

How can we avoid kelp beds turning into barren grounds?

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An excessive proliferation of urchins may also have severe ecological consequences on marine grounds as they reduce algal cover. Credit: Bernat Hereu, University of Barcelona

Urchins are marine invertebrates that mould the biological richness of marine grounds. However, an excessive proliferation of urchins may also have severe ecological consequences on marine grounds as they reduce

algal cover and affect the survival of other marine species. To explore global dynamics and the factors that turn kelp beds into barren grounds is the main objective of a new study published in the journal *Philosophical Transactions of the Royal Society B*.

The paper is signed by researchers Bernat Hereu and Mikel Zabala, from the Department of Ecology of the University of Barcelona (UB); Emma Cebrian and Enric Ballesteros, from the Centre for Advanced Studies of Blanes (CEAB-CSIC); Joaquim Garrabou, from the Institute of Marine Sciences (ICM-CSIC), and José Carlos Hernández and Sabrina Clemente, from the University of La Laguna (Canary Islands). Research centres from Australia, Canada, United States, South Africa, New Zealand, Japan, Chile and Norway also participated in the study.

From kelp forest communities to barren grounds

Urchins play a key role in the dynamics of marine coastal ecosystems. According to researcher Bernat Hereu, "urchins are on the intermediate level of the food web, as they feed on algae and they are prey to fish species (common seabream, gilthead seabream, etc.). For example, in situations of overfishing, urchin population can growth to the point of turning kelp beds into barren grounds characterised by low [biodiversity](#)".

Nevertheless, the predictions of the general model which links marine areas that present overfishing with urchin overgrazing and low algal cover are not always correct. "The general correlation fish-urchin-algae is not always true", highlights Hereu. "Some marine reserves —he adds— are rich in fish, urchins and algae; on the contrary, others do not show an abundance of fish, urchins or algae, but its kelp beds are well preserved. This indicates the existence of unknown interactions that alter the dynamics of the system".

The collapse of the ecological system

In order to decipher what processes affect the transformation of kelp beds into barren grounds, experts have applied a common protocol to study thirteen different worldwide rocky reef systems. There is evidence that shows that the process does not follow a pattern but it answers to some sudden changes in marine ecosystems. At one point, the ecological system collapses, it changes suddenly and a reduction of biodiversity takes place. "These changes, which must be analysed from the theory of alternative stable states, follow a graph model of hysteresis", explains Hereu.

The study confirms the hypothesis about a globally coherent pattern of change for all the studied systems, although each one has particular features. According to authors, the stability of marine forests is preserved by means of a series of feedback mechanisms. When urchin density arrives to a critical point, the ecological system collapses and turns into a barren ground. Then, in order to recover kelp beds, in other words, to facilitate the transition from barren grounds to kelp forests, urchin populations must be very small.

Objective: to recover marine algae population

Seaweeds are also species of great ecological value in [marine ecosystems](#). They are primary producers, they fix substrata, they modify the environment, and they create microhabitats for other [marine species](#). The study states that the feedback mechanisms that promote the stability and recovery of kelp beds are the presence of urchin predators (macro-predators and micro-predators), urchin fishing, high macroalgal productivity, large macroalgal bed biomass and other phenomena such as storms or sea temperature changes which can limit urchin population growth.

"Characteristic seaweeds species of each area are also important", points out Hereu. Biological processes usually depend on the ecology of seaweeds and the conditions to promote the resilience of a system vary if seaweeds are perennial or seasonal. "For example —says the author—, brown algae of the genus *Cystoseira*, which were abundant in the Mediterranean Sea some years ago, have disappeared in many areas due to human stressors; they are perennial but their dispersion ability is low due to the weight of propagules which does not allow them to go far". In this case, replanting and zygote dispersal activities may be effective measures to recover kelp communities on marine beds.

To protect biodiversity in marine grounds

On the contrary, the factors that promote the progression of barren grounds are overfishing, storms and sea temperature changes which can favour urchin population growth, reduced algae production, facilitation of juvenile survival by adults, and human actions that have negative consequences on biodiversity and marine ground biological richness.

Experts alert that it is crucial to know key factors in order to avoid the collapse of natural systems and the destruction of kelp forests, which are a source of biodiversity. "To avoid fishing is not enough to recover these marine habitats. If we want to restore barren grounds and recover kelp forest communities, we can take actions on urchin populations in order to generate structures (to replant algae, for instance) and accelerate the recovery process of these marine habitats", concludes Hereu.

More information: Global regime shift dynamics of catastrophic sea urchin overgrazing. S. D. Ling, R. E. Scheibling, A. Rassweiler, C. R. Johnson, N. Shears⁴, S. D. Connell, A. K. Salomon, K. M. Norderhaug, A. Pe´rez-Matus, J. C. Hernández, S. Clement⁹, L. K. Blamey, B. Hereu, E. Ballesteros, E. Sala, J. Garrabou, E. Cebrian, M. Zabala, D. Fujita and L. E. Johnson. *Philosophical Transactions of the Royal Society B*. 370:

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