DECISION POINT

Connecting conservation policy makers, researchers and practitioners

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Decision Point is the free bimonthly magazine of the ARC Centre of Excellence for Environmental Decisions (CEED). CEED is a network of conservation researchers working on the science of effective decision making to better conserve biodiversity. Our members are largely based at the University of Queensland, the Australian National University, the University of Melbourne, the University of Western Australia and RMIT University.

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Our cover: The ocean realm is a three dimensional space. Conservation planning is more efficient when features and threats can be stratified with depth. Find out how on page 6. (Photo by Thomas Vignaud)

On the point

CEEDlings to the world

It can make you sad. You see these bright-eyed, bushy-tailed young PhD students and post docs coming into the CEED network full of vitality and vigour, eager to save the world with their science (but sometimes a tad naïve about how the real world works); and before you know it they're gone. They've completed their thesis or finished their research fellowship and they're off to their next posting, often on the other side of the globe.

We saw them develop, earn their research stripes, struggle with the various challenges that beset every research project, and (mostly) triumph. And then, they move on in search of new challenges – a little bit wiser, tougher, less innocent and more mature.

It's the natural course of life. The sadness of their leaving, felt by every parent watching their children grow and leave, is offset however by the knowledge that our little CEEDlings are (and will be) making important differences wherever they take root.

Indeed, CEED (and its associated networks) has now seen many early-career researchers come and go, and while we miss them all, it's a beautiful thing to see them flourishing in foreign pastures; bringing new insights and approaches to the complex world of conservation science. You can read some of their stories in this issue (pages 18 and 19) and coming issues. And we have celebrated our clever Alumni in this year's CEED Annual Report (see page 3).

CEED's impact increases with time (see Figure 1 on page 3) and a big part of our future impact, that will likely never properly be evaluated because it's so difficult to measure, will be the interactions of our Alumni as they develop into seasoned researchers. They still keep in contact with CEED (through *Decision Point* and *Dbytes* among other things) but they also keep in touch with each other through formal conservation science associations and informal social media networks.

Our CEEDlings began their academic careers with the fervent belief their science could make a real difference. As Alumni, they still strive to do so; and as they progress they all have half an eye on their sibling CEEDlings. Long may they flourish.

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Taking spatial conservation to the next dimension

Adventures in 3D

By Ruben Venegas-Li (University of Queensland)

ABOVE: The ocean realm is fundamentally a three dimensional space. Conservation planning in such conditions is more efficient when features and threats can be stratified with depth. (Photo by Thomas Vignaud)

Spatial conservation prioritisation is a method used to identify areas where conservation goals can be achieved efficiently. Traditionally this has meant the region being considered is subdivided into two-dimensional planning units. These planning units are then allocated to a given management regime based on what biodiversity it holds, what threats are affecting it, and on how much it would cost to manage these conservation features.

Two dimensional planning units makes sense in most situations because this type of exercise is usually done on a map overlay, like a map of a coastline with a range of coral reefs and other marine ecosystems along its length. And maps, and the way we usually perceive space, are basically two dimensional.

But what if the biodiversity we are seeking to protect (or the potential threats to this biodiversity) vary at different depths in any of these planning units? Where that's the case, the traditional two-dimensional approach may not be enough.

Oceans are inherently 3D spaces and effective and efficient planning in oceans should take this third dimension – depth – into account. The vertical heterogeneity of biodiversity and threats might create conditions in which protecting biodiversity at one depth might be compatible with other uses of the ocean at another depth. For example, protecting important ecosystems on the sea floor could be compatible with some types of pelagic fishing above. In such instances, vertical zoning of the water column might prove a cost-effective conservation strategy.

In a recent paper published in *Methods in Ecology and Evolution*, we proposed and tested a novel 3D spatial conservation prioritisation approach for the marine realm. We used Marxan as the conservation planning software. This approach allows planners to create both a horizontal and a vertical zoning of management actions while still following the core principles of systematic conservation planning. It enables planners to account for depth-related variability in biodiversity, human activities, threats to biodiversity, environmental conditions and the cost of conservation actions.

The key modification enabling this is the creation of 3D planning units, with x, y and z dimensions (Fig 1). This means planning units can potentially share boundaries with other planning units that are next to them but also above or below.

Given that Marxan attempts to minimize the boundary of the resulting network of selected planning units (see Decision Point #62), we can use the 3D adjacency of planning units to integrate the third dimension into Marxan. Moreover, having 3D planning units enabled us to stratify the water column into different layers, allowing planners to account for biodiversity, threats, and cost of conservation actions, at different depths.

It makes sense in theory but how does it work in practice? We tested our new approach using the entire Mediterranean Sea as a case study. This involved developing a conservation plan which involved choosing sites where at least 20% of the

Key messages:

- Conservation features often vary with depth in the ocean realm
- 3D systematic spatial conservation planning has the potential to deal with this variation
- We demonstrated that a 3D approach to conservation planning in the Mediterranean Sea has the potential to generate more efficient outcomes than the traditional 2D approach

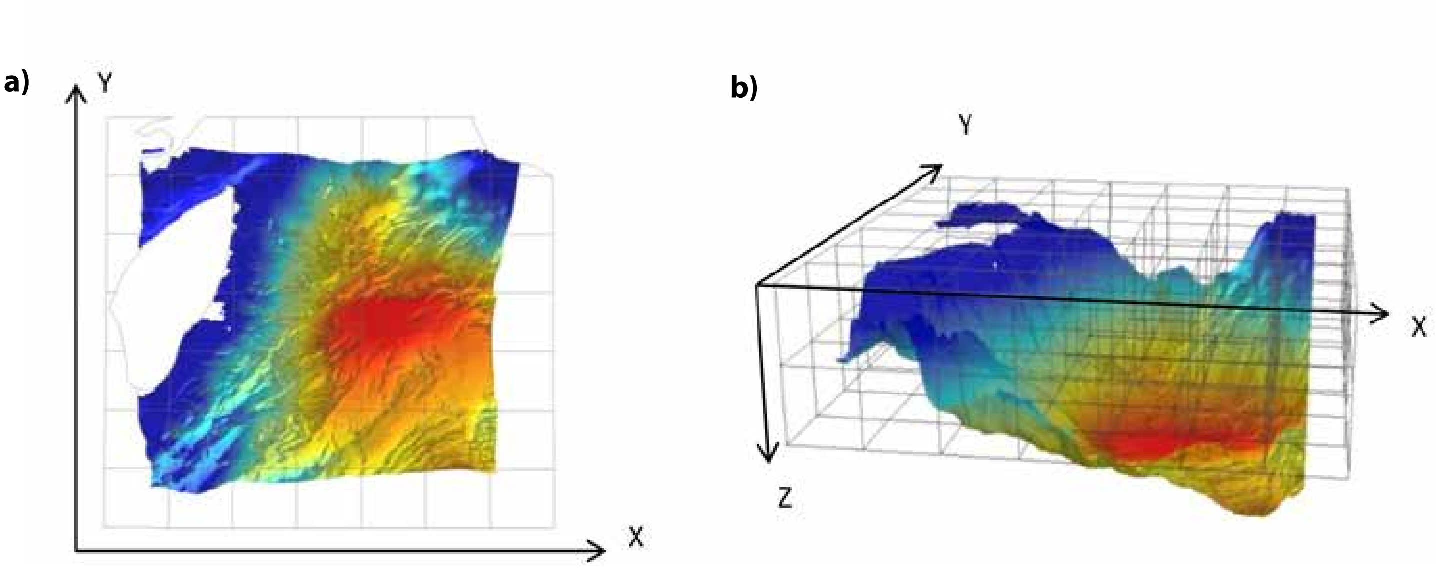

Figure 1. The concept of spatial conservation prioritisation in 2D and 3D in marine ecosystems. a) The traditional approach to marine spatial prioritisation, in which the planning region is subdivided into 2D planning units (x,y coordinates). b) The new 3D approach to marine spatial prioritisation, where planning units are defined as a three-dimensional space (x, y, z, coordinates), and are subdivided vertically (from Venegas-Li et al, 2017).

distribution (accounted for in cubic kilometres) of over 1000 conservation features was represented.

The results from our case study showed that it was possible to achieve configurations of chosen 3D planning units in which the targets for all the conservation features were achieved. More importantly, we demonstrated that through this new approach, in some areas of the ocean, not all the planning units available along the water column were selected for conservation.

The fact that only certain layers of the water column are selected, suggests that a 3D approach might prove more efficient (in terms of total cost and space protected) than a traditional 2D approach, as it would allow other uses at depths that are not a conservation priority. Indeed, this proved to be the case when we compared the total cost and volume of the resulting configuration of selected sites (as compared to the 2D approach).

Vertical zoning is already practiced as a management strategy. It is used in protected areas in Mexico, Canada, Australia and New Zealand. Our new 3D approach to spatial conservation planning could provide support in the planning on such protected areas.

This new approach to spatial conservation prioritisation opens the possibility of targeting specific threats to specific features of conservation interests at specific depths. As human intervention in the marine realm increases in both intensity and extent, tools such as this may prove critical for effective marine conservation planning and action.

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Reference

Venegas-Li R, N Levin, HP Possingham & S Kark (2017). 3D spatial conservation prioritisation: Accounting for depth in marine environments. *Methods in Ecology and Evolution* http://onlinelibrary.wiley.com/doi/10.1111/2041-210X.12896/abstract

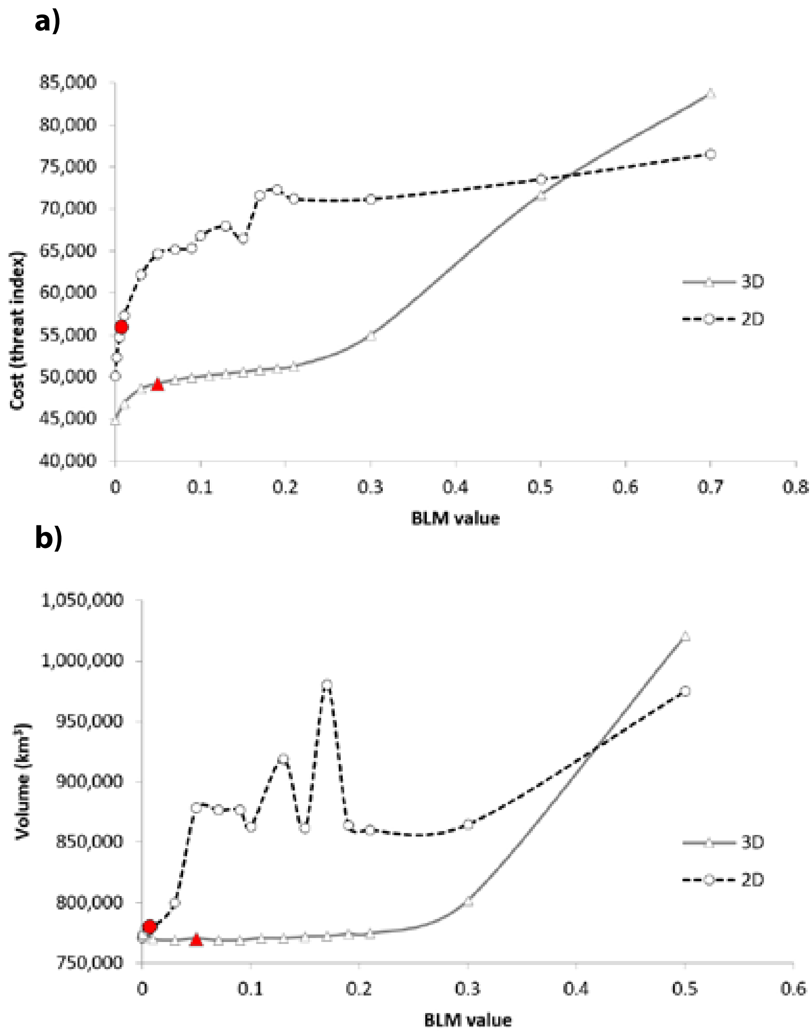

Figure 2. Example of total cost a) and volume b) of the resulting conservation area configuration for the 3D and 2D spatial conservation prioritisation approaches at different spatial compactness levels. 'Optimal' BLM values for the 3D and 2D approach were 0.05 and 0.007 respectively, shown as full red markers (from Venegas-Li et al, 2017).