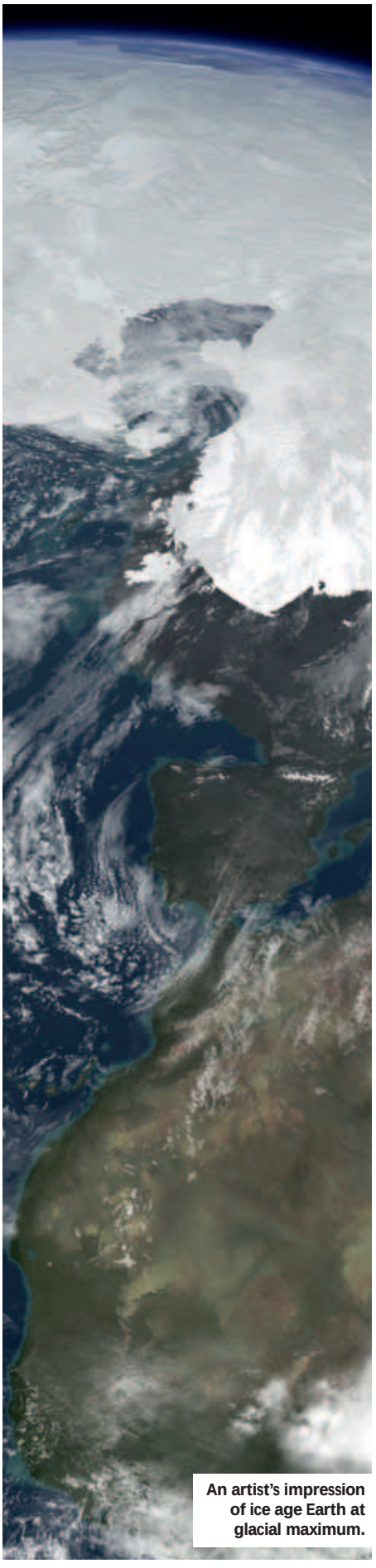

An artist's impression of ice age Earth at glacial maximum.

Image: Lttiz

Shaped by the Ice

– the origins of brown trout diversity

Although trout have only been present in current-day lakes and rivers in Britain and Ireland since the end of the last ice age, a maximum of 14,000 years ago, there is enormous genetic diversity within and among populations. This diversity is far too great to have arisen solely in this post-glacial period. It is important to note however, that brown trout have been present in North West Europe for possibly 700,000 years. During this time there have been several major glaciations, involving advances and retreats of ice sheets with associated decreasing and increasing sea levels. At maximum glacial cover, trout would have been confined to ice-free peripheral regions (refuges). During glaciations, as a result of lowered sea levels, refuges existed in areas that are currently covered by the sea; isolation of trout populations in these separate areas allowed genetically differentiated groups (lineages) to evolve. When the ice retreated these lineages would have expanded their range and colonised the newly available freshwaters. In some cases different lineages interbred when they came into contact. This pattern was repeated during each of the glaciations and interglacials, including the most recent one.

Recent work at the fish population genetics laboratory at Queen's University Belfast examined the occurrence of distinct trout lineages in over 3500 trout specimens from 81 rivers and lakes throughout Britain and Ireland (McKeown, Hynes, Duguid, Ferguson and Prodöhl, 2010, Phylogeographic structure of brown trout *Salmo trutta* in Britain and Ireland: glacial refugia, postglacial colonisation and origins of sympatric population, *Journal of Fish Biology* volume 76, pages 319 – 347). The genetic make-up of each individual was determined for its mitochondrial DNA (mtDNA) with modern DNA techniques enabling this to be done on tiny clips of the adipose fin thus avoiding having to kill the trout. The advantage of mtDNA is that it is inherited only through the maternal line and thus passes from mother to offspring unchanged except for rare mutations, which result in the formation of new mtDNA types. Thus groups of related mtDNA types characterise specific lineages. In some respects, this is analogous to paternal family-name clans that occur in many human societies. As with such family names, and spelling derivatives, mtDNA analysis allows the spread of each lineage to be followed over thousands of generations.

The analysis showed that after the last ice age Britain and Ireland was colonised by at least five different lineages originating from refuge areas in western France, east of the Baltic Sea, western Ireland, Celtic Sea and North Sea. Thus, all current brown trout populations, irrespective of river, lake or sea trout life history currently, have arisen from sea trout ancestors that moved out from these glacial refuge areas. Gillaroo, sonaghen and ferox trout that co-exist in Lough Melvin (North West Ireland) represent three of these lineages, which have remained reproductively isolated since they independently colonised the lough around 14,000 years ago. In other waters lineages have interbred to form a single highly variable population; some of this interbreeding is probably recent, resulting from contemporary habitat changes and stocking. The island nature of Britain and Ireland enabled the various lineages to extend their range easily and come into contact. This contrasts with the pattern often seen for salmonid fishes in North America and continental Europe where lack of water connections have restricted different lineages to areas contiguous with the glacial refuges.

Thus, the great genetic diversity that we see today within and among trout populations has been shaped by glacial advances and retreats over more than half a million years, together with postglacial adaptation to the wide range of environmental conditions found in Britain and Ireland. Trout genetic diversity is vitally important for the productivity, fitness, range of biological characteristics, and continued adaptation of trout populations to changing conditions, as well as being an integral component of our native biodiversity. It is therefore vitally important that conservation is targeted at individual populations, in particular those with unique biological and other characteristics.

> "the great genetic diversity that we see today within and among trout populations has been shaped by glacial activity"