



# Marl Crusts of Lough Carra

Philip Doddy





# Table of Contents

|                                                       |    |
|-------------------------------------------------------|----|
| Introduction .....                                    | 4  |
| What are marl crusts? .....                           | 5  |
| Where do marl crusts come from? .....                 | 7  |
| Where else are marl crusts found? .....               | 8  |
| What can marl crusts tell us about a marl lake? ..... | 9  |
| Using marl crusts as indicators .....                 | 12 |
| for the Lough Carra LIFE Project                      |    |



# Introduction

Take a wander along the shores of Lough Carra and you will surely see many things of interest - the beauty of the landscape, birds dabbling in the water, bright patches of wildflowers, perhaps a quiet old ringfort or an ancient castle near the water's edge. Another thing you might notice is that the rocks along the lakeshore are covered with a curious, quite slippery layer. This is a marl crust. I have spent some time studying these crusts, in Lough Carra and in other lakes, and I would like to tell you about some of the things I have found. Here are some of the questions that people occasionally ask about the marl crusts:

**What exactly are marl crusts?**

**Where do they come from?**

**Where else can you find them?**

**What can they tell us about Lough Carra?**

In this booklet, I will try to answer these questions.

Lough Carra is one of the most ecologically important marl lakes in Ireland, and in western Europe, and its habitats are of immense conservation value. Unfortunately, Lough Carra's habitats have been declining in recent decades because of nutrient pollution. However, there are now important and inspiring new efforts being made to halt that decline and to save Lough Carra's habitats. The marl crust of Lough Carra is an important part of that story.

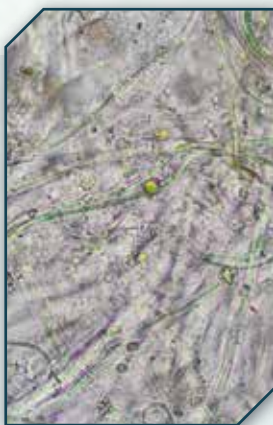
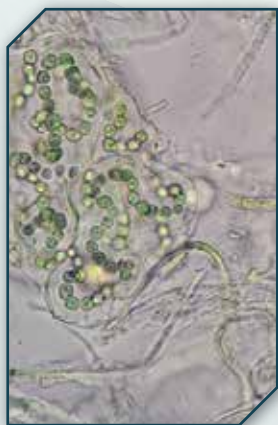




*Cross-section of a marl crust from Lough Carra. The section shown is 4 cm thick.*

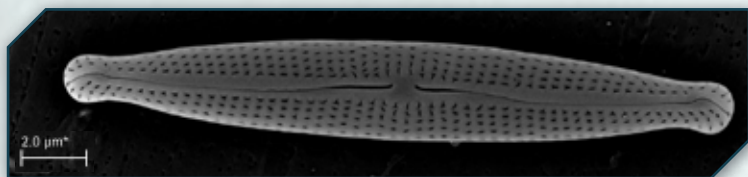
## What are marl crusts?

If you cut a slice of marl crust and look at it closely, you'll see a green layer just beneath the surface. Below this will be a soft, whitish, crumbly layer, made up of quite fine grains. A magnified view of the green material shows that it contains many living things – a community of tiny life forms. The majority of these are cyanobacteria – ancient organisms which can grow as filaments, clusters of cells, or interwoven masses, depending on the species. Cyanobacteria have been around for billions of years; indeed, some of the earliest traces of life on Earth are micro-fossils of cyanobacteria.



*Cyanobacteria in Lough Carra's marl crusts, highly magnified*

Various sorts of algae can also be seen in the living layer of marl crusts. One especially attractive group are the diatoms. Diatoms are much too small to see with the naked eye, but when you see one through a microscope the amount of detail is startling. Each diatom has an outer transparent shell made of silica. These tiny glassy cases often have exquisite patterns of minute perforations and slits. A recently-discovered species of diatom, which is found in Lough Carra and some other limestone lakes, has been named in honour of Lough Carra - *Encyonopsis carraensis*.



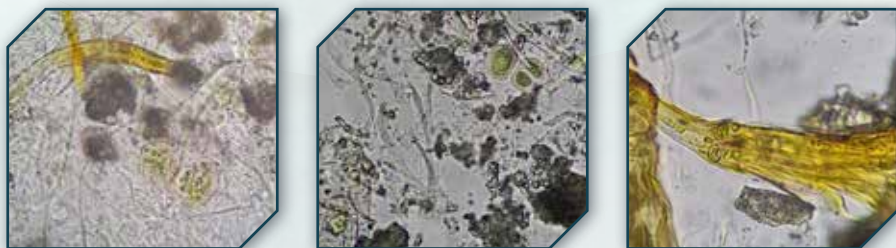
This diatom, *Encyonopsis carraensis*, has been named in honour of Lough Carra. This image is highly magnified. If 500 of these diatoms were lined up, they would form a line just 1 cm long.

Animals also live in marl crusts. Some of these are microscopic, such as the nematode worms that writhe and slither among the marl grains, but bigger animals live in these crusts too. Because thick crusts often have cavities or hollows, animals such as beetles, flatworms, and caddis fly larvae can be found living in them. Often, a water spider will emerge from a piece of crust if you examine it closely. A particularly rare beetle, called *Ochthebius nilssoni*, has also been found living on Lough Carra crusts in recent years.



The water spider *Argyroneta aquatica* (left) and beetle *Ochthebius nilssoni* (not to scale). The water spider is quite common, but Lough Carra is one of very few places in the world where this beetle can be found.

As well as these living creatures, marl crusts contain a lot of small grains of calcium carbonate (the main mineral that makes up limestone). In the upper layers of crust, these grains are bound together by many strands of filamentous cyanobacteria. This is why crusts have a firm texture. These grains also form the pale material towards the base of the crusts. Because cyanobacteria need light, they cannot grow very deep within crusts, and so the lower parts of crusts are more loose and crumbly in texture.



*In these highly-magnified images, mineral grains appear as dark masses among the cyanobacteria*

## Where do marl crusts come from?

Marl crusts grow slowly, as mineral grains are gradually incorporated into them, often forming thin, consecutive layers. The way this happens is a bit like the way that dental plaque and tartar form on teeth. A biofilm of bacteria grows between teeth and along the gum-line. Saliva contains dissolved calcium phosphate, which solidifies onto this thin film of bacteria. More bacteria grow on top of this layer and the process is repeated. Other particles, such as fragments of food, get stuck in the plaque and incorporated into the growing layer. Before long (if you don't floss) you end up with a hard microbial crust (tartar) between your teeth.

In marl lakes, the water contains a different mineral - calcium carbonate. This also solidifies onto films of bacteria - in this case, the cyanobacteria. Because the cyanobacteria in the living crust community need light, they grow upwards, over this newly-incorporated material. As the structure grows, other particles that may be washing around in the water, such as sand grains or pollen grains, get stuck in the growing crust and are eventually covered over by the accumulating layers of cyanobacteria and calcium carbonate.

Of course, a marl crust can't keep growing forever. Because cyanobacteria can't live at the base of a thick crust due to the lack of light, the mineral material there is crumbly and soft, and not tightly attached to the rock underneath. Thick crusts can therefore be dislodged and removed by waves. If this happens, the process starts again, and a new crust begins to form. Sometimes marl crusts grow on things other than rocks. In Lough Carra, I have seen small crusts growing on old pieces of reeds, and even on an old car tyre.



*In some marl crust, layers can be clearly seen*

## Where else are marl crusts found?

Lough Carra is unusual in having such a large area of marl crusts, but they can also be found in some other Irish lakes. Some parts of Lough Corrib have similar crusts, as do some of the Burren lakes such as Lough Bunny and Muckanagh Lough. Some limestone lakes in the midlands of Ireland, including Lough Owel and Lough Ennell, also have marl crusts. Crusts have been found in a few areas of Lough Mask, but are not widespread there.

Marl crusts have been reported from a few lakes in Yorkshire, England, such as Malham Tarn, and from several lakes in North America. Some of the species of cyanobacteria reported from these lakes are the same or similar to those found in Irish crusts. However, no detailed comparisons have yet been done between Irish crusts and those from other countries.



*Marl crust in two lakes in County Clare – Lough George (left)  
and Muckanagh Lough (right)*

## What can marl crusts tell us about a marl lake?

Marl crusts are interesting to people who study cyanobacteria, but can they also tell us useful things about a lake? Can we find out something about the water quality or ecological quality of Lough Carra by examining these crusts?

Let's consider for a moment some of the problems that can affect lakes. Invasive species; nutrients leaking in from agriculture, septic tanks or sewage systems; peat or soil particles washing in, often from forestry or turf-cutting in the catchment; weed-killers or other chemicals entering the water: all of these can seriously affect the ecology of a lake. For marl lakes in Ireland, leaching of nutrients into lake waters is a particularly troublesome problem. This is because these lakes, including Lough Carra, are naturally very low in nutrients, and the species that live in them are adapted to that low-nutrient state.

When concentrations of nutrients, especially phosphorus and nitrogen, are increased in lake waters, several things start to happen. The water, which was previously clear and clean, becomes cloudy and greenish in colour. This is due to the proliferation of algal cells (phytoplankton) in the water. The rocks or marl along the shore also start to take on a green colour, again due to algal growth. Floating green scums appear in the water and are often washed up on the

shore. Certain underwater plants die, whereas emergent plants such as reeds or club-rush may spread into areas which before were open water. Some species of insects, including mayflies, go into decline and may eventually disappear. The fish populations are also affected, as some native fish species can no longer survive in these conditions.



*Two signs of nutrient pollution in Lough Carra: green algal scum on the shore and increasingly dense stands of emergent vegetation such as club-rush*

By studying marl crusts from many different limestone lakes around Ireland, we can see how the state of the crust varies in different sets of conditions. These lakes range from very clean, low-nutrient lakes to lakes with quite serious nutrient pollution. This helps us to work out what things we need to measure in lake crusts to find out about the water quality and broader ecological state of a particular lake.

### **Clean lakes**

Plenty of pale or whitish marl crust, with large areas free of plants or visible algae



**Cooloorla Lough, County Clare**

### **Nutrient-polluted lakes**

Marl crust becoming scarce or patchy, with visible green algal growths



**Cullaunytheeda Lough, County Clare**

To examine further whether the changes in marl crust condition are indeed caused by nutrient pollution, I did two experiments. By growing crusts from Lough Carra in containers, with water of different nutrient concentrations, I was able to see the changes that happen when nutrient concentration in water is increased. The amount of the green pigment chlorophyll in crusts increased in response to increased nutrients in the water, as did the numbers of green algal (chlorophyte) cells found in crust samples.

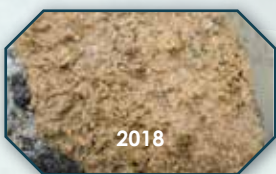
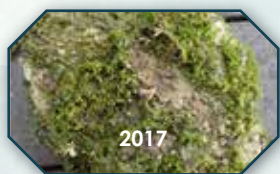


*Nutrient pollution causes marl crusts to turn green and eventually disintegrate*

I was also able to measure these changes happening within Lough Carra, by moving marl-encrusted stones between different areas of the lake. Crusts moved from the north basin of the lake down to the more nutrient-polluted area near Annie's River changed in the same way, with amounts of chlorophyll and chlorophytes in crusts both increasing.

These findings mean that marl crusts can be used as an indicator of nutrient pollution and habitat quality. The amount of chlorophyll contained in crusts is especially useful for this, as chlorophyll can be extracted from crust samples and measured in a laboratory. A related characteristic is the numbers of green algal (chlorophyte) cells found in crust samples; this can be assessed by microscopy. Finally, the percentage cover by crust in the sampling area is a useful indicator, as marl crusts gradually disintegrate in high-nutrient conditions.

There was also some good news from these experiments, showing that this process of degradation is reversible. When stones, covered with green algae and aquatic mosses, were taken from the nutrient-polluted area near Annie's River to a relatively unpolluted part of Lough Carra's north basin, there was an impressive recovery, with new crusts beginning to grow back, even within one year. After five years, the marl crust had recovered very well, as shown in the following pictures.



*Marl crusts can re-grow and recover when nutrient concentration is reduced.  
These pictures show the same stone over a period of five years.*

## Using marl crusts as indicators for the Lough Carra LIFE Project

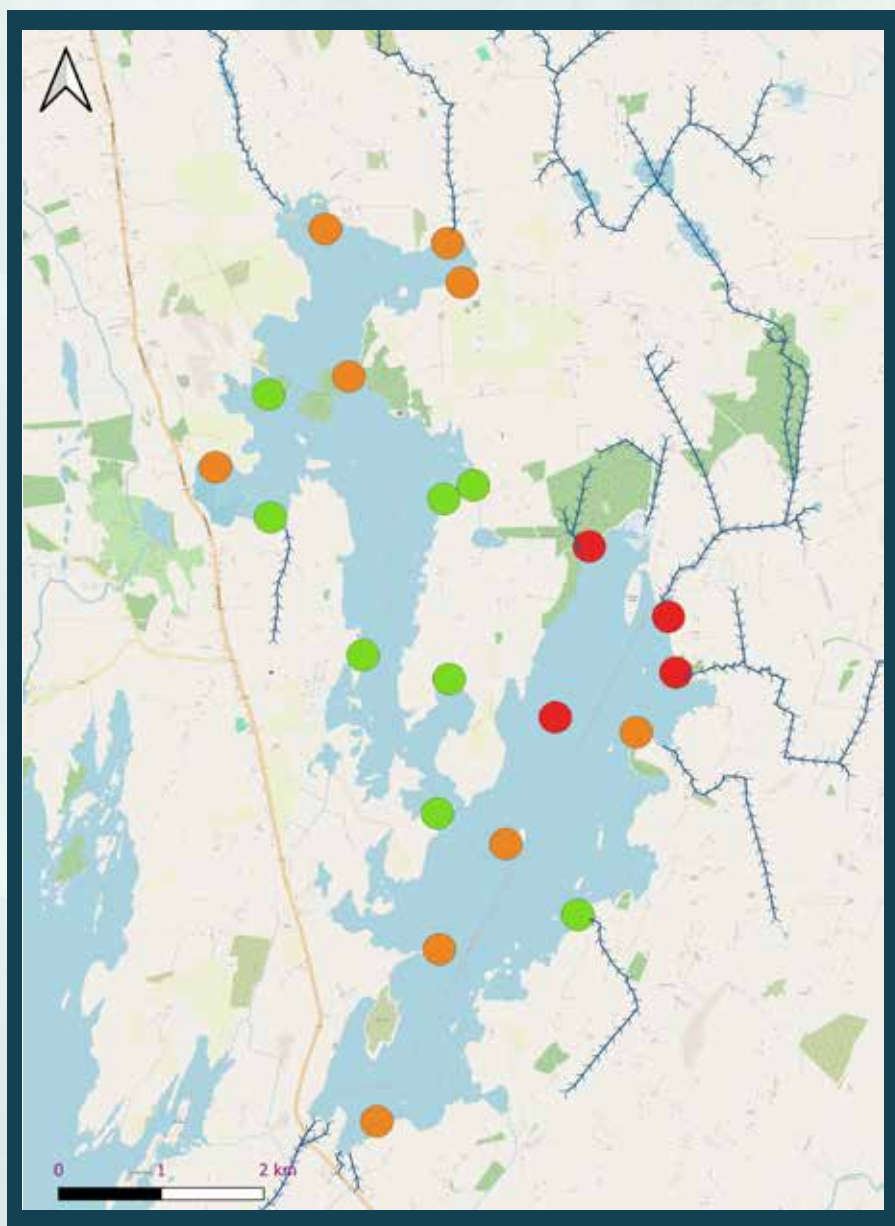
The Lough Carra LIFE Project was established to improve water quality and reduce nutrient pollution, and to begin the process of restoring Lough Carra's marl lake habitats. Various kinds of monitoring methods, including marl crust assessment, were included in the project in order to measure the effectiveness of the project actions. In 2023, a baseline survey of marl crusts was carried out in Lough Carra. While I had done smaller-scale studies in the past, this was the first comprehensive, lake-wide assessment.

Samples of the marl crust were taken at twenty-one locations around the lake, shown in the map on the following page. In choosing these sampling points, we made sure to include locations where streams and rivers enter Lough Carra, as these inflowing waters carry nutrients into the lake from various parts of the catchment. Taking samples in these locations helps to pinpoint areas where nutrient pollution is a particular problem.

The worst results were from the locations where Annie's River and the Cloondaver Stream enter Lough Carra. Results from a nearby underwater spring at Moorehall and from Castle Island were also particularly bad. These areas are shown as red dots on the following map, and all had symptoms of severe nutrient pollution and habitat degradation.

Happily, not all of Lough Carra is in this condition. The green dots on the map are places that gave good results and where the marl crusts showed little sign of nutrient pollution. Locations marked by orange dots gave intermediate results.

It is clear, therefore, that nutrient pollution and habitat degradation are not happening at the same rate throughout the lake. This makes sense when we consider that different parts of Lough Carra receive inflowing waters from different parts of the catchment. The amounts of nutrients contained in the various inflowing streams and rivers will depend on activities, especially land management, in these various parts of the catchment.



This map gives a brief visual summary of the results of the first full marl crust assessment of Lough Carra, carried out in 2023 as part of the Carra LIFE Project. Each dot is a location where samples were taken. Areas marked in green showed little or no sign of nutrient pollution, based on marl crust analysis. Orange dots show areas where clear signs of increasing nutrient pollution were found. Red dots show areas that are already badly degraded as a result of nutrient pollution.

Blue lines show streams and rivers that enter Lough Carra, and the Keel River flowing out towards Lough Mask at the bottom left.

By repeating this survey in the future, we will be able to identify changes that may result from different land management practices in the catchment. The LIFE Project is a crucial step in this, as it involves working with farmers and land-owners in the catchment to identify ways in which nutrient pollution can be reduced, and to put these measures into action. The project allows farmers, scientists, government departments, state agencies, Mayo County Council and all interested local people to come together to chart a bright future for Lough Carra. Part of that future must involve putting in place a long-term Lough Carra Programme to continue the work of the LIFE Project. The ongoing work of the Lough Carra Catchment Association is also extending and complementing the project's efforts to save Lough Carra.

Finally, it is important to emphasise again how special Lough Carra is, and the rarity of its habitats, biodiversity and beauty. Lough Carra is clearly important to many people, none more so than those who live around its shores and in its catchment, and who drink its water. It is for these people in particular, for their children and the future generations, that Lough Carra should be preserved and treasured.

Photographs by Philip Doddy except:

Front cover, pages 2, 3, 4, 14 & 15 – photos by Lynda Huxley

Page 6 – diatom photo by Bryan Kennedy, spider photo by Brian Nelson, beetle photo by Sabine Springer

### Scientific Publications:

Doddy, P., Roden, C.M. & Gammell, M.P. (2019) Microbialite crusts in Irish limestone lakes reflect lake nutrient status. *Biology and Environment: Proceedings of the Royal Irish Academy* Vol. 119, No. 1, 1–11.

Doddy, P., Roden, C.M. & Gammell, M.P. (2019) Nutrient pollution degrades microbialites in Lough Carra, an Irish marl lake. *Aquatic Microbial Ecology* Vol. 83, 203–209.

Roden, R., Murphy, P., Ryan, J. & Doddy, P. (2020) Marl lake (Habitat 3140) survey and assessment methods manual. *Irish Wildlife Manuals* No. 125. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

Roden, C. & P. Murphy. (2013) A survey of the benthic macrophytes of three hard-water lakes: Lough Bunny, Lough Carra and Lough Owel. *Irish Wildlife Manuals*, No. 70. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland.

Nelson, B., O'Connor, Á, Foster, G.N., Doddy, P. and Roden, C. (2019). A review of *Ochthebius nilssoni* Hebauer (Coleoptera: Hydraenidae) in western Ireland including a first report from Lough Carra. *Irish Naturalists' Journal* 36 (2), 117–122.



Thank you to Lynda & Chris Huxley, Áine O'Connor,  
Brian Nelson, Cillian Roden, Sabine Springer and Bryan Kennedy.



For more information please visit:

**[www.loughcarra.org](http://www.loughcarra.org)**  
**[www.loughcarralife.ie](http://www.loughcarralife.ie)**

January 2025



**Lough  
Carra** **LIFE**



Local Authority  
**Waters** Programme  
 vibrant communities | catchment assessment | healthy waters

