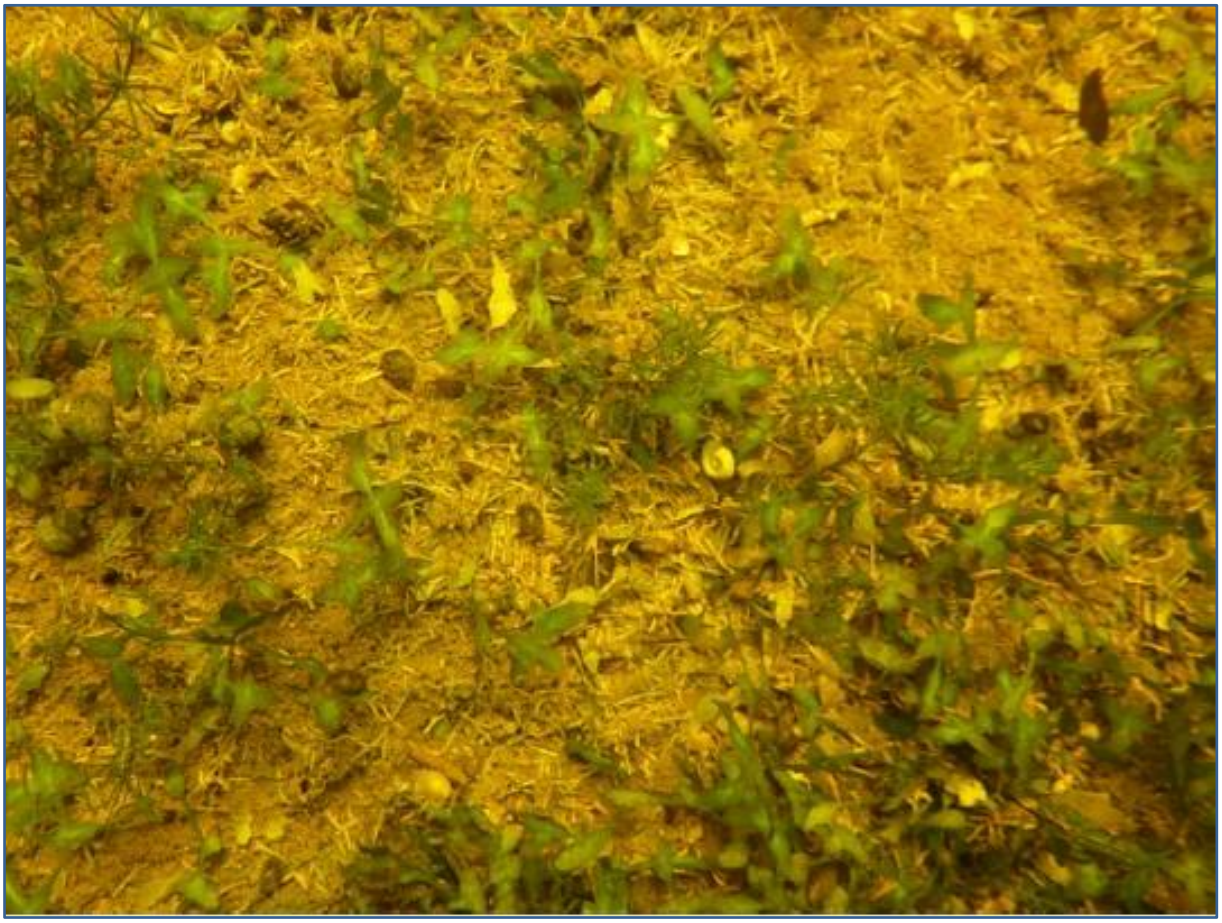
2012 condition assessment

Cullaunyheeda lies in a limestone basin, but has a very shallow euphotic zone and Secchi depth. The bottom marl suggests a former widespread distribution of charophytes but these are now confined to part of one transect (stations 362-368). Only *Chara rudis* and *Chara virgata* occur and neither grows below 2.3 m. *Elodea canadensis* and *Lemna trisulca* occur to 4 m. The Zebra Mussel is abundant. While eroded rock was seen in the shallow sub littoral, no well-developed cyanobacterial crust was noted.

As there is good evidence of the lake formerly supporting charophyte beds (*Chara* marl) and cyanobacterial crust (eroded rock), the lake is regarded as degraded and is rated *Bad*. This assessment is confirmed by the index value.

Lough Cullaunyheeda, 2012; mud with *Chara* fragments brought up from below the euphotic zone.

Lough Cullaunyheeda showing positions of 2012 transects and relevés with depth.



Cullaunyheeda, 2012; *Lemna trisulca* and *Chara virgata* growing on *Chara* marl.

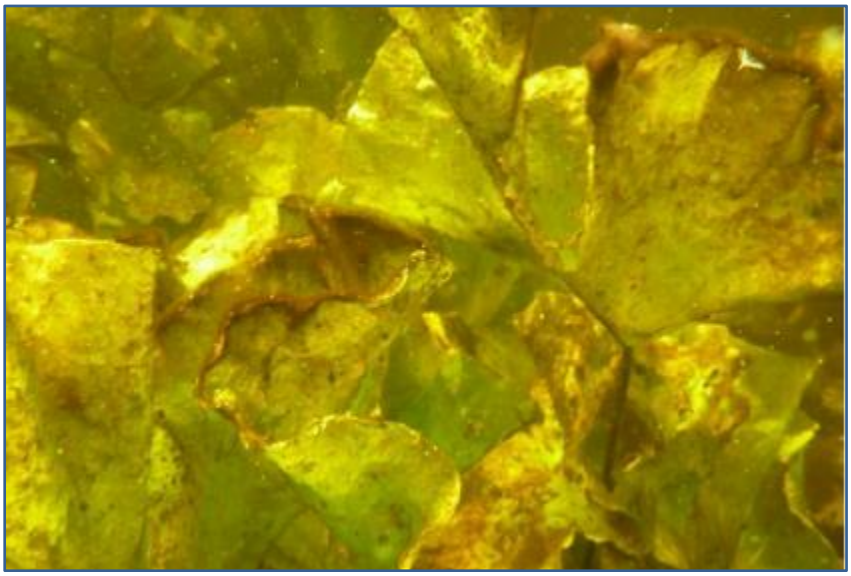
Lough Derravarragh, 2012			
Name	Derravaragh		
Alternative name(s)			
Grid Reference	242373266758, N4237366758	Depth (m)	
County	Westmeath	EPA code	26_708
Area (ha)	914.2 ha	OSi 1:50,000 sheet	41
Maximum length (km)	9.5 km	Nutrient data	EPA
Altitude (m)	61 m	SAC	n/a
Geology	Limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

	2012
Snorkel survey date(s)	13/09/12
Surveyors	CR, PM
Number of transects	1
Number of relevés	1/5
Secchi depth (m)	3.0 m
Substrates	Red silt
Noteworthy species	
A) Vegetation zones	1
B) Euphotic depth (m)	4.0 m
C) C&K score	
D) Total phosphorus (mg/l)	0.017
E) Colour (Hazen units)	32.4
F) Index (TP × Colour)	0.55
CONSERVATION CONDITION	**BAD**

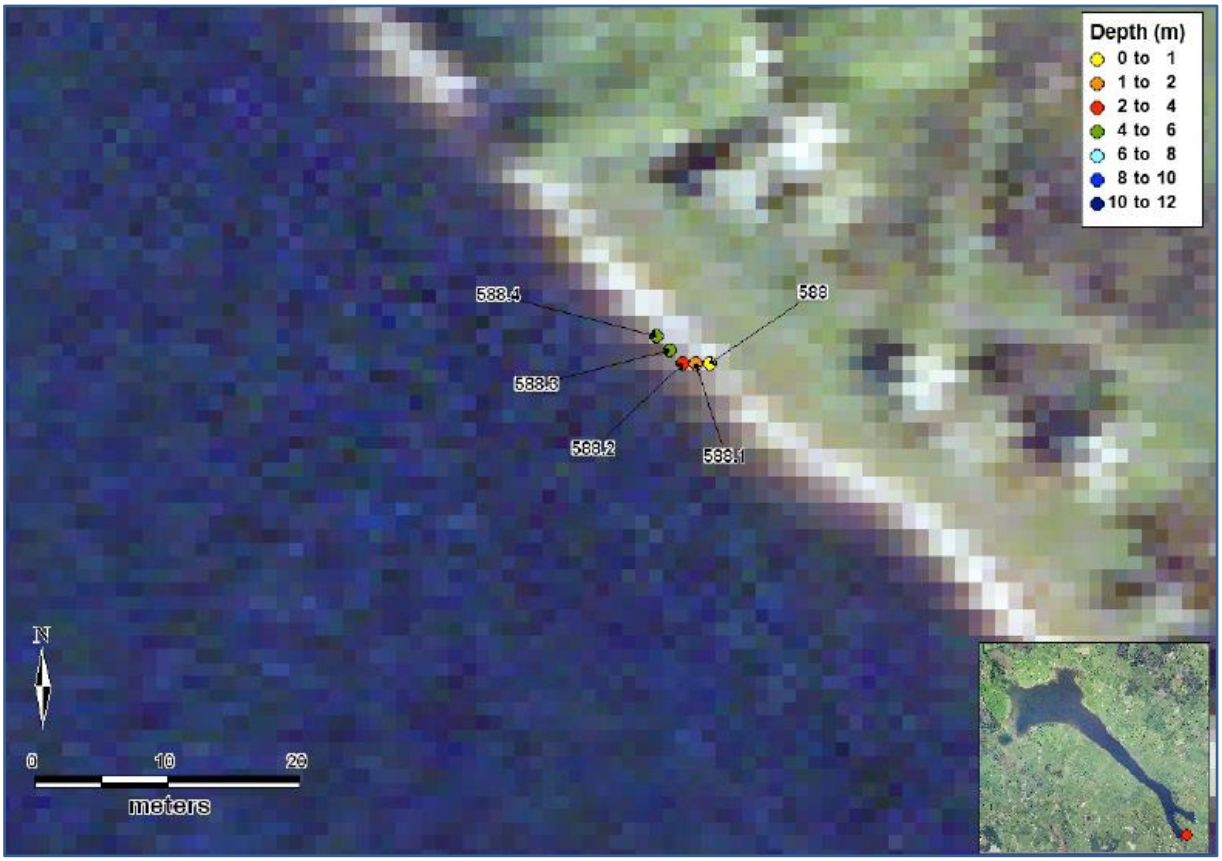
2012 condition assessment

The lake has very shallow euphotic zone and Secchi depth. The euphotic zone is largely occupied by drifting *Lemna trisulca,* which may drift downwards thus creating an overestimate of the zone's depth. Zebra Mussel is abundant. Only one charophyte was noted, a single clump of *C. vulgaris*, a possible sign of lake degradation. Cyanobacterial crust exists in very shallow water but is heavily overgrown by green algae. Given the complete absence of charophyte bands, a very shallow euphotic zone and abundant *L. trisulca* the lake is rated *Bad*.

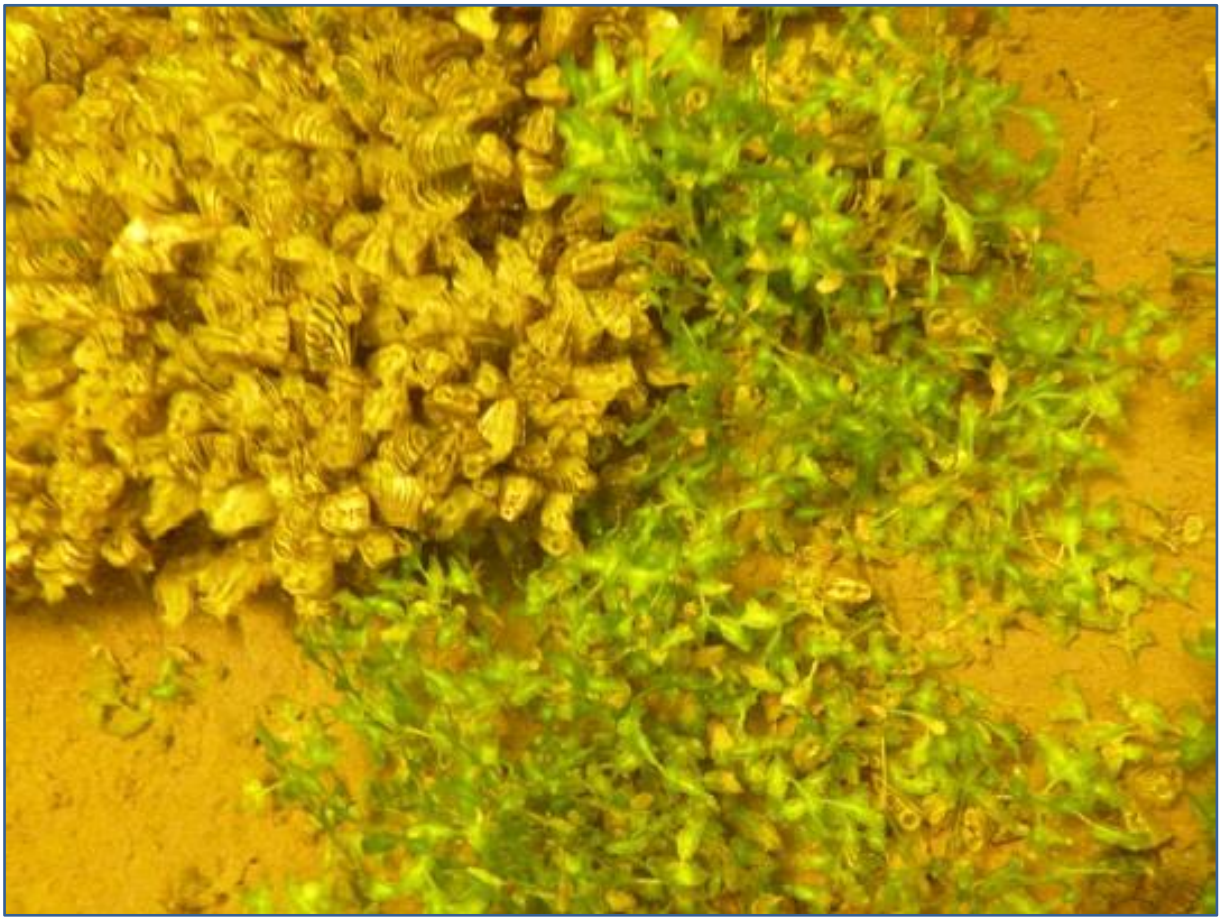
On a short visit to the north of the lake in 2009, C. Roden saw extensive beds of charophytes in 1 m depth, however deposition of peat from the River Inney was a serious problem in that part of the lake.



Lough Derravaragh, 2012; *Nuphar* leaves heavily overgrown by epiphytic diatoms at 1 m.



Lough Derravaragh showing positions of 2012 transects and relevés with depth.



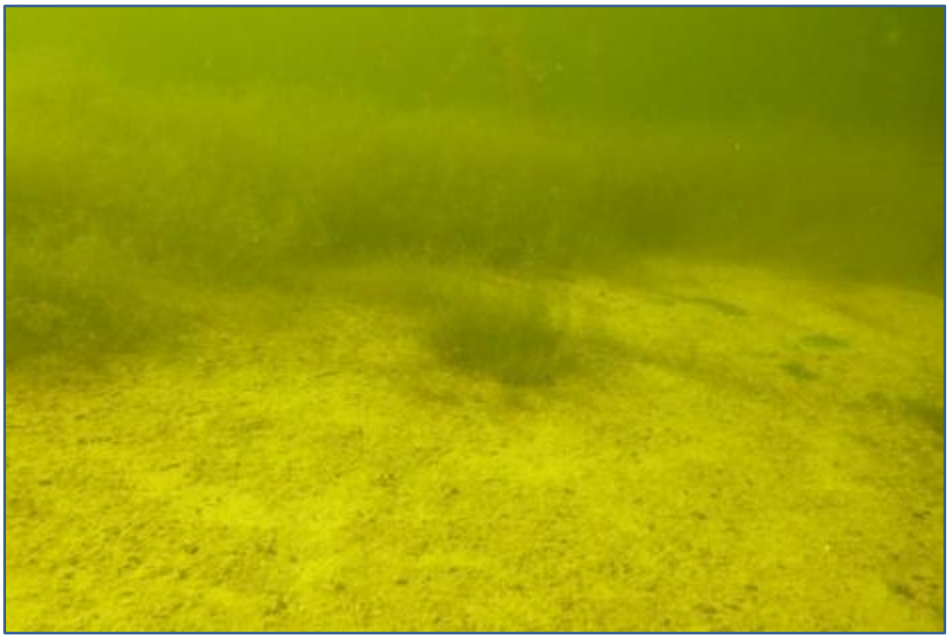
Lough Derravaragh, 2012; Dominant biota, Zebra Mussel and *Lemna trisulca* at 2 m.

Lough Ennell, 2012			
Name	Lough Ennell		
Alternative name(s)			
Grid Reference	239879246565, N3987946565	Depth (m)	
County	Westmeath	EPA code	25_188
Area (ha)	1,156 ha	OSi 1:50,000 sheet	48
Maximum length (km)	7 km	Nutrient data	EPA
Altitude (m)	81 m	SAC	000685, Lough Ennell SAC
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

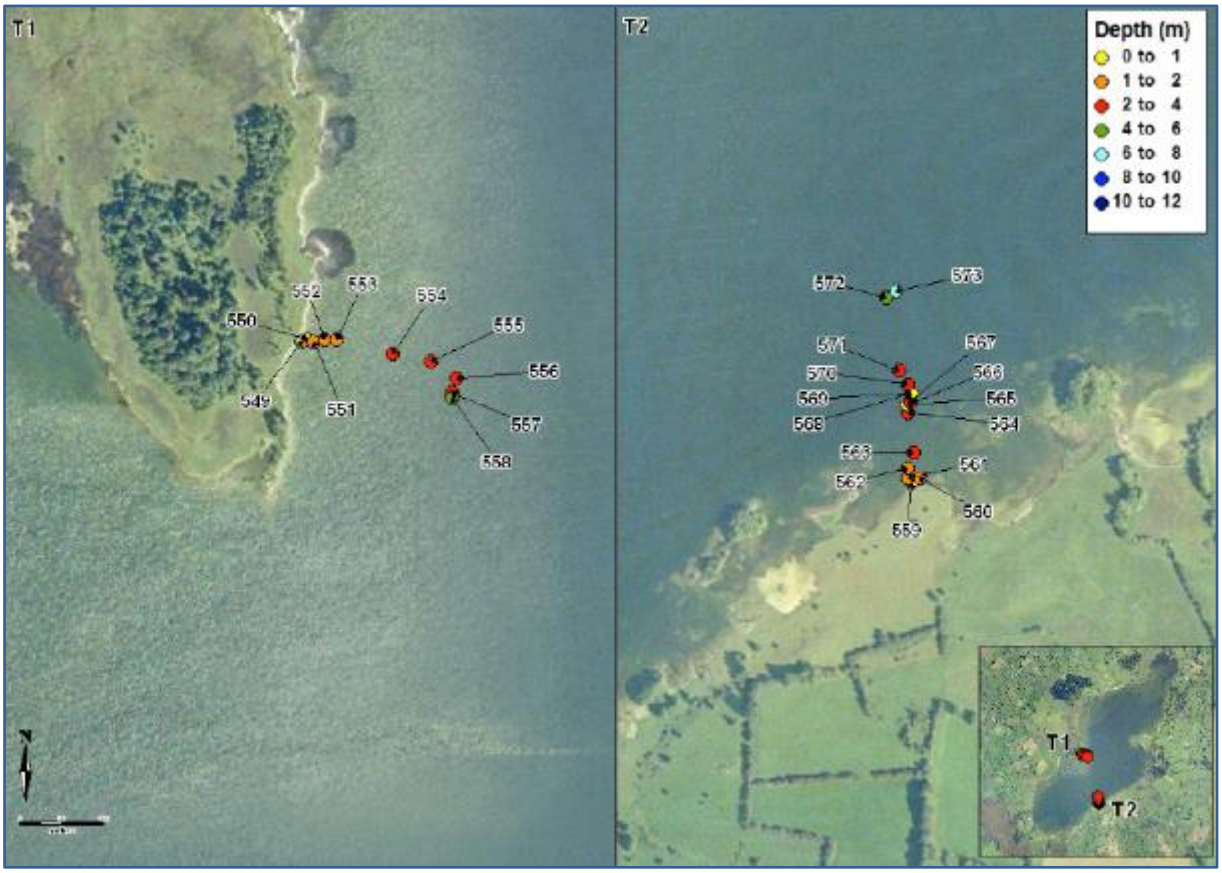
	2012
Snorkel survey date(s)	12/09/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	25
Secchi depth (m)	5 m
Substrates	Rock, white marl
Noteworthy species	*Tolypella glomerata, Chara denudata,*
A) Vegetation zones	4
B) Euphotic depth (m)	T1: 4.6 m; T2: 6.1 m
C) C&K score	0.89
D) Total phosphorus (mg/l)	0.019
E) Colour (Hazen units)	23.7
F) Index (TP × Colour)	0.45
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Lough Ennel is well known as being one of the first Irish lakes to be damaged by eutrophication, however in 2012 it showed many signs of being in good condition. Secchi depth was high while euphotic depth was intermediate. Many rocks had a good development of cyanobacterial crust not overgrown by green algae. Charophyte diversity was high with bands of *Chara curta*, *C. rudis*, *C. contraria*, *C. virgata*, *C. denudata* and *Tolypella glomerata*. The local *C. tomentosa* occurred in shallow water. Like Bleach Lough, the Zebra Mussel is present but does not form large banks. While the lake has improved since the 1980s, it is still rated *Poor* on the basis of small euphotic depth, high total phosphorus and high index value.



Lough Ennell, 2012; Base of euphotic zone at station 558. *C. denudata*



Lough Ennell showing positions of 2012 transects and relevés with depth

Lough Ennell, 2012; *Chara tomentosa* with cyanobacterial crust at station 560

Errit Lough, 2012			
Name	Errit		
Alternative name(s)			
Grid Reference	153914285143, M5391485143	Depth (m)	
County	Roscommon	EPA code	26_702
Area (ha)	82.9 ha	OSi 1:50,000 sheet	32
Maximum length (km)	2.2 km	Nutrient data	Free *et al*. (2006)
Altitude (m)	83 m	SAC	000607, Errit Lough SAC
Geology	Drift over limestone		
Previous survey	1978 (Heuff, 1984)		
Noteworthy species			

	2012
Snorkel survey date(s)	01/09/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	13
Secchi depth (m)	3 m
Substrates	Marl and peat
Noteworthy species	
A) Vegetation zones	4
B) Euphotic depth (m)	T1: 3.0 m; T2: 3.5 m,
C) C&K score	0.58
D) Total phosphorus (mg/l)	0.01
E) Colour (Hazen units)	46
F) Index (TP × Colour)	0.46
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Errit has very shallow euphotic zone and Secchi depth. It is bordered in part by bogland, which may cause reduction in water transparency. Charophyte zones are not well developed with only *Chara contraria* and *Chara rudis* forming substantial beds. Unusually, *Littorella uniflora* and *Scorpidium* sp. largely replace charophytes in shallow water at stations 436-438.1. However, charophytes do not grow below 3.0 m where *C. rudis* and *C. virgata* co-occur. Cyanobacterial crust is well developed on rocks in shallow water.

Errit is not a very good example of a marl lake due to the shallow euphotic zone and the small number of charophyte species. However, there is no evidence of eutrophication but strong evidence of highly coloured water. The index is also high. The lake is rated *Poor* due to the shallow euphotic zone, and the possibility that the lake is impacted from water colour needs further research.

Errit Lough, 2012; cyanobacterial crust and *Littorella uniflora* and *Scorpidium* sp. station 438.

Errit Lough showing positions of 2012 transects and relevés with depth.

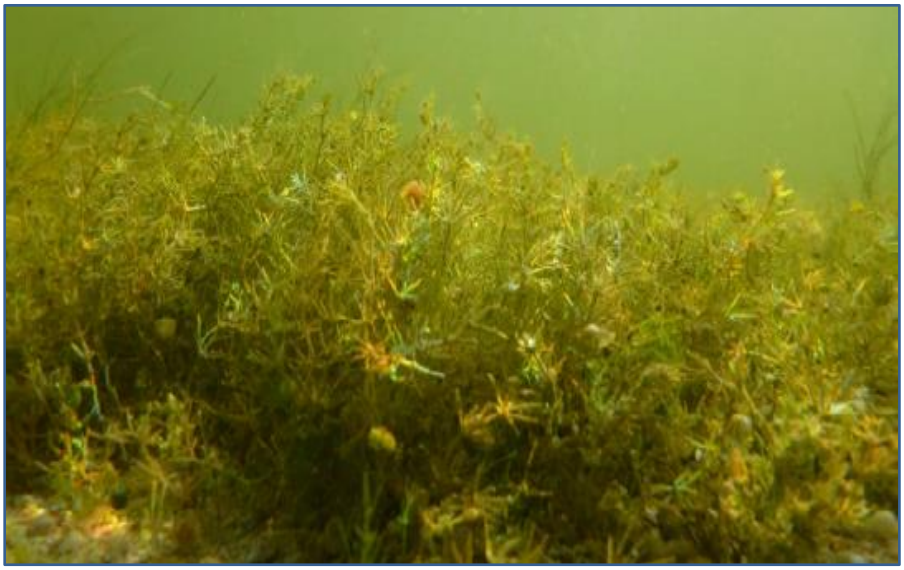
Errit Lough, 2012; looking towards the western shore.

Fahy Lough, 2012			
Name	Fahy		
Alternative name(s)			
Grid Reference	056814255539, L5681455539	Depth (m)	
County	Galway	EPA code	32_528
Area (ha)	19.1 ha	OSi 1:50,000 sheet	37
Maximum length (km)	0.7 km	Nutrient data	None available
Altitude (m)	6 m	SAC	001309, Omey Island Machair SAC
Geology	Machair sand over granite		
Previous survey	Roden (1999)		
Noteworthy species			

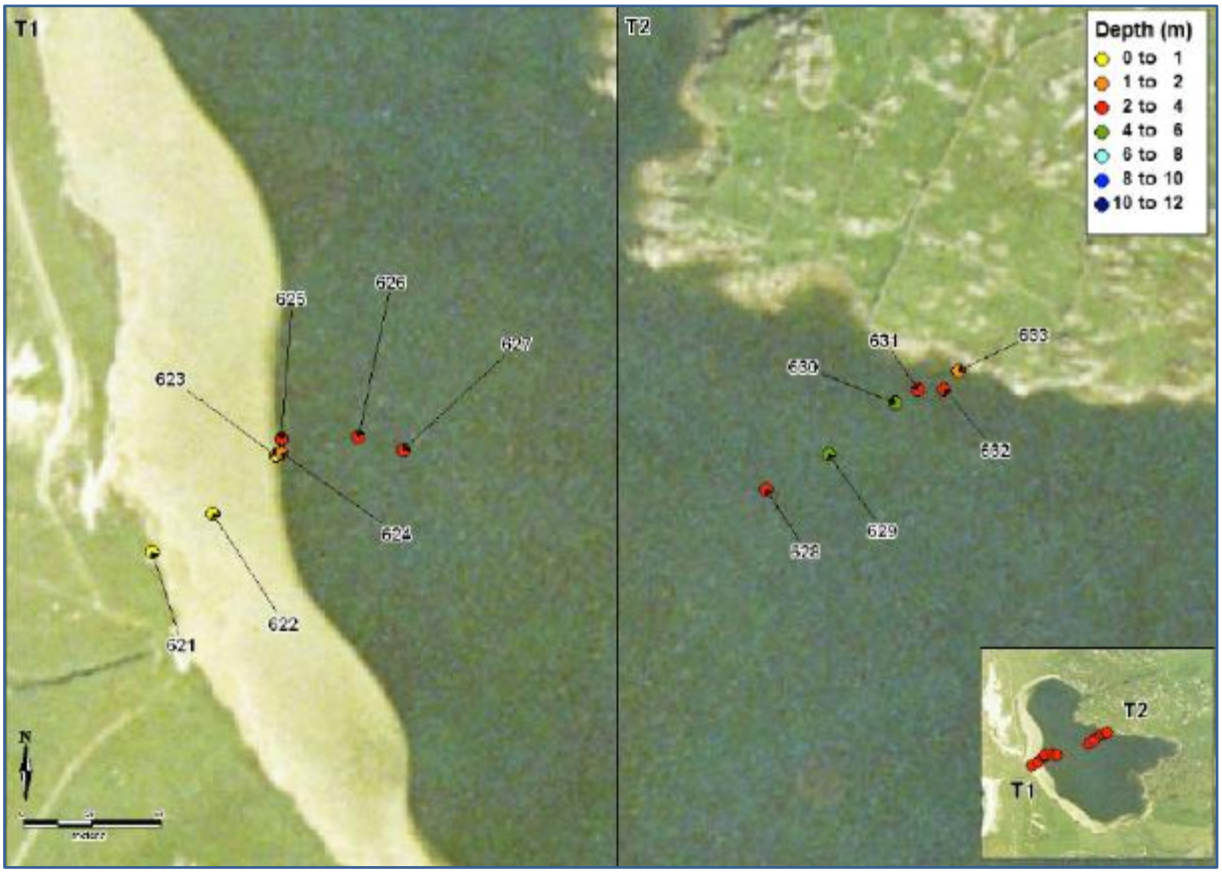
	2012
Snorkel survey date(s)	27/09/2012
Surveyors	CR, PD
Number of transects	2
Number of relevés	13
Secchi depth (m)	4.5 m
Substrates	Sand
Noteworthy species	
A) Vegetation zones	
B) Euphotic depth (m)	4.6 m
C) C&K score	
D) Total phosphorus (mg/l)	
E) Colour (Hazen units)	
F) Index (TP × Colour)	
CONSERVATION CONDITION	**GOOD**

2012 condition assessment

Fahy Lough is an excellent example of a machair lough. It is too shallow (4.6 m) for a base to the euphotic zone to be established, but Secchi depth is intermediate 4.5 m. Charophyte bands include *C. aspera*/*C. curta*, *C. rudis* and *C. globularis*, as well as *Nitella flexilis* in one place. Angiosperms include *Potamogeton perfoliatus* and *P. filiformis* and *Ranunculus baudottii*. Cyanobacterial crust is sparsely developed on granite rocks. There is no evidence of eutrophication. Like Aillebrack and other machair loughs, the shallow depth and possibly more eutrophic water mean that these lakes are somewhat different from marl loughs on limestone. Roden (1999) surveyed Fahy and 13 years later there is little change in vegetation. The lake is rated as in *Good* condition with no obvious threats.



Fahy Lough, 2012; *Chara rudis* at 2.0 m, station 625.



Fahy Lough showing positions of 2012 transects and relevés with depth.

Fahy Lough, 2012.

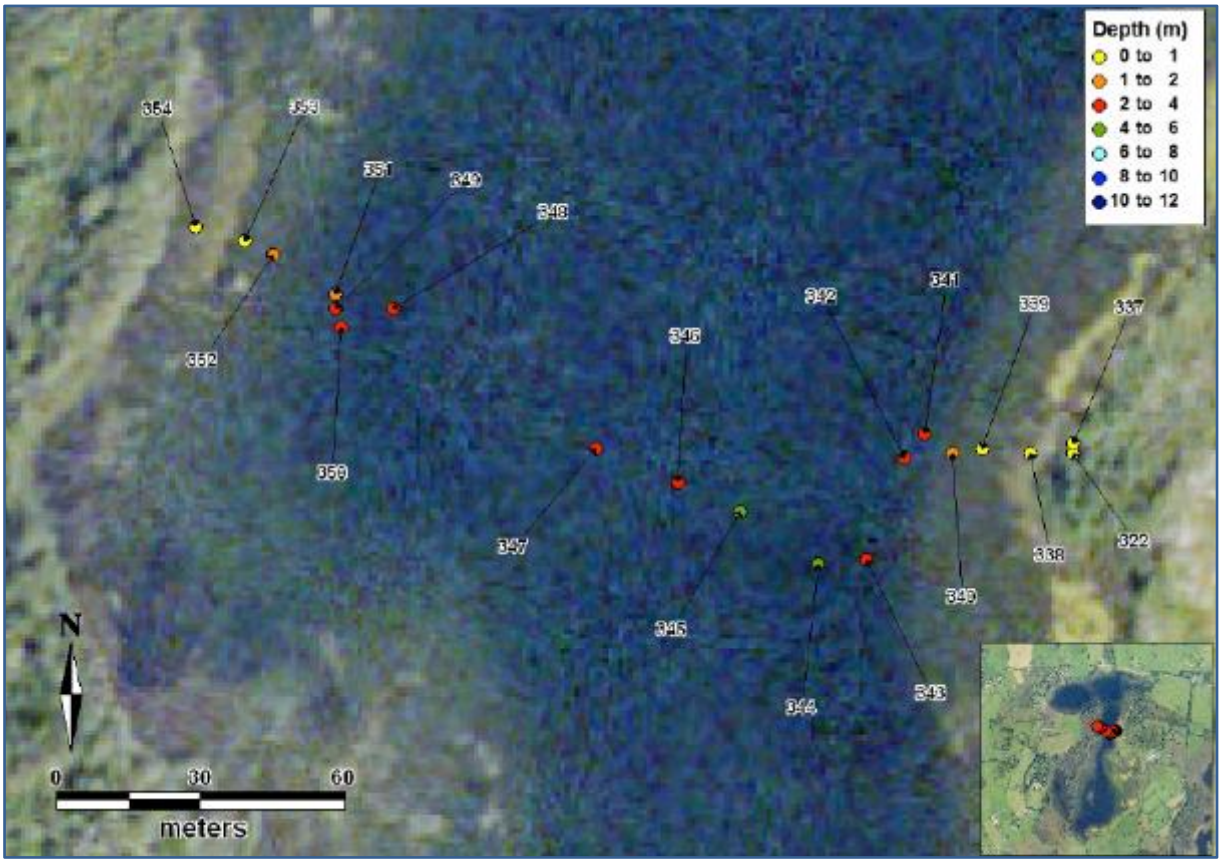
Finn Lough, 2012			
Name	Finn Lough		
Alternative name(s)			
Grid Reference	143245169592, R4324569592	Depth (m)	
County	Clare	EPA code	27_127
Area (ha)	74.1 ha	OSi 1:50,000 sheet	58
Maximum length (km)	1.6 km	Nutrient data	Free *et al.* (2006)
Altitude (m)	26 m	SAC	n/a
Geology	Limestone		
Previous survey			
Noteworthy species			

	2012
Snorkel survey date(s)	26/07/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	19
Secchi depth (m)	2.6 m
Substrates	Silt and peat
Noteworthy species	
A) Vegetation zones	4
B) Euphotic depth (m)	5.0 m
C) C&K score	0.624
D) Total phosphorus (mg/l)	0.0105
E) Colour (Hazen units)	27
F) Index (TP × Colour)	0.28
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Finn Lough is not very deep and the euphotic zone depth all but coincides with lake depth. Secchi depth however is very low at 2.6 m. Cyanobacterial crust is developed in shallow water. While *Chara curta* and *Chara rudis* zones exist to a depth of 3.7 m, *Ceratophyllum demersum* occupies the deeper part of the lake - an indicator of an impacted marl lake. This plant is also typical of eutrophic water. The lake is not a good example of a marl lake on limestone and may be enriched either from ground-water or run-off from a nearby industrial unit. The lake is rated *Poor* on the assumption that the lake's eutrophication is due to human influence.

Finn Lough, 2012; *Ceratophyllum demersum* at 4.0 m. station 344.



Finn Lough showing positions of 2012 transects and relevés with depth.

Finn Lough, 2012; Looking west from Transect 1.

Lough George, 2018			
Name	Lough George		
Alternative name(s)	Lough George is name given on six inch map, however this lake is mislabelled as "Ballyeighter Lough" on the Discovery Series and part of an eastern bay of the lake, now partially cut-off by *Cladium* swamp, is marked as "Lough George". There are large issues with the lake boundaries in this area at 1:50,000 scale, with submerged marl/cyanobacterial crust, *Cladium* swamp and reedbeds all mapped as dry land. This has led to errors in the EPA's WFD datasets, where Lough George is labelled as "Ballyeighter Lough". The original Lough George, as mapped on 6", is composed of 5 separated WFD lake segment polygons which more or less represent the deeper basins in what seems to be a contiguous lake/wetland		
Grid Reference	134268191522, R3426891522	Depth (m)	>11 m
County	Clare	EPA code	27_119, 27_299, 27_294, 27_298, 27_297
Area (ha)	*c.* 50 ha	OSi 1:50,000 sheet	52
Maximum length (km)	2 km	Nutrient data	None available
Altitude (m)	16 m	SAC	001926, East Burren Complex SAC
Geology	Carboniferous monotonous limestone and dolomite		
Previous survey	Surveyed on 29/08/1978 by H. Heuff and J. Ryan (Heuff, 1984). Langangen (2005) (referred to as "South Ballyeighter Lough (by Teernea)"). No EPA data		
Noteworthy species			

	2018
Snorkel survey date(s)	04/07/2018
Surveyors	CR, PM
Number of transects	4
Number of relevés	29
Secchi depth (m)	
Substrates	Marl rock
Noteworthy species	*Chara tomentosa*
A) Vegetation zones	4
B) Euphotic depth (m)	T1: 3.7 m; T2: 5.5 m; T3: 5.4 m; T4: 5.5 m
C) C&K score	T1: 0.3; T2: 0.48; T3: 0.78; T4: 0.8
D) Total phosphorus (mg/l)	
E) Colour (Hazen units)	
F) Index (TP × Colour)	
CONSERVATION CONDITION	**GOOD**

Previous survey

Examined by Ryan and Heuff in 1978 (Heuff, 1984). A charophyte vegetation of *Chara curta*, *C. rudis*, *C. contraria*, *C. virgata* and *C. tomentosa* was recorded with a euphotic depth of 5 m.

Noteworthy species recorded in 2018

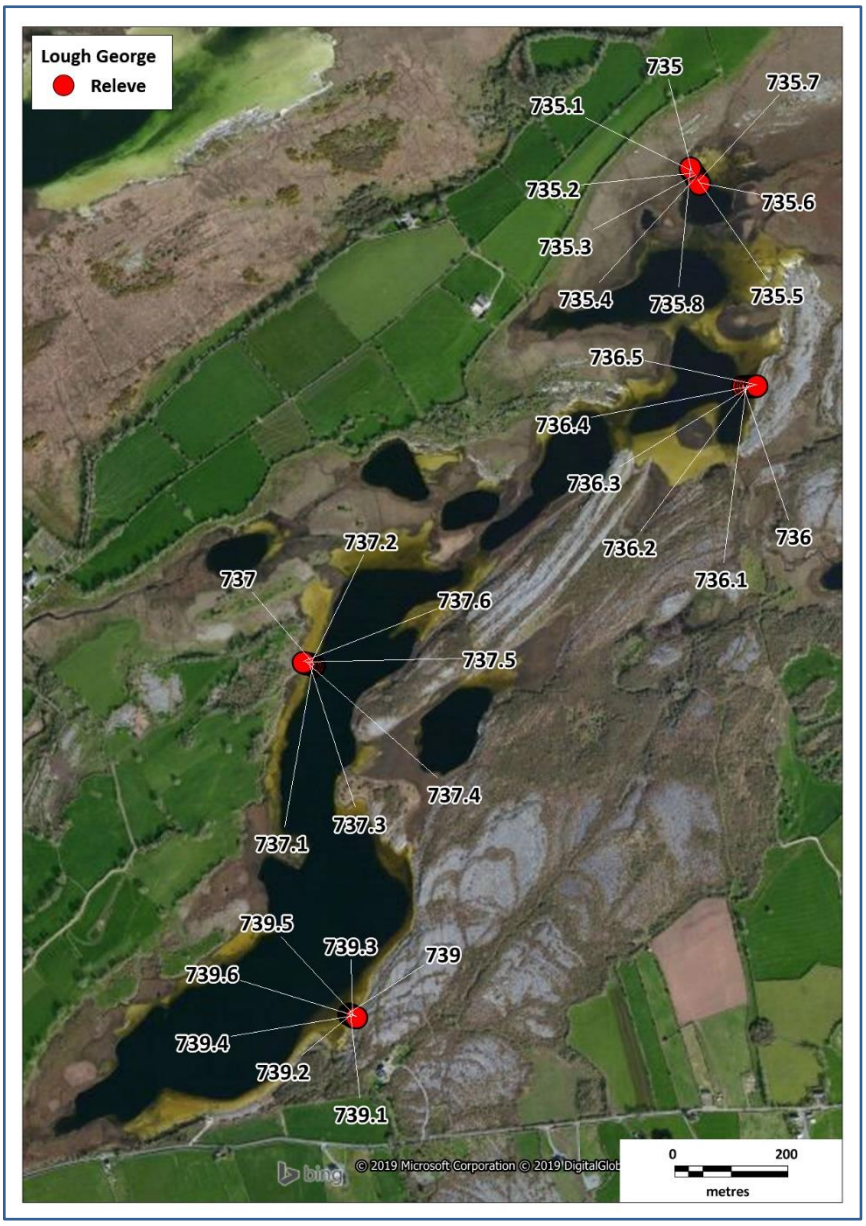
Chara tomentosa is only known from Lough George at present in Co. Clare. It was first recorded before 1985 and not seen again until this survey. It was also recorded from Muckanagh Lough but was not seen there, in this survey.

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara aculeolata	*Nuphar lutea*	Cyanobacterial crust
Chara contraria	*Phragmites australis*	
Chara curta	*Potamogeton lucens*	
Chara rudis	*Potamogeton perfoliatus*	
Chara tomentosa	*Schoenoplectrus lacustris*	
Chara virgata	*Utricularia vulgarlis/australis*	
	Utricularia intermedia agg.	

Vegetation

This long narrow lake has six separate deeps. The more northern are surrounded by fen, while exposed limestone occurs in the south. Cyanobacterial crust, *C. curta*, *C. rudis* and *C. virgata* layers occur but euphotic depth is less than 6 m. This may be an underestimate as lake level was very low due to the dry summer.



Lough George overview map showing positions of 2018 transects and relevés. Transect 1: 735-735.8; Transect 2: 736-736.5; Transect 3: 737-737.6.

Cyanobacterial crust

Crust indicator values for Lough George are all within the *Favourable* (*Good*) targets, with low values for chlorophytes and chlorophyll a, and a value of 100% for crust cover.

Change since previous survey

Apparently little change since 1978, with the rare *C. tomentosa* still present and no change in euphotic depth.

Threats and pressures

The lake is used by a small group water scheme. A few shore side fields are intensively fertilised.

2018 condition assessment

Lough George had four vegetation zones and scored well on all crust indicators, but a euphotic depth of less than 7 m is a potential cause of concern. This may be accounted for by low water levels, which may be natural, or impacted by the abstraction of drinking water. The overall assessment was *Favourable* (*Good*) conservation condition but future monitoring is advisable.

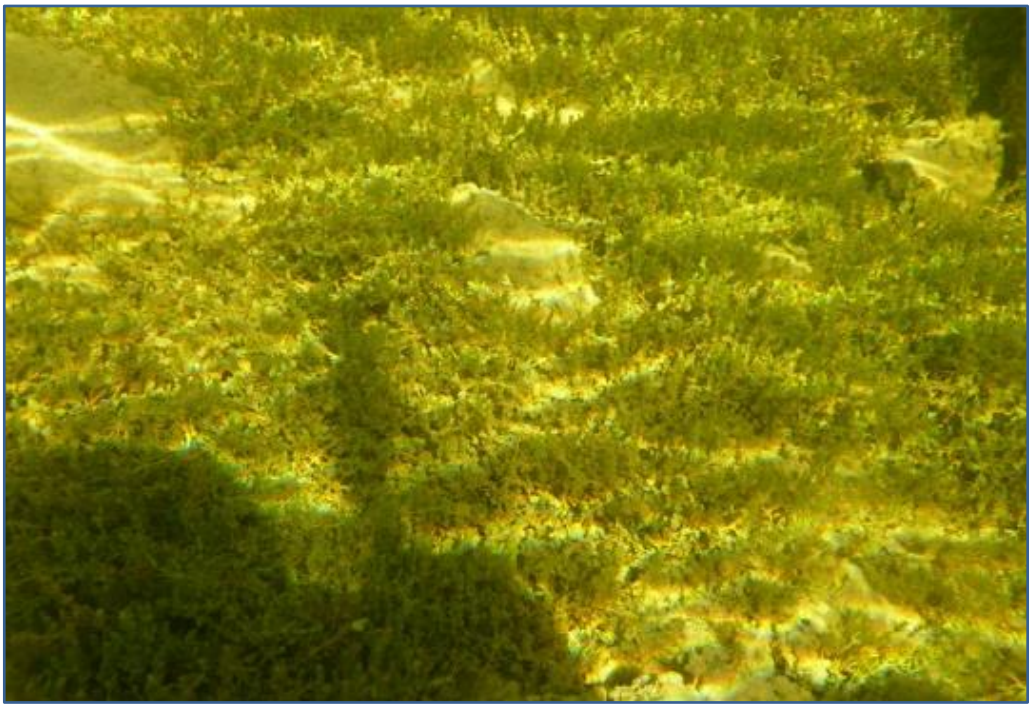
Parameter	Target	Lough George 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	4	Good
Euphotic depth (m)	>7	5.5 m	Poor
Crust cover (%)	>70	100%	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	16 (2)	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	4.0 (1.1)	Good
C&K score	>0.6	0.81	Good
Lake level	at or above cyanobacterial crust		
Total phosphorus (TP) (mg/l)	≤0.01	n/a	
Colour (Hazen units)	<15	n/a	
Index (TP × Colour)	<0.1	n/a	
Overall assessment			**Good**

Lough Hackett, 2012			
Name	Lough Hackett		
Alternative name(s)			
Grid Reference	130686249236, M3068649236	Depth (m)	
County	Galway	EPA code	30_339
Area (ha)	41.8 ha	OSi 1:50,000 sheet	45
Maximum length (km)	0.9 km	Nutrient data	None available
Altitude (m)	27 m	SAC	n/a
Geology	Drift over limestone		
Previous survey			
Noteworthy species			

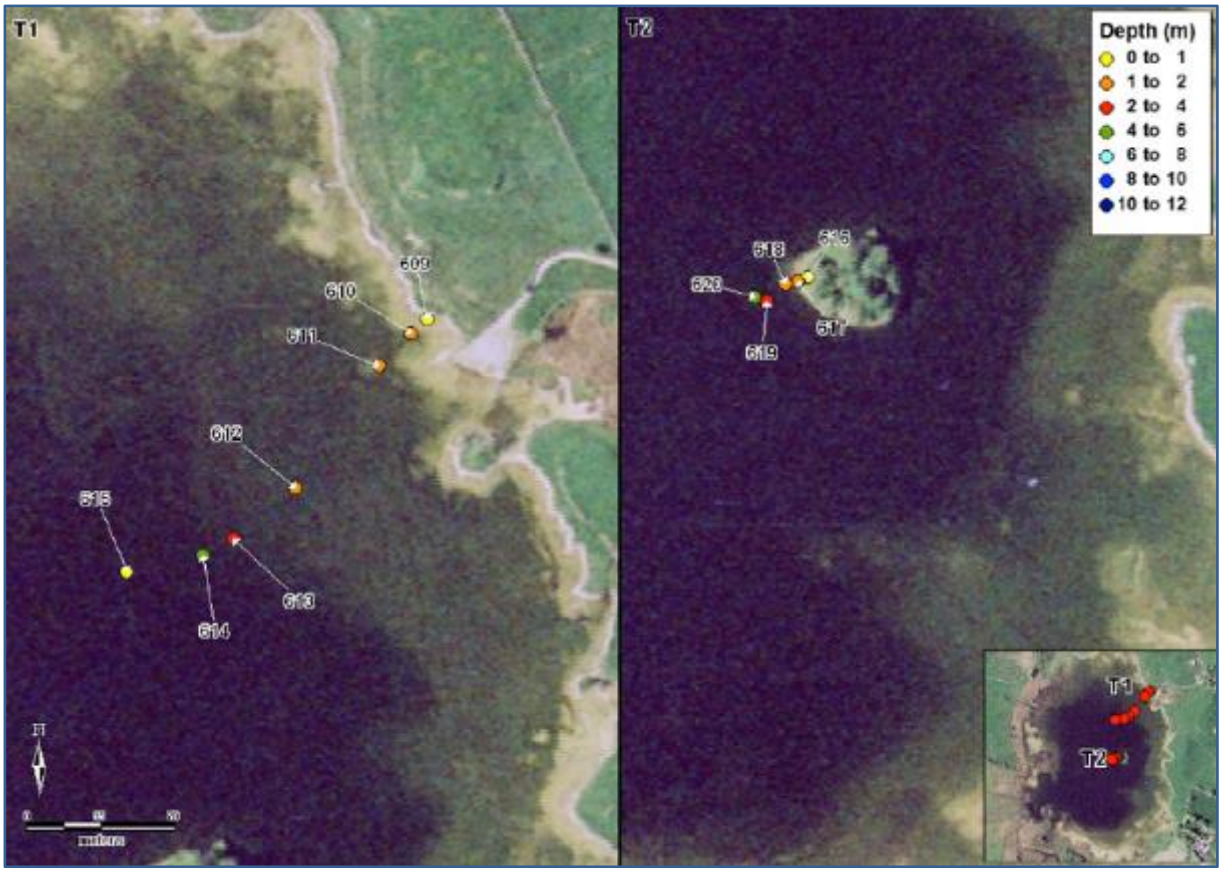
	2012
Snorkel survey date(s)	21/09/2012
Surveyors	CR, PM
Number of transects	2
Number of relevés	12
Secchi depth (m)	4.8 m
Substrates	Silt and gravel
Noteworthy species	
A) Vegetation zones	
B) Euphotic depth (m)	T1: 4.8; T2: 4.1
C) C&K score	
D) Total phosphorus (mg/l)	
E) Colour (Hazen units)	
F) Index (TP × Colour)	
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Lough Hackett is a small shallow lake in farm land east of Lough Corrib. Above 4 m, charophytes cover most of the bottom, but only two species are common, *C. curta* and *C. contraria*. Cyanobacterial crust is well developed in shallow water, but the presence of species such as *Potamogeton pectinatus* and *Ceratophyllum demersum* and the shallow euphotic depth suggest more eutrophic conditions. Because of the shallow euphotic depth the lake is classed as *Poor*.



Lough Hackett, 2012; *Chara curta* in shallow water at station 611.



Lough Hackett showing positions of 2012 transects and relevés with depth.

Lough Hackett, 2012; *Hippuris vulgaris* growing on the slope at 1.6 m.

Lough Lene, 2012			
Name	Lough Lene		
Alternative name(s)			
Grid Reference	251073268421, N5107368421	Depth (m)	
County	Westmeath	EPA code	07_274
Area (ha)	416.3 ha	OSi 1:50,000 sheet	41 & 42
Maximum length (km)	4.4 km	Nutrient data	EPA
Altitude (m)	93 m	SAC	002121, Lough Lene SAC
Geology	Drift over limestone		
Previous survey	Roden (2008), EPA WFD Monitoring Lake		
Noteworthy species			

	2012
Snorkel survey date(s)	13/09/2012
Surveyors	CR, PD
Number of transects	2
Number of relevés	14
Secchi depth (m)	5 m
Substrates	Marl sand
Noteworthy species	
A) Vegetation zones	4
B) Euphotic depth (m)	T1: 6.0 m; T2: 7.0 m
C) C&K score	0.755
D) Total phosphorus (mg/l)	0.011
E) Colour (Hazen units)	20
F) Index (TP × Colour)	0.44
CONSERVATION CONDITION	**POOR**

2012 condition assessment

Lough Lene is a clear water lake with high Secchi and euphotic depth measurements. Cyanobacterial crust is well developed. Charophyte cover is high with *C. curta*, *C. contraria*, *C. virgata* and *C. denudata* occurring to a depth of 3.5 m on Transect 1, while *C. curta* and *C. rudis* extend to 5.4 m on Transect 2. Below the charophytes, *Potamogeton perfoliatus* and *Elodea canadensis* extends to 6-7 m. While the lake appears in good condition owing to the deep euphotic zone, the replacement of deep water charophytes by angiosperms indicates some degree of eutrophication. Equally, the index measurement is quite high, indicating poor condition. While, it appears borderline between *Good* and *Poor*, it is here assessed as *Poor*. Of great interest is the presence of the Zebra Mussel in small numbers (see photo) perhaps showing that the animal can only flourish in very eutrophic conditions.

Lough Lene, 2012; *Potamogeton perfoliatus*, *Elodea canadensis* and Zebra Mussel at 6 m at station 583.

Lough Lene showing positions of 2012 transects and relevés with depth.

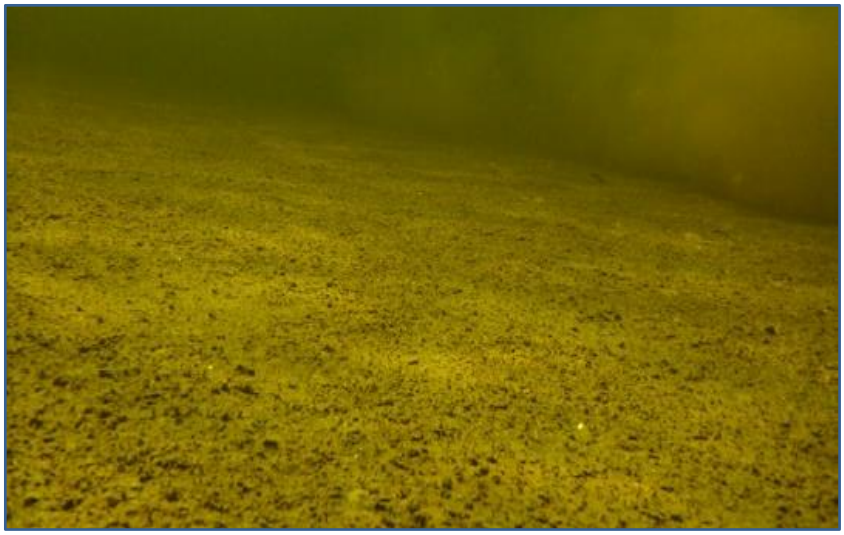
Lough Lene, 2012; looking west.

Lough Mask, 2012			
Name	Lough Mask		
Alternative name(s)			
Grid Reference	110703263710, M1070363710	Depth (m)	
County	Mayo, Galway	EPA code	30_665a
Area (ha)	7,797 ha	OSi 1:50,000 sheet	38
Maximum length (km)	16 km	Nutrient data	EPA
Altitude (m)	17 m	SAC	001774, Lough Carra/Mask Complex SAC
Geology	Limestone and sandstone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

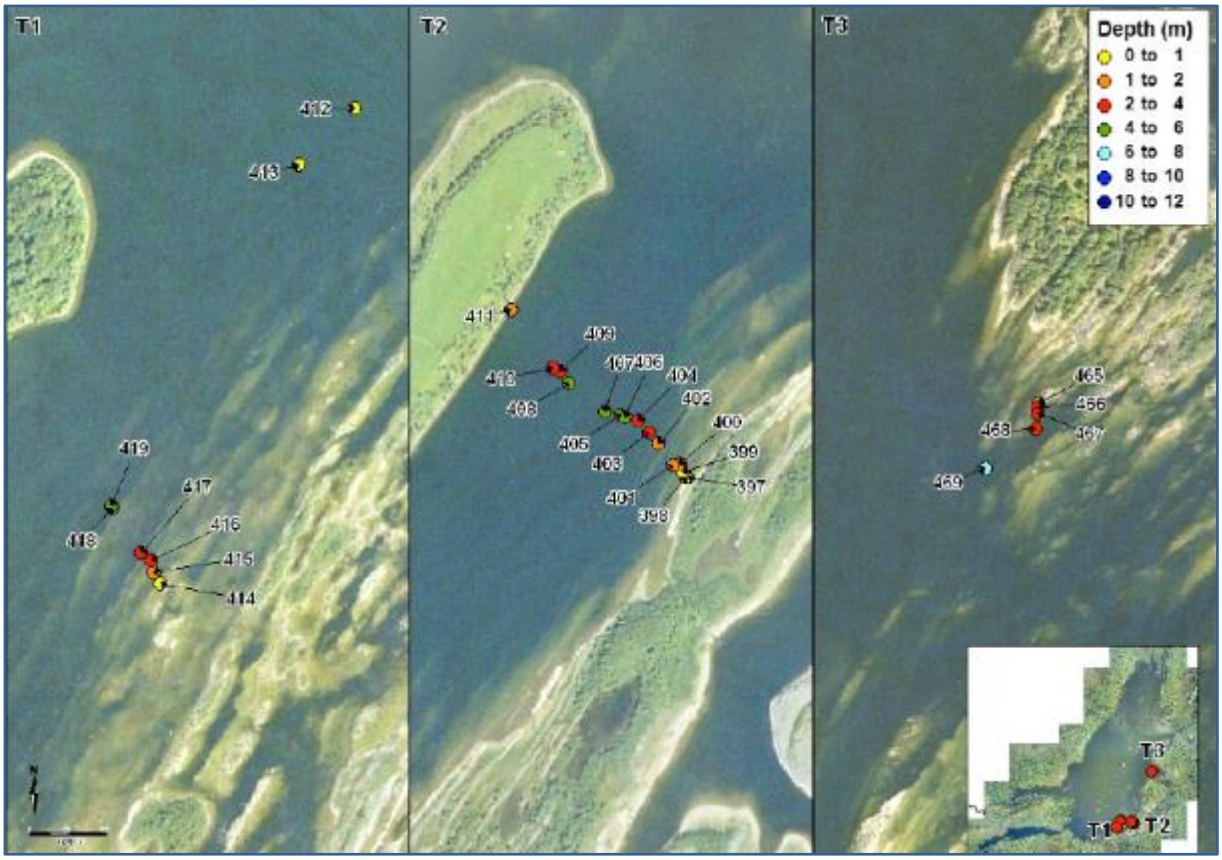
	2012
Snorkel survey date(s)	14/08/2012, 17/08/2012
Surveyors	CR, PM, JR, ÁOC
Number of transects	4
Number of relevés	28
Secchi depth (m)	5.5 m
Substrates	Sand mud rock
Noteworthy species	
A) Vegetation zones	
B) Euphotic depth (m)	T1 and T2: 5.5 m; T3: 6.5 m
C) C&K score	
D) Total phosphorus (mg/l)	
E) Colour (Hazen units)	
F) Index (TP × Colour)	
CONSERVATION CONDITION	**BAD**

2012 condition assessment

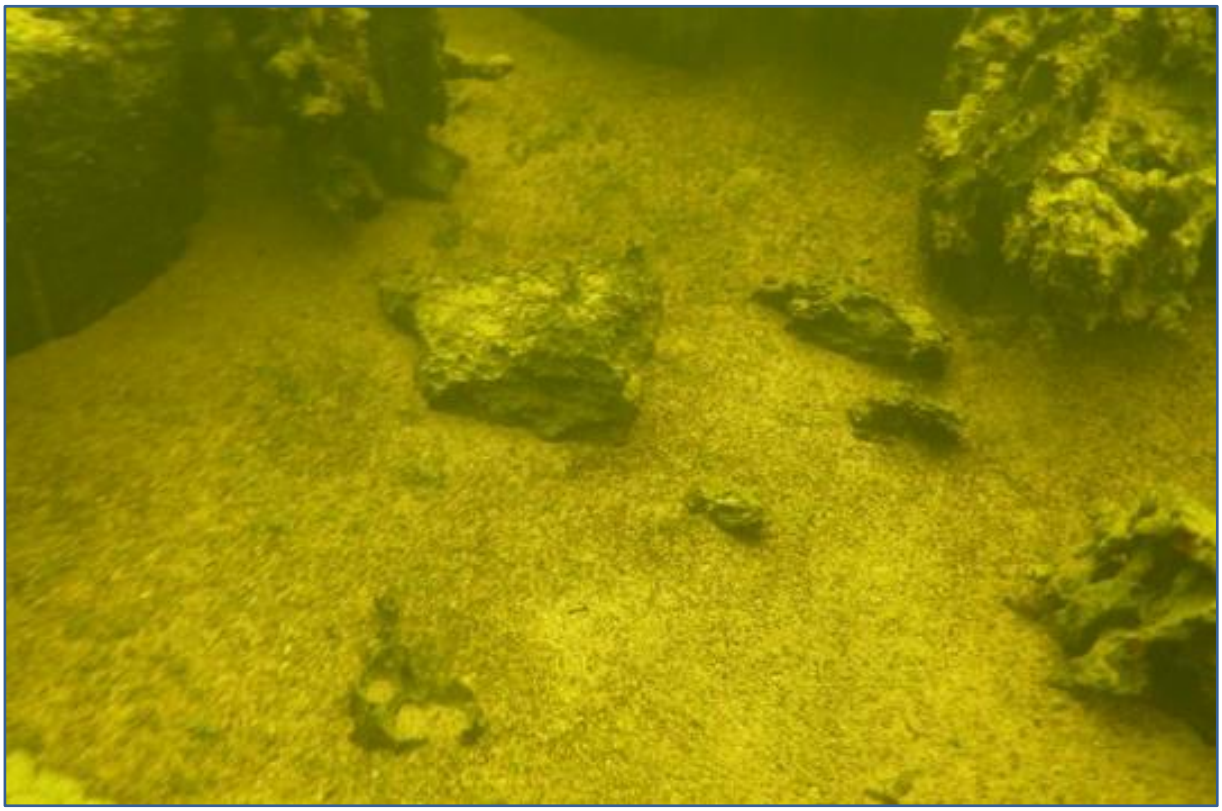
Lough Mask appears to be severely damaged. The euphotic zone is at best 4.0 m, although a few plants of *Chara virgata* were noted at 6.5 m on transect 3. Even above 4 m large areas of bare ground were encountered, however Secchi depth was high at 5.5 m. The only charophyte present along the transects was *C. virgata* growing in small clumps rather than extensive beds. C. aspera was seen close to the shore near transect 3. Cyanobacterial crust is absent, even though eroded rock is plentiful suggesting its former presence. Other plants included *Elodea canadensis* and *Potamogeton* species. It is difficult to suggest a cause for the almost complete absence of vegetation, especially as Secchi depth is high. Given the present state of the lake it is classified *Bad*. Vegetation surveys by the EPA since 2012 yield largely similar results.



Lough Mask, 2012; bare ground at 4 m. Station 409.



Lough Mask showing positions of 2012 transects and relevés with depth.



Lough Mask, 2012; bare ground at 6.7 m. Station 469.

Melmore Lough, 2018			
Name	Melmore Lough		
Alternative name(s)			
Grid Reference	212857443568, C1285743568	Depth (m)	
County	Donegal	EPA code	38_199
Area (ha)	3.4 ha	OSi 1:50,000 sheet	2
Maximum length (km)	0.4 km	Nutrient data	None available
Altitude (m)	5 m	SAC	000194, Tranarossan and Melmore Lough SAC
Geology	Blown sand on Monzogranite or diorite		
Previous survey	1989, N.F. Stewart, C.D. Preston and others; Roden (1999)		
Noteworthy species			

	2018	
Snorkel survey date(s)	21/08/2018	
Surveyors	CR, PM, JR	
Number of transects	3	
Number of relevés	11	
Secchi depth (m)		
Substrates	Sand	
Noteworthy species	*Potamogeton* x *sparganiifolius*	
A) Vegetation zones	1	
B) Euphotic depth (m)	3 m	
C) C&K score	None available	
D) Total phosphorus (mg/l)	None available	
E) Colour (Hazen units)	None available	
F) Index (TP × Colour)	None available	
CONSERVATION CONDITION	**BAD**	

Hydrochemical data

No data were available.

Previous survey

Roden (1999) described the lake as follows in 1999:

> *This small lake at the tip of the Rosguill Peninsula is of great interest. It lies between a flat machair plain and a steep hill of granite. Despite its small size, it is very deep and in places it was not possible to reach the lake bottom by snorkelling. Much of the lake bed consists of steeply shelving sandy mud with occasional rock outcrops. The sand still retains embedded snail shells down to a depth of 10 m. A small sand shelf runs along the north shore while the south and east shores are of steeply shelving rock. At the "elbow" of the lake an area of shallower sandy mud occurs at a depth of 4-6 m. The water of the lake had the highest Cl content in the survey at 120 mg/l. The water is reasonably transparent. A variety of communities occur, including charophytes on the sand shelf, and* Potamogeton pectinatus, Myriophyllum *communities at greater depths. Below the limit of vegetation in the northern arm of the lake, very large pale cream coloured freshwater sponges are abundant on rock outcrops. The lake has a diverse* Potamogeton *flora including a hybrid* P. *x* sparganiifolius.

Noteworthy species recorded in 2018

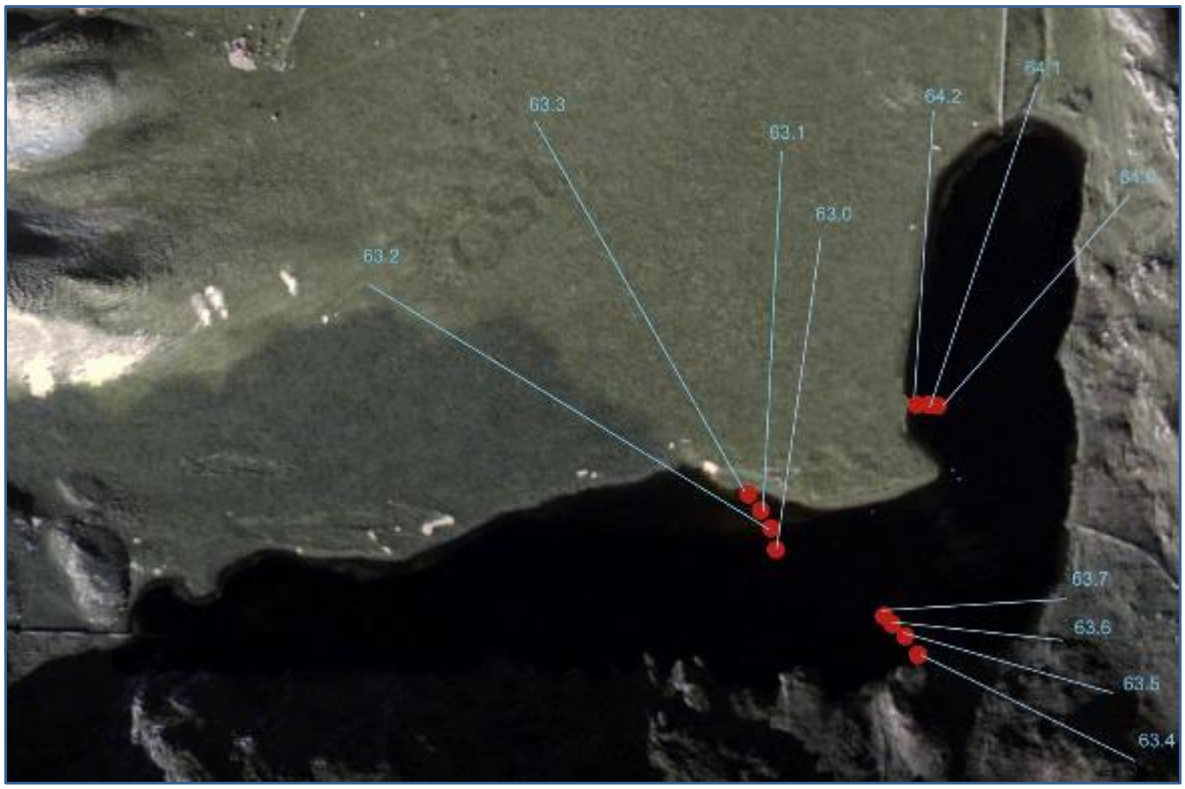
The unusual *Potamogeton* hybrid still occurs despite many other changes.

Taxa recorded in 1999 and 2018

1999	2018
Charophytes	
Chara aspera	
Chara curta	*Chara curta*
Chara contraria	*Chara contraria*
Chara virgata	
Vascular Plants	
	Elodea canadensis
Littorella uniflora	
Myriophyllum alterniflorum	
Myriophyllum spicatum	*Myriophyllum spicatum*
Polygonum amphibium	*Polygonum amphibium*
Potamogeton crispus	*Potamogeton crispus*
Potamogeton filiformis	*Potamogeton filiformis*
Potamogeton friesii	
Potamogeton hybrid	*Potamogeton* hybrid
Potamogeton pectinatus	*Potamogeton pectinatus*
Ranunculus hederaceus	
Bryophytes	
Fontinalis antipyretica	

Vegetation

The vegetation has changed greatly since 1999. The vegetation is now dominated by huge stands of *Elodea canadensis* and *Myriophyllum spicatum*. Charophytes are reduced in number of species and are very fouled with epiphytes and sediment. In addition, water is now very dark with the euphotic depth now less than 3 m. The deep sponge community was not re-found.



Melmore Lough overview map showing positions of 2018 transects and relevés.

Cyanobacterial crust

No crust survey has been conducted.

Change since previous survey

It appears an invasion of *Elodea canadensis* since 1999 has greatly changed the lake's vegetation. It is not clear why water transparency should also have declined and epiphytes increased, but it is known that *Elodea canadensis* has also invaded two nearby *Najas flexilis* lakes (Sessiagh Lough and Port Lough).

Threats and pressures

The invasion by *Elodea canadensis* has apparently changed the lake's former habitat, but the darkened water may also indicate eutrophication. However, the lake has a very small coastal catchment and the surrounding machair did not appear to be intensively farmed. It is possible that, in the future, the impact of *Elodea* will decline and the original vegetation become re-established as has happened in other lakes invaded by the species.

2018 condition assessment

The lake is rated *Unfavourable-Bad* (*Bad*) owing to the loss of several interesting species and vegetation types.

Parameter	Target	Melmore Lough 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	1	Bad
Euphotic depth (m)	>7	3 m	Bad
crust cover (%)	>70	None available	
Crust chlorophyll *a* (µg/cm^3 ± s.e.)	<45	None available	
Crust chlorophytes (% frequency, mean ±s.e.)	<45	None available	
C&K score	>0.6	None available	
Lake level	at or above cyanobacterial crust		
Total phosphorus (TP) (mg/l)	≤0.01	None available	
Colour (Hazen units)	<15	None available	
Index (TP × Colour)	<0.1	None available	
Overall assessment			**Bad**

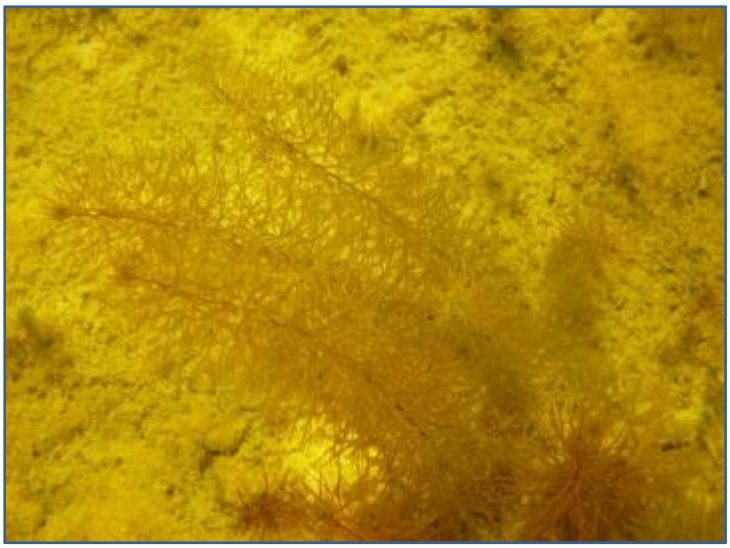
Muckanagh Lough, 2012 and 2018			
Name	Muckanagh Lough		
Alternative name(s)			
Grid Reference	137123192809, R3712392809	Depth (m)	>7 m
County	Clare	EPA code	27_94
Area (ha)	96.1 ha	OSi 1:50,000 sheet	52
Maximum length (km)	1.7 km	Nutrient data	EPA, 2008-2015
Altitude (m)	17 m	SAC	001926, East Burren Complex SAC
Geology	Carboniferous crinoidal limestone and chert		
Previous survey	August 1984 (Heuff, 1984), Langangen (2005), EPA WFD Monitoring Lake		
Noteworthy species			

	2012	2018
Snorkel survey date(s)	18/07/2012	16/07/2018
Surveyors	CR, PM	CR, PM
Number of transects	2	3
Number of relevés	19	25
Secchi depth (m)	4.3 m	5.1
Substrates	Marl peat	Marl, rock
Noteworthy species		*Potamogeton praelongus*
A) Vegetation zones	4	4
B) Euphotic depth (m)	6.5 m	T1: 6.1 m; T2: 6.1 m; T3: 5.2 m
C) C&K score	0.853	T1:0.60, T2:0.61, T3:0.67
D) Total phosphorus (mg/l)	0.008	0.008
E) Colour (Hazen units)	0.078	25
F) Index (TP × Colour)	0.2	0.2
CONSERVATION CONDITION	**GOOD**	**GOOD**

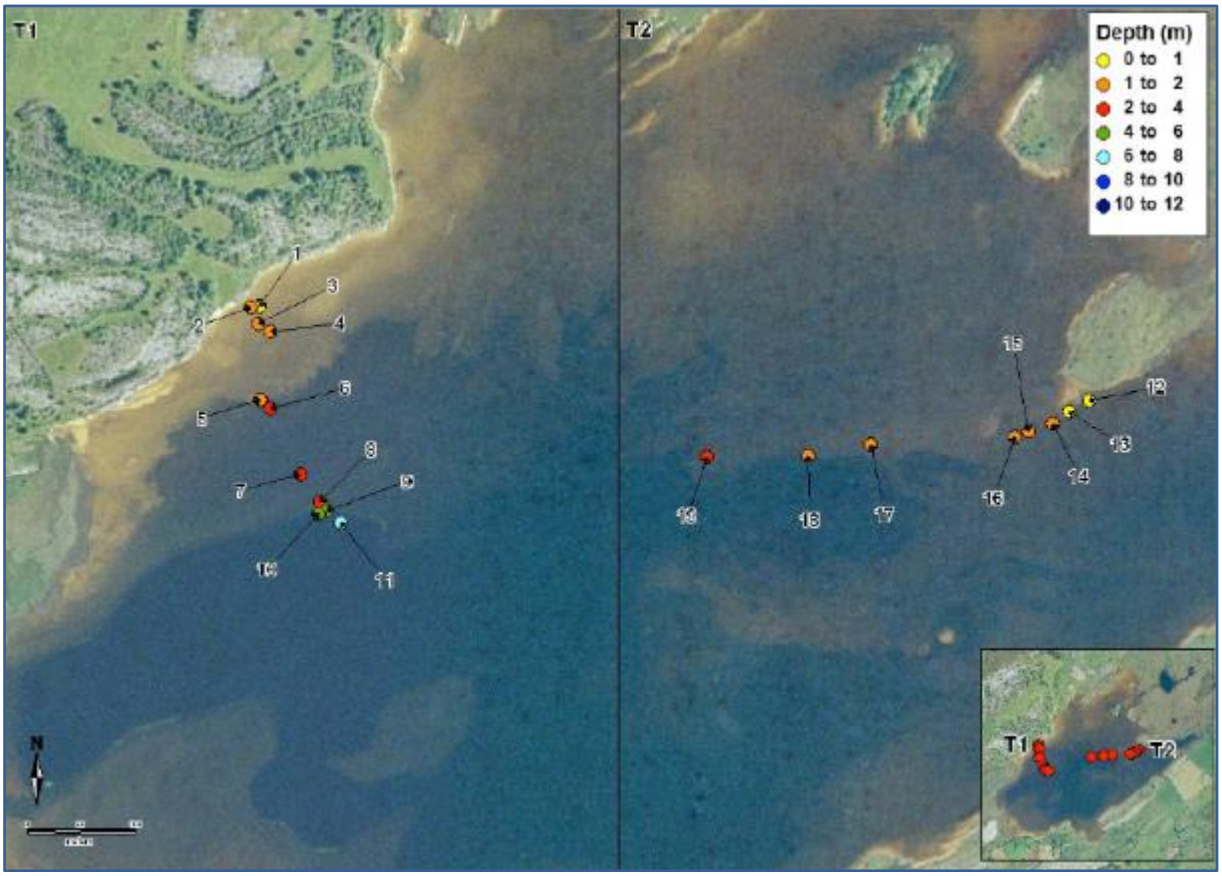
2012 SURVEY

2012 condition assessment

Muckanagh has coloured water probably due to peat runoff. Secchi and euphotic depth were intermediate. Cyanobacterial crust is extremely well-developed, apparently eroding whole boulders. Charophyte bands include *C. curta*, *C. rudis* and *C. globularis*. *Fontinalis* appears to occur on the bottom and *C. tomentosa* has been recorded in the past. Angiosperms are few with the exception of *Urticularia intermedia* which is abundant reaching cover values of 4 in places. Other than the presumed peat influence the lake is in good condition and is rated *Good*.



Muckanagh Lough, 2012; abundant *Urticularia intermedia*.



Muckanagh Lough showing positions of 2012 transects and relevés with depth.

Muckanagh Lough, 2012; *Chara curta* bed at 2 m. Station 5.

2018 SURVEY

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	Muckanagh Lough
pH		8.2
Alkalinity	mg/l	198
Colour	Hazen units	25
Ammonia	mg/l	0.17
Total phosphorus	mg/l	0.008
Chlorophyll *a*	µg/l	3.92
Secchi	m	5.1

Previous survey

Examined by Ryan and Heuff in 1977 who recorded a vegetation of charophytes, including the rare *Chara tomentosa*, but gave no precise details about its location (Heuff, 1984). The lake was sampled by C. Roden and P. Murphy in 2012 (see above). It is a WFD monitoring lake and macrophytes are surveyed by the EPA every three years.

Noteworthy species recorded in 2018

Potamogeton praelongus is scarce in Co. Clare. A pre-1985 record for *Chara tomentosa* was not confirmed but the plant grows in nearby Lough George which is connected to Muckanagh by a series of pools and fen which probably flood in winter.

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara aculeolata	*Elodea canadensis*	Cyanobacterial crust
Chara contraria	*Nuphar lutea*	Red cyanophyte
Chara curta	*Phragmites australis*	*Fontinalis antipyretica*
Chara rudis	*Potamogeton lucens*	
Chara virgata	*Potamogeton perfoliatus*	
	Potamogeton praelongus	
	Schoenoplectrus lacustris	
	Utricularia intermedia	
	Utricularia vulgaris	

Vegetation

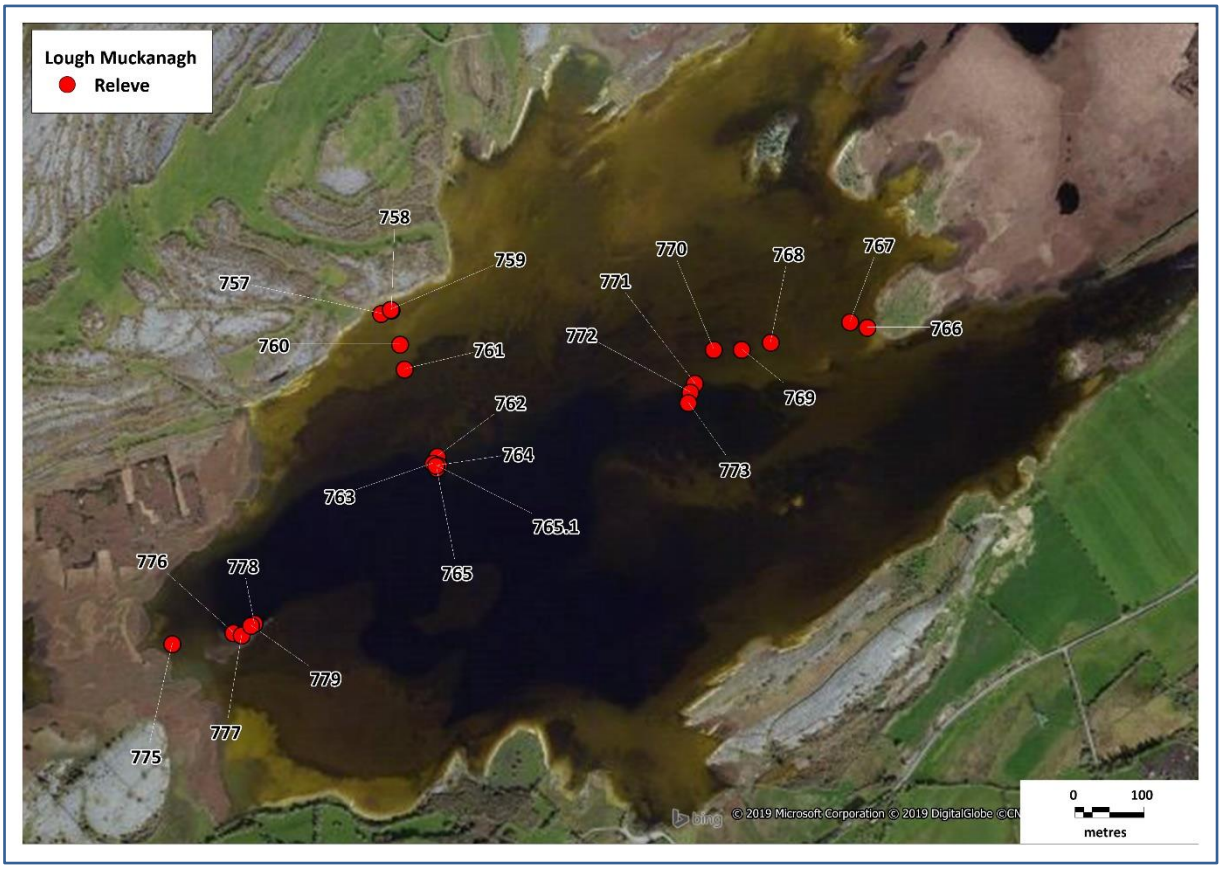
The lake is a large, shallow basin with drainage from nearby fen and cut over bog. The cyanobacterial crust is very well-developed and over 20 cm thick in places. The charophyte zones of *Chara curta*, *C. rudis* and *C. virgata* are present, with vascular plants including *Schoenoplectus lacustris* and *Phragmites australis*.

Cyanobacterial crust

The crust indicator values for Muckanagh Lake are all well within the green areas, therefore, Muckanagh is considered to be in *Favourable (Good)* condition.

Change since previous survey

No significant changes have been recorded since the survey in 2012.



Muckanagh Lough overview map showing positions of 2018 transects and relevés. Transect 1: 757-765.1; Transect 2: 766-773; Transect 3: 775-779.

Threats and pressures

There are no significant pressures or threats although water colour is high at 25 Hazen units, probably reflecting run off from cut-over bog.

2018 condition assessment

The lake remains in *Favourable* (*Good*) conservation condition. Nevertheless colour is high and euphotic depth slightly lower than the 7 m indicative of *Good* condition. Like other highly coloured but nutrient-poor lakes (*e.g.* Walshpool), it is possible that the lake is damaged by excess runoff from nearby bog land. Further research on this matter would help clarify the matter. Further searches for *Chara tomentosa* would also be useful.

Parameter	Target	Muckanagh Lough 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	4	Good
Euphotic depth (m)	>7	6.1 m	Poor
Crust cover (%)	>70	98	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	29 (±3)	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	23.7 (±3.9)	Good
C&K score	>0.6	0.67	Good
Lake level	at or above cyanobacterial crust		
Total phosphorus (TP) (mg/l)	≤0.01	0.008	Good
Colour (Hazen units)	<15	25	Poor
Index (TP × Colour)	<0.1	0.2	Poor
Overall assessment			**Good**

Lough Owel, 2011 and 2018			
Name	Lough Owel		
Alternative name(s)			
Grid Reference	240322258331, N4032258331	Depth (m)	25 m
County	Westmeath	EPA code	26_703
Area (ha)	1,021.8 ha	OSi 1:50,000 sheet	41
Maximum length (km)	6.2 km	Nutrient data	EPA, 2008-2015
Altitude (m)	97 m	SAC	000688, Lough Owel SAC
Geology	Carboniferous limestone and Chert		
Previous survey	1892-1895 Levinge, Bullock Webster, Groves, Linton, Marshall (see Groves & Bullock-Webster, 1920, 1924), 1895 Marshall, 1977 (Heuff, 1984), 1970s and 1981 by the Central Fisheries Board (reported in John *et al*., 1982). EPA WFD Monitoring Lake		
Noteworthy species			

	2011	2018
Snorkel survey date(s)	17, 18 & 31/08/2011, 01/09/2011	1/8/2018
Surveyors	CR, PM	CR, PM, JR
Number of transects	16	3
Number of relevés	132	20
Secchi depth (m)	4-5.5 m	6 m
Substrates	Peat, silt, mud, sand, gravel, cobble, rock, boulder	Marl, rock
Noteworthy species	*Chara denudata*, *Chara tomentosa*	*Chara denudata*, *Chara tomentosa*, *Potamogeton filiformis*
A) Vegetation zones	6	6
B) Euphotic depth (m)	7.0 m	T1: 8.0 m; T2: 5.7 m; T3: 6 m
C) C&K score	0.794	T1: 0.73; T2: 0.95; T3: 1.0
D) Total phosphorus (mg/l)	0.012	0.01
E) Colour (Hazen units)	8.5	6.85
F) Index (TP × Colour)	0.1	0.0685
CONSERVATION CONDITION	**GOOD**	**GOOD**

2011 Survey

2011 condition assessment

The full report of the 2011 survey of Lough Owel can be found in Roden & Murphy (2013). Euphotic depths of 7 m were recorded in Owel in 2011, similar to that found in 1977 (Heuff, 1984). Species recorded in the 1890s by Levinge, Bullock Webster, Groves, Linton and Marshall (see Groves & Bullock-Webster, 1920, 1924) were re-found, including *Chara aspera* and *Chara rudis*. Full development of charophyte zones was found and a cyanobacterial crust zone was present. Lough Owel was assessed as in *Good* conservation condition.

2018 SURVEY

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	Lough Owel
pH		8.4
Alkalinity	mg/l	108
Colour	Hazen units	6.85
Ammonia	mg/l	0.033
Total phosphorus	mg/l	0.01
Chlorophyll *a*	µg/l	4.77
Secchi	m	6.0

Previous survey

Heuff and Ryan surveyed the lake in 1977, and found charophyte vegetation to a depth of 7 m (Heuff, 1984). *Chara contraria* occurred at depth, while *C. rudis*, *C. aculeolata* and *C. tomentosa* occurred in shallower water. John *et al*. (1982) resurveyed the lake in 1980-81 and reported many of the same communities. The lake vegetation was mapped by Roden & Murphy (2013). The EPA surveyed the lake in 2007, 2010 and 2013. All surveys suggested the lake was in *Good* conservation condition.

Noteworthy species recorded in 2018

Chara denudata, *Chara tomentosa* and *Potamogeton filiformis.*

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara aspera	*Elodea canadensis*	Cyanobacterial crust
Chara contraria	*Littorella uniflora*	*Fontinalis* sp.
Chara curta	*Myriophyllum alterniflorum*	
Chara denudata	*Myriophyllum spicatum*	
Chara rudis	*Potamogeton filiformis*	
Chara tomentosa	*Potamogeton friesii*	
Chara virgata	*Potamogeton gramineus*	
	Potamogeton perfoliatus	
	Potamogeton x *angustifolius*	
	Ranunculus sp	

Vegetation

During the survey, the water level was low so that the cyanobacterial crust zone was exposed and dry. The east and south shores shelve rapidly, the western shore has a wider vegetation zone. *Chara curta*, *C. contraria*, *C.rudis*, *C. virgata* and *C. denudatata* zones were seen. Euphotic depths measured on T1-T3 had not changed since 2011.

Cyanobacterial crust

Values for Lough Owel fall within the orange '*Unfavourable-Inadequate*' or '*Poor*' zone for two of the factors considered (crust cover and chlorophyll concentration). Furthermore, the figure for chlorophyll a, at 46 µg/cm³, is substantially higher than the mean value recorded in 2016 (30 µg/cm³). Lough Owel has a number of underwater springs which deliver water from the catchment into parts of the lake. It was observed during this study that proximity to one of these springs has a strong effect on the phytobenthos; cyanobacterial crust, which is an indication of good conditions, does not grow close

to the ground-water springs. The photograph below shows two stones, one (right) from beside a spring, another from 5 m away from the spring. Each spring is surrounded by a crust-free zone for at least a few metres in diameter. The long-term effect of this inflowing ground-water in the lake is expected to be negative.

Lough Owel overview map showing positions of 2018 transects and relevés. Transect 1: 841-844; Transect 2: 846-849; Transect 3: 851-854.

Underwater springs, which deliver ground-water from the catchment into Lough Owel, are surrounded by a crust-free zone. The stone on the right, without crust, is from such a spring. The encrusted stone (left), from 5m away from the spring, shows the more typical crust cover.

Change since previous survey

No significant changes noted in the macrophytes since the 2011 surveys.

Threats and pressures

The lake is a water source, both for drinking and supplying the Royal Canal. There is little evidence of excess nutrients (but see discussion on cyanobacterial crusts) and water colour is very low. The absence of crust around ground-water springs does suggest that this water is nutrient enriched.

2018 condition assessment

With the exception of the crust metrics, indicators are assessed as Good. Crust values may reflect ground-water inputs at the location sampled, as ground-water might be nutrient enriched. It is also possible however, that the crust metrics are indicators of forthcoming problems. As crust metrics are a new indicator, further work on sample location may be needed to take account of localised enrichment. Overall, the lake is assessed as in *Good* conservation condition, with the caveat that the crust data, euphotic depths on two of the three transects and observed water levels indicate the lake may be in decline and, therefore, regular monitoring is essential.

Parameter	Target	Lough Owel 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	6	Good
Euphotic depth (m)	>7	8.0	Good
Crust cover (%)	>70	50	Poor
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	46 (±1)	Poor
Crust chlorophytes (% frequency, mean ±s.e.)	<45	37.7 (±11)	Poor
C&K score	>0.6	1.0	Good
Lake level	at or above cyanobacterial crust	Below	Poor
Total phosphorus (TP) (mg/l)	≤0.01	0.01	Good
Colour (Hazen units)	<15	6.85	Good
Index (TP × Colour)	<0.1	0.0685	
Overall assessment			**GOOD**

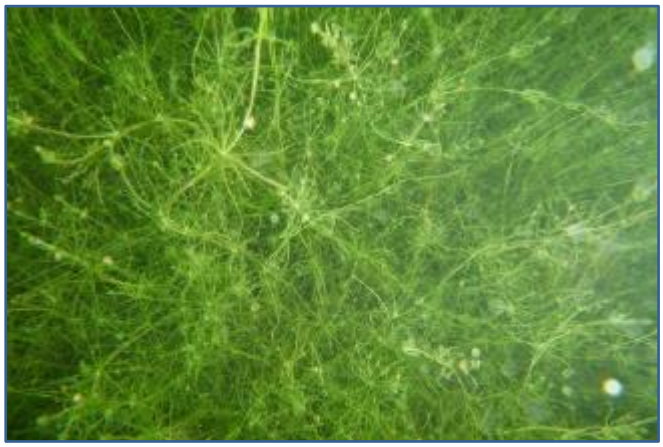
Lough Rea, 2012 and 2018			
Name	Lough Rea		
Alternative name(s)	Loughrea		
Grid Reference	161538215480, M6153815480	Depth (m)	>20 m
County	Galway	EPA code	29_194
Area (ha)	301.1 ha	OSi 1:50,000 sheet	52
Maximum length (km)	2.7 km	Nutrient data	EPA, 2008-2015
Altitude (m)	81 m	SAC	000304, Lough Rea SAC
Geology	Carboniferous Waulsortian limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

	2012	2018
Snorkel survey date(s)	01/07/2012, 20/07/2012	31/08/2018
Surveyors	CR, PM	CR, PM, JR
Number of transects	2	2
Number of relevés	26	13
Secchi depth (m)	5.2 m	5.5 m
Substrates	Marl	Marl, rock
Noteworthy species	*Chara tomentosa*	*Chara tomentosa*, *Potamogeton pectinatus*
A) Vegetation zones	4	4
B) Euphotic depth (m)	T1: 11 m; T2: 11 m	T1: 8.5 m; T2: 8.5 m
C) C&K score	0.93	T1: 0.85; T2: 0.94
D) Total phosphorus (mg/l)	0.008	0.008 mg/l
E) Colour (Hazen units)	5.7	5.7
F) Index (TP × Colour)	0.00427	0.0427
CONSERVATION CONDITION	**GOOD**	**GOOD**

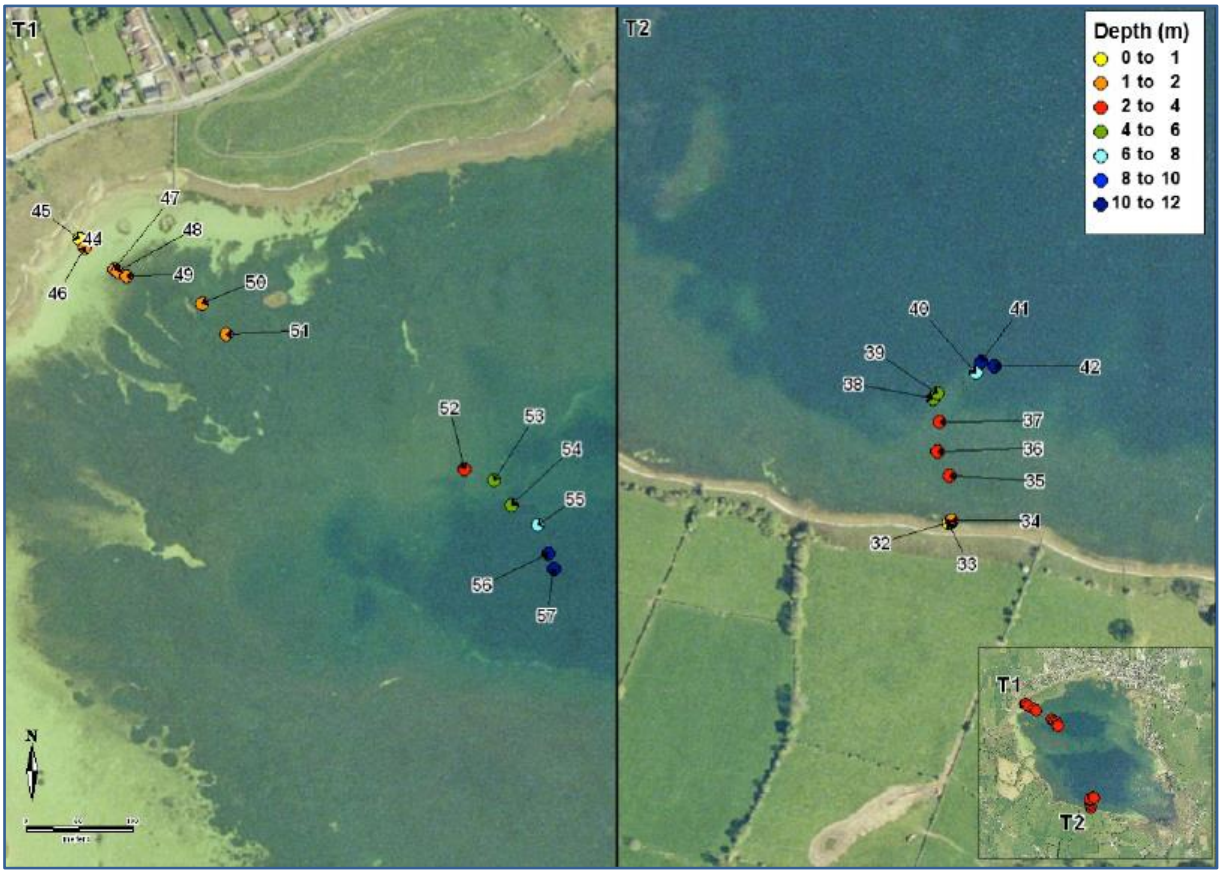
2012 Survey

2012 condition assessment

Lough Rea has the deepest euphotic zone encountered in the survey, 10-11 m. Secchi is high at 5.2 m. It is an excellent example of a marl lake almost completely dominated by charophytes and cyanobacterial crust with very little angiosperm cover. The *C. rudis* band is barely present, a possible indicator of a marl lake with very low nutrients. It closely resembles Lough Owel surveyed in 2011 (and 2018), which also supports a population of *C. tomentosa*. Surprisingly, no *C. denudata* was encountered but the deep *C. contraria* had ecorticate branches. Further survey might increase the charophyte species list. Given its deep euphotic zone, charophyte dominance and clear water, it is in *Good* (very good?) condition. As the town of Loughrea is on the lakeshore this total absence of eutrophication is surprising.



Lough Rea, 2012; *Chara contraria* at depth (10 m), station 56.



Lough Rea showing positions of 2012 transects and relevés with depth.

Lough Rea, 2012; *Chara contraria* at 4 m, station 38.

2018 SURVEY

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	Lough Rea
pH		8.1
Alkalinity	mg/l	106
Colour	Hazen units	5.7
Ammonia	mg/l	0.21
Total phosphorus	mg/l	0.008 (0.0075)
Chlorophyll *a*	µg/l	9.32
Secchi	m	5.5

Previous survey

The lake vegetation was examined by C. Roden and P. Murphy in 2012 (see above). The EPA surveyed the lake in 2007, 2010 and 2013. It is a WFD monitoring lake.

Noteworthy species recorded in 2018

Chara tomentosa is rare in the west of Ireland only growing in Lough Rea, Lough George, and Lough Carra where it appears introduced.

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara aculeolata	*Littorella uniflora*	Cyanobacterial crust
Chara contraria	*Myriophyllum alterniflorum*	*Ophrydium versatile*
Chara curta	*Myriophyllum spicatum*	
Chara rudis	*Potamogeton pectinatus*	
Chara tomentosa		
Chara virgata var. *annulata*		

Vegetation

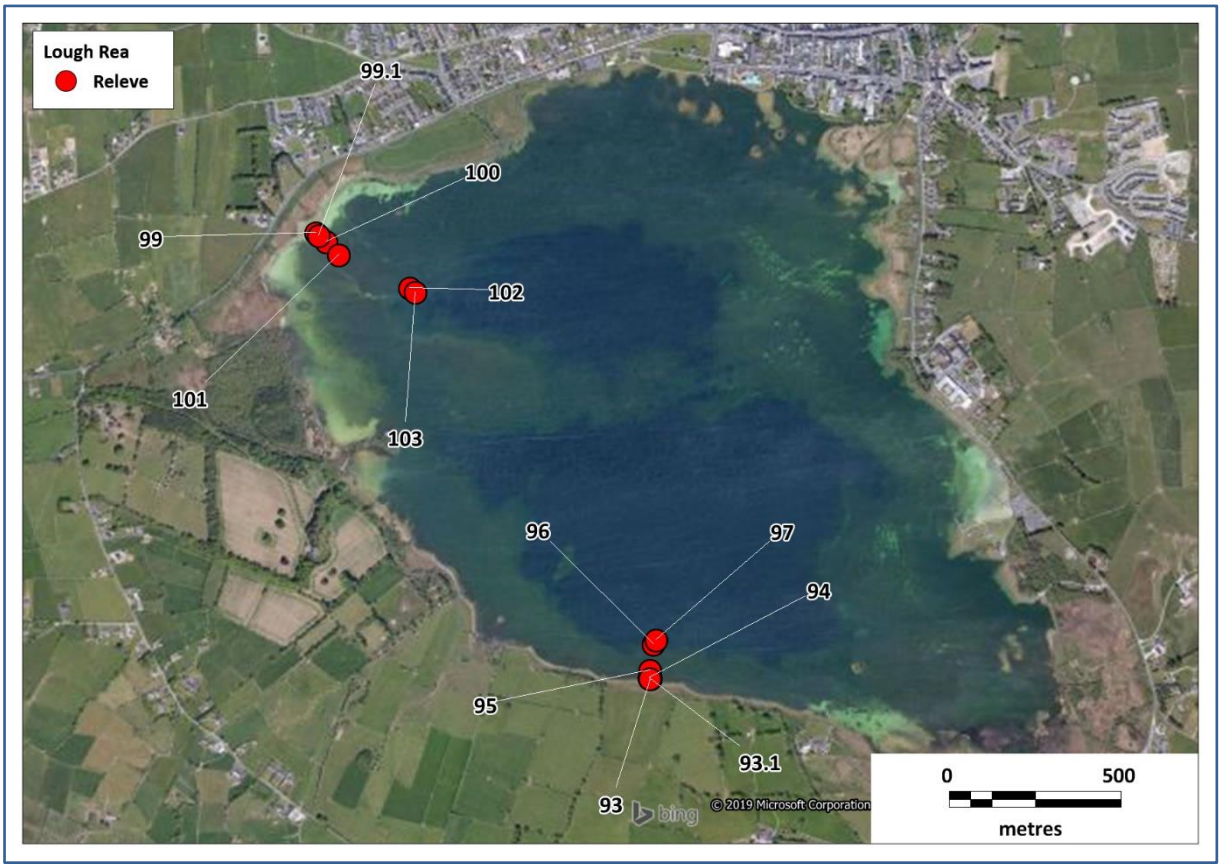
Lough Rea is notable for the extensive beds of *C. contraria* which partially replace *Chara rudis*.

Cyanobacterial crust

The crust values for Lough Rea are within the targets for *Favourable* conservation condition, and it is considered to be in *Favourable* (*Good*) condition. However with crust chlorophyll of 40 µg/cm³ (up from 28 µg/cm³ in 2016), it is approaching the threshold between *Favourable* (*Good*) and *Unfavourable-Inadequate* (*Poor*). Crust cover was also measured in 2016, giving a value of 96%. The present figure of 88% may again indicate a slight decrease in quality. This is a lake which needs careful monitoring to see if this indication of decline is part of a longer-term trend.

Change since previous survey

No significant changes were noted between surveys, however euphotic depth, while still excellent, was lower than the extreme value of 11 m recorded in 2012. This partially reflects low water levels in 2018 but it may also reflect variations in the vegetation lower boundary over small distances along the lake bed.



Lough Rea overview map showing positions of 2018 transects and relevés. Transect 1: 93-97; Transect 2: 99-103.

Threats and pressures

The town of Loughrea lies on the north shore of the lake, and the lake is the water supply for the town, but no signs of human impact were detected.

2018 condition assessment

All parameters were assessed as at Good status, therefore the lake as a whole was assessed as in *Favourable* (*Good*) conservation condition. However, crust data may indicate slight nutrient enrichment and further monitoring is essential.

Parameter	Target	Lough Rea 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	4	Good
Euphotic depth (m)	>7	8.5	Good
Crust cover (%)	>70	88	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	40 (±3)	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	22.7 (±0.4)	Good
C&K score	>0.6	0.94	Good
Lake level	at or above cyanobacterial crust	above cyanobacterial crust	Good
Total phosphorus (TP) (mg/l)	≤0.01	0.008	Good
Colour (Hazen units)	<15	5.7	Good
Index (TP × Colour)	≤0.1	0.043	Good
Overall assessment			**Good**

Spring Lough, 2012			
Name	Spring Lough		
Alternative name(s)			
Grid Reference	286106303952, H8610603952	Depth (m)	>9 m
County	Monaghan	EPA code	06_198
Area (ha)	10.3 ha	OSi 1:50,000 sheet	35
Maximum length (km)	0.6 km	Nutrient data	EPA
Altitude (m)	28 m	SAC	n/a
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

2012		
Snorkel survey date(s)	07/09/2012	
Surveyors	CR, PM	
Number of transects	2	
Number of relevés	14	
Secchi depth (m)	3.0 m	
Substrates	Marl	
Noteworthy species		
A) Vegetation zones	4	
B) Euphotic depth (m)	T1: 6.7 m; T2: 7.2 m	
C) C&K score	0.64	
D) Total phosphorus (mg/l)	0.014	
E) Colour (Hazen units)	25.2	
F) Index (TP × Colour)	0.35	
CONSERVATION CONDITION	**GOOD**	

2012 condition assessment

Spring Lough is a ground-water-fed kettle-hole lake in drift. Euphotic depth is 6-7 m, but Secchi depth is low, perhaps due to a blue-green algal bloom. Restricted *Chara curta* and *C. aculeolata* zones occur, but *C. rudis* forms the only large charophyte zone, while *C. virgata* occurs at depth along with abundant *Fontinalis antipyretica*. Angiosperms include *Nymphaea alba*, *Elodea canadensis* and *Potamogeton* species. Cyanobacterial crust is well developed on a few boulders but bed rock is absent. This lake closely resembles Brick Lough. While vegetation structure (number of vegetation zones, C&K score) and euphotic depth are favourable, total phosphorus and colour are somewhat high and the lake is subject to cyanobacterial blooms. Provisionally it is rated *Good*. Small kettle hole lakes in glacial drift, fed by ground-water may require different assessment than the more typical marl lakes on limestone bedrock. It is used as part of the Carrickmacross water supply but future plans will see less water being abstracted.

Spring Lough, 2012; *Chara aculeolata* at station 534.

Spring Lough showing positions of 2012 transects and relevés with depth.

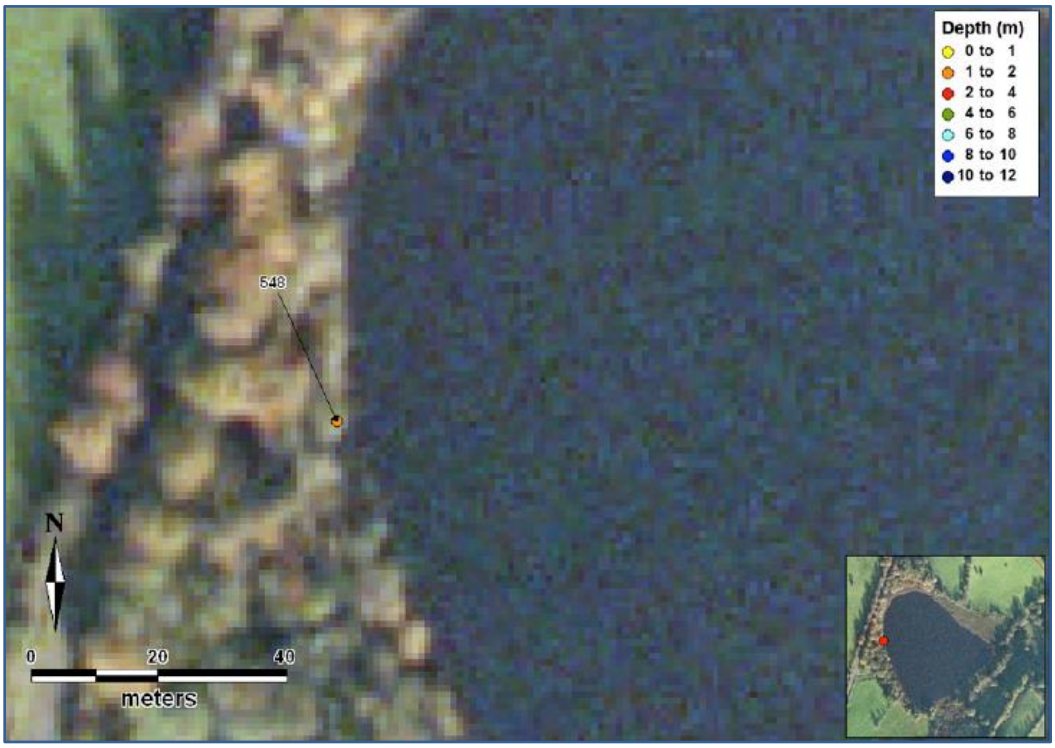
Spring Lough, 2012; *Fontinalis antipyretica* growing at depth, station 547.

Summerhill Lough, 2012			
Name	Summerhill Lough		
Alternative name(s)			
Grid Reference	249066327952, H4906627952	Depth (m)	
County	Monaghan, Fermanagh	EPA code	36_721
Area (ha)	2.5 ha	OSi 1:50,000 sheet	28A
Maximum length (km)	0.25 km	Nutrient data	EPA
Altitude (m)	57 m	SAC	001786, Kilroosky Lough Cluster SAC
Geology	Calcareous drift		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species	none		

2012		
Snorkel survey date(s)	07/09/2012	
Surveyors	CR, PM	
Number of transects	1	
Number of relevés	0	
Secchi depth (m)		
Substrates	Dark mud	
Noteworthy species	none	
A) Vegetation zones	0	
B) Euphotic depth (m)	1.5	
C) C&K score	0	
D) Total phosphorus (mg/l)	0.0245	
E) Colour (Hazen units)	46.1	
F) Index (TP × Colour)	1.129	
CONSERVATION CONDITION	**BAD**	

2012 condition assessment

The lake contained no charophytes along the transect examined. The water was dark and total phosphorus high. Apparently in one small area charophytes persist (N. Stewart, pers. com.) Based on the 2012 data the lake is rated *Bad*.



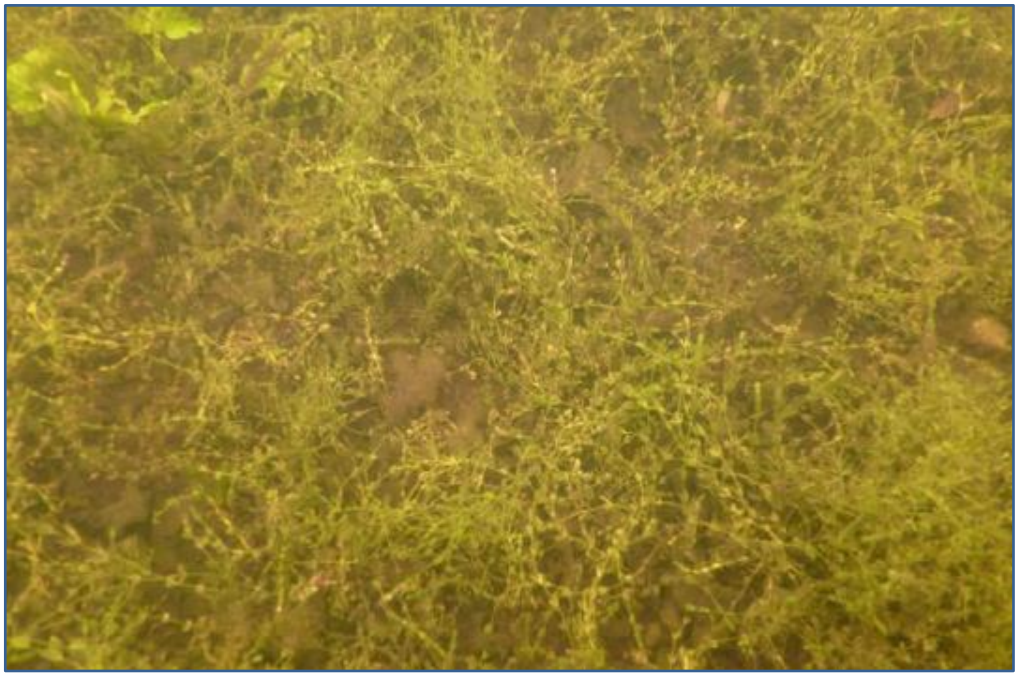
Summerhill Lough showing position of 2012 transects and relevé with depth.

Urlaur Lough, 2012			
Name	Urlaur Lough		
Alternative name(s)			
Grid Reference	151141288814, M5114188814	Depth (m)	
County	Mayo	EPA code	26_689
Area (ha)	115.7 ha	OSi 1:50,000 sheet	32
Maximum length (km)	3 km	Nutrient data	EPA
Altitude (m)	81 m	SAC	001571, Urlaur Lakes SAC
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

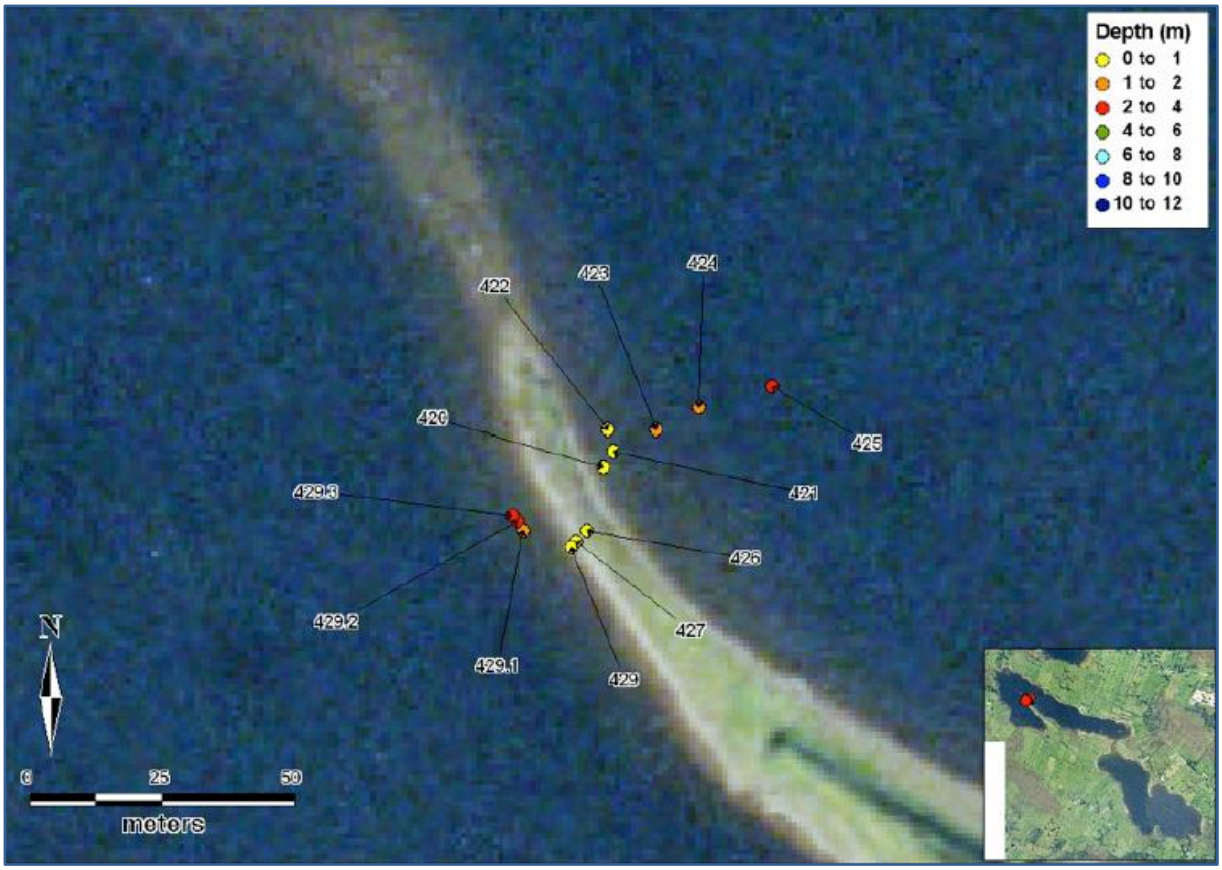
2012		
Snorkel survey date(s)	16/08/2012	
Surveyors	CR, PM	
Number of transects	2?	
Number of relevés	12	
Secchi depth (m)	1.5 m	
Substrates	Sand mud	
Noteworthy species	*Callitriche hermaphroditica*	
A) Vegetation zones	2-3	
B) Euphotic depth (m)	T2: 1.4 m; T1: 2.1 m	
C) C&K score	0.77	
D) Total phosphorus (mg/l)	0.012	
E) Colour (Hazen units)	41.5	
F) Index (TP × Colour)	0.498	
CONSERVATION CONDITION	**POOR**	

2012 condition assessment

Urlaur Lough has both a shallow euphotic zone and low Secchi depth. Charophyte bands include *Chara curta*/*C. contraria* and *Chara virgata*, extending to about 2 m. Cyanobacterial crust is well developed on occasional boulders. The Swan Mussel is abundant. *Callitriche hermaphroditica* is an unusual angiosperm. Given the shallow euphotic zone, few charophyte bands with *Elodea cannadensis* common along the base of the euphotic zone, the lake is rated *Poor*.



Urlaur Lough, 2012; *Chara contraria* at station 427.



Urlaur Lough showing positions of 2012 transects and relevés with depth.

Urlaur Lough, 2012; esker extending into the lake.

Walshpool Lough, 2012

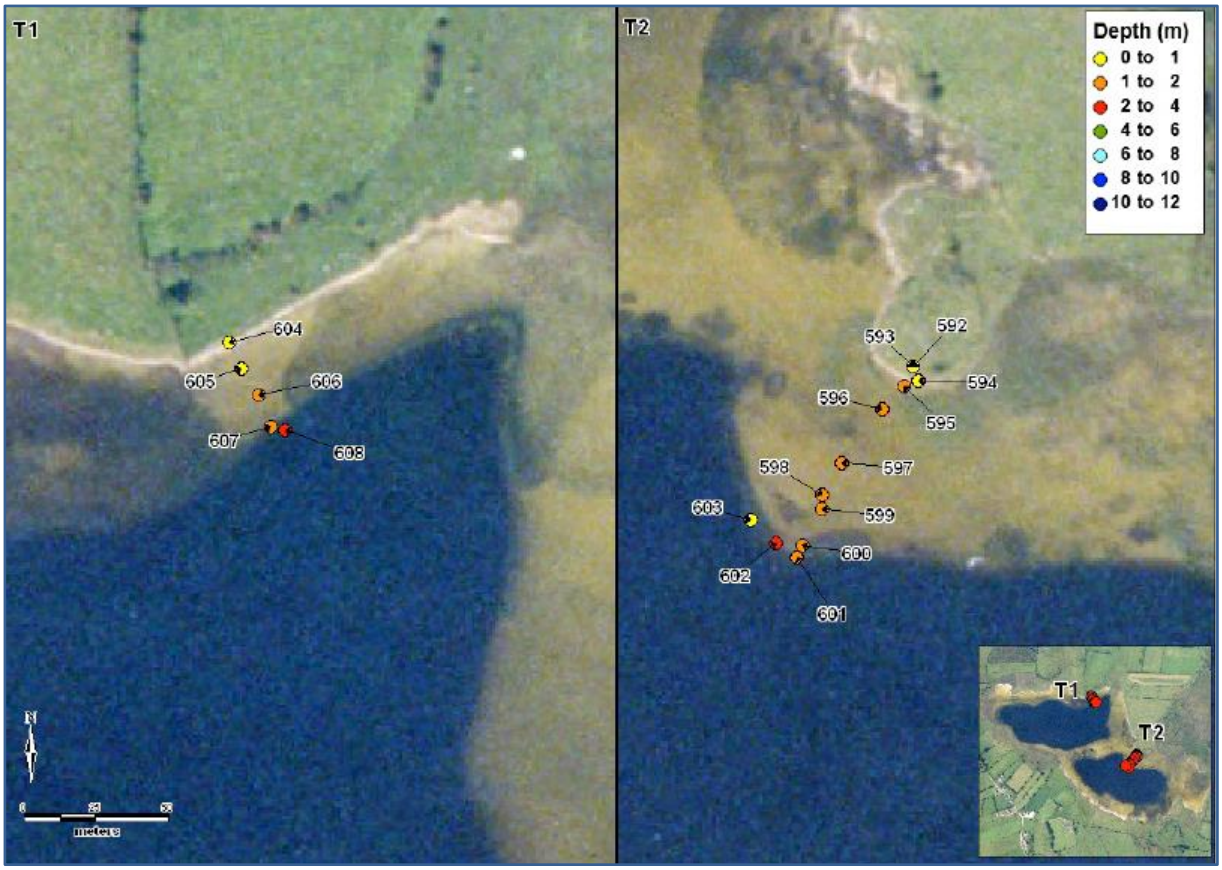
Name	Walshpool Lough		
Alternative name(s)	'Washpool' (typographic error on 1:50,000 data sets)		
Grid Reference	121632284137, M2163284137	Depth (m)	
County	Mayo	EPA code	34_402
Area (ha)	44.7 ha	OSi 1:50,000 sheet	31
Maximum length (km)	1.2 km	Nutrient data	EPA
Altitude (m)	32 m	SAC	n/a
Geology	Drift over limestone		
Previous survey	EPA WFD Monitoring Lake		
Noteworthy species			

	2012	
Snorkel survey date(s)	21/09/2012	
Surveyors	CR, PM	
Number of transects	2	
Number of relevés	17	
Secchi depth (m)	3.8 m	
Substrates	Marl	
Noteworthy species	*Potamogeton filiformis*	
A) Vegetation zones	4	
B) Euphotic depth (m)	3.3 m,	
C) C&K score	0.822	
D) Total phosphorus (mg/l)	0.0095	
E) Colour (Hazen units)	34.8	
F) Index (TP × Colour)	0.33	
CONSERVATION CONDITION	**POOR**	

2012 condition assessment

Walshpool is a lake with large deposits of marl. While the euphotic zone is shallow well-developed charophyte bands occur including *Chara curta*, *C. rudis* and *C. virgata*. Cyanobacterial crust is well-developed. Water clarity is high, but has an obvious yellow hue. There is a wonderful sponge fauna present. Few angiosperms occur other than *Potamogeton filiformis*. As the euphotic zone is very shallow, conservation condition is problematic to assess. Water colour is high and euphotic depth low, therefore the lake is rated *Poor* on the assumption that high colour is due to peat drainage.

Walshpool Lough, 2012.



Walshpool Lough showing positions of 2012 transects and relevés with depth.

Walshpool Lough, 2012; Large Sponge at base of *Schoenoplectus lacustris.*

White Lough, 2018			
Name	White Lough		
Alternative name(s)	Annagh Lough		
Grid Reference	251154273108, N5115473108	Depth (m)	
County	Meath, Westmeath	EPA code	07_258
Area (ha)	25.1 ha	OSi 1:50,000 sheet	41
Maximum length (km)	1.2 km	Nutrient data	EPA, 2008-2015
Altitude (m)	106 m	SAC	001810, White Lough, Ben Loughs and Lough Doo SAC
Geology	Carboniferous Cherty Limestone		
Previous survey	Roden (2008), EPA WFD Monitoring Lake		
Noteworthy species			

	2007	2018
Snorkel survey date(s)	Sep& Oct 2007	31/07/2018
Surveyors	CR,	CR, PM, JR
Number of transects	3	3
Number of relevés	35	21
Secchi depth (m)		9 m
Substrates	Marl, rock	Marl, rock
Noteworthy species	*Potamogeton filiformis*	*Potamogeton filiformis*
A) Vegetation zones	4	4
B) Euphotic depth (m)	8.1	T1: 6.4 m; T2: 6.4 m; T3: 6.4 m
C) C&K score	0.73	0.74, 0.86, 1.0
D) Total phosphorus (mg/l)		0.006 mg/l
E) Colour (Hazen units)		12.5
F) Index (TP × Colour)		0.075
CONSERVATION CONDITION	**GOOD**	**GOOD**

Hydrochemical data

Water quality data for the period 2008 to 2015 were made available by the EPA, for many samples from multiple depths. Values presented and used in assessment are averages of all data.

Parameter	Unit	White Lough
pH		8.2
Alkalinity	mg/l	191
Colour	Hazen units	12.5
Ammonia	mg/l	0.033
Total phosphorus	mg/l	0.006
Chlorophyll *a*	µg/l	6.59
Secchi	m	9.1

Previous survey

The lake vegetation was examined by C. Roden in 2007 (Roden, 2008). He recorded four vegetation zones, a euphotic depth of 8.1 m and calculated a C&K score of 0.73. The EPA surveyed the lakes in 2007, 2010 and 2013 and rated it as Good Ecological Status under the WFD.

Noteworthy species recorded in 2018

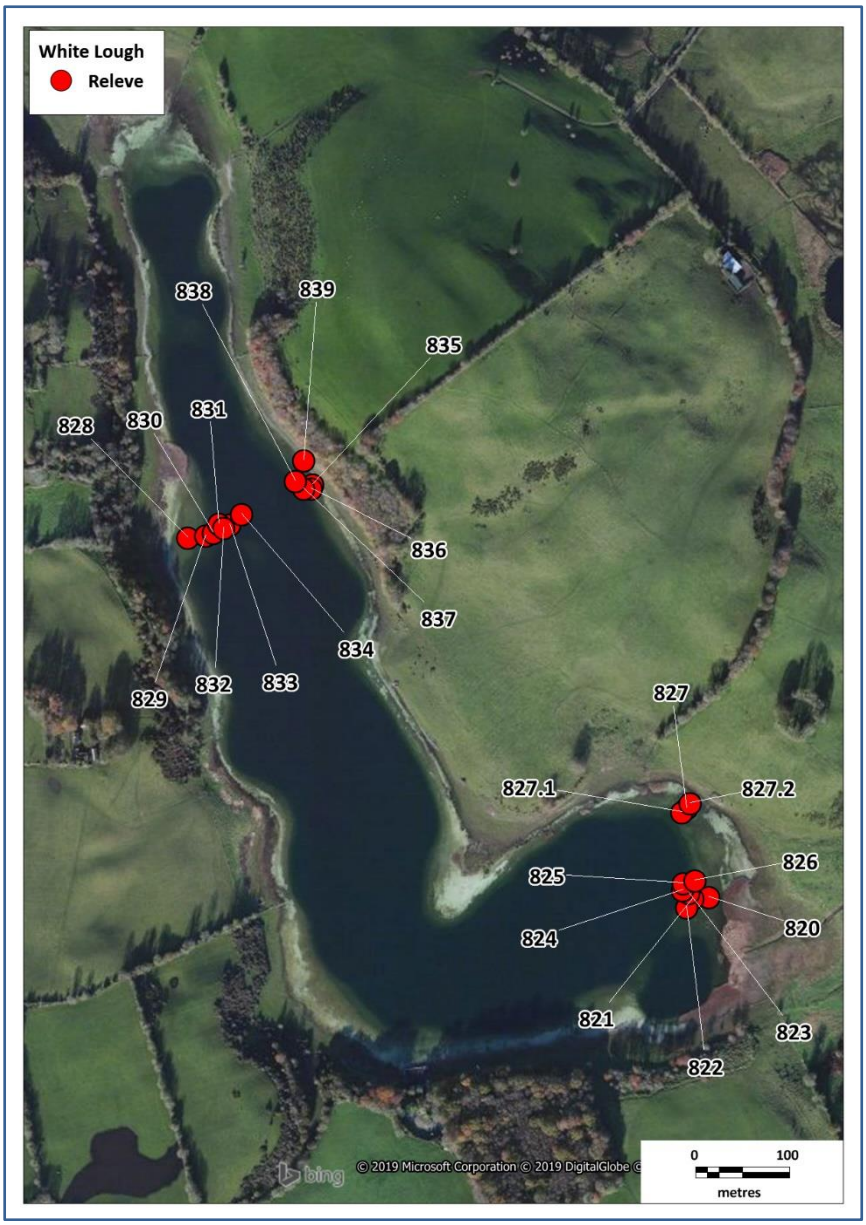
Potamogeton filiformis is a pondweed mainly found in the north and west of Ireland.

Taxa recorded in 2018

Charophytes	Vascular plants	Other
Chara aculeolata	*Elodea canadensis*	*Fontinalis antipyretica*
Chara contraria	*Hippuris vulgaris*	Cyanobacterial crust
Chara curta	*Myriophyllum verticillatum*	*Ophrydium versatile*
Chara rudis	*Potamogeton filiformis*	
Chara virgata	*Potamogeton natans*	
	Schoenoplectrus lacustris	
	Utricularia vulgaris/australis	

Vegetation

A very small but clear marl lake that has fluctuations in water level. In 2018, levels were too low to find much cyanobacterial crust. An underwater spring was surrounded by *Hippuris vulgaris* and filamentous algae. Four vegetation zones occur: cyanobacterial crust, *Chara curta*, *C. rudis* and, in the north arm, *C. virgata*.



White Lough overview map showing positions of 2018 transects and relevés. Transect 1: 820-826; Transect 2: 828-834; Transect 3: 835-839; relevés 827-827.2: investigation of an underwater spring.

Cyanobacterial crust

Due to very low summer water levels in 2018, rocks with crust were too dry to sample from the shore. Therefore no crust data were collected.

Change since previous survey

No significant changes noted since 2007 survey. Very low water levels during sampling did reduce the measured euphotic depth.

Threats and pressures

While the lake appears in very good ecological condition, it is fed by ground-water and its level fluctuates. Intensive farming or increased ground-water use may be a problem in future. The low water level in 2018 was possibly caused by the dry summer of that year. Thus changes in seasonal rainfall due to climate change could become an issue.

2018 condition assessment

All parameters were assessed as Good with the exception of water level, which was marginal *Poor*, being just above the *Chara curta* zone, therefore the lake as a whole was assessed as in *Favourable* (*Good*) conservation condition. Crust seen at depth appeared to be in good order, but could not be reached from the shore by Dr Doddy and so was not sampled.

Parameter	Target	White Lough 2018	Condition
Area	Stable or increasing		
Number of vegetation zones	4 or more*	4	Good
Euphotic depth (m)	>7	6.4	Good
Crust cover (%)	>70	not measured	Good
Crust chlorophyll *a* (µg/cm^3 ±s.e.)	<45	not measured	Good
Crust chlorophytes (% frequency, mean ±s.e.)	<45	not measured	Good
C&K score	>0.6	1.0	Good
Lake level	at or above cyanobacterial crust	below cyanobacterial crust	Poor
Total phosphorus (TP) (mg/l)	≤0.01	0.006	Good
Colour (Hazen units)	<15	12.5	Good
Index (TP × Colour)	<0.1	0.075	Good
Overall assessment			**Good**