# Green fuel is possible with artificial ecosystems

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Green algae on the surface of a pond.

For algae to power our cars and planes, production needs to be low carbon and cost effective, which means working with natural processes, not against them, say scientists.

Algae could become an important source of sustainable biofuel, as production doesn't compete with food crops for land. But we may need to change the way we grow algae from closed systems to open ponds if it is to be low-carbon and cost-effective.

This is because current algae production in closed systems – usually for cosmetic ingredients – uses too much energy keeping the ecosystem isolated from the surrounding environment.

To overcome this issue, scientists from the University of Cambridge

suggest that when grown in open ponds, algae should be supplemented with multiple species that help support the algae in some way. This would make the system less vulnerable to outside influences such as predators.

They say that ecosystems with greater numbers of species are more stable and more resilient to change than monoculture systems made up of just one crop. The scientists have coined the term synthetic ecology to describe the creation of artificial ecosystems with multiple species.

"A complex synthetic community mirrors natural communities much more closely," argues Elena Kazamia, whose scientific review is published in the *Journal of Biotechnology*. "Monoculture is not very natural. There is a tendency towards complexity in the natural environment - communities get more complex with time."

In a natural ecosystem there are plenty of potential roles, or niches, to be filled by species. The more developed the ecosystem is, the greater its complexity as more of these roles will be filled. These complex ecosystems often reach a stable state, which is best adapted to the local conditions, and all of the niches are filled.

It is difficult for any new species to get a foothold in the community as they have to compete against established species in that niche. As new species are unlikely to invade successfully, the ecosystem doesn't change. For the algae, it could mean that no pest species will be able to easily establish themselves in the crop area.

The other species in this artificial ecosystem would have more roles than just protecting the ecosystem against invaders. Adding grazing animals like plankton that eat algae other than the crop might prevent these other types of algae from taking over. Carefully selected bacteria might provide essential vitamins or nutrients for the algae.

"There is a point for all communities where growth is limited by nutrients available in the ecosystem. One thing synthetic ecology can do is look into clever ways to get round this. In a nitrogen poor environment you could use nitrogen fixing bacteria, for example," Kazamia explains.

Nitrogen fixing bacteria convert nitrogen in the air to more easily used nitrate compounds. They are an essential part of most ecosystems, enabling plants to use nitrogen to make proteins. The researchers are also looking at combining algae with bacteria that produce the essential vitamin B12.

"Because we have little or no experience of growing algae on a large scale, we have a good opportunity to try something new, based on the science," Kazamia adds. For the researchers, algae as a new crop represent a chance to start developing techniques from scratch, using science to inform the techniques used and working with nature instead of against it.

There's still a great deal of debate over the best way to harness algal fuels, and industrial trials are few. The scientists have published their work as a call to action for the new algal biofuel industry to put ecological principles into practice.

"Maybe we could do with a better understanding of algal biology but we have enough theoretical knowledge about ecosystems - what we need are some trials in the field," says Kazamia. "We should be looking at how many players we need for a robust system. Earlier studies on land-based agriculture suggest we need 20 species. Is that the same for aquatic ecosystems? It's still very much an unknown."

**More information:** Elena Kazamia, et al., Synthetic ecology - a way forward for sustainable algal biofuel production?, *Journal of Biotechnology*, available online April 5, 2012,

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