National Science Challenges

SUSTAINABLE SEAS

Ko ngā moana whakauka

Utilising ecosystem services to support marine ecosystem management

Image: Eva Siwicka

Summary

Marine species and habitats provide valuable ecosystem services

Marine ecosystems provide services to people and communities, such as food, coastal protection, improved water quality, and nutrient cycling. These ecosystem services are also known as 'Nature's Contributions to People' which is a concept used by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) to promote knowledge of the importance of Earth's biodiversity and ecosystems. Ecosystem services can be used as a tool in marine management and ecosystem-based management. Identifying, measuring, and mapping ecosystem services in different places helps managers make decisions around things like resource use, planning and consents, catchment management, and marine protected areas.

Ecosystem services can help us understand and communicate multiple uses of marine ecosystems The benefits of ecosystem services to people go far beyond making money and providing food. Marine ecosystems provide many services that are less obvious and may go unnoticed, yet the value and importance of these are poorly understood and difficult to measure. For example, shellfish beds provide water filtration, nutrient regulation, cultural and spiritual values, as well as food.

Ecosystem services can be used as a tool to communicate and understand the importance of natural ecosystems beyond the values we typically associate with them such as food and resource provision. This is important since management decisions often come with benefits and losses (trade-offs) for different services (Rullens et al. 2019). The benefits of marine ecosystem services are also sometimes delivered or realised in a different place to where they are generated (Townsend et al. 2018).

Ecosystem services can help us understand and manage different values

People of differing backgrounds, locations and worldviews are likely to value ecosystem services in different ways. For some, these values are tangible and visible, such as the ability to harvest kaimoana, or to swim in clean water. Less obvious 'supporting' or 'regulating' services provided by biodiversity, such as waste recycling or carbon fixation, may underpin a wide range of tangible values. Ecosystem managers need to be able to account for this broader range of values. It is important to communicate that natural resource extraction, while valued, may come at the expense of other vital services. In this way, the ecosystem services concept can facilitate careful and balanced decision making.

Identifying ecosystem service 'bundles' – collections of interrelated services linked to particular species or habitats – is a technique for capturing a broader range of values. Bundling ecosystem services can be used to communicate ecosystem service delivery more holistically, and to understand the trade-offs and synergies between provision of different services (Rullens et al. 2019). For example, when shellfish are harvested (food provision service) there can be reduction or loss of other services, including coastal water quality regulation (by filter feeding shellfish) and foodweb structure (shellfish as food for other marine animals).

Marine ecosystems deliver many services and there are a range of ways to assess, measure and map them at different scales. Although difficult, it is important to quantify ecosystem services that have recreational, cultural, and social values that cannot or should not be given dollar values alongside services that are easier to value such as food or resource provision.

Guidance

Using ecosystem service bundles to improve marine management

Ecosystem services can help us manage and conserve the marine environment

Calculating the ecosystem service potential of a place or habitat is a way to balance and manage the current usage of an ecosystem with longer term resilience of ecosystem service provision (Townsend et al. 2014). Ecosystem service matrices can demonstrate the multiple services and benefits of ecosystems, for example the services associated with different seafloor habitats in new or existing marine protected areas (Geange et al. 2019). This approach can be used to track the benefits of marine protection through time, a powerful tool for communicating the value of marine protected areas, since the intrinsic value of conserving biodiversity does not always resonate with people.

A matrix approach can also incorporate non-marketable ecosystem services such as social and cultural values. A shortcoming is that it gives only a presence/absence of services provided, but effective ecosystem management requires knowledge of the extent or quantity of services of a particular habitat or species.

Presentation

Measuring and mapping marine ecosystem services

Mapping and modelling can help us understand how and where ecosystem services are generated

This information can then be used for management and planning of our marine spaces. Models based on relationships between measured ecosystem functions (that underly the services) and local environmental variation (e.g. sediment type, density of key species) help to identify and predict where and to what extent ecosystem services are occurring. Such models can be used to scale up and create predictive maps of ecosystem service delivery. The pollutant removal service (denitrification, the natural removal of excess nitrogen by marine sediments) was mapped and modelled in the Whitford Embayment (Lohrer et al. 2020), and habitat provision services (i.e. nursery areas for juvenile fish) were mapped and modelled in the Hauraki Gulf (Townsend and Lohrer 2019), Queen Charlotte Sound and Te Tau Ihu/Top of the South.

Ecosystem service maps can be used to forecast how service delivery may change in the future as environmental conditions change, for example an increase in the mud content of an estuary will likely reduce the nutrient removal service of denitrification. Similarly, reduction in the density of large kelp species will result in reduction of the habitat provision services.

Ecosystems with high natural capital (the stock of natural resources in an ecosystem) are often assumed to be associated with high ecosystem service provision. However, this may only hold true for single ecosystem services such as food provision where a higher density of a species results in a higher service output, and may be too simple to holistically manage ecosystems delivering multiple services. Multifunctionality of ecosystem services can be used to spatially predict services. For two key bivalve species, *Austrovenus stutchburyi* and *Paphies australis*, hotspots of ecosystem service multifunctionality were located by assessing and mapping areas of high service potential alongside species density (Rullens et al. 2022c). This work highlighted the need for context-specific management rather than simply protecting areas of high natural capital to sustain ecosystem service delivery.

To confidently use models and maps of ecosystem services, the uncertainty in their predictions needs to be understood and accounted for. Predicting uncertainty is a necessary part of spatial management for targeting areas of greatest ecological value (Rullens et al. 2021). If ecosystem services maps are validated and presented alongside robust uncertainty information, they can be adapted and used for proxies of services in other locations. For example, the pollution removal service models developed in Whitford Embayment were used to predict pollution removal services in Wairoa Estuary (Lohrer et al. 2020).

Human activities impact ecosystem service delivery

Stressors influence the ecosystem functions that contribute to ecosystem services. This impact can be recognised through analysis of relationships between ecosystem functioning (species density, ecosystem processes) and the intensity of human activities in the sea (e.g. aquaculture, fisheries, tourism, recreation) as well as on land (e.g. activities that deliver sediment, nutrients, and contaminants to the coast). Such information needs to be incorporated when ecosystem services are used to inform management decisions (Rullens et al. 2022b).

Ecosystem services can support restorative marine economies

Restoring marine ecosystems is of interest to many New Zealanders wanting to regain ecosystem services that have been lost with environmental degradation. Financing restoration can have benefits for investors in industries that wish to offset activities or improve their company image.

Developing restorative marine economies has great potential in Aotearoa New Zealand but requires robust frameworks that can demonstrate pathways to success through gaining funding, buy-in and trust with local communities, as well as traction with industry and government. Ecosystem services provide a tool to support this because they can be used to quantify, communicate, monetise, and monitor the benefits and trade-offs of ecosystem restoration. Restorative economy endeavours require financing and demonstration of positive social feedbacks (i.e. the benefits to people and communities), both of which are challenging yet critical to success.

To use ecosystem services as a tool to support decision making, metrics are needed of the services of interest so that they can be measured and monitored. Unfortunately, ecosystem services data in the marine environment is scarce, and furthermore ecosystem service delivery is context specific, i.e. different from place to place. We have developed tools that can be used as proxies for services, as well as ways to model and map the distribution of services in a place, based on local environmental characteristics.

Summary

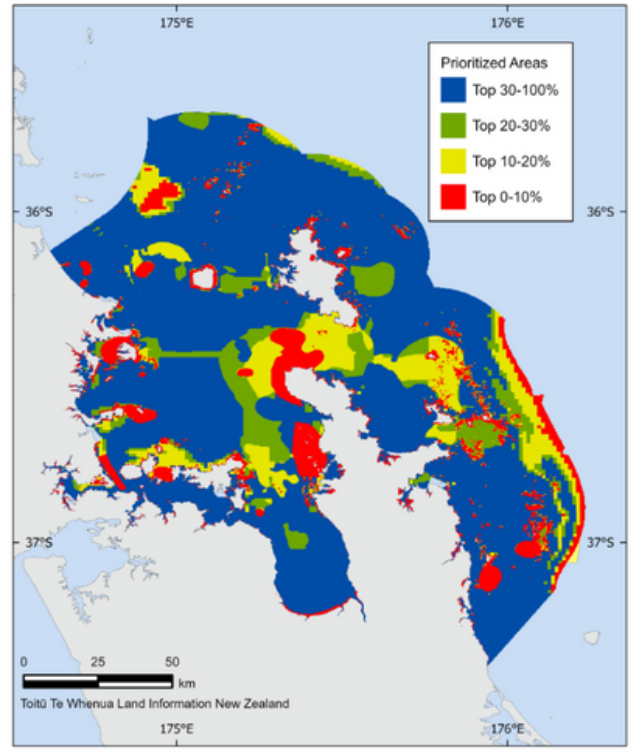
[Restorative marine economies](#)

[Ecosystem service metrics](#)

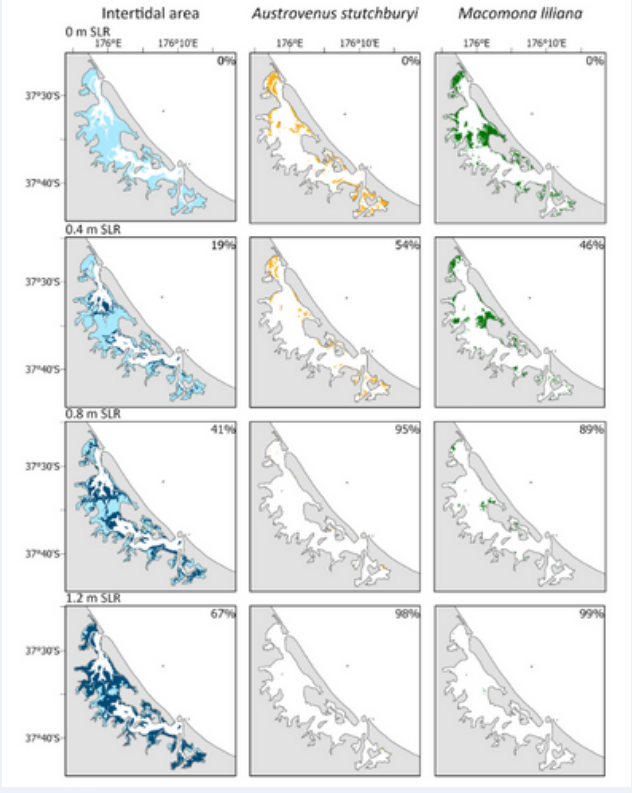
Ecosystem services can support ecosystem-based management and developing a blue economy in New Zealand

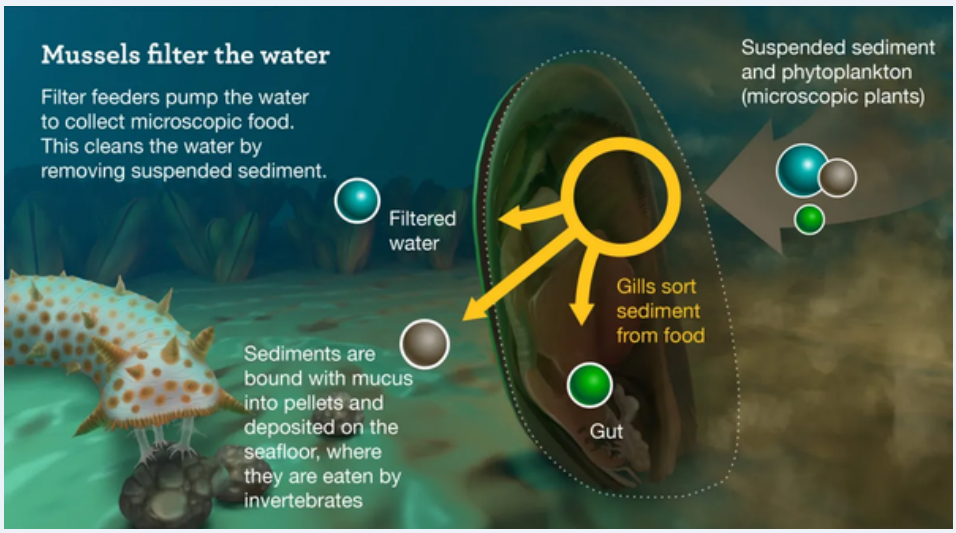
Ecosystem services tools are already in use for managing Aotearoa New Zealand's marine environment and there is huge potential to extend this.

Maps of biogenic habitat provision ecosystem service have been used to evaluate the biodiversity benefits of proposed marine protected areas in the Hauraki Gulf (Fig. 2, Tablada et al. 2022).



Shellfish ecosystem service maps have been extended to predict changes in ecosystem service delivery with sea level rise with different future climate change scenarios in Tauranga Harbour (Fig. 3, Rullens et al. 2022a).





The Revive Our Gulf Green-lipped mussel restorations in the Hauraki Gulf have effectively used ecosystem services to communicate the project's success resulting in a snowball effect of further investment and expansion of restorations.

What kūtai do – the 'ecosystem services' of mussels (Department of Conservation)

Ecosystem services, especially cultural and social values, are always context-specific and a one-size-fits all approach to ecosystem management will not suffice. Social services (particularly indigenous and cultural values) need to be identified and communicated alongside ecological and economic values to effectively manage marine ecosystems.

A range of ecosystem services approaches (ecosystem service matrix, modelling and mapping, bundles, and multifunctionality) are available that can be used to aid marine ecosystem-based management and assist blue economy development in New Zealand.

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