

# Addressing cumulative effects in marine management decisions

Cumulative effects need to be urgently addressed to halt the degradation of our marine ecosystems and the decline in services ecosystems provide. The costs of environmental degradation are significant – with impacts to cultural, social, and recreational values, risks to fishery and tourism industries, and the risk of failure to meet national and international obligations.

Moving away from managing activities and stressors in isolation to using an ecological footprint approach is essential. We can achieve better marine outcomes by introducing a decision-making approach that assesses and manages cumulative effects more effectively.

Cumulative effects in marine ecosystems come from incremental, accumulating, and interacting stressors. These stressors come from human activities and natural events, and they can overlap in space and time.

## About this document

This document summarises Sustainable Seas National Science Challenge research into cumulative effects on the marine ecosystem. The main audience is regional and central government, as well as people and organisations involved in environmental management. This summary:

- describes what cumulative effects are
- explains why cumulative effects matter
- recommends approaches to addressing cumulative effects
- introduces a four-step action plan to assess and manage cumulative effects.

For more detailed information, see our *Guidance document on Addressing cumulative effects*.

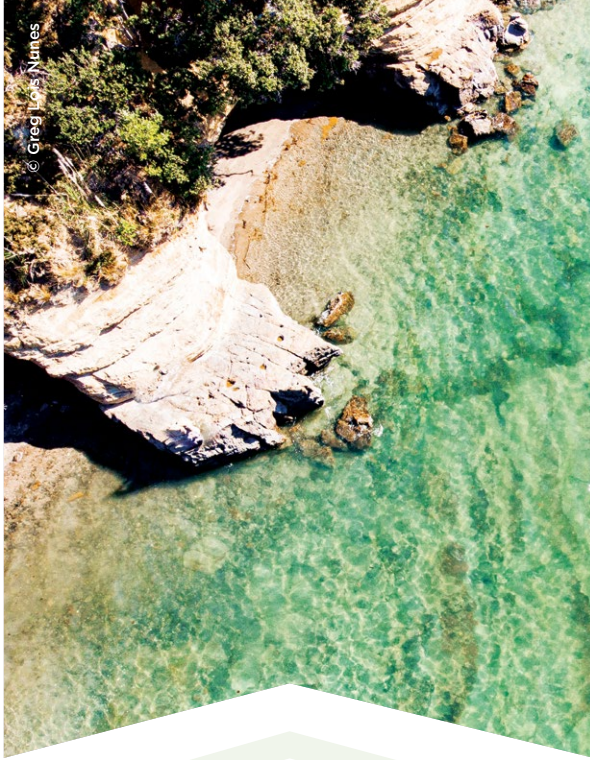
## Recommendations

Addressing cumulative effects is a key step towards arresting further environmental degradation and shifting our focus towards ecosystem recovery – helping to sustain the marine environment and the benefits it provides for future generations.

To address cumulative effects, we recommend that environmental managers:

- » transition from managing activities and stressors in isolation to focusing on managing ecological responses to cumulative effects
- » ensure assessments of cumulative effects are ecologically relevant and account for:
  - » ecological resilience and vulnerability
  - » ecological connectivity
  - » ecological responses to multiple interacting stressors through space and time.





## We need to manage cumulative effects in better ways

Marine ecosystems face multiple stressors from land and sea-based activities (for example, deforestation, climate change, and fishing), which cause cumulative effects and the degradation of the marine environment (figure 1). The costs of degradation are enormous.

Despite plans, policies, and legislation stating that cumulative effects should be accounted for in management decision-making, in practice cumulative effects are not meaningfully addressed in current management practices. In addition, marine and coastal laws, policies, governance institutions, and sectoral frameworks are not well-aligned across different marine spaces and timescales. This fragmentation presents challenges for cumulative effects management because marine decision-makers and managers may not be directed by legislation or policy to consider stressors that are managed under another sectoral legal framework.

Failure to adequately assess and manage cumulative effects is a key driver of marine environmental decline and needs to be urgently addressed. This failure to manage cumulative effects has been driven by a continued focus on managing individual activities and stressors, often in isolation. This existing approach is due in part to the inherent complexity and uncertainty of cumulative stressor impacts and associated ecosystem responses.

A lack of data or uncertainty in underpinning ecological relationships should not be an excuse for management inaction. While it's essential to improve the availability of data, we can still act in the meantime.

## Managing cumulative effects is challenging, but can be done

Managing cumulative effects is challenging because of the complexity, lack of data, and uncertainty in underpinning ecological relationships – but it can be done. If cumulative effects continue to be poorly managed, management decisions will continue to be inappropriate for the activity of interest and avoidable environmental decline will continue to occur. We've created a four-step action plan (figure 2) to step you through better assessment and management of cumulative effects.

## Ecological and stressor principles and ecosystem response footprints are useful frameworks

To help assess cumulative effects, our researchers developed two key principle-based concepts: 'Ecological and stressor principles' and 'ecosystem response footprints'. These concepts can be used to identify the most appropriate management action to combat cumulative effects.

The ecological and stressor principles account for an ecosystem's response to change and the impacts and interactions between different stressors.

Ecosystem response footprints describe the space and time scale of an ecosystem's response to stressors. These footprints are characterised by both ecological and biophysical characteristics of ecosystems and the stressors they face.

## Ecological and stressor principles can help inform the status of an ecosystem

Ecological and stressor principles can inform the ecological and stressor status of an ecosystem. This status can indicate the likely response to protective and restorative interventions for maintaining or improving ecosystem health. We've described these principles below and you can read more about them in our longer guidance document .

- **Ecological principles** account for an ecosystem's ability to respond, resist, or adapt to change. These principles recognise the role of intrinsic ecological dynamics and particular types of species in generating responses.
- **Stressor principles** characterise the stressor regime, either past, present, or predicted future. These principles focus on the ecosystem elements they impact on and how stressor effects interact.

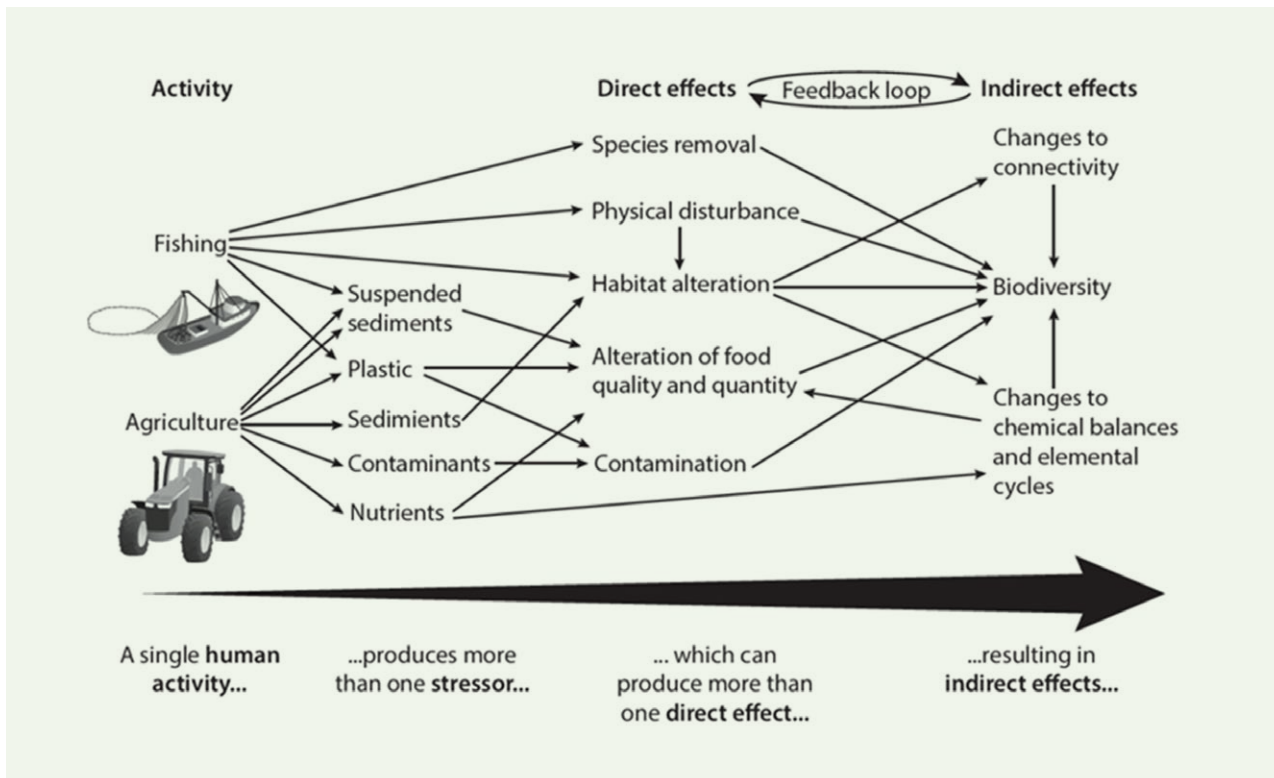


Figure 1 Single activities can produce more than one stressor, which can produce more than one direct effect and result in a range of other indirect cumulative effects on marine ecosystems (Thrush et al 2021)

## Use a four-step action plan to assess and manage cumulative effects

We've developed an action plan that focuses on these ecological responses and principles (figure 2). The plan steps through how to assess and manage the potential cumulative effects of activities using ecological principles to identify both stressor and ecosystem responses or states. The plan will also help you understand what's driving any change.

The assessment in the action plan can be used to inform consent decisions, coastal and marine planning, and the most appropriate management actions for ecosystem restoration, for example consent approvals or declines, interventions to limit stress, or requirements for assisted recovery.

**Step 1:** Identify where you want to be. What outcomes do you want?

**Step 2:** Identify what's affecting the location. Assess the stressors associated with the activity or management action of interest, using stressor principles.

**Step 3:** Identify what the state of the current ecosystem is and how it's responding to the stressors. Assess the ecosystem response footprint using ecological principles.

**Step 4:** Identify the best management approach to achieve step 1.

Figure 2 Four-step action plan



## Decision-making scenarios showed the necessity of an ecosystem response focus

We applied this action plan to three hypothetical decision-making scenarios to show its usefulness to central and regional government.

We applied the plan to:

- a large-scale aquaculture consent
- a small-scale seawall consent
- a management plan for kina barren recovery.

We found that the cumulative effects of each of the activities, and associated management actions, was context dependent, based on the status of ecological communities and stressors both within the direct activity footprint and the wider ecosystem.

This emphasises the necessity of focusing on ecosystem responses rather than stressor management in isolation.

To find out more about these examples, read our full Guidance document, *Addressing cumulative effects in marine management decisions*.

## References

- Gladstone-Gallagher R, Hewitt J, Low J, Pilditch C, Stephenson F, Thrush S & Ellis J (2024). **Coupling marine ecosystem state with environmental management and conservation: A risk-based approach**. *Biological Conservation*. 292: 110516.
- Hewitt J, Gladstone-Gallagher R, & Thrush S (2022). **Disturbance-recovery dynamics inform seafloor management for recovery**. *Frontiers in Ecology and Environment*. 20: 564-572.
- Low J, Gladstone-Gallagher R, Hewitt J, Pilditch C, Ellis J, & Thrush S (2023). **Using Ecosystem Response Footprints to Guide Environmental Management Priorities**. *Ecosystem Health and Sustainability* 9: 0115



- Macpherson E, Jorgensen E, Paul A, Rennie H, Fisher K, Talbot-Jones J, Hewitt J, Allison A, Banwell J, & Parkinson A (2023). **Designing law and policy for the health and resilience of marine and coastal ecosystems – Lessons from (and for) Aotearoa New Zealand**. *Ocean Development & International Law* 54: 2
- Macpherson E, Urlich S, Rennie H, Paul A, Fisher K, Braid L, Banwell L, Torres Ventura J, & Jorgensen E (2021). **'Hooks' and 'Anchors' for relational ecosystembased marine management**. *Marine Policy* 130: 104561.
- MfE (2022) Ministry for the Environment and Stats NZ. **New Zealand's environmental reporting series: our marine environment**.
- Rojas-Nazar U, Hewitt J, Pilditch C, & Cornelisen C (2023). **Managing cumulative effects in the marine environment – research roundup**. Sustainable Seas National Science Challenge
- Sustainable Seas National Science Challenge (2024). Enabling ecosystem-based management in Aotearoa New Zealand's marine law and policy<sup>1</sup>. [sustainableseaschallenge.co.nz/tools-and-resources/addressing-risk-and-uncertainty-in-decision-making](https://sustainableseaschallenge.co.nz/tools-and-resources/addressing-risk-and-uncertainty-in-decision-making)
- Sustainable Seas National Science Challenge (2024). Addressing risk and uncertainty in decision-making<sup>2</sup>. [sustainableseaschallenge.co.nz/tools-and-resources/addressing-risk-and-uncertainty-in-decision-making](https://sustainableseaschallenge.co.nz/tools-and-resources/addressing-risk-and-uncertainty-in-decision-making)
- Thrush S, Hewitt J, Gladstone-Gallagher R, Savage C, Lundquist C, O'Meara T, Vieillard A, Hillman J R, Mangan S, Douglas E, Clark D, Lohrer A, & Pilditch C (2020). **Cumulative stressors reduce the self-regulating capacity of coastal ecosystems**. *Ecological Applications* 31 (1)

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This document was prepared by Richard Bulmer and Georgina Flowers. We thank Challenge researchers and co-development partners for participating in workshops and reviewing drafts that informed the content.

For more information and support with marine management decisions, please see our other synthesis project summaries and guidance documents in this series.