It's survival of the most useful when protecting species

January 12 2015, by Simon J. Brandl

Coral reefs are like an underwater metropolis – and function in similar ways. Credit: Simon Gingins, CC BY-SA

Consensus is growing that we are steering towards a sixth mass extinction event. There are calls for increased efforts to stop the accelerating loss of plants and animals. But do we really need to protect all species from global extinction?

Over the past decade, ecologists have increasingly replaced the value of biodiversity – the diversity of plants, animals and bacteria – with the concept of "functional diversity". The best way to understand this concept is to compare it with a familiar, striking equivalent: our cities.

Our decision to live in permanent settlements is a success story that is fundamental to the rise of human civilisation. It is based on the partitioning of tasks and professional specialisation, which cohesively provides services to the community.

Food, health, security and construction are among the life-blood of cities. Yet all of these professions are inherently diverse and without this diversity the community would soon collapse.

In the natural world, ecosystems such as forests, lakes or deserts are just like cities. Their persistence relies on the functions provided by the organisms living within just as we rely on the grocery store around the corner and our general practitioner.

The coral city

In this analogy, exceptionally diverse ecosystems such as coral reefs are the equivalent of bustling metropolitan hubs such as New York, London or Sydney.

With outstanding numbers of organisms comes a plethora of functional roles. Corals build structure and living space, selected fishes provide diligent grooming services, big predators control prey populations and some species clean the reef of algae to safeguard coral growth and replenishment.

This latter function, performed predominantly by algae-eating or herbivorous fishes, is important for coral reefs. Herbivorous fishes are like human gardeners, maintaining the beauty and health of reef-building corals. Consequently, great efforts are taken to monitor herbivore communities on coral reefs.

But are these fishes really a homogeneous group of organisms, providing

the same service? Absolutely not.

About a decade ago, researchers began to classify herbivorous reef fishes into functional groups based on their feeding behaviours and this is now the go-to characterisation of herbivore communities.

Unfortunately, this rough characterisation appears to be insufficient. Just as gardeners with lawnmowers and landscape artists with hedge clippers perform fundamentally distinct work, herbivorous coral reef fish species differ in their contribution to the reef in more ways than the traditional classification captures.

These distinctions are exemplified, but not exhausted, by:

1. what they eat
2. how they eat it
3. where they get it from.

The first distinction, what fishes eat, has an obvious impact on targeted prey. A particular alga may be eaten by only a single species of fish. If this species declines due to human influence, the algae it typically consumes will thrive and may overpopulate the reef.

Take the unicornfish, *Naso unicornis* (above), as a typical example. It is often the only consumer of fleshy brown algae and therefore responsible for keeping these algae in check. Unfortunately, this species is also heavily fished in many areas of the world (with the Great Barrier Reef being an exception, at the moment), threatening ecosystems through the loss of its function.

The second characteristic, how herbivores feed, is best explained by the giant humphead parrotfish, *Bolbometopon muricatum* (below). This species feeds on various species of algae and coral but owing to its

extraordinary size and jaw anatomy, it is the only species that significantly erodes reefs through its feeding activity.

In essence, this species creates space for the new settlement of organisms by taking golf-ball-sized bites from the reef. Despite its crucial importance for reef systems through its particular way of foraging, it is heavily exploited in many developing countries.

The third measure, where herbivores feed, is exemplified by a group of fishes that feed in holes and crevices on coral reefs.

While the majority of herbivorous fishes prefer flat, open surfaces, some rabbitfishes (family Siganidae) (below) target concealed surfaces such as crevices to reach for algae.

They may be the only species to control algal growth in these cracks and crevices, a habitat that represents a refuge for newly settled corals. This difference in their feeding strategy has long been overlooked but may be an important functional process for juvenile corals.

Given the potential for differentiation outlined by only three cases, it is not hard to imagine that many species will perform unique functions on coral reefs.

With this in mind, let us reiterate the questions asked in the beginning. What is the true value of biodiversity? Do we really need all the different critters that populate our world?

So what can we do?

The answer is that, at the bare minimum, we need those species that perform unique functions. What's more is that these species need to be present in large enough numbers at a *local* scale, which is often

inconsistent with *global* extinction risk.

The unicornfish Naso unicornis. Credit: Jordan M Casey

In other words, the unconscious or conscious local eradication of a single species, which may face no risk of global extinction and is therefore unprotected against local threats, may result in the degradation of an entire system.

In this context, humanity has two options. Firstly, we can try to play it safe and strive to protect all species, globally and locally, to diminish our risk of accidentally removing important ecosystem components. While this will ensure that any crucial ecosystem function is adequately covered, this is costly and rather unrealistic.

Secondly, we can take our chances and strive to identify and protect only important ecological functions and their main performers, which are the most crucial pieces in the complex puzzle that is our natural world. This will require increasing research efforts to investigate the tight links between biodiversity and ecosystem function, but has the potential to overlook cryptically important functions.

The dramatic consequences of such oversight are visible in the collapse of some ecosystems such as Caribbean coral reefs, where the exploitation of herbivorous fishes and the loss of sea-urchins has triggered shifts from coral-dominated systems to algal beds.

Unfortunately, globally, we commonly fail to fulfil either of these options by affecting entire ecosystems through large-scale developments.

The giant humphead parrotfish, Bolbometopon muricatum. Credit: Simon J Brandl

Collateral damage

In Australia, for example, although herbivorous fishes are rarely targeted by fishermen and are in no threat of global extinction, we continue to collaterally impact the Great Barrier Reef through activities such as dredging or the extraction of large predators such as sharks and groupers, not knowing about the potential consequences for organisms inhabiting the reef or the functions they perform.

Do we really want to jeopardise the future of the natural coral cities that our planet has to offer? And would we equally lightheartedly risk the degradation of our great cultural centres such as New York, Paris, London or Sydney? I don't think so.

So there is a clear need to increase our research efforts regarding the role of functional diversity on coral reefs and in other ecosystems around the world in order to identify those critical processes that we must not disturb.

Without this knowledge, our actions and interferences with the natural world are little more than a blind stumble through a minefield of most dire and irreversible consequences.

Source: The Conversation