WELCOME HOME

Concrete can support plant and animal life in surprising and often beautiful ways, finds Tony Whitehead

Since 1950 the UK hedgehog population has shrunk by 96%. Tree sparrow numbers are down 95%. Many other birds, including starlings, swifts and songthrushes have also suffered depressing declines, along with bees, butterflies and even earthworms.

All of this adds up to a steep decrease in Britain's biodiversity. Everything from climate change to wind farms to modern farming practice has been blamed, and insensitive building too has played its part. From later this year, however, the construction sector will, by law, become part of the solution. With few exceptions, planning permission will be withheld from all development in England that cannot demonstrate a 10% net gain in biodiversity. The new regulations are set to become law this autumn and will apply fully by 2022 (see box, overleaf).

Many planning authorities already impose net gain conditions on schemes, so the new rules should not prove too much of a hardship for developers who have adopted advanced environmental policies. But the changes will certainly serve to raise the profile of urban wildlife, not least as a focus for innovation in construction materials and techniques. Beyond biodiversity, the myriad benefits of nature in cities are well rehearsed and often intuitive. From mitigating air pollution, overheating and flooding to improving psychological wellbeing, we clearly stand to gain a lot by welcoming in the wild.

It turns out that concrete can be a very good way to do this. Far from being grey and inert, it can support plant and animal life in surprising and often beautiful ways. Researchers are using it as durable substrate, robust shelter,

even a source of nutrients for many different creatures from the smallest to the most useful to the most endangered.

Take the work of concrete scientist Dr Elizabeth Gilligan. Her company, Material Evolution, is developing concrete panels that are specially adapted to host sedums, the low-maintenance succulent plants used extensively on green roofs. "The panels have deep indents in which sedums can take root," she explains. "This happens with the panels horizontal, but after a few days, when the plants are established, the panels can be made vertical to form a building facade."

Much of Gilligan's research has focused on developing a plant-friendly concrete mix. "It's a hyper-porous concrete with a very open cell structure to allow for plant and water ingression," she says. "It holds water like a sponge, so its qualities are exactly what most precast panel manufacturers would try to avoid. However, the concrete still forms a protection for waterproof membranes and insulation behind it."

The mix comprises 90% recycled material, as well as nutrients for the plants, along with elastic fibres which help the concrete cross-knit back together if it starts to crack under the influence of roots. The exact details remain secret, pending patent approval, but Gilligan says it can be adapted to recycle local waste streams: "For example, a lot of seafood gets eaten in the San Francisco area. We have done some experimental work there using crushed oyster shells as a nutrient source."

Opposite: Green and Blue's bee homes are all made from concrete with a 70% recycled mix using local china clay waste
Right: Material Evolution's concrete mix contains 90% recycled material as well as nutrients for the plants

A test wall of Gilligan's panels is already in place at Queen's University, Belfast and performing well: "The bees, butterflies and other bugs love it." But the panels do more than just support local biodiversity: "The concrete carbonates, reabsorbing CO_2 relatively quickly. The sedums also absorb CO_2 and are good at trapping pollution particulates. They could be particularly effective lining an urban canyon – we have measured local improvements in air quality of up to 60%."

The panels must be irrigated to protect the plants from drought, and grey water can be used for this: "The panels can form part of a filtration system, cleaning the water and then returning it to the building."

Of course, not all green walls require specialist concrete. Precast panels are routinely shaped to hold various systems of planters, with the concrete simply providing a tough, root-resistant background against which plants can thrive. Dr Eleanor Atkins, lead researcher at Staffordshire University's Green Walls Centre, addresses the potential concern that plants will damage a building: "Plants can damage buildings, but roots tend to find existing cracks – so if the facade is new and sound, it shouldn't be a problem."

In fact, a covering of plants can be a shield against local environmental conditions: "As well as boosting biodiversity, green walls can protect a building by providing insulation and reducing weathering, including frost shattering. They can also keep a building cool in summer by providing shade, and if the plants are deciduous, this shade will be reduced in winter to let the sun through – particularly useful for seasonal window shading."

Atkins advises that green walls should be selectively placed where they can do most good, as they can be relatively expensive and may require some irrigation and maintenance. If that puts off some building owners, they might prefer a new sort of concrete panel created by two academics at the Bartlett School of Architecture at University College London.

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Professor Marcos Cruz and lecturer Richard Beckett have been researching how concrete can be made more bioreceptive, and have developed facade panels specially designed to encourage the growth of cryptogams – organisms such ▶

Photos: Green and Blue; Elizabeth Gilligan / Material Evolution

as moss, algae and lichens – which require no irrigation.

The aesthetic effect has been a major focus of their work, says Beckett. "After all, a green stain on a white building can look terrible. It often marks some point of failure like a leak. So we have experimented with ways to encourage mosses and lichens to grow in a way that is pleasing to the eye as well as beneficial to the environment." This has involved designing a range of mixes – most of which result in a slightly porous concrete that allows the rhizoids (root structures) to get a foothold. "We have also altered the pH so that it is more conducive to the plants," says Beckett. "The concrete is perhaps a little weaker than standard mixes, but we are proposing it for facade panels rather than structural purposes."

The surface can either be "seeded" with spores, or cultivated cryptogams can be transplanted onto the panels. "Alternatively you can just wait and see what develops. This gives you plants that are well adapted to the location, but obviously takes longer and gives less control over aesthetics."

The panels' benefits are wide ranging: mosses and lichens absorb CO_2 and punch above their weight when it comes to purifying air by trapping particulates. They also provide a habitat for micro fauna and small insects on which birds can feed.

None of these benefits will be realised, however, unless the panels look attractive enough to be specified. "We have tried various patterns and the ones with more flowing shapes tend to look best," says Beckett. He points out that lichen-covered statues in churchyards develop a pleasingly romantic aspect: "You'll often pay more at auction for a garden statue with patina than for a new, unweathered one."

There are plans to install the panels at two sites in London – a school and an underground station. Meanwhile, Beckett has turned his attention to the role of biodiversity in improving the indoor micro biome. "This is the population of bacteria that inhabit your building," he says. "The more cleaned and sealed our buildings become, the less diverse the bacteria. You end up with too many human-related bacteria, which can be unhealthy."

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A rich diversity of plant and animal life outside a building can improve the bacterial diversity

Photos: Sarah Lever; Richard Beckett, Marcos Cruz and Javier Ruiz

Opposite: The UCL facade panels, produced in partnership with Pennine Stone, are designed to encourage plant growth
Right: Green and Blue's bee homes can be built into the fabric of a house without compromising its structure

inside, says Beckett. He is looking to boost this further – again by using concrete. "We have found that by seeding specially adapted concrete with healthy bacillus we can encourage good bacteria at the expense of the bad, and end up with panels that are resistant to MRSA, the bacteria that causes infections in hospitals."

Working on an altogether larger scale, a company in Cornwall is using concrete to provide builders with an easy way of making their developments more friendly to local fauna. Green and Blue's range of small animal homes are all made from concrete with a 70% recycled mix using local china clay waste.

"We chose concrete because it is a material builders are familiar with," says founder Gavin Christman. "It's long-lasting and structural, so our homes for bats, swifts and bees can be built into the fabric of a house without compromising its structure. And being integral to the building, they are there for good, whereas wooden boxes can decay over time through lack of maintenance."

Initially interest in the products came mainly from developers specialising in building with nature, but Christman says that it is receiving more enquiries from mainstream companies, thanks to the biodiversity net gain rules. Formalising biodiversity requirements within the planning system also chimes with a wider change in public awareness, he suggests: "We have ambitious housebuilding targets in the UK, so I think there is an understanding that the more we build, the more important it is that every house gives something back to nature."

Photo: Green and Blue

Biodiversity net gain explained

The requirement for developers to achieve a biodiversity net gain of 10% is expected to become law in autumn this year, which will mark the start of a two-year transition period. To begin with, biodiversity will probably be measured using the Biodiversity Metric, an online tool published by Natural England. Developers will comply first by minimising any destruction of habitat and then by adding improvements.

"Currently different local planning authorities use different metrics and require different levels of mitigation or improvement," says Dr Nick White, Natural England's principal net gain adviser. "The new rules should make it easier for developers to know where they stand."

The metric includes a range of things that could count as a credit, such as green roofs, green walls or urban trees. "What's required will vary according to what you start with," says White. "If you are building on an relatively uninteresting brownfield site, then an area of community grassland or a sustainable drainage scheme may be all you need to do to achieve a 10% gain. But if you are building in an area rich in wildlife you will have to do more and possibly add off-site improvements."

While in most cases it is best to achieve the net gain on the site concerned, where this proves impossible developers can offset by improving nearby sites or purchasing sites that have been improved by others. "For example, we have worked closely with the Mineral Products Association as their members are typically good at achieving net gain from quarries that have stopped operating. Many of them restore sites to a standard beyond what is required, and this gives them the potential to make surplus gain available to others. This would in effect create a market in biodiversity."

To avoid having to purchase off-site improvements, White recommends architects and developers consider the biodiversity target at an early stage. "Too often the site is designed, and then handed to ecologists to green," he says. "It is much easier and better to look to integrate green infrastructure early on. Ideally this can be done in a way that delivers wider functional benefits such as mitigating flood risk and improving air quality."